United States Department of the Interior

FISH AND WILDLIFE SERVICE

ARCATA FISH & WILDLIFE OFFICE
1125 16TH STREET, ROOM 209
ARCATA, CA 95521

IN REPLY REFER TO:

Memorandum

February 24, 1999

To: Manager, California/Nevada Operations Office
Fish and Wildlife Service

Regional Administrator, Southwest Region
National Marine Fisheries Service

From: Project Leader, Arcata Fish and Wildlife Office
Fish and Wildlife Service

Bruce G. Halstead

Subject: Biological and Conference Opinions Regarding Issuance of an Incidental Take Permit to the Pacific Lumber Company, Scotia Pacific Company LLC and Salmon Creek Corporation (collectively "PALCO") (1-14-99-18)

This document constitutes the Biological/Conference Opinion prepared by the Northern California Area Office of the National Marine Fisheries Service (NMFS) and the Arcata Fish and Wildlife Office of the Fish and Wildlife Service pursuant to Section 7 of the Endangered Species Act of 1973, as amended (Act), on the effects of issuing an incidental take permit to PALCO for 17 species pursuant to Section 10(a)(1)(B) of the Act and signing an Implementation Agreement with PALCO. The proposed incidental take of up to 17 species would occur as a result of habitat loss and disturbance associated with timber management and associated activities on PALCO lands as described in the *Habitat Conservation Plan for the Properties of the Pacific Lumber Company, Scotia Pacific Company, LLC and Salmon Creek Corporation* dated February 1999 which are hereby incorporated by reference.

Through my signature, I approve the Biological/Conference Opinion on behalf of the Fish and Wildlife Service and through this transmittal I submit, the Opinion to Dr. Hogarth for his approval, as evidenced by his signature in the signature block below, on behalf of the National Marine Fisheries Service.

William T. Hogarth

Dr. William T. Hogarth, Ph.D

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213
TEL (310) 980-4000; FAX (310) 980-4018

STATEMENT OF APPROVAL

On February 24, 1999 on behalf of the National Marine Fisheries Service (NMFS) I approved the Biological and Conference Opinions for covered species and proposed critical habitat under the jurisdiction of NMFS, Regarding Issuance of an Incidental Take Permit to the Pacific Lumber Company, Scotia Pacific Company, LLC and Salmon Creek Corporation (collectively "PALCO") (FWS 1-14-99-18).

For each of the covered species under NMFS jurisdiction I concur with the finding of no jeopardy and the finding of no adverse modification to proposed critical habitat.

William J. Hogarth

William T. Hogarth, Ph.D
Regional Administrator
Southwest Region
National Marine Fisheries Service

Biological Opinion

Pacific Lumber Company
Habitat Conservation Plan/Sustained Yield Plan
for the
Headwaters Forest Project

February 24, 1999

Errata List:
Biological Opinion on Pacific Lumber Company's
Sustained Yield Plan/Habitat Conservation Plan for the
Headwaters Forest Project

March 22, 1999

For purposes of this errata list, a paragraph (¶) is any continuous block of print. This includes the end of a paragraph from the prior page, a table or figure, and anything else that generally is perceived as one block. Any heading is to be considered part of the paragraph that follows it.

Section	Pg.	¶	Change from [Delete]	Change to [Add]
{Introduction}				
	1	1		{Insert above the "Memorandum" line} **In reply refer to:** 1-14-99-18
Species Not Covered by the Incidental Take Permit	2	2	SYP/HCP and IA	Sustained Yield Plan and Habitat Conservation Plan (SYP/HCP) and Implementing Agreement (IA)
	2	4	ITP	Incidental Take Permit (ITP)
Consultation History	4	1	30 unlisted species	29 unlisted species and one proposed species
	4	3	ESA	Acts
DESCRIPTION OF THE PROPOSED ACTION				
COMPONENTS OF THE PROPOSED ACTION				
Covered Activities: Timber Management	13	2	Data are from the proposed SYP/HCP.	Compiled from data in unnumbered table "Harvest Regime (acres)" in Final EIS/EIR, Appendix Q.
Operating Conservation Programs: Marbled murrelet conservation plan	21	7	[described infra]	
STATUS OF THE SPECIES (rangewide and/or recovery unit)				
LISTED SPECIES/CRITICAL HABITAT				
American peregrine falcon	56	2	USDI Fish and Wildlife Service 1998	USDI Fish and Wildlife Service 1998a
	58	2	USDI Fish and Wildlife Service 1998	USDI Fish and Wildlife Service 1998a
	58	7	USDI Fish and Wildlife Service 1998	USDI Fish and Wildlife Service 1998a
	59	3	USDI Fish and Wildlife Service 1998	USDI Fish and Wildlife Service 1998a

Section	Pg.	¶	Change from [Delete]	Change to [Add]
Northern Spotted Owl	66	5	[Berbach et al. (Berbach et al. 1993) reported that over 75 percent of the quarter-townships in the coastal counties of Del Norte, Humboldt, and Mendocino exceeded this standard.]	{move text to page 312, paragraph 5. Last sentence}
	69	3	[HEREAFTER THIS REFERENCE ISN"T HIHGLIGHTED]	
	70	5	population	populations
Marbled murrelet	74	5	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	75	1	Nelson (1997)	Nelson (1997a)
	75	4	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	76	1	Nelson 1997	Nelson 1997a
	76	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	76	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	76	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	76	4	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	76	5	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	76	6	Nelson 1997	Nelson 1997a
	77	2	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	77	3	Nelson 1997	Nelson 1997a
	77	5	Nelson 1997	Nelson 1997a
	78	1	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	78	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	78	4	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	78	5	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	78	6	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	78	7	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	79	4	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	80	4	Nelson 1997	Nelson 1997a
	81	2	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	81	2	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	81	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	81	4	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	81	4	Nelson 1997	Nelson 1997a
	81	4	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	82	1	Nelson 1997	Nelson 1997a

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	82	1	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	82	2	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	82	2	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	82	3	Nelson 1997	Nelson 1997a
	82	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	83	4	(K. Moore, pers. comm.)	(K. Moore, pers. comm., January 18, 1999)
	84	2	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	84	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	84	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	86	2	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	86	2	Nelson 1997	Nelson 1997a
	86	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	87	2	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	87	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	87	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	88	1	USDI Fish and Wildlife Service 1998	USDI Fish and Wildlife Service 1998b
Marbled murrelet critical habitat	90	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
Western snowy plover	94	1	CDFG	California Department of Fish and Game
SONC Coast ESU coho salmon	96	4	50 FR 38011	USDC National Oceanic and Atmospheric Administration 1995
	96	4	62 FR 24588	USDC National Oceanic and Atmospheric Administration 1997a
	97	3	Bell (1986)	Bell (1991)
	97	4	Lester and Genoe 1970	Lister and Genoe 1970
	98	4	62 FR 24588	USDC National Oceanic and Atmospheric Administration 1997a
	98	4	62 FR 3847	USDC National Oceanic and Atmospheric Administration 1997b
	98	4	62 FR 62741	USDC National Oceanic and Atmospheric Administration 1997c
	99	2	CDFG (1994)	the California Department of Fish and Game (1994)
	99	2	NMFS (1997)	National Marine Fisheries Service (1997a)
	101	1	CDFG (1994)	the California Department of Fish and Game (1994)
	101	1	(CDFG 1994).	(California Department of Fish and Game 1994).

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	101	1	CDFG (1994)	The California Department of Fish and Game (1994)
	102	2	(PALCO 1998)	(Pacific Lumber Company 1998)
	102	2	(IFR 1998)	(Institute for Fisheries Resources 1998)
	102	2	Plan	PALCO ownership
	102	2	IFR (1998)	Institute for Fisheries Resources (1998)
	102	2	Plan	PALCO ownership
PROPOSED SPECIES/CRITICAL HABITAT				
Southern Oregon and California Coastal ESU chinook salmon	102	4	54 FR 32085	USDC National Oceanic and Atmospheric Administration 1989
	102	4	55 FR 46515	USDC National Oceanic and Atmospheric Administration 1990
	102	4	59 FR 440	USDC National Oceanic and Atmospheric Administration 1994
	102	4	63 FR 11482	USDC National Oceanic and Atmospheric Administration 1998a
	103	2	[Bell 1986, cited in]	
	103	5	(NMFS 1997)	(National Marine Fisheries Service 1997b)
	105	3	63 FR 11482	USDC National Oceanic and Atmospheric Administration 1998a
	105	4	CDFG (1965)	California Department of Fish and Game (1965)
	105	4	CDFG (1965)	California Department of Fish and Game (1965)
	105	4	NMFS (1996)	The National Marine Fisheries Service (1996)
	106	1	NMFS (1997)	National Marine Fisheries Service (1997a)
Coho salmon critical habitat	108	3	62 FR 62741	USDC National Oceanic and Atmospheric Administration 1997c
Proposed chinook salmon critical habitat	110	2	63 FR 11482	USDC National Oceanic and Atmospheric Administration 1998a
UNLISTED SPECIES				
Bank swallow	112	1	(CDFG 1992)	(California Department of Fish and Game 1992)
	112	8	(CDFG 1995)	(California Department of Fish and Game 1995)
	113	2	(CDFG 1992)	(California Department of Fish and Game 1992)
Pacific fisher	113	4	The fisher is a medium-sized carnivorous mammal	The fisher (*Martes pennanti*) is a medium-sized carnivorous mammal

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	113	5	The Pacific fisher is one of three subspecies	The Pacific fisher (*Martes pennanti pacifica*) is one of three subspecies
Red tree vole	123	7	(CDFG 1997)	(California Department of Fish and Game 1997a)
	124	4	CDFG (1997)	California Department of Fish and Game (1997a)
	124	5	Meiselman (1996)	Meiselman (1992)
Northern red-legged frog	127	5	[Mark Jennings, pers. comm., 1993, cited in]	
Foothill yellow-legged frog	131	1	Ashton et al. 1997	Ashton et al. 1998
	132	3	[G. Fellars, pers. comm., cited in]	
Northwestern pond turtle	136	2	(CDFG 1998a)	(California Department of Fish and Game 1998a)
Tailed frog	139	3	[The authors did not provide statistics for the mean area of suitable sites they evaluated, but they are mostly on the order of several square yards to several tens of square yards each (Ollivier, pers. comm., 1998).]	
	141	5	(L. Ollivier, pers. comm., 1998)	(L. Ollivier, pers. comm., November 4, 1998)
	144	2	(L. Ollivier, pers. comm., 1998)	(L. Ollivier, pers. comm., November 4, 1998)
Northern California ESU steelhead	148	5	61 FR 41541	USDC National Oceanic and Atmospheric Administration 1996a
	149	1	62 FR 43937	USDC National Oceanic and Atmospheric Administration 1997d
	149	1	63 FR 13347	USDC National Oceanic and Atmospheric Administration 1998b
	151	1	Bell (1973)	Bell (1991)
	151	4	61 FR 56138	USDC National Oceanic and Atmospheric Administration 1996a
	151	5	63 FR 13347	USDC National Oceanic and Atmospheric Administration 1998b
	152	1	61 FR 56138	USDC National Oceanic and Atmospheric Administration 1996a
	152	1	NMFS (1997)	National Marine Fisheries Service (1997a)
	152	3	63 FR 13347	USDC National Oceanic and Atmospheric Administration 1998b
	153	1	CDFG 1994	California Department of Fish and Game 1994

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	153	2	CDFG (1965)	California Department of Fish and Game (1965)
	153	4	CDFG 1991	California Department of Fish and Game 1991
	154	4	CDFG (1994)	The California Department of Fish and Game (1994)
SOC Coasts coastal cutthroat trout	156	3	Johnson 1999	Johnson et al. 1999
	158	2	Michael 1980. Fuss 1982	Michael 1980, Fuss 1982
	159	1	CDFG	California Department of Fish and Game
	159	1	1980-1989,	1980-1989;
	159	2	61 FR 41514	USDC National Oceanic and Atmospheric Administration 1996b
	160	5	T. Confer, Oregon Department of Fish and Wildlife, unpublished data	Johnson et al. 1999
	160	5	T. Confer, Oregon Department of Fish and Wildlife, unpublished data	Johnson et al. 1999
	161	1	T. Confer, Oregon Department of Fish and Wildlife, unpublished data	Johnson et al. 1999
ENVIRONMENTAL BASELINE (in the action area)				
Baseline common to all species	162	4	action outside	action area outside
BASELINE COMMON TO PACIFIC SALMONIDS				
	163	3	209,803	211,000
Essential habitat features for Pacific salmonids	164	2	NMFS Draft 1997	National Marine Fisheries Service 1997c
	164	3	DO	dissolved oxygen (DO)
	166	4	CDFG (1997) and PALCO	the California Department of Fish and Game (1997b) and the Pacific Lumber Company
	168	3	NMFS (1997)	The National Marine Fisheries Service (1997c)
	169	3	(NMFS 1996)	(National Marine Fisheries Service 1996)
	169	4	(NMFS 1996)	(National Marine Fisheries Service 1996)
	170	3	mush	must
Existing habitat conditions in the action area	170	4	209,803	211,000
	171	2	209,834	211,000
	172	2	Project Area	action area
	174	2	IFR (1998) provides	The Institute for Fisheries Resources (1998) provides

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	174	2	According to IFR (1998)	According to the Institute for Fisheries Resources (1998)
	176	1	IFR (1998) analyzed	The Institute for Fisheries Resources (1998) analyzed
	176	1	IFR (1998) reported	The Institute for Fisheries Resources (1998) reported
	177	5	IFR (1998) noted	The Institute for Fisheries Resources (1998) noted
	179	2	IFR (1998) noted	The Institute for Fisheries Resources (1998) noted
	179	2	IFR (1998) were	The Institute for Fisheries Resources (1998) were
	181	1	[Elements of recovery: an inventory of upslope sources of sedimentation in the Mattole River Watershed with rehabilitation prescriptions and additional information for erosion control prioritization (MRC, Petrolia, CA).]	
	182	1	IFR (1998) noted	The Institute for Fisheries Resources (1998) noted
	182	1	IFR (1998) shows	The Institute for Fisheries Resources (1998) shows
	182	1	IFR (1998) notes	The Institute for Fisheries Resources (1998) notes
Known or suspected factors affecting salmonid habitat	183	5	Construction of road network networks has	The construction of road networks has
	183	5	Swanston and Swanston 1976	Swanston and Swanson 1976
	184	1	Crossings have also be a source	Crossings have also been a source
	190	1	NCRWQCB	North Coast Regional Water Quality Control Board
	192	2	(Pacific Fisheries Management Council 1997, 1998).	(Pacific Fisheries Management Council 1997).
	192	3	NMFS 1996	National Marine Fisheries Service 1996
	193	3	CDFG	California Department of Fish and Game
	193	3	NMFS	National Marine Fisheries Service
	194	4	63 FR 13347	USDC National Oceanic and Atmospheric Administration 1998b
	195	2	(NMFS 1997)	(National Marine Fisheries Service 1997a)
	196	2	(NMFS 1986)	(National Marine Fisheries Service 1996)
	196	3	Opinion	opinion
	196	3	These effects are discussed in NMFS (1996)	The National Marine Fisheries Service (1996) has previously discussed these effects
	197	1	from the Project to at the action area	from the project to the action area
	198	2	NMFS 1996	National Marine Fisheries Service 1996
	199	3	(NMFS 1998)	(National Marine Fisheries Service 1998a)
	199	3	NMFS (1998)	National Marine Fisheries Service (1998a)

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	200	3	action areal	action area
LISTED SPECIES/CRITICAL HABITAT				
American peregrine falcon	204	4	USDI Fish and Wildlife 1998	USDI Fish and Wildlife Service 1998a
Northern spotted owl	205	4	EIS/EIR.	EIS/EIR).
	205	4	(S. Chinnici, pers. comm., Wildlife Biologist, PALCO, December 1, 1998)	(S. Chinnici, pers. comm., Wildlife Biologist, Pacific Lumber Company, December 1, 1998)
	206	3	table 23, footnote 1: based on PALCO	based on Pacific Lumber Company
	206	3	table 23, footnote 4: (USDI Fish and Wildlife 1992a)	(USDI Fish and Wildlife Service 1992a)
	207	1	(PALCO 1999)	(Pacific Lumber Company 1999)
	207	2	PALCO (1999)	Pacific Lumber Company (1999)
	207	5	(PALCO 1999)	(Pacific Lumber Company 1999)
Bald eagle	208	5	CDFG	California Department of Fish and Game
	208	6	table 24, footnote 1: CDFG	California Department of Fish and Game
	209	4	69,231	63,170
	209	5	Table 25: total of first column 69,231	Table 25: total of first column 63,170
Marbled murrelet	210	8	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
	211	2	Nelson 1997	Nelson 1997a
	211	5	researchers (USDI Fish and Wildlife Service 1997)	researchers (USDI Fish and Wildlife Service 1997a)
	211	5	Recovery Team (USDI Fish and Wildlife Service 1997)	Recovery Team (USDI Fish and Wildlife Service 1997a)
	213	1	Ralph et al. 1994	Ralph et al. 1994b
	213	2	Service	FWS
	213	2	(S. Chinnici, January 19 and January 25, 1999)	(Chinnici 1999a and 1999b)
	213	2	Appendix 1	Appendix A
	213	4	table 26, footnote 1: Appendix 1: 12477 - 1837 (S. Chinnici, January 25, 1999) = 10, 610	Appendix A: 12,477 - 1,837 = 10,610 acres (Chinnici 1999b)
	214	4	Service	FWS
	215	1	(Marbled Murrelet Recovery Team, November 30, 1998; S. Chinnici, PALCO, pers. comm., January 19, 1999)	(Marbled Murrelet Recovery Team, November 30, 1998; Chinnici 1999a)
	215	3	the Service believes	the FWS believes
	215	3	The Service discussed	The FWS discussed

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	215	7	Service	FWS
	215	7	(Marbled Murrelet Recovery Team, November 30, 1998).	(Marbled Murrelet Recovery Team 1998)
	215	7	(S. Chinnici, pers. comm., January 19 and January 25, 1999)	(Chinnici 1999a and 1999b)
	216	1	(as updated by P. Detrich, USFWS, pers. comm., January 2, 1999, T. Reid, pers. comm., January 11, 1999, and S. Chinnici, PALCO, pers. comm., January 19 and January 25, 1999).	(as updated by Detrich (1999); T. Reid, pers. comm., January 11, 1999; and Chinnici 1999a and 1999b)).
	216	1	table 27, footnote 3: 376 (unoccupied per S. Chinnici, pers. comm., January 25, 1999)	376 (unoccupied per Chinnici 1999b)
	216	1	table 27, footnote 4: (unsuitable per S. Chinnici, pers. comm., January 25, 1999) = 10,610	(unsuitable per Chinnici 1999b) = 10, 610 acres
	217	3	Service	FWS
	218	2	table 28, footnote^: continuos	continuous
	219	2	Service	FWS
	219	3	Ralph et al. 1994	Ralph et al. 1994b
	220	1	(USDI Fish and Wildlife Service, pers. comm., February 28, 1997)	(USDA Forest Service et al. 1997)
	220	1	S.K. Nelson, pers. comm., October 31, 1997)	Nelson 1997b)
	221	3	Hamer and Nelson 1995b, page 80;	Hamer and Nelson 1995, page 80;
	221	4	(Hamer and Nelson 1995b)	(Hamer and Nelson 1995)
	222	1	(T. Robards, pers. comm.)	(T. Robards, pers. comm. as cited in USDI Fish and Wildlife Service and California Department of Forestry and Fire Protection 1998, appendix N)
	222	3	USDI Fish and Wildlife Service 1997	USDI Fish and Wildlife Service 1997a
SONC Coast ESU coho salmon	227	2	population in California (CDFG 1994)	population in California (California Department of Fish and Game 1994)
	227	2	(CDFG 1994)	(California Department of Fish and Game 1995)
	227	2	(CDFG 1964)	(California Department of Fish and Game 1965)
	227	3	in 1996 (IFR 1998).	In 1996 (Institute for Fisheries Resources 1998)
	227	3	(CDFG 1995)	(California Department of Fish and Game 1995)
	227	3	survey by CDFG	survey by the California Department of Fish and Game

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	227	3	Mattole River (IFR 1998)	Mattole River (Institute for Fisheries Resources 1998)
	227	3	(MSG 1997)	(Mattole Salmon Group 1997)
Proposed Species/Critical Habitat:				
Southern Oregon and California Coastal ESU chinook salmon	228	3	mainstem (IFR 1998)	mainstem (Institute for Fisheries Resources 1998)
	228	3	CDFG (1995) reported	California Department of Fish and Game (1995) reported
	228	3	these watersheds (IFR 1998)	these watersheds (Institute for Fisheries Resources 1998)
	228	3	watershed (IFR 1998)	watershed (Institute for Fisheries Resources 1998)
	228	3	MSG (1997)	Mattole Salmon Group (1997)
	228	3	(cited in IFR 1998)	(cited in Institute for Fisheries Resources 1998)
Unlisted Species:				
Bank swallow	230	2	(CDFG 1995)	(California Department of Fish and Game 1995)
Pacific fisher	230	7	On PALCO lands there are 69,231 acres of LSH. This constitutes approximately 32 percent of the current ownership outside of the Headwaters acquisition area, and Grizzly Creek Complex.	On PALCO lands there are an estimated 63,170 acres of LSH. This constitutes approximately 30 percent of the current ownership.
	231	2	{in first column of numbers} 69,231	63,170
	231	2	Action area (outside of PALCO lands)[2])	Action area (outside of PALCO lands)[1,2]
	231	2	62,491	67,795
	231	2	{First footnote} Habitat information derived from PALCO 1999.	Habitat information for PALCO lands was derived from Pacific Lumber Company (1999).
	231	2	{second footnote} Habitat information for California derived from...	Habitat information for California outside of PALCO lands was derived....
Red tree vole	233	2	Approximately 69,231 acres of LSH (redwood, Douglas-fir, and montane hardwood/conifer habitat types combined) occur on PALCO lands.	Approximately 63,170 acres of LSH (redwood, Douglas-fir, and montane hardwood/conifer habitat types combined) occur on PALCO lands, and an additional 5,304 acres occur within the Headwaters acquisition area.
	233	3	{in first column of numbers} 69,231	63,170

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	233	3	Action area (outside of PALCO lands)[2]	Action area (outside of PALCO lands)[1,2]
	233	3	{in first column of numbers} 62,491	67,795
	233	3	{First footnote} Habitat information derived from PALCO 1999.	Habitat information for PALCO lands was derived from Pacific Lumber Company (1999).
	233	3	{second footnote} Habitat information for California derived from...	Habitat information for California outside of PALCO lands was derived....
Northern red-legged frog	234	3	(PALCO 1998)	(Pacific Lumber Company 1998)
Foothill yellow-legged frog and northwestern pond turtle	237	1	(PALCO 1998)	(Pacific Lumber Company 1998)
	237	3	July 28, 1998, in Final EIS/EIR).	July 28, 1998).
	237	3	(PALCO 1998)	(Pacific Lumber Company 1998)
Tailed frog	242	3	Hanski 1977	Hanski 1997
Southern torrent salamander	243	5	Ollivier (pers. comm., 1998 and 1999)	Ollivier (pers. comm., November 4, 1998)
	244	1	17of 28	1 of 28
	244	2	(unpublished data)	(unpublished data, reviewed in Welsh et al. 1998)
Northern California ESU steelhead	244	5	tributaries (IFR 1998)	tributaries (Institute of Fisheries Resources 1998)
	244	5	CDFG (1995)	the California Department of Fish and Game (1995)
	245	1	(IFR 1998)	(Institute for Fisheries Resources 1998)
	245	1	CDFG (1995)	California Department of Fish and Game (1995)
SOC Coasts ESU coastal cutthroat trout	245	4	(IFR 1998)	(Institute for Fisheries Resources 1998)
EFFECTS OF THE ACTION				
EFFECTS COMMON TO SPECIES ASSOCIATED WITH LATE-SERAL HABITAT				
Effects Common to Species Associated with Late-Seral Habitat	248	5	47	46
	249	1		{Add the following sentence at the end of the title for table 36} [Decades 1 through 5 do not include the Grizzly Creek complex.]
	249	1	{in first column of numbers} 6,569	7,181
	249	1	{in first column of numbers} 18,205	16,223

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	249	1	{in first column of numbers} 44,457	39,766
	249	1	{in first column of numbers} 69,231	63,170
	250	1	18,383 acres	18,402 acres
	250	2		{Add the following sentence at the end of the title for table 37} [Acres in the present row include the Headwaters acquisition area and the Grizzly Creek Complex, but acres in the rows for decades 1 through 5 do not.]
	250	2	{first column} Present	Present[1]
	250	3		{The following footnote is added} [[1] The present baseline includes LSH within the Headwaters acquisition area.]
	251	1	6347	6346
	252	2	Using a "worst-case" estimate, LSH could be reduced within the PALCO ownership from 32 percent (69,231 acres) to 10 percent (21,170 acres) of the ownership. This would constitute a 60 percent (47,304 acre) decrease in the amount of LSH.	Using a "worst-case" estimate, LSH could be reduced within the PALCO ownership (excluding the Headwaters acquisition area and the Grizzly Creek Complex) from 30 percent (63,170 acres) to 10 percent (21,170) acres of the ownership. This would constitute a 66 percent (42,000 acre) decrease in the amount of LSH.
	252	4	12885	12991
	253	3	7382	7385
	253	3	30 percent	31 percent
EFFECTS COMMON TO PACIFIC SALMONIDS				
Assessment approach	258	3	62 FR 62741, November 1997	USDC National Oceanic and Atmospheric Administration 1997c
	258	3	63 FR 11482, March 1998	USDC National Oceanic and Atmospheric Administration 1998a
Background summary of baseline conditions	260	2	PALCO	The Pacific Lumber Company
	260	4	558.0	557.0
	261	1	PALCO	The Pacific Lumber Company

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	261	1	CDF	the California Department of Forestry and Fire Protection
	262	1	PALCO	The Pacific Lumber Company
	262	1	CDF	the California Department of Forestry and Fire Protection
	262	7	PALCO	The Pacific Lumber Company
	263	2	PALCO	The Pacific Lumber Company
Summary of the proposed incidental take permit	263	3	211,700	211,000
Effects of the proposed incidental take permit	269	2	MRC 1987	Mattole Restoration Council 1989
	271	4	315.24	316.24
	272	2	MRC	Mattole Restoration Council
	274	4	afer	after
Effects of the proposed conservation measures	275	2	Plan	SYP/HCP
	276	1	[, and others}	
	276	4	CDFG	the California Department of Fish and Game
	284	1	Foster Wheeler, 1999	Pacific Lumber Company (1999)
	284	3	NMFS (1998)	the National Marine Fisheries Service (1998b)
	285	1	Bingham, in litt. 1991, California Board of Forestry, in litt. 1992	Bingham 1991, California Board of Forestry 1992
	289	4	PALCO	The Pacific Lumber Company
	289	4	PALCO	The Pacific Lumber Company
	290	1	PALCO	The Pacific Lumber Company
	291	4	Knudsen 1992	Knudsen et al. 1992
	295	2	[, in litt.,]	
	297	1	NMFS	National Marine Fisheries Service
Listed Species/Critical Habitat:				
Northern spotted owl	306	2	draft Recovery Plan (USDI 1992).	draft Recovery Plan (USDI 1992a).
	306	4	(USDI Fish and Wildlife Service et al. 1997).	(USDA Forest Service et al. 1997).
	309	1	an increase of 6,769 acres	an increase of 6,770 acres
	309	2	(data from PALCO 1999).	(data from The Pacific Lumber Company 1999).
	309	2	Table 51. Total, Decade 0: 170,404	Table 51. Total, Decade 0: 170,403
	309	2	Table 51. Total, Decade 1: 167,313	Table 51. Total, Decade 1: 167,312

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	309	2	Table 51. Total, Decade 2: 166,247	Table 51. Total, Decade 2: 166,246
	309	2	Table 51. Total, Decade 3: 175,112	Table 51. Total, Decade 3: 175,113
	309	2	Table 51. Total, Decade 4: 172,506	Table 51. Total, Decade 4: 172,507
	309	2	Table 51. Total, Net Change: 6,769	Table 51. Total, Net Change: 6,770
	311	3	(a benefit to the owl) of 6,769 acres	(a benefit to the owl) of 6,770 acres
	311	3	an increase of 3.9 percent from the total of 170,404	an increase of 3.9 percent from the total of 170,403
	312	5		Add the following sentence to the end of the paragraph: Berbach et al. (1993) reported that over 75 percent of the quarter-townships in the coastal counties of Del Norte, Humboldt, and Mendocino exceeded this standard.
Bald eagle	315	2	69,231	63,170
Marbled murrelet	317	1	(S. Chinnici, pers. comm., January 19and January 25, 1999)	(Chinnici 1999a and 1999b)
	318	2	Updated source from Appendix 1 and S. Chinnici, pers. comm., January 25, 1999.	Updated source from Appendix 1 and Chinnici 1999b.
	319	1	(as updated by S. Chinnici, pers. comm., January 25, 1999).	(as updated by Chinnici 1999b).
	319	1	Footnote 5: Table 5A:6533-1837 (unsuitable per S. Chinnici, January 25, 1999)- 376 (unoccupied per S. Chinnici, January 25, 1999) =4334	Footnote 5: Table 5A:6533-1837 (unsuitable per Chinnici 1999b)- 376 (unoccupied per Chinnici 1999b)=4334
	319	1	Footnote 6: (unsuitable per S. Chinnici, January 25, 1999)	Footnote 6: (unsuitable per Chinnici 1999b)
	319	1	Footnote 8: P. Detrich, January 2, 1999	Footnote 8: Detrich 1999
	325	2	UOG stands (S. K. Nelson, pers. comm., November 12, 1998)	UOG stands (Nelson 1998)
	326	3	(see also Marbled Murrelet Recovery Team, November 30, 1998)	(see also Marbled Murrelet Recovery Team 1998)
	327	1	(see also Marbled Murrelet Recovery Team, November 30, 1998)	(see also Marbled Murrelet Recovery Team 1998)
	329	4	(approximately 30 mmbf per acre; T. Reid, pers. comm.)	(approximately 30 mmbf per acre; T. Reid, pers. comm., December 16, 1998)
	330	4	(Marbled Murrelet Recovery Team, November 30, 1998; P. Karieva, December 7, 1998)	(Marbled Murrelet Recovery Team 1998, P. Karieva 1998a)

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	333	1	land management practices (USDI Fish and Wildlife Service 1997)	land management practices (USDI Fish and Wildlife Service 1997a)
	333	2	and the Recovery Plan (USDI Fish and Wildlife Service 1997)	and the Recovery Plan (USDI Fish and Wildlife Service 1997a)
	335	3	recovery of the species (USDI Fish and Wildlife Service 1997)	recovery of the species (USDI Fish and Wildlife Service 1997a)
	335	3	Marbled Murrelet Recovery Team, November 30, 1998).	Marbled Murrelet Recovery Team 1998).
	337	5	(P. Karieva, December 7, 1998).	(P. Karieva 1998a).
	338	2	D. Murphy, September 10, 1997; P. Karieva, December 7, 1998).	D. Murphy 1997; P. Karieva 1998a).
	338	4	Karieva, December 7, 1998; D. Murphy, September 10, 1997).	Karieva 1998a, Murphy 1997).
	338	5	(USFWS 1997	(USDI Fish and Wildlife Service 1997a
	339	3	3,473 acres of young seral	3,472 acres of young seral
	341	1	Table 57. Total, Residual DF OG: 13	Table 57. Total, Residual DF OG: 14
	341	1	Table 57. Total, Mid-seral: 3003	Table 57. Total, Mid-seral: 3,004
	341	1	Table 57. Total, Young seral: 3473	Table 57. Total, Young seral: 3,472
	341	1	Table 57. Total, Other seral: 408	Table 57. Total, Other seral: 409
	341	1	Table 57. Grand total: 18759	Table 57. Grand total: 18,760
	342	2	(USDI Fish and Wildlife Service 1997, page 142-144).	(USDI Fish and Wildlife Service 1997a, page 142-144).
	342	2	(USDI Fish and Wildlife Service 1997, page 143).	(USDI Fish and Wildlife Service 1997a, page 143).
	342	3	(USDI Fish and Wildlife Service 1997) describes	(USDI Fish and Wildlife Service 1997a) describes
	342	3	(USDI Fish and Wildlife Service 1997, page 133). Therefore,	(USDI Fish and Wildlife Service 1997a, page 133). Therefore,
	342	3	lands" (USDI Fish and Wildlife Service 1997	lands" (USDI Fish and Wildlife Service 1997a
	343	1	weather (USDI Fish and Wildlife Service 1997	weather (USDI Fish and Wildlife Service 1997a
	344	1	Table 58. Total, Late-seral: 2,786	Table 58. Total, Late-seral: 2,787
	344	1	Table 58. Total, Other MMCAs: 3,440	Table 58. Total, Other MMCAs: 3,441
	344	1	Table 58. Grand total: 12,306	Table 58. Grand total: 12,307
	346	1	(CDFG 1998a, PALCO 1998).	(California Department of Fish and Game 1998a, The Pacific Lumber Company 1998).

Section	Pg.	¶	Change from [Delete]	Change to [Add]
Unlisted Species				
	351	2	{First column in Table 59} Baseline	Baseline[1]
	351	2		{The following footnote is added} [[1] Baseline acres include habitat within the Headwaters acquisition area.]
Pacific fisher	352	1	{First column in Table 60): Baseline	Baseline[1]
	352	1		{The following footnote is added} [[1] Baseline acres include habitat within the Headwaters acquisition area.]
	352	3	LSH would be reduced within the PALCO ownership	LSH would be reduced within the PALCO ownership (excluding the Headwaters acquisition area)
	352	3	32 percent (69,231acres)	30 percent (63,170 acres)
	352	3	69 percent (47,304 acres)	66 percent (42,000 acres)
Northern red-legged frog, foothill yellow-legged frog and northwestern pond turtle	361	5	126.814	126,328
	363	3	Therefore, the FWS concludes that outside RMZs an unknown amount of habitat could be affected by timber harvest and associated activities.	Therefore, the FWS concludes that outside RMZs an unknown amount of habitat could be affected by timber harvest and associated activities; however, a gross estimate is provided.
Tailed frog and southern torrent salamander	367	3	PALCO	The Pacific Lumber Company
Summary of response to proposed action				
Listed Species/Critical Habitat: Northern spotted owl	369	2	6,769	6,770
	370	4	6,769	6,770
	370	4	170,404	170,403
Listed Species/Critical Habitat: Bald eagle	371	2	69,231	63,170
Listed Species/Critical Habitat: Marbled murrelet	371	5	(Marbled Murrelet Recovery Team, November 30, 1998; P. Karieva, December 7, 1998).	(Marbled Murrelet Recovery Team 1998, Karieva 1998a).
	372	1	(H. Carter, pers. comm., November 11, 1998; S. K. Nelson, Pers. comm., November 12, 1998).	(Carter 1998, Nelson 1998).

Section	Pg.	¶	Change from [Delete]	Change to [Add]
	372	2	(P. Karieva, pers. comm., December 7, 1998).	(Karieva 1998a)
	373	1	(Marbled Murrelet Recovery Team, pers. comm., November 30, 1998, P. Karieva. pers. comm., December 1 and 7, 1998).	(Marbled Murrelet Recovery Team 1998, Karieva 1998a and 1998b).
	373	2	(Marbled Murrelet Recovery Team, pers. comm., November 30, 1998).	(Marbled Murrelet Recovery Team 1998).
Unlisted Species: Northern red-legged frog, foothill yellow-legged frog and northwestern pond turtle	389	6	Adverse impacts are likely to occur as a result of the loss or modification of 91,840 to 191,767 acres. Additional habitat associated with 486 acres of mapped wetlands may be adversely affected.	Adverse impacts are likely to occur as a result of the loss or modification of 91,840 to 191,767 acres (page 238 and Table 63).
CUMULATIVE EFFECTS				
Listed Species/Critical Habitat				
Marbled murrelet	401	4	(e.g., D. Murphy, September 10, 1997).	(e.g., Murphy 1997).
	402	1	(P. Karieva, December 1, 1998)	(Karieva 1998b)
	402	1	Marbled Murrelet Recovery Team (November 30, 1998).	Marbled Murrelet Recovery Team (1998).
	402	2	(see USDI Fish and Wildlife Service letters dated May 20, 1997, August 8, 1997, November 25, 1997).	(USDI Fish and Wildlife Service 1997b, 1997c, and 1997d).
	402	3	(National Resource Council 1995; Karieva, December 1 and December 7, 1998).	(National Resource Council 1995, Karieva 1998a and 1998b).
	402	4	(USDI Fish and Wildlife Service 1997, page 3).	(USDI Fish and Wildlife Service 1997a, page 3).
	402	4	(USDI Fish and Wildlife Service 1997).	(USDI Fish and Wildlife Service 1997a).
	403	4	(USDI Fish and Wildlife Service Jan. 28, 1998).	(USDI Fish and Wildlife Service 1998b).
	404	1	(Frampton, November 29, 1994; Henson, August 23, 1994).	(Frampton 1994, Henson 1994).
	404	2	(USDI Fish and Wildlife Service Jan. 28, 1998).	(USDI Fish and Wildlife Service 1998b).
INCIDENTAL TAKE STATEMENT				
	407	3	{delete entire third paragraph}	
Pacific fisher	412	1	51,400	42,000
	412	2	51,500	42,000

Section	Pg.	¶	Change from [Delete]	Change to [Add]
Red tree vole	412	5	51,400	42,000
	412	6	56,900	47,000
	412	6	51,500	42,000
Reasonable and prudent measures & terms and conditions				
	415	8	All of the conservation and management measures of the HCP's Operating Conservation Program, together with the terms identified in the associated IA, are hereby incorporated...	All of the conservation and management measures of the HCP's Operating Conservation Program, together with the terms identified in the associated IA, and any section 10(a)(1)(B) permit and permits issued with respect to the proposed HCP/SYP, are hereby incorporated...
Reporting Requirements	416	2	PALCO	Pacific Lumber Company

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List of tables (continued).

LIST OF APPENDICES

List of Acronyms and Abbreviations

AB	Assembly Bill
Act	Endangered Species Act of 1973 as amended
AFS	American Fisheries Society
Bioregion	Southern Humboldt Bioregion
BLM	USDI Bureau of Land Management
CDF	California Department of Forestry and Fire Protection
CDFG	California Department of Fish and Game
CDMG	California Division of Mines and Geology
CESA	California Endangered Species Act
CEQA	California Environmental Quality Act
CFPR	California Forest Practice Rules
cfs	cubic feet per second
CHERT	County of Humboldt Extraction Review Team
CHU	Critical Habitat Unit
CMZ	Channel Migration Zone
COE	U. S. Army Corp of Engineers
CWD	coarse woody debris
CWHR	California Wildlife Habitat Relationships System
CWT	coded-wire tag
D50	median particle size
dbh	diameter at breast height
DDT	dichloro-dephenyhl-trichloroethane
DFOG	old-growth Douglas-fir
DI	Disturbance Index
DO	dissolved oxygen
Draft EIS/EIR	October 1998 Draft Environmental Impact Statement and Environmental Impact Report
Draft SYP/HCP	July 1998 Draft Sustained Yield Plan and Habitat Conservation Plan
EEZ	Equipment Exclusion Zone
EPA	Environmental Protection Agency
ESU	Evolutionarily Significant Unit
FEMAT	Report of the Forest Ecosystem Management Assessment Team
Final EIS/EIR	January 1999 Final Environmental Impact Statement and Environmental Impact Report
SYP/HCP	January 1999 Final Sustained Yield Plan and Habitat Conservation Plan
FSEIS	*Final Supplemental Environmental Impact Statement for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl*
FWS	USDI Fish and Wildlife Service
GCSP	Grizzly Creek State Park
GIS	Geographic Information System
GPS	Global Positioning System
HCN	cyanic acid
HCP	Habitat Conservation Plan

HFAC	Humboldt Fish Action Council
HRSP	Humboldt Redwoods State Park
HU	Hydrologic Unit
IA	Implementation Agreement
ITP	Incidental Take Permit
LOP	Letter of Permission
LSH	late successional habitat
LSR	Late Successional Reserve
LTO	Licenced Timber Operator
LTSYP	Long-term Sustained Yield Plan
LWD	large woody debris
MBF	thousand board feet
MMBF	million board feet
MMCA	Marbled Murrelet Conservation Area
MWAT	maximum weekly average temperature
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
ODFW	Oregon Department of Fish and Wildlife
ONRC	Oregon Natural Resources Council
PALCO	Pacific Lumber Company, Scotia Pacific Holding Company, and Salmon Creek Corporation
PFC	properly functioning condition
PG&E	Pacific Gas and Electric
ppm	parts per million
PWA	Pacific Watershed Associates
RBV	Relative Bird Value
RCD	Resource Conservation District
RMZ	Riparian Management Zone
ROG	residual old-growth redwood
RPF	Registered Professional Forester
PSG	Pacific Seabird Group
RWQCB	North Coast Regional Water Quality Control Board
Rx	prescription
Services	USDI Fish and Wildlife Service and National Marine Fisheries Service
Simpson	Simpson Timber Company
SOCC	Southern Oregon and California Coastal
SONCC	Southern Oregon and Northern California Coast
State	State of California
SYP	Sustained Yield Plan
THP	Timber Harvest Plan
UOG	unentered old-growth redwood
USFS	USDA Forest Service
WAA	Watershed Assessment Area
WDNR	Washington State Department of Natural Resources
wildlife agencies	USDI Fish and Wildlife Service, National Marine Fisheries Service, and California Department of Fish and Game
WLPZ	Watercourse and Lake Protection Zone

The proposed permit action may affect the threatened marbled murrelet (*Brachyramphus marmoratus marmoratus*), designated marbled murrelet critical habitat, threatened northern spotted owl (*Strix occidentalis caurina*), threatened bald eagle (*Haliaeetus leucocephalus*), endangered American peregrine falcon (*Falco peregrinus anatum*), threatened western snowy plover (*Charadrius alexandrinus nivosus*), threatened coho salmon (*Oncorhynchus kistutch*) in the Southern Oregon-Northern California Coast (SONCC) Evolutionarily Significant Unit (ESU), proposed coho salmon critical habitat, proposed threatened chinook salmon (*Oncorhynchus tshawytscha*) in the Southern Oregon-California Coastal (SOCC) ESU, and proposed chinook salmon critical habitat.

The proposed SYP/HCP and IA also include ten species which are unlisted and not currently proposed for listing. These species will be treated as if they were listed for the purposes of the biological and conference opinions. The ten unlisted species are coastal cutthroat trout (*Oncorhynchus clarki*) in the SOCC ESU, steelhead (*Oncorhynchus mykiss*) in the northern California ESU, southern torrent salamander (*Rhyacotriton variegatus*), tailed frog (*Ascaphus truei*), red-legged frog (*Rana aurora*), foothill yellow-legged frog (*Rana boylei*), northwestern pond turtle (*Clemmys marmorata marmorata*), bank swallow (*Riparia riparia*), California red tree vole (*Arborimus pomo*), and Pacific fisher (*Martes pennanti pacifica*).

Critical habitat has not been designated for any of the above 10 unlisted species, therefore critical habitat for these species will not be discussed further in the biological and conference opinions. The proposed action would not affect northern spotted owl critical habitat, American peregrine falcon critical habitat, or proposed western snowy plover critical habitat, therefore critical habitat for these species will not be discussed further in the biological and conference opinions.

The use of the term "significant" in the biological and conference opinions only refers to effects to species proposed for coverage under the ITP issued in accordance with the Act and is not meant to address "significance" under either the National Environmental Policy Act (NEPA) or the California Environmental Quality Act (CEQA).

Species Not Covered by the Incidental Take Permit

This document also addresses potential impacts from adoption of the proposed SYP/HCP on the following three plant species: Federally endangered western lily (*Lilium occidentale*), proposed endangered Kneeland Prairie penny-cress (*Thlaspi montanum var. californicum*), and two-flowered lathyrus (*Lathyrus biflorus*), a candidate for listing. Incidental take of these species was not requested by PALCO and will not be authorized under the section 10(a)(1)(B) permit. Impacts on these species will continue to be considered in accordance with existing laws and regulations. However, incidental take of these plants is not anticipated for the reasons described below.

The western lily occurs in early successional bogs or coastal scrub on poorly drained soils, generally underlain by an iron pan or clay layer, from sea level to 330 feet in elevation. All known occurrences are within 4 miles of the coastline between Eureka, California and Coos Bay, Oregon. Given the narrow coastal distribution of this species, it is very unlikely to occur on PALCO lands or within the 1-mile acquisition area. The proposed action would provide for the detection of potential suitable habitat which would trigger a survey by a qualified botanist, and the mitigation requirements should result in no adverse effect.

The Kneeland prairie penny-cress is known from only one location of coastal prairie on serpentine outcrops in Humboldt County, California. The strong ultramafic characteristics of this habitat make it likely that the penny-cress requires this substrate. PALCO reports that no similar serpentine habitat exists in their current holdings. If such habitat did occur, it should be detected under the existing provisions of the proposed action, and a qualified botanist would survey the area. Implementation of the mitigation requirements should result in no adverse affect. The existing population of penny-cress is within the 1-mile acquisition area covered under the proposed SYP/HCP. If PALCO were to acquire this land and propose any activities under the proposed SYP/HCP, the FWS would have review authority per the existing provisions of the proposed action.

The two-flowered lathyrus is known from only one location in Humboldt County, at an elevation of 4,500 feet in the understory of Jeffrey pine and incense cedar. The site is underlain by weak peridotite soils. The current population's restriction to this soil type indicates that ultramafic soils are a component of its habitat. PALCO reports that no serpentine soils or Jeffrey pine stands occur within their current holdings. If such habitat did occur, it should be detected under the existing provisions of the proposed action and a qualified botanist would survey the area. Implementation of the mitigation requirements should result in no adverse affect.

The three plants discussed above are not addressed further in the biological and conference opinions.

Administrative Record

On November 16,1998, you requested intra-Services consultation. The biological and conference opinions are based on information provided in the following sources: *Public Review Draft Pacific Lumber Company Sustained Yield Plan and Habitat Conservation Plan* (Draft SYP/HCP) dated July 1998; *Draft Environmental Impact Statement/Environmental Impact Report for the Headwaters Forest Acquisition and the PALCO SYP/HCP* dated October 1998 (Draft EIS/EIR); *Final Environmental Impact Statement/Environmental Impact Report for the Headwaters Forest Acquisition and the PALCO SYP/HCP* (Final EIS/EIR) dated January 1999 which includes the final habitat conservation plan (HCP) as Appendix P, the Sustained Yield Plan (SYP) as Appendix Q and the final proposed IA as Appendix S; and information contained in the Services' files. A complete administrative record of this consultation is on file in the FWS, Arcata office and in the NMFS, Santa Rosa office.

Consultation History

The Services initiated formal consultation on the proposed SYP/HCP on November 16, 1998 in a letter to Mr. John Campbell of PALCO. The November 16, 1998 consultation initiation letter stated that the proposed ITP would authorize take of six Federally listed species and 30 unlisted species. The Services were subsequently notified in early January 1999 that the applicant decided not to seek coverage for 19 unlisted species originally proposed for coverage. Prior to initiation of consultation, development of an HCP on PALCO's ownership went through many phases which led to the proposed action.

In December 1992, PALCO was enjoined by the District Court of the Northern District of California from continuing timber harvest in marbled murrelet habitat in the Owl Creek timber stand. The District Courts decision was upheld by the Ninth Circuit Court of Appeals. In early 1993, PALCO and the FWS began discussions regarding a possible HCP for the marbled murrelet. PALCO provided a draft marbled murrelet HCP for review by the FWS in October 1993. Discussions regarding the HCP continued into 1994, but the HCP was not finalized and PALCO did not apply for an ITP at that time.

In May 1996, PALCO filed claims for compensation against the United States and State of California (State), alleging a regulatory taking of its property under the Federal and California ESAs. On September 28, 1996, the Maxxam Corporation, PALCO, the United States and the California Resources Agency entered into an agreement providing for the stay of the takings claims and for the acquisition of the Headwaters Forest. The Headwaters Agreement provided for the transfer of the Headwaters forest and other timberlands to public ownership in exchange for property and other assets, and linked the approval of an HCP and ITP by the Services, and approval of a SYP by the California Department of Forestry and Fire Protection (CDF) to the transfer of lands. The Services, the Environmental Protection Agency (EPA), several State agencies and PALCO began work in October 1996 on developing a multi-species HCP and a SYP based on the September agreement.

Federal legislation was passed in October 1997 appropriating $250 million from the Federal Land and Water Conservation Fund for the purchase of Headwaters forest, Elk Head Springs forest and Elk River Timber Company land. An additional $10 million was provided for Humboldt County for economic assistance. Specific provisions were attached to the $250 million for PALCO, including the following: the Services must issue ITP's under section 10 of the Act to PALCO for all of its remaining lands; the State must approve a SYP and provide $130 million as its share of the purchase price for the Headwaters forest, Elk Head Springs forest, and the Elk River property provision of public access to the Headwaters Forest; and PALCO must dismiss its lawsuits against the state and federal governments.

On February 27, 1998 a Pre-Permit Application Agreement in Principle was signed between the Federal and State governments, Maxxam, and PALCO outlining the approaches to marbled murrelet and aquatic strategies for the SYP/HCP.

On June 12, 1998, PALCO submitted an application for an ITP to the Services. In July 1998, a completed application package was submitted and accepted by the Services and the draft SYP/HCP and draft IA were released to the public. In October 1998, the Draft EIS/EIR were also released to the public for comment.

The California Legislature passed Assembly Bill (AB) 1986 on August 31, 1998. The State Legislation provided the State's share of the funds for the Headwaters and Elk Head Springs purchase and, in addition appropriated up to $80 million to purchase the Owl Creek redwood grove and up to $20 million towards the purchase of the Grizzly Creek redwood grove. An additional $15 million was provided to Humboldt County for economic assistance. The allocation of this $245 million was contingent on the SYP/HCP containing specific conservation measures specified in AB 1986 for marbled murrelets and aquatic species.

In January 1999, the proposed SYP/HCP, as modified by AB 1986, public comment and further discussions between the State and Federal Wildlife agencies and PALCO, was released to the public as part of a Final EIS/EIR. The biological and conference opinions analyze the proposed SYP/HCP as presented in above document.

BIOLOGICAL AND CONFERENCE OPINIONS

DESCRIPTION OF THE PROPOSED ACTION

PALCO has applied to the Services for a permit to authorize the incidental take of species listed under the Act (listed species) over a 50-year period pursuant to section 10(a)(1)(B) of the Act, and to enter into an IA. Incidental take of listed species and some species that currently are not but may be listed during the 50-year period, may occur due to implementation of the proposed SYP/HCP. The application includes coverage for 17 species (six listed species, one proposed species, and 10 unlisted species); these 17 species are hereafter collectively referred to as the "covered" species. PALCO would receive assurances under the Services' "no surprises" rule codified at 50 CFR §§ 17.3, 17.22(b)(5) and (6) and 17.32(b)(5) and (6) (FWS) and 50 CFR §§ 222.3 and 222.22 (NMFS) for all the covered species.

PALCO Lands

The SYP/HCP would apply to PALCO lands as they are anticipated to exist on the effective date of the ITP (i.e., exclude the Headwaters Reserve) and up to 25,000 acres of additional lands adjacent to the main contiguous portion of PALCO's ownership that may be acquired by PALCO over the life of the ITPs.. This area will be referred to in the biological and conference opinions as PALCO lands. The existing PALCO lands encompass approximately 211,000 acres of forest and associated grasslands in Humboldt County, California. The Draft and Final EIS/EIRs show the area for PALCO lands ranging from 211,000 to 211,799 acres. For the purpose of this consultation, the existing PALCO lands are assumed to encompass 211,000 acres. PALCO manages the land primarily for commercial timber production. Adjacent properties include other large commercial timber operations, small commercial timber operations, private parcels, State and Humboldt County public parks and reserves, and Federal government lands. Adjacent private lands are used for grazing, agricultural, and residential purposes.

PALCO land is located close to several Federal or State administered lands, including Redwood National and State Parks, Six Rivers National Forest, Humboldt Redwoods (HRSP) and Grizzly Creek (GCSP) State Parks, and various parcels administered by the USDI Bureau of Land Management (BLM). National and State Parks are managed primarily to preserve and protect resources and for public enjoyment and visitor experience. Lands administered by the National Forest system and the BLM are managed in accordance with a multiple-use concept; these lands encompass many habitat reserves. These habitat reserves include Late Successional Reserves (LSRs), which are managed to protect and enhance conditions of late-successional and old-growth forest ecosystems.

The distances from the PALCO lands to adjacent habitat reserves vary. The Redwood National and State Park complex is located 20 miles to the north. LSRs RC-306 and RC-307 are located approximately 6 and 7 miles, respectively, to the east, on the Six Rivers National Forest. LSRs RC-323 (5 miles to the south), RC-325 (less than 1 mile to the east), and RC-324 (3 miles to the southeast) all occur on BLM administered lands. The BLM also manages the Kings Range National Conservation Area, which is designated as an LSR. HRSP occurs outside and adjacent to PALCO land on the south, and GCSP occurs within the eastern PALCO boundary.

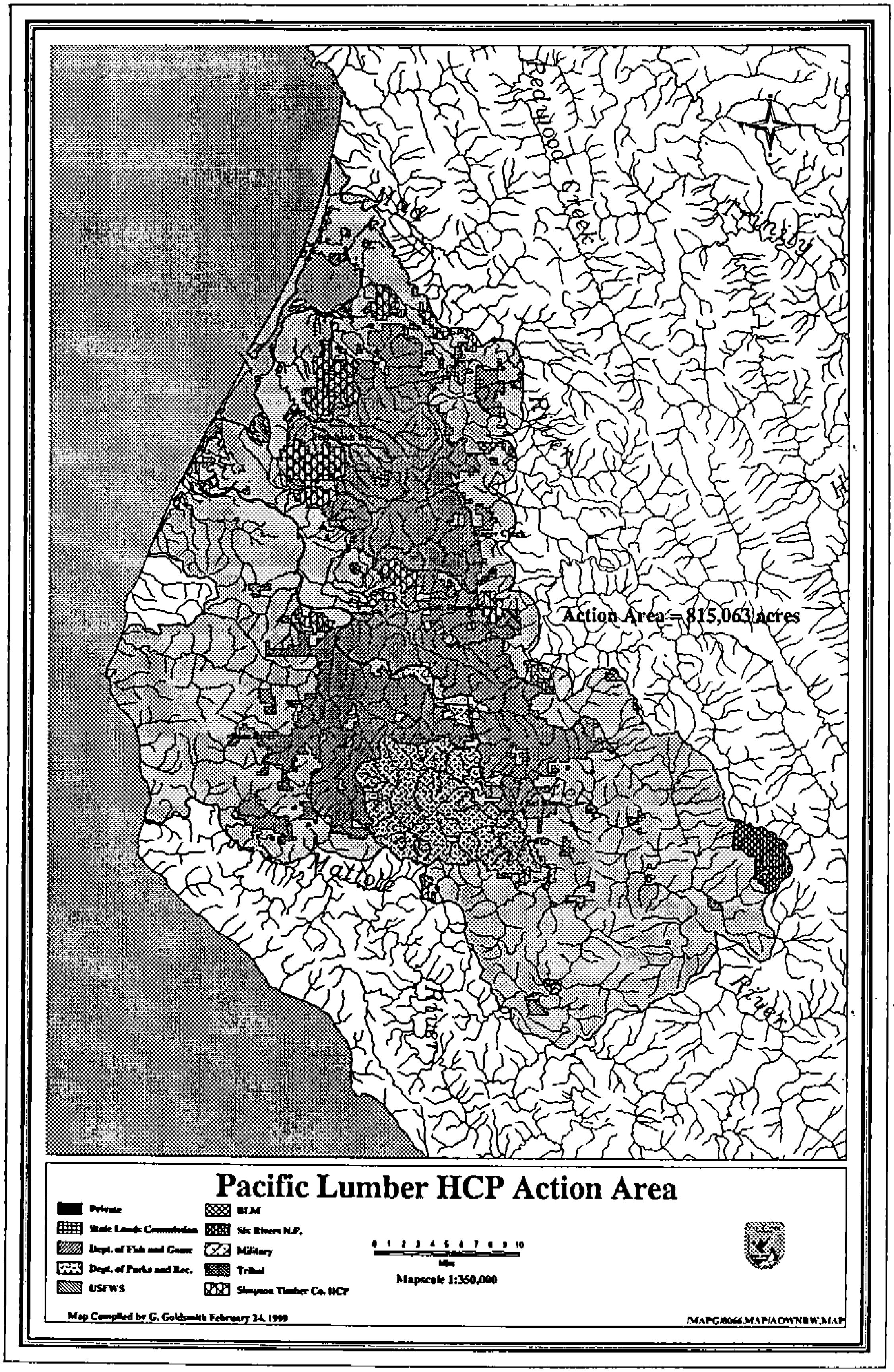
PALCO lands occur primarily in watersheds of the Elk, Van Duzen, Eel, Bear, Salt, and Mattole Rivers. A smaller portion of the ownership occurs within watersheds of Jacoby, Freshwater and Salmon Creeks. The Yager Creek watershed, a tributary to the Van Duzen River, encompasses a major portion of the ownership.

Action Area

The "action area" is defined as all areas to be affected directly or indirectly by the Federal action, not merely the immediate area involved in the action (50 CFR 402). Although the actions that would be covered by the proposed permit are restricted to PALCO lands, the effects of the proposed action on covered species may extend beyond this area. For this consultation, we have defined the action area to include: 1) PALCO lands; 2) a 1.3-mile buffer around PALCO lands; and 3) the following watersheds: Mad River (Butler Valley hydrologic unit), Jacoby Creek, Freshwater Creek, Elk River, Salmon Creek, Humboldt Bay, Eel River (including Van Duzen River and its tributary), Yager Creek, Bear River, Salt River, and Mattole River. The action area includes approximately 815,063 acres. The action area is depicted in Map 1.

Components of the Proposed Action

The proposed action includes public acquisition of the Headwaters Reserve and authorization of incidental take for covered species resulting from various land management activities and specific silvicultural prescriptions related to timber management and associated activities on PALCO lands.



Pacific Lumber HCP Action Area

Acquisition of Headwaters Reserve and Other Lands

In 1997, the United States Congress passed Public law 105-83 , which appropriates $250 million for the Federal portion of the acquisition of the Headwaters Reserve. Under this legislation, completion of the acquisition is conditioned upon agency issuance of ITPs for the remainder of the PALCO property. In 1998, the California Legislature passed AB 1986, appropriating over 240 million dollars for the State's portion of the acquisition of the Headwaters Reserve, as well as the possible acquisition of PALCO lands in the Owl Creek area and the Grizzly Creek area. The acquired land would include 5,739 acres from PALCO and 9,468 acres from the neighboring Elk River Timber Company. The acquired PALCO land and approximately 1,764 acres of the Elk River Timber Company land would be placed into the Headwaters Reserve (7,503 acres); the remaining land would be transferred to PALCO.

The Headwaters Reserve would be owned by the Federal government, subject to a conservation easement in favor of the State of California. Under AB 1986 the Owl Creek grove and all or portions of the Grizzly Creek grove could eventually pass into State ownership if the State acquisitions were completed. If acquisition of the Owl Creek grove did not occur, that area would be protected from timber harvest for the term of the ITPs as a Marbled Murrelet Conservation Area (MMCA). Under AB 1986 the Grizzly Creek grove would be protected for five years following permit issuance to facilitate acquisition and permanent protection of the grove by the State. If such acquisition did not occur, the Grizzly Creek grove would be protected as a MMCA for the life of the permit if the FWS, California Department of Fish and Game (CDFG), and NMFS (wildlife agencies) determined such protection to be necessary to prevent jeopardy to the marbled murrelet; otherwise the grove could be harvested in accordance with the provisions of the HCP applicable to areas outside of MMCAs.

Headwaters Reserve Management

Management of the Headwaters Reserve, following acquisition, is not part of the proposed action, therefore future management activities in the Headwaters Reserve are not evaluated at this time. It is anticipated that BLM and the California Resources Agency would cooperatively manage the Headwaters Reserve to protect old-growth redwood forests and the associated threatened and endangered species. A detailed management plan and schedule of management activities would be developed in the future. Consistent with the Federal and State Headwaters Reserve acquisition legislation, management principles would include the following: protection and monitoring of terrestrial and aquatic threatened and endangered species; protection of wildlife species and natural values; provision for reasonable public access and public enjoyment consistent with protection of the reserves's wildlife and habitat values; rehabilitation and restoration of previously logged areas, and collaborative Federal, State, and local government oversight. Scientific research on forests, fish, and wildlife would be fostered and permitted on the Headwaters Reserve. A minimal number of facilities would be constructed. Public use would include hiking, animal watching, and interpretive education. Public access would be provided from the north side, and administrative access would be provided from the south and north sides.

The management plan would be developed in accordance with applicable Federal laws, including the NEPA and the Act and be circulated for public review and comment. Potential impacts to Federally listed species resulting from management activities would be evaluated during future consultations under section 7 of the Act.

Seral stage distribution in the Reserve
Late Seral Habitat (LSH), including residual old-growth and uncut old-growth redwood, comprises the majority (71 percent, 5,304 acres) of the Headwaters Reserve (table 1). The reserve is comprised of a variety of age classes, including young forest stands and open or non-timbered areas.

Table 1. Distribution of acres by seral stage within the Headwaters Reserve, Humboldt County, California. All acres, except open and non-timbered areas, represent the redwood vegetation type (Final EIS/EIR, Volume I, pages 2-50).

Seral stage	Acres
Young	1,404
Mid-seral stage	625
Late-successional	1,521
Residual old-growth redwood	666
Old-growth redwood	3,117
Open or non-timbered	169
Total:	7,502

Relationship between the SYP and the HCP
The SYP, which is approved by CDF, has several objectives: establish long-term sustained yield timber harvest levels; avoid or mitigate potentially significant adverse impacts on listed and other species; avoid or mitigate potentially significant adverse impacts upon water quality, fisheries, and aquatic wildlife; and establish procedures to document implementation and evaluate the efficacy of SYP measures. The HCP incorporates information contained in the SYP for purposes of addressing effects of timber management on the covered species.

Covered Activities
The section 10(a)(1)(B) permits would be issued subject to the criteria established in the Act. They would authorize the incidental take of covered species associated with implementation of the following covered activities: timber management; road and landing construction, **reconstruction and upgrading, storm-proofing, inspections,** maintenance, closure, decommissioning and use; **water drafting; burning; development and operation of borrow pits;** commercial rock quarry operations; and scientific surveys and studies, so long as covered

activities are not likely to jeopardize the continued existence of any listed species or result in adverse modification of designated critical habitat. These activities are further described as follows.

Timber Management

Timber management is the primary activity on PALCO lands, occurring on approximately 203,000 acres. Management activities include timber harvest, site preparation, planting, vegetation management, thinning, and fire suppression.

Timber Harvesting Methods

Before a forest stand can be harvested, a Registered Professional Forester (RPF) must prepare a timber harvest plan (THP). The THP is reviewed by State and, in some cases, Federal agencies for consistency with all applicable laws and regulations to ensure that potentially significant environmental impacts are analyzed and fully mitigated to the extent feasible. This requirement has applied to commercial timber operations in California since 1973 (see SYP/HCP, Part A in Volume V for additional details).

Harvesting operations begin with the felling and bucking of trees. Logs are moved (yarded) to a landing site using methods determined based on topographic considerations, access, worker safety, and other factors. Generally, tractor-based systems are used on relatively mild terrain, cable yarders are used on steeper slopes, and helicopters are used in areas where road access is a problem. At the landings, the logs are loaded onto trucks and transported to processing facilities (mills) over private and public roads.

Under the HCP, full suspension yarding will be used, when feasible, in the Riparian Management Zones (RMZ). Full suspension is not feasible on flat ground, on other sites with limited deflection, on sites where an adjacent landowner will not provide permission to secure a cable, or in situations where a full suspension yarding system would jeopardize the safety of field personnel. Yarding, through RMZs, in these situations will be conducted in a manner that avoids, to the maximum extent practicable, ground disturbance which may deliver sediment to a watercourse. Where ground disturbance occurs, PALCO will treat (e.g., through seeding, mulching, etc.) all sites exhibiting exposed mineral soil that can reasonably be expected to deliver sediment to a watercourse (e.g., gullies, ruts). No requirements exist to mulch with native species mix or otherwise prevent the establishment of non-native, invasive species.

On all other areas of PALCO's timberlands there are no HCP specified yarding methods. Approximately 40,482 acres (74 percent of first decade harvest acres) could be subject to tractor logging, and 14,399 acres (26 percent) could be yarded with cable systems (Final EIS/EIR, table 3.9-7, p. 3.9-42). No projections of the acreage to be helicopter yarded are available. The amount of land subject to tractor logging may be overestimated, because slope steepness constraints were not well modeled. California Forest Practice Rules (CFPR) use a 50 percent slope as the limit for tractor logging. Approximately 35 to 40 percent of PALCO's ownership is suitable for tractor logging (D. Opalach, pers. comm., September 9, 1998). No data are presented on the actual portion of the landscape that has been subject to soil compaction from prior tractor yarding, and no estimate is available on the portion that is likely to be subjected to soil compaction in the future.

Silvicultural Prescriptions

Even-aged and uneven-aged silvicultural prescriptions would be used on PALCO lands. Even-aged silviculture is used to regenerate a stand of trees of approximately the same age by harvesting stands in blocks that typically range in size from 20 to 30 acres. Harvest methods include seed tree removal, shelterwood removal, and clearcutting. Uneven-aged silviculture is used to harvest trees individually or in small groups, with the goal of developing or maintaining a variety of age classes within a stand. Typically, sites are restocked through natural regeneration or, where necessary, seedlings obtained from a nursery.

A silvicultural prescription consists of a combination of vegetation management treatments applied to forest stands to achieve a specified objective. Approximately 170 silvicultural prescriptions were considered for each of PALCO's strata types; these prescriptions were grouped into silvicultural regimes. A silvicultural regime is a set of silvicultural prescriptions that begin in different decades. Silvicultural regimes were grouped into the following major categories: no harvest, restocking, late-seral selection, selection, even-aged, and shelterwood/seed tree. These regimes are further described in table 2.

Timber Harvest Scheduling

Other silvicultural practices meant to optimize growth rates and production of wood fiber, such as site preparation, planting with genetically improved stock, and precommercial thinning would occur. However, use of forest chemicals (i.e., herbicides, pesticides, and fertilizers) would not be covered under the ITPs. Another objective of these silvicultural prescriptions is the growth and retention of some wildlife habitat structures to minimize and mitigate some adverse impacts on covered species. Table 4 summarizes the approximate acreage on which harvest prescriptions would be applied during the 5 decades of the plan (original data from unnumbered tables in Volume III, Part C of the SYP/HCP).

Timber harvest of trees would occur in various seral stages, including old-growth, late-seral, mid-successional, and young forest. In addition, some harvest would occur within stands dominated by hardwoods. Table 5 summarizes the acres of timber harvest, by major silvicultural prescription type, in each of the six stand types on PALCO lands during the first decade of the plan. Information is not available for the second through fifth decades.

Approximately seven percent of PALCO's timberlands are covered by currently approved, active, or planned THPs.

Table 2: General description of silvicultural regimes, based on descriptions provided in the SYP/HCP, Volume III, Part B, pages 9-24.

<table>
<tr><th>Silvicultural Regime</th><th>General Description</th></tr>
<tr><td>No harvest</td><td>No timber harvest for 50 years.</td></tr>
<tr><td>Restocking</td><td>Goal is to restock capable sites. Plant 400 trees per acre. Commercial thin within 60 years to basal area of 160. Clearcut 20 years after thinning.</td></tr>
<tr><td>Late-seral selection</td><td>Goal is to create and maintain late-seral forest conditions (e.g., multistoried and uneven-aged structure, decadence, snags, and downed logs). Pre-harvest basal area and long-term objective of the site dictate which of two groups of regimes is applied. General post-harvest conditions include:
<table>
<tr><th></th><th>Group A</th><th>Group B</th></tr>
<tr><td>maximum dbh[1] (inch) of retention trees</td><td>40</td><td>48</td></tr>
<tr><td>basal area (square feet/acre), post-harvest</td><td>240</td><td>300</td></tr>
<tr><td>% of basal area in trees >24 inch dbh</td><td>62</td><td>64</td></tr>
</table>
For both groups, next cut occurs after 20 years, as needed.</td></tr>
<tr><td>Selection (20 regimes total)</td><td>Goal is to create and maintain late-seral forest conditions. Post-harvest conditions:
<table>
<tr><td>maximum dbh (inch) of retention trees</td><td>40</td><td></td></tr>
<tr><td>basal area (square feet/acre), post-</td><td>100-250</td><td>(varies by site class)</td></tr>
<tr><td>% of basal area in trees >24 inch dbh</td><td>9-10</td><td></td></tr>
</table>
Next cut occurs after 10-20 years, as needed.</td></tr>
<tr><td>Even-aged (96 total regimes)</td><td>Goal is to harvest all trees and restock site. First precommercial thin is within 20 years. Post harvest basal area is 100-200 square feet/acre. First commercial thin is 10-20 years before next clearcut. On intensively managed sites, initial cut is a commercial thin, depending on pre-harvest basal area (115-230 square feet/acre) and volume (10-25 MBF). Post-harvest basal area ranges from 100 to 200 square feet/acre. Initial harvest is a clearcut if basal area exceeds a minimum standard and volume exceeds 25 MBF[2].</td></tr>
<tr><td>Shelterwood/seed tree (24 regimes total)</td><td>Goal is to remove most trees but retain some as shade trees or as seed trees. Post-harvest conditions of first entry (seed step): retain basal area of 75 square feet/acre inch largest trees up to 40 inch dbh. After 20 years (shelterwood removal step), remove all trees greater than 18 inch dbh, retaining a basal area of 75 square feet/acre. After 20 years, repeat the cycle. Stocking levels dictate whether commercial thin precedes or follows seed step. Seed step post-harvest conditions: basal area of 50 square feet/acre in trees >40 inch dbh which are left as seed trees. After 20 years, remove seed trees >18 inch dbh and leave 50 square feet/acre</td></tr>
</table>

[1] dbh=diameter at breast height.
[2] MBF=thousand board feet.

The area subject to the various silvicultural regimes is shown (table 3). An even-aged regime, followed by no harvest and selection regimes, would be applied to most timber harvest units.

Table 3. Harvest regime for the permit period. Data are from the proposed SYP/HCP.

Management Regime	Acres
No harvest	56,835
Restock	451
Late-seral (240 square feet)	28,710
Late-seral (300 square feet)	2,076
Selection	2,958
Even-aged	98,549
Shelterwood/Seed Tree	7,671
Current THP	14,453

Site preparation

Excessive amounts of slash and unwanted shrub and tree species on clearcuts would be removed, through broadcast burning or mechanical methods, to ensure uniform planting of trees throughout the harvest unit and to reduce wildfire potential. Broadcast burning permits must be obtained from CDF and the regional air quality board. Fire trails may be constructed to protect resources at risk (e.g., riparian habitat adjacent to a stream). Burns would be monitored by on-site personnel who would take action to extinguish or control an escaped fire.

Planting

Tree planting would be the principal reforestation method used to meet CFPRs stocking requirements. Seedlings would be selected to fit local site conditions.

Vegetation Management

Vegetation management may be used to control unwanted vegetation. Some sites may require more than one treatment. Use of forest chemicals (i.e., herbicides, pesticides, and fertilizers) would not be covered under the ITPs.

Thinning

Precommercial thinning will be applied to overstocked, even-aged stands (approximately 15 years old), where appropriate, to redistribute the growth potential to conifer trees; stems are cut down and left on the site to decay. Commercial thinning may be applied to stands as young as 35 years and requires preparation of a THP. Leave trees (i.e., the trees that will be retained) are selected to ensure that they are evenly distributed throughout the site and have the potential to take advantage of the increased growing space. Harvested trees are removed from the site and commercially processed.

Table 4. Approximate acres of timber harvest, by silvicultural prescription by plan decade. Compiled from data in unnumbered table "Area Assigned by Silvicultural Prescription Code, Alternative 164g" in SYP/HCP, Volume III, Part C.

Plan Decade	Clearcut Acres	Active THPs[1]	Late-Seral Selection	Single Tree Selection	Restock	Total Acres Harvested
1	36,005	14,479	3,265	637	497	54,883
2	49,612	0	3,275	115	0	53,002
3	39,242	0	6,600	327	0	46,169
4	17,025	0	7,059	6	1,690	25,780
5	5,887	0	4,235	0	0	10,122
Totals	147,771	14,479	24,434	1,085	2,187	189,956

[1] Most existing THPs result in commercial thinning in decade 1, followed by clearcut in decades 2 or 3. For the purposes of this analysis, we assume that all active THPs will be implemented and these acres have been considered as harvested in the environmental baseline.

Table 5. Acres of timber harvested in first decade (does not count active THPs) by seral stage and major silvicultural prescription. Compiled from unnumbered table "Acres Manaoed [sic] in First Decade by Stand Type and Major Silvicultural Prescription" from SYP/HCP, Volume III, Part C.

Seral Stage	Selection Harvest	Late-seral Selection	Clearcut	Commercial Thin	Seed Tree[1]	Shelter-wood	Total Acres Harvested
Old-growth	0	166	2,236	148	28	0	2,578
Late-seral	444	2,902	22,074	3,606	1,298	0	30,324
Mid-Successional	194	193	8,556	4,376	1,189	0	14,508
Young Forest	0	3	147	4,390	108	0	4,648
Forest Opening	0	0	0	0	0	0	0
Hardwoods	0	0	1,890	29	405	0	2,324
Totals	638	3,264	34,903	12,549	3,028	0	54,382

[1] Includes overstory removal prescriptions.

Fire suppression
In the event of wildfires, activities similar to those used for escaped control burns will be used to minimize the total number of affected acres. These activities will be covered by the ITPs and, under this Plan, fire management plans will be prepared for the MMCAs.

Roads and landings
Activities for the maintenance, upgrading, construction, reconstruction and closure of roads and landings include: 1) implementation of PALCO's storm-proofing program (see SYP/HCP, Volume I, page 57); 2) construction and reconstruction of new roads in connection with timber management, including clearing vegetation from road rights-of-way, removing trees, grubbing (removing stumps and surface organics), grading, and compaction; 3) extraction of rock, sand, and gravel from small borrow pits for use in road construction and maintenance, drainage facility repair, and erosion control; 4) construction of stream crossings (bridges, fills with culverts, fords, and a variety of temporary crossings); 5) maintenance of surfaced roads, seasonal roads, culverts, bridges, fords, cuts and fill slopes; and 6) closure of roads, temporarily (i.e., decommissioned) or permanently (i.e., abandoned).

Approximately 400 miles of road will be built during the permit period: 150 miles in the first decade, 100 miles in the second decade, 75 miles in the third decade, 50 miles in the fourth decade, and 25 miles in the fifth decade. An unspecified, unlimited amount of roads and landings may be reconstructed. At least 750 miles of existing roads will be storm-proofed per decade within the first 20 years until all roads on the property have been brought up to that standard. Additional details regarding road-related activities are provided in the Guidelines for Forest Roads and Landings (SYP/HCP, Part N of Volume II).

Commercial Rock Quarries
PALCO operates two permitted commercial hard rock quarries on their lands, identified as Rock Quarry 1/Road 24 (Quarry 1) and Rock Quarry 2/Road 9 (Quarry 2). These two quarry operations will be covered by the ITPs for 2 years. Coverage for these operations beyond the 2-year period and coverage for any additional quarry sites proposed by PALCO will require amendments to the ITPs and HCP.

Quarry 1 is located in the Yager Creek drainage, approximately 5 miles upstream from Carlotta, California. The approved Humboldt County conditional use permit and the approved mining and reclamation plan for the quarry provide for a total production of approximately 125,000 cubic yards of aggregate material. The entire quarry site includes approximately 3.5 acres. Quarry 2 is located in the Lawrence Creek drainage of the Yager Creek watershed. It was operated for many years for in-house use only; following approval of the conditional use permit, it would be mined for commercial purposes. The volume of available material in Quarry 2 is estimated at approximately 450,000 cubic yards, and the site encompasses approximately 10 acres.

Quarry operations involve excavation, drilling, blasting, screening, loading, and hauling. Activities ancillary to the quarry operation include road relocation, erosion control, annual closure, and final reclamation. Materials are hauled off-site and transported by truck or rail to their ultimate destination for use as slope stabilization, bedding, and road base. Operations are seasonal, with most mining occurring from April through November. Minor quarrying may occur from December through March in response to local demand for material or the need to provide material for erosion control or road storm-proofing activity. Additional information about the quarries is provided in Part J of Volume II (SYP/HCP). PALCO also uses many small sand or rock sources (borrow pits) on their lands for road maintenance, drainage facility repair, and erosion control. Because of their small size and minor impacts, these borrow pits do not require permits under Federal or State regulations and are not mapped or inventoried. Activities associated with these borrow pits are part of PALCO's road and sediment control program and are covered by the ITPs for a period of 5 years after the effective date.

Scientific surveys and studies

Scientific surveys and studies are conducted on PALCO lands by PALCO personnel and contractors, resource agency staff, and independent researchers. Surveys and studies of listed species are subject to approval by the Federal and State agencies with jurisdiction over the species and, if collection or other forms of take are involved, authorization under the Act and an equivalent State authorization are required as appropriate. PALCO currently is seeking a section 10(a)(1)(A) permit from the NMFS for scientific collection of coho salmon.

Changed and Unforeseen Circumstances

Under the SYP/HCP, PALCO could be required to provide additional mitigation in response to the changed circumstances identified under the plan. These circumstances are described below, along with the mitigation that PALCO would carry out. Unforeseen circumstances are also described. PALCO would not be responsible for additional mitigation consisting of additional commitments of land, water, or financial compensation or additional restrictions on the use of land, water, or other natural resources with regard to the covered species beyond that required under the SYP/HCP in response to unforeseen circumstances. Refer to attachment 4 in the proposed SYP/HCP.

Changed circumstances identified in the proposed SYP/HCP include fire, windthrow, landslides, floods, and earthquakes. The mitigation for all categories of changed circumstances is the same: PALCO, in cooperation and consultation with the wildlife agencies, would conduct an expedited watershed analysis on the hydrologic unit impacted by the changed circumstance. The analysis would begin as soon as the requisite personnel from PALCO and the wildlife agencies could be made available. The wildlife agencies would establish the site-specific prescriptions for implementation upon completion of the watershed analysis. Ongoing covered activities could continue under the existing aquatic species conservation plan until new prescriptions were developed, but as the wildlife agencies deem necessary and in consultation with PALCO, measures would be promptly implemented to minimize adverse effects on covered species prior to completion of the watershed analysis. Changed circumstances identified in the proposed SYP/HCP are as follows:

- Wildfires (including those originating from timber operations and prescribed burning) that cover 20 percent or more of a planning watershed but cover 5,000 acres or less. Any fire as described that covers more than 5,000 acres would be considered an unforseen circumstance.

- A windstorm that results in the complete blowdown of trees of an area between 200 and 500 feet within the RMZ, as measured along the length of any Class I or II water. A windstorm that results in the complete blowdown of more than 500 feet of trees within the RMZ would be considered an unforseen circumstance.

- A landslide or landslides that cause, or are substantially likely to cause, alteration of between 10 and 80 percent of the instream condition in any one Class I water, and a landslide or landslides that cause, or are substantially likely to cause, alteration of between 10 and 80 percent of the instream condition of the total length of all Class II waters within a planning watershed. A landslide or landslides that cause, or is likely to cause, alteration more than 80 percent of the instream condition in any one Class I water, and a landslide or landslides that cause, or are substantially likely to cause, alteration of 80 percent or more of the instream condition of the total length of all Class II waters in a planning watershed would be considered an unforseen circumstance.

- A 50-year to 100-year recurrence interval flood event. A flood event that is greater in magnitude than a 100-year recurrence interval flood event would be an unforseen circumstance.

- An earthquake that causes a landslide or landslides as described above. Earthquakes of such significant magnitude as may substantially alter habitat status or require additional conservation or mitigation measures, other than addressed above, would be considered unforseen circumstances.

Operating Conservation Programs

Several aspects of the proposed action form the basis of the terrestrial and aquatic conservation strategies. The conservation strategies consist of the following operating conservation programs: THP checklist; HCP Monitor; marbled murrelet and northern spotted owl conservation plans; additional species' conservation plans; measures to conserve habitat diversity and structural components; and aquatic species conservation plan.

Timber Harvest Plan checklist and Habitat Conservation Plan Monitor

The *Pacific Lumber Company Timber Harvest Plan Checklist* will guide PALCO resource professionals preparing THPs and timber harvest exemptions, in addition to agencies conducting the environmental review of PALCO's plans. The checklist will be used to confirm that all relevant elements of the Operating Conservation Program are contained in the THPs and made enforceable under the THPs. PALCO and the wildlife agencies (comprised of FWS, NMFS and

CDFG) will revise the checklist during watershed analysis to create a THP checklist for each watershed to ensure implementation of watershed-specific prescriptions.

To assist the wildlife agencies in monitoring PALCO's compliance with the Operating Conservation Programs below, PALCO shall fund one or more independent third parties to monitor the implementation of the Final HCP Operating Conservation Program. The third party will be approved by the wildlife agencies and is known as the "HCP Monitor." The HCP Monitor would also monitor the effectiveness of the Plan if so directed by the wildlife agencies. The HCP Monitor shall be qualified in forestry, fisheries biology, and wildlife biology. The HCP Monitor shall have full access to PALCO's land at all times to inspect any covered activity, and shall be present on site during every timber harvest conducted by or on behalf of PALCO.

The HCP Monitor shall report immediately to designated representatives of the wildlife agencies and CDF any deviations by PALCO from the conservation and management measures provided for under the Final HCP Operating Conservation Program. The wildlife agencies and CDF may take appropriate action to enforce Federal and State permits, the CFPRs, and other applicable Federal and State laws. The HCP Monitor shall also report quarterly to the wildlife agencies, regarding implementation and compliance by PALCO.

The intensity of the compliance monitoring by the HCP Monitor will be reevaluated by the wildlife agencies at the end of the first 10-year period following the effective date of the HCP, and every 10 years thereafter based on PALCO's record of compliance during the prior 10-year period.

<u>Marbled murrelet conservation plan</u>

Conservation Measures

1. Establishment of MMCAs and Other Protective Buffers:

    a) Establish 11 MMCAs and the Grizzly Creek complex as identified in the proposed SYP/HCP, which includes the addition of approximately 274 acres to the Owl Creek MMCA and 350 acres to Grizzly Creek Complex

    b) All MMCAs, will be protected for the life of the permit.

    c) The Grizzly Creek complex will be protected for the first 5 years of the permit. As described in the IA, at the end of 5 years, any portions of this area remaining in the ownership of PALCO will be evaluated by a panel and the FWS and CDFG. The agencies will then make a finding as to whether allowing timber harvest and the other covered activities in the complex would jeopardize the marbled murrelet. If the agencies determine that harvest of the area would jeopardize the murrelet, the area would be protected as an MMCA for the life of the permit. If the agencies determine that harvest of the area would not jeopardize the species, the area would not be designated as an MMCA and would be managed in accordance with the SYP/HCP's Operating Conservation Programs applicable to acres outside of the MMCAs.

d) A process will be established for further delineation of boundaries of MMCAs and conditions within MMCAs within the first year of the permit. Aerial photos, maps, written descriptions, and, where feasible, Global Positioning System (GPS) points will be used to describe boundaries. Videos will document existing conditions along all roads within MMCAs. When THPs are proposed in stands contiguous with MMCAs, formal land surveys will be conducted to establish boundaries prior to harvest.

e) When possible using property owned by PALCO, the MMCAs were designed with 300-foot buffers incorporated within their boundaries. In some cases, where intervening features such as ridgelines and roads would substantially reduce the effectiveness of buffers, vegetated buffers might not be deemed necessary. In several instances, buffers additional to the ones described in the proposed SYP/HCP are or may be appropriate. These additional instances are described as follows.

1). Additional 300-foot buffers will be established at certain points along the south edge of the Headwaters Reserve and the northwest edge of the North Fork Elk MMCA.

2). If property bordering an MMCA is acquired by PALCO, buffers shall be added to the MMCA immediately on the acquired property, and the acquired property will be subject to the measures described in the Operating Conservation Plan, relating to areas adjacent to MMCAs.

3). During the review of MMCA boundaries, the mapped buffers will be reviewed by the wildlife agencies and PALCO to ensure that they meet the objectives of protection of MMCA values to the maximum extent feasible, and to consider whether additional buffers should be added to meet the objectives.

MMCAs would remain in PALCO ownership. MMCAs currently comprise a total of 8,510 acres, including 1,522 acres of uncut old-growth redwood and 3,174 acres of second-growth containing remnant residual old-growth redwood trees (table 6). The remainder of the area is comprised of young or other unsuitable nesting habitat.

Table 6. Distribution of acres within MMCAs by habitat type, including the Grizzly Creek Complex (Final EIS/EIR, Volume I, table 3.9-2, page 3.9-4).

Habitat type	Acres
Uncut old-growth redwood	1,522
Uncut old-growth Douglas-fir	202
Residual old-growth redwood	3,174
Residual old-growth Douglas-fir	14
Late-seral	462
Mid-successional	1,251
Other[1]	1,885
Total:	8,510

[1] "Other" habitat type is defined as including young forest, open forest, hardwood, open/non-timber, and grassland/prairie habitat types.

2. Management in the MMCAs. Management in the MMCAs shall be consistent with the following goals and objectives of the MMCAs: 1) maintain the value of currently suitable marbled murrelet nesting habitat; 2) recruit suitable marbled murrelet nesting habitat in old-growth residual stands; and 3) provide buffering for and contiguity of suitable and recruitment nesting habitat in young-growth stands. Except as expressly provided, management shall be conducted in consultation with the FWS and CDFG.

a). *MMCA Silviculture*. In consultation and with the concurrence, or at the request of the FWS and CDFG, and at PALCO's option, the silvicultural prescriptions described in proposed SYP/HCP may be employed to advance the goals and objectives of the MMCAs.

b). *MMCA Infrastructure and Land Use*. Certain activities, roads, and other facilities within the MMCAs on PALCO's lands will remain available for use, consistent with the aquatic species conservation plan and the IA and subject to the following conditions:

1). Existing, active, and previously used haul roads may be used, maintained, storm-proofed, upgraded, closed or decommissioned as limited by Section 3.1.1(a)(1) of the IA.

2). Properly licensed and permitted game hunting may occur from September 16 of each year until March 23.

3). Maintenance and use of existing roads and facilities can require the removal of trees. To the extent feasible, such activities with potential for disturbance shall be conducted outside the marbled murrelet breeding season. Trees removed within the RMZ or blocking a road will be left in the vicinity of its removal.

4). Tree removal or salvage necessary for road maintenance, storm-proofing, upgrading, closure, or decommissioning shall be kept to a minimum. Downed, wind thrown and hazard trees within the RMZ must be retained as required by the terms of the aquatics species conservation plan.

5). Fuel removal will be allowed only in residual and second-growth buffers and will require consultation and written concurrence from the FWS and CDFG.

6). Fire suppression will be allowed as otherwise provided in a fire management plan for the MMCAs provided within one year of permit issuance, and approved by the wildlife agencies.

7). Stream enhancement projects may be undertaken with prior written concurrence of the FWS and CDFG.

8). Borrow pits and rock material sources within the MMCAs may be opened, and the material used for roads, drainage, maintenance, and repair without consultation or concurrence with the FWS and CDFG so long as no trees greater than 12 inch diameter at breast height (dbh) are removed from said locations, and no single new borrow pit area greater than 2 acres is cleared, with a maximum limit of no more than 2 new sites in any MMCA, with a cumulative total area of 4 acres cleared, after the effective date of this permit, for the full life of the permit, in any one MMCA. Any borrow pit site tree removal or land clearance in excess of these limits from and after the effective date of this permit will require consultation with and concurrence by FWS and CDFG and full compliance with applicable Federal and State laws including NEPA, California Endangered Species Act (CESA), and CEQA. Borrow pits are covered activities under the ITPs for a period of 5 years from the date the ITPs are issued. Coverage of borrow pits beyond the five year period will require an amendment to the ITP.

9). Scientific surveys and studies as part of the Plan monitoring program described infra may be undertaken.

10). PALCO will limit all blasting to the period after September 15 and prior to March 24 of each year at the hard rock quarry within the Allen Creek MMCA, To the maximum extent feasible, PALCO will also implement measures to mitigate disturbance impacts at other times of the year.

3. Minimization of Take of Marbled Murrelets

a). One-quarter mile seasonal buffers and 300-foot buffers with PALCO's late-seral silvicultural prescription will be established on PALCO lands bordering old-growth marbled murrelet habitat on public lands.

b). All activities proposed within MMCAs, within 0.25 mile of MMCAs, within 0.25 miles of old-growth habitat in parks and acquired reserves, and within 0.25 mile of other occupied stands, will be reviewed by PALCO, FWS, and CDFG to ensure that disturbance of murrelets in MMCAs has been minimized to the greatest extent feasible.

c). A habitat rating evaluation process will be established for residual and old-growth stands authorized for harvest which have not been surveyed to protocol. Stands that have been determined to be occupied, or determined by protocol surveys to not be occupied, are not subject to this process. The rating process will divide those stands into two groups that are equal or nearly equal in acreage: a "higher quality" habitat group and a "lower quality" group. The group with the lower habitat quality rating may be harvested without other restrictions related to murrelets, except for inclusion in the take minimization measures described 3a and 3b. Along with the occupied stands, the group with the higher habitat rating will be subject to the take minimization process described in 3a and 3b above and in the two paragraphs below.

1). To minimize take of nesting murrelets, eggs, and young in old-growth redwood stands rated as higher quality habitat and in old-growth redwood stands known and documented to be occupied by murrelets at the time of ITP issuance, and which are authorized for harvest, the following restrictions apply: (a) Operations associated with falling (road construction, marking, layout construction, and falling) will occur outside the breeding season. (b) Operations associated with log removal (e.g., yarding, loading, and hauling) may take place at any time, except: 1) within 0.25 mile of MMCAs or other occupied habitat (and thus subject to review under process described above); 2) as restricted by other HCP measures; or 3) where restricted by other laws or regulations. Unsurveyed old-growth redwood stands in the lower quality habitat group are not subject to the seasonal restrictions in this section, except as provided in 3a and 3b above.

2). For old-growth and residual redwood authorized for harvest, including the higher quality habitat group identified in the process described above, conduct prioritization process for harvest. The prioritization process and harvest phasing will not apply to the lower quality habitat group of unsurveyed habitat. The FWS, CDFG, and PALCO will work cooperatively to schedule harvest of old-growth redwood and residual redwood in a manner which minimizes impacts to marbled murrelets while recognizing PALCO's operational needs.

Monitoring

Monitoring to determine whether the SYP/HCP conservation strategies are implemented as written will be carried out by the HCP Monitor and wildlife agencies. Effectiveness monitoring will be carried out by PALCO and/or by outside contractors including the HCP Monitor, approved by the wildlife agencies. Effectiveness monitoring will seek to document changes in the marbled murrelet populations on PALCO lands, and to a lesser degree on neighboring lands and waters, and to document changes in the habitat of these populations on PALCO lands. PALCO will provide to the FWS and CDFG an annual report on the effectiveness monitoring.

The United States Forest Service (USFS), and/or outside contractors will conduct off-shore monitoring. PALCO will contribute $30,000 annually for at least the first 5 years to the existing cooperative research and monitoring effort through the Marbled Murrelet Study Trust, or the USFS Pacific Southwest Forest and Range Experiment Station. No land management adjustments, except potentially to the Grizzly Creek Complex, are required or anticipated under this plan pursuant to results or analyses of offshore census data.

A research fund will be established to provide funding for research into the conservation needs of the marbled murrelet. Funding will be applied according to the recommendations of a scientific panel and agencies, with the addition of one member of the Marbled Murrelet Recovery Team. Funding may be applied to projects within marbled murrelet conservation zones 4 and 5. A total of $200,000 per year for the first 5 years and $100,000 per year for next 5 years will be provided by PALCO.

Northern spotted owl conservation plan

The northern spotted owl strategy will rely upon other conservation elements of the proposed SYP/HCP for the retention and recruitment of potential foraging, roosting, and nesting habitat in watersheds across the ownership and through the HCP period. Specifically, the silvicultural requirements associated with RMZs, the mass wasting avoidance strategy, cumulative effects and disturbance index restrictions, MMCAs, and retention standard of 10 percent late-seral habitat for each Watershed Assessment Area (WAA) are likely to provide habitat which spotted owls may find suitable. At individual activity sites, the strategy provides specific habitat retention requirements to conserve habitat for foraging, roosting, and nesting.

Management Objectives

1. Retain a minimum of 108 activity sites each year over the life of the HCP.

2. Maintain northern spotted owl pairs on an average of 80 percent of the activity sites on the ownership.

3. Maintain an average reproductive rate of at least 0.61 fledged young per pair.

4. During the initial 5 years of the HCP, maintain and document the following minimum number of activity sites (table 7):

Table 7. Management objectives for northern spotted owl activity sites

Years After Permit Issuance	Minimum Number of Activity Sites
1	145
2	135
3	125
4	115
5	108

Conservation Measures

1. PALCO, the FWS, and the CDFG shall establish a Scientific Advisory Panel. This panel shall review and make recommendations for monitoring techniques, offer expert review of monitoring results, and make recommendations to PALCO on habitat retention standards for the maintenance and recruitment of northern spotted owl activity sites. This panel shall be convened, at a minimum, in years 1, 6, and 11 following issuance of the ITP.

2. Conduct complete annual censuses to monitor all activity sites on the ownership and determine the numbers of pairs, nesting pairs and reproductive rates. PALCO may use a sampling methodology, rather than a complete census, provided the sampling proposal has been reviewed by the Scientific Advisory Panel and approved by the FWS and CDFG. Monitoring data shall be provided annually to the Scientific Advisory Panel, FWS, and CDFG.

3. **Surveys**

   a). For active operations which begin before the breeding season (March 1), the THP area and a 1,000-foot buffer will be surveyed, with one visit between March 1 and March 15, or later if necessary. Two additional surveys at least 1 week apart will be performed between March 15 and August 31.

   b). For new operations initiated between March 1 and August 31, the THP area and a 1,000-foot buffer shall be surveyed. Three survey visits, each separated by at least 1 week, shall occur prior to the start of operations but after March 1.

   c). When northern spotted owls are contacted on the surveys, a daytime follow-up will be conducted as soon as possible to determine nesting status. If northern spotted owls are detected within areas where management activities will occur, operations shall cease until status is determined.

   d). Once nesting status has been determined, the following three conservation measures (4, 5, and 6) shall be implemented.

4. PALCO shall select and identify to the FWS and CDFG before June 1 each year at least 80 activity sites which shall be maintained using the following habitat retention guidelines (referred to as Level One Protection). Activity sites selected for Level One habitat retention must have supported northern spotted owls in the previous year and must also be active for the year in which the site is selected. PALCO may select any 80 activity sites which meet Level One habitat retention standards. Selection of a site in one year does not imply that the site must be maintained in subsequent years.

a). For activity sites where the northern spotted owl status has been determined to be nesting, or until a wildlife biologist determines that nesting has failed or that young are capable of avoiding direct impacts of timber harvest (e.g., young are capable of sustained flight or can take live prey independently), no harvesting shall occur during the breeding season (March 1 through August 31) within a 1,000-foot radius of the nest tree.

b). Within 500 feet of the activity center, the characteristics of suitable nesting habitat, if present, must be maintained. No timber operations, including salvage, shall be conducted in this area during the breeding season unless approved by the FWS and CDFG. Timber operations may be conducted in this area outside the breeding season if appropriate measures are adopted to protect suitable nesting habitat.

c). Within 500 to 1,000 feet of the activity center, retain sufficient suitable characteristics, if present, to support roosting and provide protection from predation and storms.

d). Five hundred acres of suitable northern spotted owl habitat must be provided, if present, within 0.7 mile of the activity center. Less than 50 percent of the retained habitat shall be under operation in any one year. If fewer than 500 acres of suitable northern spotted owl habitat are present, the acreage shall not be reduced. The 500 acres should be as contiguous as possible.

e). A total of 1,336 acres of suitable northern spotted owl habitat must be provided, if present, within 1.3 miles of each activity site. If fewer than 1,336 acres of suitable northern spotted owl habitat are present, the acreage shall not be reduced.

f). The shape of the areas established for habitat retention objectives shall be adjusted to conform to natural landscape attributes, such as draws and stream courses, while retaining the total area required.

5. At activity sites which have not been designated for Level One protection, PALCO shall apply Level Two protection measures as follows:

a). For activity sites where the northern spotted owl status has been determined to be nesting or until a wildlife biologist determines that nesting has failed or that young are capable of avoiding direct impacts of timber harvest (e.g., young are capable of sustained flight or can take prey independently), no harvesting shall occur during the breeding season (March 1 through August 31) within a 1,000-foot radius of the nest tree.

b). Following the breeding season, 18 acres around the activity site shall be maintained as suitable nesting habitat, if present. The protected 18 acres shall conform to natural landscape features, as designated by PALCO's wildlife biologist, and the buffer protecting the activity site must be at least 400 feet wide.

c). For activity sites which have been determined to be occupied by a non-nesting pair or single northern spotted owl, 18 acres around the activity site shall be maintained as suitable nesting habitat, if present. The protected 18 acres shall conform to natural landscape features, as designated by PALCO's wildlife biologist, and the buffer protecting the activity site must be at least 400 feet wide. Harvesting may occur adjoining the 18-acre habitat retention area during the breeding season at PALCO's discretion.

6. Activity sites which are not needed to meet management objectives 1 or 4 may be harvested before March 1 or after August 31. All nest trees shall be marked by PALCO's wildlife biologist and shall be retained if the activity site is harvested.

Adaptive Management

1). PALCO is encouraged to conduct research to identify alternative activity site retention models for long-term management through the permit period. After 5 years, or at any later date during the permit period, PALCO may present for review by the Scientific Advisory Panel alternative activity site retention models, to substitute for Conservation Measures 4d and 4e above. Alternative activity site retention models shall not be implemented until they have been reviewed and approved by the FWS and CDFG. PALCO may use these models to manage for recruitment of suitable habitat and potential establishment of new activity sites.

2). PALCO, the FWS or the CDFG may at any time propose modifications to the characterizations of northern spotted owl suitable habitat (refer to table 7 in proposed SYP/HCP). Proposals shall be validated against any relevant data, including that collected in the performance of Conservation Measure 2. The Scientific Advisory Panel shall review applicable information and provide a recommendation to PALCO, the FWS and the CDFG, who shall mutually agree upon any modifications.

3). Management objectives may be modified if new information becomes available following review of the Scientific Advisory Panel and approval by the FWS and CDFG.

4). The seasonal bounds and duration of the prohibition on harvesting adjacent to activity sites may be modified, based upon ownership-specific information provided at PALCO's discretion, upon review by the Scientific Advisory Panel and approval by the FWS and CDFG.

5). The actual or estimated number of activity sites shall remain at or above Management Objectives 1 and 4 for each year of the HCP. If the applicable management objective is not achieved for any year of Plan operations, or if, for any reason, PALCO is unable to accomplish conservation measure 4, PALCO shall convene the Scientific Advisory Panel for a joint meeting with the FWS and CDFG to review potential reasons why the objectives are not being met and potential corrective measures to implement. PALCO, the FWS, and the CDFG shall jointly develop modified or additional measures to conserve activity sites, including the potential implementation of no-take management procedures. Any modifications shall be consistent with the issuance criteria for section 10(a)(1)(B) of the Act and the CESA.

6). Proportions of activity sites occupied by pairs and reproductive rates shall be averaged over running 5-year periods. If the 5-year average for either parameter does not meet the management objective, PALCO shall convene the Scientific Advisory Panel for a joint meeting with the FWS and CDFG to review potential reasons why the objectives are not being met and potential corrective measures to implement. Following this consultation PALCO, the FWS and the CDFG shall jointly develop modifications for Conservation Measures in Part b. Any modifications shall be consistent with issuance criteria for section 10(a)(1)(B) of the Act and the CESA.

7). Management Objective 1 and Conservation Measure 4 may be modified commensurate with changes in size of the ownership following review by the Scientific Advisory Panel and approval by the FWS and CDFG. Modifications, based upon size of the ownership and scope of incidental take coverage extended by the FWS and CDFG, may be proposed either by PALCO or the wildlife agencies.

<u>Bald eagle conservation plan</u>

Management Objectives

1. Implement nest site identification and protection measures which have a high probability of providing for the successful nesting of bald eagles.

2. Minimize disturbance of foraging bald eagles.

Conservation Measures

1. Surveys

    a). Focused surveys for bald eagle nests shall be conducted for THPs located within 0.5 mile of Class I waters that provide potential foraging habitat. Potential nesting habitat (old-growth or residual forest with trees greater than 40 inches in diameter) within THP areas and out to 0.5 mile from their boundaries shall be surveyed during the breeding season immediately prior to the commencement of operations. Operations shall not commence until surveys have been completed.

b). To increase the probability of detecting any adult eagles nesting on the ownership, surveys for eagles and their nests shall be conducted between March 1 and April 15. Surveys shall consist of at least three site visits, one of which shall occur after April 1. Thorough searches for eagles and their nests shall be made of the survey area. Repeated float trips down Class I waters that provide potential foraging habitat or surveys conducted by airplane or helicopter to search for adult birds and nests may be necessary.

c). If bald eagles are observed during surveys, additional visits shall be conducted to determine if eagles are nesting within a THP area or within 0.5 mile of its boundary. This determination may be aided by observing the eagle's behavior, location, and direction of flight. Plan operations shall not commence until surveys have been completed and the results of any positive surveys have been reviewed and approved by the FWS and CDFG.

d). Field personnel shall be trained to recognize bald eagle nests and other signs indicating their presence. Although most bald eagle nests are likely to occur within 0.5 mile of suitable foraging habitat, they could potentially occur anywhere on PALCO lands where nesting habitat is suitable. Therefore, all THPs shall be evaluated for the existence of suitable nesting habitat, and localized searches for nests and eagles shall be conducted if necessary.

e). Documentation (i.e., survey forms and written summaries) of field surveys performed for THPs shall be provided to the FWS and CDFG annually.

2. Nest Site Protection Measures

a) An active nest tree shall be defined as a tree used by bald eagles for nesting at least once within the previous 5 years. If inadequate data exist to document the status of individual nests, they shall be considered to be active. Occupied nests shall be defined as nests currently being used by bald eagles for reproduction. This shall include territorial behavior by one or more adults in the vicinity of a known nest, nest construction, egg laying, incubation, or rearing of young.

b). No trees within 500 feet of an active bald eagle nest shall be cut without prior consultation and concurrence from the FWS and CDFG. Harvest within the 500-foot radius will be limited to prescriptions which will enhance long term eagle habitat, such as precommercial or commercial thinning, selection, or an alternate prescription.

c). Timber operations including helicopter yarding shall not occur closer than 0.5 mile from occupied nests during the breeding season (January 15 through August 15, or post-fledging). Blasting or pile driving activities shall not occur within 1 mile of occupied nests. Disturbance buffers may be modified with consultation and concurrence by the FWS and CDFG based upon topographic and other site-specific and project-specific circumstances. Disturbance buffers may also be lifted through monitoring and a determination that the site is not occupied, that nesting is not occurring or has failed, or that the young have fledged.

3. Mitigation for Disturbance of Foraging Eagles

a). Skyline cables over Class I waters shall be marked to reduce the possibility of collisions when operating in or adjacent to known bald eagle foraging habitat.

b). Winter foraging by bald eagles on PALCO lands is currently known to occur between November and February but is uncommon. Implementation of the aquatic species conservation plan, specifically measures to reduce disturbance in the channel migration zones (CMZ) and Class I RMZs, and restrictions on winter use, construction, reconstruction, and storm proofing of roads are expected to effectively minimize the potential for disturbance.

Monitoring

Nest sites for which buffers are established shall be monitored during the breeding season each year the THP is in effect and for at least one breeding season following completion of the plan. Annual reports describing monitoring efforts shall be provided to the FWS and CDFG. PALCO, the FWS, and the CDFG shall meet at 5-year intervals to review the results of monitoring activities and to evaluate implementation and effectiveness of measures and potential procedural improvements.

American peregrine falcon conservation plan

Management Objective

Implement nest site identification and protection measures which have a high probability of providing for the successful nesting of peregrine falcons.

Conservation Measures

1. Surveys

a). Surveys of potential nesting habitat (i.e., at Scotia Bluffs, Holmes Bluff or any other location where suitable cliffs over 70 feet in height occur) shall be conducted within THP areas and within 0.5 mile of their boundaries if operations will occur during the breeding season (January 15-August 15). This distance shall be increased to 1 mile for projects involving blasting or pile driving activities. Surveys shall follow the guidelines in Pagel (1992), *Protocol for Observing Known and Potential Peregrine Falcon Eyries in the Pacific Northwest*, any year operations will occur.

1). Field personnel shall be trained to recognize peregrines and potential nesting habitat.

2). Documentation (i.e., survey forms and written summary) of field surveys performed for THPs shall be provided to the FWS and CDFG annually.

2. Nest Site Protection Measures

a). No trees within 500 feet of an active peregrine falcon nest shall be cut without prior consultation and concurrence from the FWS and CDFG.

b). To minimize disturbance, timber operations shall not occur closer than 0.5 mile from occupied nests during the breeding season. Blasting, pile driving, helicopter yarding, or similar activities (other than ambient conditions) capable of introducing loud noise, shall not occur within 1 mile of occupied nests.

Disturbance buffers may be modified with consultation and concurrence by the FWS and CDFG based upon topographic and other site-specific and project-specific circumstances. Disturbance buffers may also be lifted through monitoring and a determination that the site is not occupied, that nesting is not occurring or has failed, or that the young have fledged. Surveys shall follow the guidelines in Pagel (1992), *Protocol for Observing Known and Potential Peregrine Falcon Eyries in the Pacific Northwest.*

Monitoring

Nest sites for which buffers are established shall be monitored during the breeding season each year the THP is in effect and for at least one breeding season following completion of the plan. Annual reports describing monitoring efforts shall be provided to the FWS and CDFG. These reports shall disclose the dates of surveys, identity of surveyors, survey methods, and results (nest condition, occupancy rates, and nesting success). At 5-year intervals, PALCO, the FWS, and the CDFG shall meet to review the results of monitoring activities and to evaluate implementation and effectiveness of measures and potential procedural improvements.

Western snowy plover conservation plan

Conservation Measures

PALCO will conduct reconnaissance-level surveys (as described in United States Army Corp of Engineers (COE) gravel extraction permits for the area) on gravel bars above the Rio Dell bridge. If reconnaissance-level surveys locate plovers above the Rio Dell bridge, full protocol surveys will be instituted on all gravel bars within 1 mile of the sighting If snowy plovers are detected, the individual(s) shall be observed for evidence of nesting behavior. If a nest site is discovered, a 1,000-foot seasonal operations buffer will be applied until the end of the breeding season (March 24-September 15), or until it is determined that the nest has failed or nesting has been completed.

If PALCO acquires rights to gravel bars on the Eel River downstream from the Rio Dell bridge, those bars shall be surveyed in full compliance with FWS protocol existing at the time, and nest protection measures implemented that are consistent with measures used in the Eel River area at the time. If the species' breeding range is determined by any means to extend up the Eel River to the Rio Dell bridge, PALCO shall begin full protocol surveys of gravel bars above the Rio Dell bridge, and, if nests are located, PALCO shall implement nest protection measures as above. PALCO shall evaluate proposed gravel extraction levels with respect to potential indirect effects downstream. Within 3 years of permit issuance, PALCO and the agencies will meet to evaluate indirect effects of extraction on downstream gravel bars and to determine whether practicable mitigation measures would be appropriate.

Bank swallow conservation plan

Management Objectives

1. Avoid impacts on bank swallow nesting colonies on streambanks and hillsides.

2. Prevent nest colony establishment in stock-piled sand associated with in-stream mining operations.

Conservation Measures

1. Aquatic conservation measures, principally the CMZ and RMZ measures will minimize potential disturbance to nesting colonies.

2. Where new road construction crossing low gradient Class I waters is planned, where potential bank swallow habitat exists, PALCO shall survey the proposed alignment once in May and once in June to identify any nest colonies within 200 feet of the construction area. If nest colonies are found, PALCO shall consult with the FWS and CDFG to jointly develop measures which shall maintain the nest colony.

> a). Activities which may indirectly impact or disturb active nest colonies shall be separated by at least a 200-foot buffer during May and June. Alternative mitigation measures may be developed through consultation with the FWS and CDFG.
>
> b). PALCO shall attempt to prevent bank swallows from nesting in stock-piled sand associated with in-stream mining operations using netting or other means developed in consultation with the FWS and CDFG.

Monitoring

When conservation measures 2a or 2b above are implemented, PALCO shall monitor the nest colony each year that the covered activity operates within 300 feet of the site and for 1 year following cessation of operations. Monitoring shall determine the approximate dates that the colony is established and abandoned and the approximate number of adult birds, and document any indication that disturbance adversely affects success of the colony. Documentation (i.e., survey forms and written summary) of field surveys shall be provided to the FWS and CDFG annually.

Locations of identified colonies shall be reported by PALCO, within 90 days of discovery, to the CDFG Natural Diversity Data Base. At 5-year intervals, PALCO, the FWS, and the CDFG shall meet to review the results of monitoring activities, evaluate implementation and effectiveness of measures, and evaluate potential procedural improvements.

Pacific fisher conservation plan

The conservation strategy for this species is a combination of a "habitat based" approach with an additional structural component element. Specifically, the silvicultural requirements associated with RMZs, mass wasting avoidance strategy, cumulative effects/disturbance index restrictions, MMCAs, and the retention standard of 10 percent late-seral habitat for each WAA, is likely to provide for denning and resting habitat for Pacific fishers.

Management Objective
Maintain a sufficient amount of suitable habitat to contribute to a sustainable population of Pacific fisher in the Coastal Province of Northern California.

Conservation Measures
Retention of late-seral habitat on the ownership, through the life of the permit, is expected to provide sufficient habitat, in terms of quantity, quality and distribution to contribute to a viable population. CMZs and RMZs are expected to provide connectivity across the landscape. In many locations, CMZs and RMZs will intersect with other RMZ's or be augmented by habitat subject to silvicultural restrictions (e.g., northern spotted owl activity sites, mass wasting sites or steep slopes adjacent to RMZs). These areas, MMCA's and adjoining public lands will form an interconnecting network of habitat which is expected to provide opportunities for denning and resting sites in the Humboldt, Yager, and Van Duzen WAAs. PALCO land within the Bear Mattole and Eel WAAs are not expected to provide blocks of late-seral habitat through the life of the permit. Late-seral and old-growth habitats on public lands adjacent to PALCO lands in these two WAAs are expected to provide suitable habitat for the species.

The conservation measures to retain and recruit habitat structural components within and outside of RMZs across the ownership are expected to provide older forest legacies in younger stands when these stands reach a mid-successional seral stage. These legacy components are expected to provide suitable substrate for Pacific fisher denning and resting sites.

Implementation/Compliance Monitoring
Seral stage distribution will be tracked and reported as described in the conservation measures described in the proposed SYP/HCP under Measures to Conserve Habitat Diversity and Structural Components (pages 72-73).

Effectiveness Monitoring
Within 1 year of permit issuance PALCO, the FWS, and the CDFG will jointly develop a forest carnivore survey methodology. The objective would be to determine the extent of Pacific fisher use of habitat types and seral stages present on PALCO lands. The research/monitoring project will commence by the end of the second year after permit issuance. Between years 5 and 7 of the permit, PALCO, the FWS, and the CDFG shall meet to review the results of surveys and potential additional research needs.

<u>Red tree vole conservation plan</u>

The conservation strategy for this species is the same as for the Pacific fisher. Refer to the discussion above for the fisher.

Management Objective
Sustain viable red tree vole populations within each watershed assessment area on PALCO land, through the life of the permit.

Conservation Measure
The conservation measure for this species is the same as the measure described above for the Pacific fisher.

Implementation/Compliance Monitoring
The implementation/compliance monitoring for this species is the same as described above for the Pacific fisher.

Effectiveness Monitoring and Adaptive Management
Within 1 year of permit issuance PALCO, FWS, and CDFG will jointly develop a research/monitoring effort to examine red tree vole habitat seral stage use and habitat connectivity requirements on PALCO lands. The objective would be to determine conditions needed in younger forests to provide for and promote opportunities for maintaining tree vole populations capable of interbreeding and dispersing to other suitable habitats. Survey methodology will be based on the draft study plan developed by the Pacific Northwest Research Station (Biswell 1997).

The research/monitoring project will commence by the end of the second year after permit issuance. Between years 5 and 7 of the permit, PALCO, the FWS ,and the CDFG shall meet to review the results of monitoring/research activities and any other new information available on the species. Total acreage of habitat considered to be capable of supporting red tree vole populations will include an assessment of habitat connectivity based on available information on the dispersal capabilities of the species. This information will be used to evaluate the effectiveness of conservation measures and evaluate potential changes to the measures. In the event that PALCO, the FWS, and the CDFG cannot reach consensus on changes necessary to the operating conservation plan, the FWS and CDFG may terminate coverage for the California red tree vole under the ITP.

Amphibian and reptile conservation plan

Management Objectives
Sustain viable populations of the northern red-legged frog, foothill yellow-legged frog, tailed frog, southern torrent salamander, and the western pond turtle within each watershed assessment area in which they occur on PALCO land, through the life of the permit.

Conservation Measures

Conservation measures outlined in the aquatic species conservation plan are expected to provide for sustainable populations of these species where suitable habitat types occur across the PALCO lands. This plan outlines interim habitat protection measures for aquatic and adjacent riparian habitats as well as upslope management practices that are designed to reduce impacts on aquatic resources.

As part of the watershed analysis process an amphibian and reptile assessment module shall be developed which includes key and critical questions regarding life history requirements, including those upslope of the RMZ boundaries. This module will be part of every watershed analysis conducted under the Plan. Results from this module shall be integrated into synthesis and prescription development to minimize and mitigate management effects on all phases of life history. Refer to the aquatic species conservation plan for additional information.

Monitoring
Refer to the aquatic species conservation plan for a description of the implementation/compliance and effectiveness monitoring.

<u>Measures to conserve habitat diversity and structural components for covered species where applicable</u>

Management Objective

1. Habitat Diversity
    a). Ensure a mix of vegetation types and seral stages are maintained across the landscape over the permit period.

2. Structural Components
    a). Maintain and recruit sufficient amounts of and distribution of forest structural components to contribute to the maintenance of wildlife species covered under the ITP.

Conservation Measures

1. Habitat Diversity
    a) At the end of each 5-year period, PALCO will report the seral stage distribution for each hydrologic unit to gauge conformity with projected forest seral types for PALCO lands described in the SYP as approved by CDF and demonstrate compliance with the following measure in the SYP/HCP:

        1) Throughout the planning period, PALCO's forested lands within each WAA will include at least 10 percent late-seral, 5 percent mid-successional, 5 percent young forest, and 5 percent forest opening.

2. Habitat Structural Components
    a). All snags (standing dead trees) that do not constitute a safety hazard to workers will be retained during timber harvest.

b). At a minimum, the following numbers of snags (conifer and hardwood) shall remain averaged over the THP area following timber harvest and site preparation (larger snags may be substituted for smaller snags):

- 1.2 snags per acre over 30 inches dbh and over 30 feet tall;
- 2.4 snags per acre over 20 inches dbh and over 16 feet tall;
- 1.2 snags per acre over 15 inches dbh and over 12 feet tall.

c). Snags in RMZs adjacent to harvest units may be counted toward the objective; but at least one-half the snags in each size category must be outside Class I and II RMZs.

d). If snags are not present to meet the above objective, green trees in the same size categories shall be retained in numbers sufficient to meet the objective. Conifer species other than redwood shall have priority for retention. Green trees identified as replacement trees for snags shall be retained during subsequent timber harvest entries through the permit term.

e). In the event of an emergency, as described in Section 1052.1 of the CFPRs, such as wildfire, pest or disease outbreak, the requirement for retention of all snags may be waved through consultation with and approval by the FWS and CDFG.

f). Retain at least 4 live cull trees per acre outside of Class I and II RMZs that do not constitute a safety hazard. Trees 30 inches dbh, and trees with visible defects such as broken tops, deformities, or cavities will have priority for retention. Live cull trees may include trees with merchantable (8 inches or greater dbh)logs. These trees shall be retained during subsequent timber harvest entries through the permit term so long as they do not constitute a safety hazard.

g). All live hardwood trees over 30 inches dbh that do not constitute a safety hazard will be retained following timber harvest and site preparation, to a maximum of two per acre. Hardwoods within all RMZs count towards this objective.

h). Two logs per acre greater than 15 inches in diameter and over 20 feet long will remain following timber harvest and site preparation. One of these logs per acre must be in decay class 1, 2, or 3 (Maser and Trapp 1984). Hollow logs over 30 inches in diameter will have priority for retention. Logs in Class I and II RMZs will not be counted toward this objective. There will be no requirement to leave down logs where they do not exist currently unless results of the first 5 years of monitoring indicate management objectives are unlikely to be met.

I). Snag, live cull, hardwood, and down log conservation measures shall apply to THPs, Timber Harvest Exemptions, and Notice of Emergency Timber Operations, and will be evaluated based on the average number measured over a 40-acre harvest unit.

c. Monitoring

1. Implementation/Compliance

Because of the current lack of information regarding quantity and quality of snags and downed logs, monitoring is a key component of this strategy. Monitoring will develop data on these habitat components for each hydrologic unit on PALCO lands.

a). During preparation of THPs, the RPF (or designee) shall gather information on presence of snags, down logs, hardwoods, and live culls for inclusion in the habitat component monitoring process described below.

b). Monitoring of snags, live culls, hardwoods, and downed logs will occur during reforestation inspections, timber stand improvement monitoring, or timber stand cruises. This monitoring program may be altered in the future, but if alternations are made they will conform to the standards set forth here, and those developed in consultation with the FWS and CDFG.

c). A training program for RPFs, wildlife and fisheries biologists, Licensed Timber Operators (LTO), and all other technicians responsible for implementing this strategy will be designed and implemented. PALCO will work with the FWS and CDFG in developing the training program.

At the end of the first year of plan implementation, PALCO will meet with the FWS and CDFG to review the data collection and monitoring procedures and determine if they are effective in producing the information required to implement the snag and downed log measures. Changes in procedures, if necessary, will be developed by PALCO in cooperation with the FWS and CDFG.

2. Effectiveness Monitoring and Adaptive Management.

a). To ensure the HCP measures will be effective in achieving the desired level and distribution of snags and down logs, PALCO shall conduct the following:

b). After 5 years of plan implementation, the effectiveness of the recruitment measures will be evaluated against the objectives based on monitoring results and following an intensive inventory and measuring of stand components. If the snag objectives are not being met through the recruitment procedures identified above, PALCO will develop and implement aggressive measures. Such measures may include additional marking and retention of recruitment trees, girdling and inoculation of trees with pathogens to accelerate mortality and decay, or modification of site preparation techniques.

c). In addition to the snag and down log inventories conducted during reforestation inspections, timber stand improvement monitoring, and timber stand cruises, a random sampling methodology will be developed in consultation with the FWS and CDFG and implemented on a 5 to10 year basis throughout the life of the permit. This sampling design will follow the framework described in Volume III, Part E of the SYP/HCP for timber volume estimates.

d). There will be no requirement to leave down logs where they do not exist currently until results of the first 5 years of monitoring have been evaluated. If the down log objectives are not being met through the recruitment measures identified in the SYP/HCP above, PALCO will develop and implement additional measures in consultation with the FWS and CDFG.

e). The HCP Monitor shall have full access to PALCO's land at all times to inspect any Covered Activity, and shall be present on site during every timber harvest conducted by or on behalf of PALCO. The HCP Monitor shall also, at the request of the wildlife agencies, monitor the effectiveness of the SYP/HCP measure for retaining and recruiting structural components of wildlife habitat.

Aquatic Species Conservation Plan

The aquatic species conservation plan is comprised of interim prescriptions and prescriptions generated from watershed analysis. The interim prescriptions are presented in the proposed Final HCP and would be implemented across PALCO's ownership unless and until modified as a result of a completed watershed analysis or the adaptive management process. Completion of the individual watershed analyses may lead the NMFS, FWS, and CDFG to establish tailored prescriptions for each individual watershed. The stated goal of the proposed Final HCP aquatic species conservation plan and that to which the post-watershed analysis prescriptions and adaptive management must adhere is to maintain or achieve, over time, a properly functioning aquatic habitat condition, as defined by NMFS. Full details of the proposed aquatic species conservation plan are found in section F3 of the proposed Final HCP.

The proposed aquatic conservation plan consists of six main interrelated elements for timber harvesting activities: riparian management strategy, hillslope management, road management, watershed analysis, a disturbance index, and monitoring. The aquatic species conservation plan also includes measures for other covered activities: burning, rock quarries, borrow pits, and water drafting. Monitoring would be conducted to determine compliance, effectiveness, and trends for all covered activities. Through watershed analysis, new scientific studies, monitoring, or information from other sources, prescriptions for any covered activity could be modified, as part of adaptive management, such that the plan continues to meet the objective of maintaining or achieving, over time, a properly functioning aquatic habitat condition. Mitigation for changed and unforseen circumstances in accordance with the "no surprises" rule would also be implemented.

Riparian Management Strategy

The riparian prescriptions would use a similar stream classification system as defined in the CFPRs for Class I, II and III watercourses. A minor expansion was made to the definitions so that the watercourses are now referred to as Class I, II and III waters. This strategy consists of prescriptions for the channel migration zone (CMZ) and for Class I, Class II and Class III waters. CMZs would be established by a qualified fluvial geomorphologist along Class I and II waters that have a Rosgen (1996) C, D, or E-type channel morphology. Within the CMZs, timber harvesting, including exemption harvest, sanitation salvage logging, and emergency timber operations, would be prohibited except in emergencies that could result in the loss of life or property and as per prior agreement with the wildlife agencies.

On Class I waters, a 170-foot RMZ would be established, measured by slope distance from the outer edge of the CMZ, where present, or the watercourse transition line. On Class II waters, a RMZ would also be established, measuring 130 feet from the outer edge of the CMZ or watercourse transition line. Class I and II RMZs would be further divided into two bands with different levels of management. On Class III streams, a 50-foot or 100-foot RMZ would be established, depending on slope. Class III RMZs would also be divided into two bands. The RMZ widths may be modified as a result of watershed analysis.

Class I waters

Prior to watershed analysis, the proposed Class I RMZ consists of a 100-foot No Harvest Band and a 70-foot Outer Band on each side of the water, measured from the outer CMZ edge or the watercourse transition line. Prescriptions for Class I RMZs are summarized in table 8.

Class II waters

Prior to watershed analysis, the proposed Class II RMZ consists of a 30-foot No Harvest Band and a 100-foot Selective Entry Band on each side of the water, measured from the outer CMZ edge or the watercourse transition line. Prescriptions for Class II RMZs are described in table 9.

Class III waters

Prior to watershed analysis, the proposed Class III RMZ would be either 50 feet wide for slopes less than 50 percent, or 100 feet wide for slopes equal to or greater than 50 percent, measured from the watercourse transition line. The first 30 feet of all Class III RMZs would be a No Harvest Band, except for certain acres where limited harvesting would be allowed (see below). Prescriptions for all Class III RMZs are described in Table 10.

Burning

In addition to the restrictions described for RMZs, the following prescriptions would be applied:

- No fire ignition in RMZs or EEZs. Ignite fires so that flame will back its way towards the RMZs and EEZs.

- Ignite fire on one side of RMZ at a time if, due to topographic features and/or fuel patterns, there is a likelihood that fires would intrude into the RMZ.

- Burning would be limited to spring and fall when fuel moisture conditions, relative humidity, and atmospheric conditions are conductive to controlled burning.

- Fuel breaks in RMZs would be avoided, except for some hand clearing that could be conducted to control escaped fires. No overstory vegetation would be removed.

- Areas of bare soil exposed from fuel breaks or fire that could result in fine sediment input into waters would be treated per the surface erosion requirements (see below).

- Where available and feasible, a helitorch would be used to ignite fires to better control the direction and speed of the fire.

Table 8: Summary of management prescriptions in Class I RMZs.

Band Width	Prescriptions
Entire RMZ	No sanitation salvage, exemption harvest, or emergency timber operations, except as per agreement with the wildlife agencies. EEZ[1], except for roads and permitted equipment crossings. Retain all downed wood, except slash as defined in the HCP. Trees felled during current harvesting and approved road construction are not considered downed wood. Felled hazard trees or snags not associated with a THP are considered downed wood; retain in general vicinity. Trees that fall naturally onto roads, landings, or harvest units within the RMZ are considered downed wood; retain in general vicinity. Retain all non-hazard snags, as per snag policy. Full suspension yarding used when feasible. Full suspension is not feasible on flat ground, in other sites with limited deflection, where an adjacent landowner will not provide permission to secure a cable, or where a full suspension yarding system would jeopardize the safety of field personnel. If full suspension yarding cannot be used, to maximum extent practicable avoid ground disturbance that may deliver sediment to a watercourse. Treat all sites of exposed mineral soil caused by yarding that can reasonably be expected to deliver sediment to a watercourse. To ensure worker safety, trees not marked for harvest can be felled to provide safety clearance for cable corridors. To the extent possible, such trees will be felled towards the watercourses to provide LWD[2]. Regardless, such trees must be retained in the general vicinity. Retain all trees not marked for harvest that are damaged during yarding. Maximum one entry every 20 years. The mass wasting strategy applies to any area within the RMZ, including the 50% slope provision band (see below), that falls within the boundary of a mass wasting area of concern.
No Harvest Band: 0-100 feet	No harvest, including sanitation salvage, exemption harvest, or emergency timber harvest. If a road exists within the first 30 feet of the No Harvest Band, increase band width on the opposite side of the watercourse an equivalent distance of that portion of the road prism.

Band Width	Prescriptions
Outer Band: 100-170 feet	Minimum 276 square feet conifer basal area per acre of RMZ, each side of watercourse, before harvesting may occur. Minimum 240 square feet post-harvest conifer basal area per acre of RMZ, per side. Basal area measurements made every 200-feet lineal segment of RMZ. Surface area covered in roads and landings included in basal area calculation. Single-tree selection only. Tree size and quantities retained per table 17 (SYP/HCP, Volume I). Larger tree size classes can be used for replacement if stated size classes are not present. No more than 40% of conifer basal area removed in a single entry.
50% slope provision	For slopes ≥50% adjacent to the RMZ, extend the RMZ Outer Band prescriptions, at a minimum, upslope to the break in slope or a slope distance of 400 feet (from the stream), whichever is less.

[1] EEZ=Equipment Exclusion Zone.
[2] LWD=Large woody debris.

Table 9: Summary of management prescriptions in Class II RMZs

Band Width	Prescriptions
Entire RMZ	Prescriptions identical to Class I, Entire RMZ.
No Harvest Band: 0-30 feet	No harvest, including sanitation salvage, exemption harvest, or emergency timber operations. If a road exists within the No Harvest Band, increase band width on the opposite side of the watercourse an equivalent distance of that portion of the existing road prism.
Selective Entry Band: 30-130 feet	Minimum 276 square feet pre-harvest conifer basal area per acre of RMZ, per side Minimum 240 square feet post-harvest conifer basal area per acre of RMZ, per side Basal area measurements made every 200 feet lineal segment of RMZ. Surface area covered in roads and landings included in basal area calculation. Single-tree selection only. Tree size and quantities retained per table 17 (SYP/HCP, Volume I). Larger tree size classes can be used for replacement if stated size classes are not present. No more than 40% of conifer basal area removed in a single entry
Sediment filtration band	For slopes <50% adjacent to the RMZ, establish a sediment filtration band from 130-170 feet. This band is an EEZ. Retain all down wood, except slash. No fire ignition.
50% slope provision	For slopes $\geq$50% adjacent to the RMZ, extend the RMZ Outer Band prescriptions, at a minimum, upslope to the break in slope or a slope distance of 400 feet (from the stream), whichever is less.

Table 10: Summary of management prescriptions in Class III RMZs.

Slope Class	Prescriptions
All slopes	The mass wasting strategy applies to any area within the RMZ that falls within the definition of a mass wasting area of concern. All RMZ width requirements stop at the hydrologic divide. EEZ, except for roads and permitted equipment crossings. Flag all tractor watercourse crossings on the ground prior to the pre-harvest inspection; show on the THP map. All skid trails would be stabilized, per the 1998 CFPR, per an approved THP in accordance with the Class I/II standard. Retain all downed wood and debris within the RMZ, except for cases of emergency as per agreement with the wildlife agencies. Retain all downed wood and debris in the channel. Trees felled during current harvesting and approved road construction are not considered downed wood. Felled hazard trees or snags not associated with a THP are considered downed wood; retain in general vicinity. Trees that fall naturally onto roads, landings, or harvest units within the RMZ are considered downed wood; retain in general vicinity. Full suspension yarding used when feasible. Full suspension is not feasible on flat ground, in other sites with limited deflection ,where an adjacent landowner will not provide permission to secure a cable, or where a full suspension yarding system would jeopardize the safety of field personnel. If full suspension yarding cannot be used, avoid ground disturbance that may deliver sediment to a watercourse to maximum extent practicable. Treat all sites of exposed mineral soil caused by yarding that can reasonably be expected to deliver sediment to a watercourse.

Slope Class	Prescriptions
	To ensure worker safety, trees not marked for harvest can be felled to provide safety clearance. To the extent possible, such trees will be felled towards the watercourses to provide LWD. Regardless, such trees must be retained in the general vicinity. Retain all trees not marked for harvest that are damaged during yarding. Harvesting would not be allowed within the first 30 feet (No Harvest Band), with exception of 1,400 acres of mid-successional and late-seral forest and 775 acres of forest identified in the SYP for commercial thinning. No sanitation salvage or exemption harvest. Harvesting would be permitted on the 1,400 acres of mid-successional and late-seral forest identified in the SYP over the first 5 years within the No Harvest Band, subject to all other applicable HCP requirements and watershed analysis, following the standards below: ▸ One harvest entry prior to watershed analysis. ▸ No harvest in the first 10 feet. ▸ Maximum removal of 30% of the conifer basal area/200 linear feet. ▸ Distribute harvesting across all diameter classes. ▸ Any trees removed for a road, skid trail, or cable corridor would be counted towards the maximum volume and basal area calculations. ▸ Leave all sub- and non-merchantable conifers on site, if feasible. ▸ No sanitation salvage, exemption harvest, or emergency timber operations. Commercial thinning would be permitted on the 775 acres identified in the SYP over the first 5 years within the No Harvest Band, subject to all other applicable HCP requirements and watershed analysis, following the standards below: ▸ One thinning entry prior to watershed analysis. ▸ No harvest in the first 10 feet. ▸ Maximum removal of 30% of the conifer basal area/200 linear feet. ▸ Distribute commercial thinning across all diameter classes. ▸ Any trees removed for a road, skid trail, or cable corridor would be counted towards the maximum volume and basal area calculations. ▸ Leave all sub- and non-merchantable conifers on site, if feasible. ▸ No sanitation salvage, exemption harvest, or emergency timber operations.
Slopes <50%	No Harvest Band from 0-30 feet, with exception of the 1,400 acre commercial harvest and 775 acre commercial thinning identified above. Sedimentation filtration band from 30-50 feet; prescriptions identified above apply.
Slopes ≥50%	No Harvest Band form 0-30 feet, with exception of the 1,400 acre commercial harvest and 775 acre commercial thinning identified above.

Slope Class	Prescriptions
	Sediment filtration band from 30-100 feet; prescriptions identified above apply.

Surface erosion in RMZs

Within all RMZs and EEZs, PALCO would treat all sites of exposed mineral soils that are caused by forestry activities greater than or equal to 100 square feet. On hillslopes greater than 30 percent, all sites of exposed mineral soils, regardless of size, would be treated if the site could deliver fine sediment to waters. Treatments could include revegetation or other erosion control measures including, but not limited to, seeding and mulching. Watercourse crossings would also be treated to avoid or minimize sediment delivery, using watershed analysis and/or road storm-proofing protocols (described below) to determine the appropriate treatments. Cable corridors that divert or carry water away from natural drainage patterns or that channelize run-off that reaches watercourses would have waterbreaks installed at intervals as per the skid trail prescriptions by Weaver and Hagans (1994).

<u>Hillslope Management</u>

The hillslope management mass wasting strategy would apply to all portions of the ownership, including RMZs. Prescriptions could be modified as a result of watershed analysis. Within RMZs, the prescriptions will be no less restrictive than the riparian prescriptions developed as part of watershed analysis.

General prescriptions

"Mass wasting areas of concern" are defined as areas of extreme, very high, or high mass wasting hazard, inner gorges, headwall swales, and unstable areas, including those within Class I, II, and III RMZs. These terms are further defined in the proposed SYP/HCP aquatic species conservation plan.

Before and/or after watershed analysis, mass wasting areas of concern could be further defined on the ground with respect to the area boundaries as part of individual THPs. This ground-truthing would be conducted by the California Division of Mines and Geology (CDMG) or a qualified professional geologist.

The area that has not yet been characterized for mass wasting would be treated in the interim, prior to characterization, as a mass wasting area of concern. On an individual THP basis, these areas could be correctly characterized with defined boundaries, using the same process as used for the entire ownership, or during the watershed analysis process. This characterization would be conducted by the CDMG or a qualified professional geologist.

Harvesting restrictions

PALCO would not harvest, including sanitation salvage, exemption harvest, or emergency timber operations, on mass wasting areas of concern prior to watershed analysis.

Road construction restrictions
Except as described below, PALCO would not construct or reconstruct roads across mass wasting areas of concern prior to watershed analysis.

- Newly constructed and reconstructed roads (not including storm-proofing) on mass wasting areas of concern would be permitted prior to watershed analysis only if certain information was provided to the wildlife agencies. Items include maps of the mass wasting area of concern overlaid with all existing roads and proposed new construction and reconstruction, and a geologic analysis of the risk of hillslope failure posed by the proposed new construction or reconstruction.

- The wildlife agencies would determine if all or a subset of the proposed road construction or reconstruction could be permitted, based upon the road locations, specifications, and likelihood of avoidance of significant adverse impacts on covered species. The wildlife agencies would make this determination within 60 days. If any wildlife agency determines that the action could not be permitted, it would work with PALCO and the other wildlife agencies to develop feasible alternatives.

After watershed analysis, roads could be constructed or reconstructed across mass wasting areas of concern if the watershed analysis determines that roads across these areas are appropriate. If watershed analysis determines that roads across these areas are appropriate, the proposed road and road specifications would be further evaluated at the time of road design by a qualified professional geologist(s). The geologist would make a determination that the road and road specifications were sufficient to result in a stable road prism that is not likely to trigger or exacerbate mass wasting.

<u>Road Management</u>
The proposed measures for roads are described by seven categories: sediment assessment, road storm-proofing, road construction, reconstruction and upgrading, road maintenance, road inspections, and wet weather use.

Sediment assessment
PALCO would assess the existing road network and associated sediment sources on its land within 5 years as part of watershed analysis or within 5 years of the planned storm-proofing (described below). Inventories would be updated within 5 years of the actual storm-proofing. Road assessments would follow the Pacific Watershed Associates (PWA) protocols (SYP/HCP, Volume II, Part O, with attachments).

Road storm-proofing
Roads would be storm-proofed to the standards identified in Weaver and Hagans (1994) within 20 years of the effective date, at a minimum rate of 750 miles per decade and 75 miles per year.

All sites that are identified through the sediment assessment as high and medium would be storm-proofed within 5 years of completion of the assessments, with all storm-proofing completed within 20 years of the issuance of the ITP.

To the extent feasible, PALCO would storm-proof the worst sites (those most likely to fail) within the first 10-year period. The very highest priority sites would be storm-proofed in the first 3 years.

Storm-proofing activities would be limited to between May 2 and October 14, but could not occur during periods of rainfall of 0.25 inch or greater within a 24-hour period. Operations would cease and not resume until and unless soil are dry (see definition below under "wet weather road use").

Storm-proofing would not be allowed between October 15 and May 1, except for the following:

- Specific storm-proofing treatments could continue until the first storm of 0.25 inch or greater in a 24-hour period or less. Specific treatments are: installation of rolling dips and water bars, armoring culvert inlets and outlets, armoring unstable road fill, and rocking road surfaces.
- After the first storm, as defined above, all storm-proofing treatments would comply with the road construction/reconstruction/upgrading wet weather standards (see below) until May 1.

Road fill and actively eroding slopes at high risk of failure that could deliver sediment to watercourses could be treated between October 15 and May 1.

Road construction, reconstruction, and upgrading

Roads would be considered upgraded when they are well drained and show no signs of imminent failure that could deliver sediment to a watercourse.

THP-related roads and landings would be storm-proofed or closed as per Weaver and Hagans (1994) and result in sufficient sediment reduction to offset sediment production from current projects. This requirement would remain in effect until a completed watershed analysis indicates that sediment is no longer causing an adverse impact.

Other road construction, reconstruction, and upgrading requirements are described below:

- All new and reconstructed roads be built to site-specific storm-proofing specifications as described in Weaver and Hagans (1994).
- All structures over fish-bearing and restorable fish-bearing streams for new and reconstructed roads designed to provide for unimpeded fish passage.
- All new and reconstructed culverts sized to pass the 100-year recurrence interval flood without overtopping the culvert. NMFS would develop culvert installation standards or approve alternative measures.
- Roads constructed or reconstructed as single-lane, 12-14 feet wide, with periodic turnouts, totaling 18 feet.
- All roads located outside of RMZs except for crossings, which would be minimized.

- Drainage structures and facilities spaced at appropriate intervals so not to create a gully or sediment plume that connects with the channel network.
- Construction or reconstruction by outsloping, maintaining with rolling dips, or ditched roads with well-spaced ditch relief systems.
- Ditch relief culverts for inside ditches spaced at intervals no greater than specified in Weaver and Hagans (1994).
- New and reconstructed stream crossings constructed so as not to have potential to divert flows down road or inside ditch.
- No roads constructed or reconstructed across mass wasting areas of concern, except as approved following the mass wasting avoidance strategy.
- No road or landing construction, reconstruction, or upgrading between October 15 and June 1 except under certain conditions:
  - No construction, reconstruction, or upgrading within 170 feet of a Class I or II waters, or within the EEZ of a Class III water.
  - Road would not cross Class I, II, or III waters.
  - Road or landing would not cross a mass wasting area of concern.
  - Soils moved for purposes of construction, reconstruction, or upgrading are dry.
  - During activities, no visible increase in turbidity in any drainage facility, or any construction/reconstruction site, or road surface, any of which drain directly to a Class I, II, or III water.
  - Erosion control material of sufficient quantity would be stockpiled on site.
- Between June 2 and October 14, no road or landing construction or reconstruction during periods of rainfall of 0.25 inches or greater during a 24-hour period or less. Do not resume until and unless soils are dry. Operations shouldn't result in a visible increase in turbidity in any drainage facility which drain directly to a Class I, II, or III water.

Road maintenance

Permanent roads through RMZs, including water crossings, would be treated and maintained with rock, chip seal, or pavement. During maintenance activities, the proper surface drainage configuration would be maintained. Inboard ditches would be bladed only where blockage or insufficient capacity occurs. Regardless of the time of year, routine corrective work (e.g., repair to inside ditches, cross drains, water bars, road surface, unblocking of culverts) to prevent water diversion would be preformed as soon as conditions permit. Other maintenance needs identified between June 1 and October 15 would be performed prior to October 15. Maintenance needs, other than those identified above, identified during the rest of the year, would be performed after June 1.

Road inspections

All THP roads, landings, and drainage facilities would be inspected annually for at least 5 years after operations. During the winter, all roads would again be inspected at least once during January or February following a storm event of 3 inches or greater in a 24-hour period. Those roads or landings that cannot be inspected during any one of the annual inspections must be closed or decommissioned according to guidelines provided by Weaver and Hagans (1994) within storm-proofing guidelines.

Wet weather road use
All road use would be permitted when roads are dry, defined as a road which moisture is less than or equal to that found during normal watering treatments or light rain and is not rutting or pumping fines causing a visible increase in turbidity in a drainage facility or road surface, any which drain directly to a Class I, II, or III water. The use of roads during wet weather would be restricted by the following conditions:

- Emergency access would be allowed on roads during wet weather to correct emergency road-related problems and emergency human safety situations.

- Except for as described below, use of non-paved roads would stop during periods when precipitation is sufficient to generate overland flow off the road; use would not resume until road surface is dry, as defined above. This restriction would be applied using the rule of reasonableness. For example, it would not prohibit use of a small segment of wet road on an otherwise dry road, but if any damage results which would likely cause sediment to reach a stream, the damage would have to be repaired within 24 hours after the damage occurred.

- On non-rocked roads, for the purposes of wildlife, fisheries and plant surveys; HCP Monitor activities; agency inspections; and, erosion inspections, light vehicles (3/4 ton trucks or less) could be used during wet weather, but if damage to the road surface, drainage facilities, water bars, or stream crossings results from the use, that damage would have to be repaired using hand tools within 24 hours after the initial damage occurred. Damage should not be to such extent that heavy equipment would be required for repairs.

- On non-rocked roads, for the purposes of timber related operations only, including reforestation, felling, bucking, etc., light vehicles (3/4 ton trucks or less) could be used during wet weather 48 hours after cessation of precipitation and if any damage to the road surface, drainage facilities, water bars, or stream crossings, caused by vehicle use would be repaired using hand tools within 24 hours after the initial damage occurred. Damage should not be to such extent that heavy equipment would be required for repairs.

- On rocked roads, light vehicles (3/4 ton trucks or less) could be used during wet weather, but if damage to the road surface, drainage facilities, water bars, or stream crossings results from the use, that damage would have to be repaired using hand tools within 24 hours after the initial damage occurred. Damage should not be to such extent that heavy equipment would be required for repairs.

Watershed Analysis

Process

Watershed analysis would be required for all covered lands in the SYP/HCP. A modified version of the Washington Department of Natural Resources' (WDNR) *Washington Forest Practices Board Manual: Standard Methodology for Conducting Watershed Analysis -Version 4.0* dated November 1997, or a modified version of the most current WDNR methodology would be used.

The process would include an assessment, synthesis (with a distinct cumulative effects assessment), prescription development, monitoring, and revisitation components.

The watershed analysis process would be guided by the following requirements:

- Timelines for completion of individual components would be developed based on mutual agreement between PALCO and the wildlife agencies.

- The following assessment modules would be used, in a modified format: mass wasting, surface erosion, riparian function, fish habitat, and stream channel assessment. The PWA sediment source assessment methodology (SYP/HCP, Volume II, Part O, with attachments) could be used with additions for non-road related surface erosion in place of the WDNR methodology surface erosion module. Water quality "critical and key" questions could also be incorporated into the assessment. "Key and critical" (as used in the WDNR methodology) questions for use in the modules would be adapted for covered species and PALCO's ownership.

- A cumulative effects assessment would be required, utilizing, among other information, the information developed as part of the Disturbance Index (DI) assessments.

- Entire watersheds where PALCO owns all or portions of the land would be assessed. A Level 2 assessment (as described in the WDNR methodology) would be conducted on land owned by PALCO, while a Level 1 assessment would be conducted on all other lands in each watershed.

- An amphibian and reptile assessment module would be developed, including key and critical questions regarding life history requirements including habitat upslope of RMZs.

- The analysis area would be watersheds approximately 10,000 to 50,000 acres, as delineated by the wildlife agencies and PALCO, and approved by the wildlife agencies.

- A interdisciplinary team of qualified scientists and technical staff from PALCO and the wildlife agencies would perform the analysis. At least one representative from PALCO and from each wildlife Agency would serve on the team. Representatives from the EPA, California Department of Conservation, North Coast Regional Water Quality Control Board (RWQCB), and CDF may also participate.

Post-watershed analysis prescriptions
The end result of watershed analysis would be site-specific prescriptions. Watershed analysis could modify hillslope, CMZ, and RMZ prescriptions, the DI, and monitoring. These prescriptions must be designed to achieve, over time, or maintain a properly functioning aquatic habitat condition, as defined by NMFS. Once watershed analysis is completed, the NMFS and FWS would establish the site-specific prescriptions for implementation.

Post-analysis prescriptions for Class I and II RMZs would have the following minimum and maximum sideboards:

- As a minimum, RMZ widths for both Class I and II waters would include no less than 30-feet no harvest zones (slope measurement) on each side of the water. On Class II waters, this minimum could be adjusted to a minimum10 foot no harvest zone if the wildlife agencies determine that this adjustment would benefit aquatic species or habitat.

- The maximum width for no harvest zones on Class I and II RMZs would be 170 feet (horizontal measurement) on each side of the water.

In Class I RMZs, if watershed analysis allows for harvest entry into the 30-100 feet zone, then at a minimum, the 18 largest conifer trees per acre would be retained on each side of the water per harvest entry. Exclusive to the 18 largest trees per acre, any additional trees left for retention would be those that have the highest probability of recruitment into the stream.

Prescriptions could not be any less than that required under the CFPRs.

Peer review, monitoring, and revisitation
The NMFS and FWS, in consultation with CDF, RWQCB, and CDFG, would establish a peer review process to evaluate, on a spot-check basis, the appropriateness of completed analysis and prescriptions developed through watershed analysis. Separate peer review would be required if PALCO or any wildlife agency member of the watershed analysis team disagreed with one or more of the prescriptions recommended by the analysis team.

The watershed analysis would be used to derive monitoring objectives and hypothesis to assess the effectiveness of prescriptions and trends (see monitoring).

Completed watershed analyses would be reviewed at 5 year intervals. Revision of the prescriptions could occur as a result of this review, but any proposed prescription modifications resulting from revisitation would be subject to the same process as the initial analysis, including NMFS, FWS, and CDFG establishment of prescriptions, maximum and minimum sidebars, etc.

Disturbance Index
The Disturbance Index (DI) is a method for calculating the cumulative land-use related disturbances within a hydrologic unit, and to adjust management actions accordingly to minimize adverse impacts on aquatic species due to sediment produced by such disturbances. The basic process for calculating DI is described in the SYP/HCP, Volume II, Part E. Roads, timber harvesting, and other management activities would be assigned disturbance ratings based on their relative potential for producing sediment. Roads, various types of timber harvest, yarding methods, and mass wasting events would all have distinct disturbance ratings. This rating would be multiplied by the acres affected by a particular management activity. Because sediment generated from some management activities declines over time, the DI also incorporates a time factor. For purposes of this HCP, a 10-year time factor would be used. Roads used or

maintained at least once during the 10-year interval would remain in the calculation and the ratings would not diminish over time. Improperly abandoned roads would also be treated this way. The sum of the results for each management activity is calculated, then divided by the total acres within the hydrologic unit in order to express the DI as a percentage. Special management prescriptions are triggered whenever a hydrologic unit's DI reaches 20 percent.

PALCO would develop the initial DI's for the entire ownership, at the hydrologic unit scale. Subsequent calculations would be on a THP basis.

If the calculated DI is at or above 20 percent for a hydrologic unit, PALCO management would be limited to activities with DI ratings below 0.7. Management activities could not increase the DI from one THP to another. Management activities would be conducted in such a manner such that the DI lowers on an annual basis, such that the DI falls below 20 percent within 10 years.

If a DI above 20 percent is calculated for a hydrologic unit within a Class I sub-basin containing a salmonid population before watershed analysis has been completed, the following restrictions would be applied to prevent extirpation of salmonid populations within that sub-basin:

- No clearcut or rehabilitation harvest.
- Full suspension skyline or helicopter yarding only.
- No new road construction or reconstruction.
- Wet weather period operations (October 15-June 1) limited to erosion control maintenance, planting, falling and bucking, and full suspension yarding to landings outside of the sub-basin.
- No broadcast burning.
- No skid trail or layout construction,
- Outside of RMZs and EEZ, treat all areas of bare mineral soil created by timber operations greater than 400 square feet, or any sites less than 400 square feet if the site can deliver sediment to waters.
- No more than 50 percent of the basal area shall be removed in one entry.

After watershed analysis is complete, site specific information could be used to tailor the prescriptions.

If the DI is below 20 percent, PALCO could not conduct any activities that would increase the DI above the 20 percent upper limit.

Other Activities on PALCO lands

Burning

Refer to the description in the riparian management strategy.

Commercial rock quarries

Two rock quarries would be covered under the ITP from the Effective Date to March 1, 2001. The quarries are identified as Rock Quarry 1/Road 24 in the Yager Creek drainage, and Rock

Quarry 2/Road 9 in the Lawrence Creek drainage. Rock quarry management and use would be permitted with the following conditions:

- Detention ponds and erosion control would continue to be used to reduce impacts.
- Mitigation would be implemented so that operations would not result in a visible increase in turbidity in any drainage facility, work site, quarry area, etc, any of which drain to a Class I, II, or III water. Appropriate mitigation would include wet wether limitations, sediment control structures, limitations on overburden placement and distribution, removal of spoils, revegetation, and abandonment.

The rock quarries would be evaluated during watershed analysis. Additional mitigation could be implemented depending on the results of the analysis.

Borrow pits
Borrow pits would be covered under the ITP from the Effective Date to March 1, 2004. The mitigation required for roads would also be used for borrow pits, including the prohibition on new borrow pits in RMZs, on mass wasting areas of concern prior to watershed analysis, the road construction/reconstruction standards, and wet weather operations. As part of watershed analysis, all borrow pits would be mapped an analyzed for site specific and hydrologic unit scale impacts. Additional mitigation and minimization measures could be required as a result. These mitigations could include sediment control structures, limitations on overburden placement and distribution, removal of spoil material, revegetation, and abandonment.

Water drafting
PALCO would utilize the most current NMFS water drafting screening specifications. The current screening specifications include the following:

- Screens kept in good repair and used whenever water is drafted.
- Screen face should be parallel to the water flow.
- Approach velocity no greater than 0.33 feet per second.
- At least 12 square feet of open area per cubic foot per second of the maximum diversion rate (12 square feet of screen per 450 gallons per minute).
- Openings: round openings no greater than 3/32 inches in diameter, square openings no greater than 3/32 inch measured diagonally, slotted openings no greater than 0.0689 inch in width (approximately 1/16 inch).
- Clean screen as frequently as necessary to prevent the approach velocity from exceeding 0.33 feet per second. The head differential should not exceed 2 inch.
- Diversion rate should not exceed inflow.

Aquatic Monitoring
PALCO's monitoring program would include compliance, effectiveness, and trend monitoring. PALCO would be responsible for the cost of the monitoring program. Elements of the proposed monitoring program would be revised after each watershed analysis to respond to site specificity of prescriptions, assumptions, and questions for each watershed.

Compliance monitoring

This type of monitoring would contribute to the goal of achieving 100 percent compliance with prescription implementation. There would be three components: third party monitoring, the THP checklist, and a Best Management Practices evaluation program. These three forms of compliance monitoring would allow PALCO and the wildlife agencies to identify recurring successes and problems with prescription implementation. Problems with implementation would lead to remedies such as: training of personnel, adjustments in Registered Professional Forester (RPF) and Licensed Timber Operator (LTO) oversight and supervision over contractors and field crews, changes in equipment, refinements of prescriptions, and regulatory sanctions.

Effectiveness monitoring

PALCO would use effectiveness monitoring as the basis for evaluating the results of prescription implementation on the features or processes that occur on the hillslope and in the instream environment. Hillslope effectiveness monitoring would help PALCO and the wildlife agencies determine whether properly implemented prescriptions on the hillslope actually "work". Instream effectiveness monitoring would be used to determine whether the prescriptions result in protection of aquatic values.

PALCO, with input from the wildlife agencies and peer review panels, would craft hillslope effectiveness monitoring, instream effectiveness monitoring, and trend monitoring strategies for each hydrologic unit. The details of these monitoring programs have not been worked out yet, but would include monitoring of LWD and riparian buffers (baseline information, recruitment levels, stand condition), water temperature, sediment (instream sediment levels, channel morphology, streambed agradation/degradation, and biological metrics sensitive to sediment; upslope sediment production rates from roads and hillslopes, and sediment source inventories), amphibian habitat monitoring, and cost-benefit effectiveness. All monitoring would be focused at achieving objectives, answering specific questions, or testing well-considered hypotheses. The results from annual reviews of the instream effectiveness monitoring would be used to modify prescriptions that are identified as ineffective in protecting and restoring aquatic resources.

Trend monitoring

Trend monitoring is a process where measurements are made at regular, well-spaced time intervals so as to determine a long-term trend in a particular parameter. This monitoring would not be used to evaluate specific management practices, but the results of trend monitoring could be used to corroborate the findings of effectiveness monitoring. Trend monitoring can indicate whether watersheds as a whole are on a long-term trajectory of recovery.

PALCO would use the results of trend monitoring as part of their cumulative effects analyses in watershed analysis. Where appropriate, PALCO would also implement watershed-specific modifications in management regimes to reverse trends that lead away from properly functioning aquatic habitat conditions. This would be completed through the watershed analysis prescription process or adaptive management.

Adaptive Management

Adaptive management would be used to change prescriptions in the aquatic conservation plan in response to new information. PALCO may propose changes at any time. The wildlife agencies may approve changes to the Aquatic Conservation Plan if they find that the proposed prescription changes will not impair the Plan's ability to maintain or achieve, over time, properly functioning aquatic habitat conditions.

STATUS OF THE SPECIES (range-wide and/or recovery unit)

Status common to all species
Our baseline and analysis of effects was based on a landscape comparison at four levels: PALCO lands; action area; regional area; and species-specific range-wide. The PALCO lands encompass approximately 211,000 acres. The action area encompasses 815,063 acres. The regional area encompasses four counties totaling 6,218,220 acres: Mendocino (2,245,940 acres, California Department of Finance 1998a), Humboldt (2,286,590 acres, California Department of Finance 1998b), and Del Norte (645,050 acres, California Department of Finance 1997) Counties, California; and Curry County (1,040,640 acres, Oregon State Archives 1998), Oregon. Variation from this landscape level of analysis, if needed due to limitations of existing data, is described later in this document on a species-specific basis. In addition, the regional area encompasses 2,849,410 acres of redwood forests.

LISTED SPECIES/CRITICAL HABITAT:

American peregrine falcon
A complete, detailed account of the taxonomy, ecology, and reproductive characteristics of the American peregrine falcon may be found in the following documents: *The Pacific Coast American Peregrine Falcon Recovery Plan* (USDI Fish and Wildlife Service 1982) and *Proposed Rule to Remove the Peregrine Falcon in North America from the List of Endangered and Threatened Wildlife: Proposed Rule* (USDI Fish and Wildlife Service 1998).

Species description
The peregrine falcon is a medium-sized, circumpolar raptor weighing approximately 36 ounces. It has a nearly cosmopolitan distribution, occurring on every continent except Antarctica, and has bred over most of its range (Hickey and Anderson 1969). The American peregrine falcon occurs throughout much of North America from the subarctic boreal forests of Alaska and Canada south to Mexico. This subspecies nests from central Alaska, central Yukon Territory, and northern Alberta and Saskatchewan, east to the Maritimes and south (excluding coastal areas north of the Columbia River in Washington and British Columbia) throughout western Canada and the United States to Baja California, Sonora, and the highlands of central Mexico.

Life history
Definition of suitable habitat
The peregrine falcon is found in a wide variety of habitats, including arctic tundra, mountain ranges, open forests, and grasslands. The primary need of this species is nesting cliffs within foraging range of prey species, normally birds.

Reproduction
The peregrine normally lays from 3 to 7 eggs (generally 3 to 4) (Zeiner et al. 1990) during the nesting season, approximately January 1 to June 30. The courtship period begins in early January, when nest site selection occurs and males court females. Fledging begins in late May, but young

may still be found in the vicinity of the nest in July or August, especially for pairs nesting in higher altitudes. Successful pairs fledge an average of 2.2 to 2.5 young per breeding season (Monk 1981).

Diet

Prey are primarily small- to medium-sized birds and are captured in spectacular aerial flights, although a few records exist of peregrines taking small mammals, especially bats (Kirven 1978, Monk 1981). In urban environments, the primary prey may be rock doves (*Columba livia*).

Cover requirements

For nest and perch sites, the peregrine falcon prefers tall cliffs that provide protection from mammalian predators and weather. These cliffs are often associated with water bodies and other sources of avian prey. Nest ledges often include a recessed platform that provides protection from inclement weather.

Dispersal

American peregrine falcons that nest in subarctic areas generally winter in South America, while those that nest at lower latitudes exhibit variable migratory behavior. Others (especially coastal birds) may be migratory or may winter and nest in the same region.

Special habitat needs

Well protected, vertical nest cliffs associated with foraging areas are the preferred nesting habitat, although recently peregrines have nested on bridges and high-rise buildings in urban environments. For successful nesting, abundant prey near the nest site is essential. The most preferable nest sites are sheer cliffs 150 feet or more in height, with a small cave or overhung ledge large enough to contain three or four full-grown nestlings. Several holes or ledges that can be used in alternate years are apparently not an absolute requirement but probably increase the suitability of the cliff (USDI Fish and Wildlife Service 1982).

Although some peregrines appear to be somewhat tolerant of human intrusion into the nest area, the species in general is intolerant of disturbance at the nest site. Noise and human presence near the nest site may be of no consequence to the species if these sources are at some distance and are established before the onset of courtship and nest site selection.

Current legal status

Listing history

The peregrine falcon is listed as a California endangered species, a California fully protected species, and a Federal endangered species.

In 1970, the FWS listed the following two of the three North American peregrine falcon subspecies as endangered under the Endangered Species Conservation Act of 1969: the American peregrine falcon and the Arctic peregrine falcon (*F. p. tundrius*). The subspecies were listed due to population declines caused by the negative effects of dichloro-dephenyhl-trichloroethane (DDT) and its metabolites (primarily DDE) on peregrine falcon reproduction and survival.

American and Arctic peregrine falcons were included in the list of threatened and endangered foreign species on June 2, 1970 and the native list of endangered and threatened species on October 13, 1970. Upon passage of the Act, both subspecies were listed as endangered throughout their respective ranges.

On August 26, 1998, the FWS published a proposed rule to delist the American peregrine falcon throughout its range (USDI Fish and Wildlife Service 1998), based on the analysis of recovery goals and current population levels and reproductive rates. Regulations mandate the monitoring of any delisted species for a period not less than 5 years after delisting to ensure that no significant problems arise that would indicate the need to reconsider the delisting decision. Federal delisting of the peregrine falcon will not remove the peregrine falcon from State threatened and endangered species lists or suspend any other legal protections provided by State law.

In the absence of habitat protection under the Act, no other existing Federal laws specifically protect the habitat of this species; however, loss of habitat has not been identified as a primary threat to the species and was not a primary factor identified as contributing to the species original decline.

Six critical habitat units have been designated for American peregrine falcon in the Pacific coast region, all within central and southern California. None of these critical habitat units are within or near the action area.

Current known listed range

The American peregrine falcon is currently listed as an endangered species throughout its range in North America. All subspecies of peregrine falcons are currently protected within the conterminous 48 states under the similarity of appearance criteria.

Reasons for listing

The primary reason for the listing of the American peregrine falcon was significant reduction in numbers and distribution due to reproductive failure, caused primarily by eggshell thinning as a result of accumulations of DDE in its tissues.

An overwhelming body of accumulated evidence shows that organochlorine pesticides affected survival and reproductive performance enough to cause the decline. The scientific community currently does not question that organochloride contamination was the principal cause of the drastic declines and extirpations in peregrine falcon populations that occurred in most parts of North America (USDI Fish and Wildlife Service 1998).

Threats

In some portions of California, the lingering effects of DDT have caused reproductive rates to remain low. Point source contamination may even cause continued reproductive problems in these areas in California. Some predation from great horned owls (*Bubo virginiatus*), other raptors, and mammalian predators has been noted, and several diseases and parasites are known to occur in peregrine populations; however, no information exists as to the level of significance of these potential mortality factors. Additional threats as reported in the Pacific population recovery plan (USDI Fish and Wildlife Service 1982) include collisions with electrical transmissions lines, electrocution, shooting, and the capture of nestlings for falconry. In some California locations, these factors were responsible for a significant portion of the total known mortality.

The peregrine falcon is particularly sensitive to disturbance near the nest cliff during the breeding season. Disturbances may be caused by rock climbers, hikers, overzealous birdwatchers and photographers, and low flying aircraft, among other causes. The effects of disturbances vary with the timing and proximity to the eyrie. Many disturbances are tolerated quite well during the non-breeding season; however, during courtship disturbed birds are particularly liable to desert an area (USDI Fish and Wildlife Service 1982). Even if direct mortality does not occur due to disturbance, the cumulative effects of adults being away from the nest – inadequate brooding of eggs or insufficient feeding of young – can increase the risk of mortality and lower the reproductive rates of the species. If human activities are centered generally throughout the nesting area, the entire territory may be abandoned, and the pair may not nest (Fyfe and Olendorff 1976).

Because rapid population growth rates and high densities were achieved despite considerable habitat modification in North America, habitat modification or destruction has not been a limiting factor in peregrine recovery. The FWS concludes that habitat modification and destruction do not currently threaten the existence of the peregrine falcon nor is this likely in the foreseeable future (USDI Fish and Wildlife Service 1998).

Conservation needs

While habitat loss has not been identified as a limiting factor for the recovery of the species, reduction of reproductive capacity through disturbance at nest sites during the critical nesting period could result in local losses that might significantly affect local populations. Measures to reduce the potential for this disturbance have been implemented for activities within 0.25 miles (up to 0.5 line-of-site miles) of known nest sites during periods when nesting behavior is noted. Generally, this period begins on approximately January 1 and continues until the young are successfully fledged (normally June 30 or later), or until nest abandonment or failure has been documented (Pagel 1992, Pagel 1998).

State and Federal agencies and many private interests are involved in a variety of efforts to increase the numbers of peregrine falcons in the Pacific states. These efforts included captive breeding programs, artificial incubation of eggs, double clutching, foster parenting, captive breeding, and reintroduction by hacking (placing captive hatched juveniles into historic nest sites) (USDI Fish and Wildlife Service 1982).

PALCO lands play a limited role in the conservation of the American peregrine falcon. PALCO lands contain only one known nest site. Two additional nest sites exist in the action area and within approximately 0.5 miles of PALCO lands. PALCO lands offer potential sites and foraging habitat for peregrines in the action area. No specific recovery plan goals are established for lands under PALCO ownership, or for the action area in general.

Status and distribution

Species

Numbers

By the 1960's, the peregrine falcon had essentially been extirpated from the eastern United States and eastern Canada south of the boreal forest. In 1975, there were only three peregrine falcons in Alberta, and no other peregrines were found south of latitude 60 degrees north and east of the Rocky Mountains in Canada. In the western United States, peregrine falcon nesting was reduced to 33 percent of historic nest sites in the Rocky Mountains. Major declines had occurred in other parts of the western United States and western Canada. In contrast, peregrine falcons in most areas of the Pacific coast of Alaska remained fairly stable during this period, owing to lower exposure to organochlorine pesticides.

Currently, populations of American peregrine falcons have increased to a minimum of 1,388 pairs in Alaska, Canada and the western United States, and a minimum of 205 pairs are found in the eastern and midwestern United States. The American peregrine falcon has met or exceeded recovery goals for number of breeding pairs in each of the five recovery areas within its range.

Distribution

Since the early 1970s, efforts to reestablish peregrine falcons in the United States have successfully returned this species to areas from which it had been extirpated. Peregrine falcons are now found nesting in all States within their historical range, except for Rhode Island and Arkansas.

Reproduction

Productivity (measured as the number of young produced per nesting pair per year during the period 1993 through 1997) ranges from 1.4 to 2.0 for the four recovery regions for which productivity goals were established during recovery planning. Productivity goals have been met or exceeded in each of these recovery regions.

Suitable habitat

Amount, acreage, and distribution

Suitable nesting habitat occurs throughout the species range wherever nesting cliffs and ledges occur nearby suitable prey sources. Suitable foraging, dispersal and wintering habitat occurs, likewise, wherever avian prey are present, especially in association with marsh, lacustrine, and marine habitats. Generally, suitable habitat may occur within the historic range of the species wherever sufficient prey species and perch sites might occur. Since suitable habitat occurs widely throughout the species' range, no precise estimate of the acreage is available.

Quality

Although some nest cliffs have been permanently lost to urban development and other landscape modifications (most notably in southern California), there has not been a major range-wide or region-wide loss of suitable nesting cliffs. High-rise buildings and tall bridges currently provide nest sites where none historically existed. Therefore, no major change in nest site quality is known to have occurred, despite local modifications to or loss of suitable nest sites.

Region (includes California, Oregon, Washington and Nevada)

Species

Numbers

Until 1950, reproduction of peregrines in California "was generally successful, and the number of eyrie sites attended by adults was not reduced markedly" (Herman et al. 1970). However, by 1970 the peregrine nearly disappeared as a breeding species in California, with only two confirmed active sites (Herman 1971).

Currently, approximately 239 breeding pairs of peregrine falcons are known to occur within the Pacific coast region (California, Oregon, Washington and Nevada). This exceeds the recovery goal of 185 breeding pairs within this area (as established in the Pacific Coast Recovery Plan (USDI Fish and Wildlife Service 1982)) for delisting the species.

Distribution

The species is widely distributed within the four-state region, except for desert areas of Nevada and southern California. Recovery plan distribution goals for all four states have been met. Recovery of the species in recent years has been enhanced by the widespread introduction of captive-reared juveniles and by nest augmentation. Currently, the species is distributed within this range to the point where additional introductions may no longer be necessary. The release of captive-bred peregrines was suspended in Nevada in 1989 and in California in 1992. The relocation of wild hatchlings continued afterwards.

Reproduction

Available data indicate that the average productivity over the 5-year period 1993 to 1997 in Washington, Oregon and California was 1.5 fledged young per pair per year, which meets the recovery goal for productivity (as established in the Pacific Coast Recovery Plan). Within California, fledging rates currently exceed this goal, at 1.6 young fledged per pair per year (range 1.4 to 1.7). Current reproduction supports an expanding population in most areas despite high organochlorine residue concentrations and associated eggshell thinning that still occurs in some areas of the Pacific population.

Although no recovery goals were established within the Pacific coast region for DDT residues in eggshells and eggshell thinning, eggs from coastal California continue to show residue levels and eggshell thinning that are substantially above pre-DDT era eggs, and remains a cause of concern. However, these levels do not seem to have resulted in limitations on reproduction to the point where recovery of the species has been significantly impaired.

Northern Spotted Owl

A complete, detailed account of the taxonomy, ecology, and reproductive characteristics of the spotted owl is found in the following reports: *Conservation Strategy for the Northern Spotted Owl* (Thomas et al. 1990); the final rule designating the spotted owl as a threatened species (USDI Fish and Wildlife Service 1990a); and *Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Management Assessment Team* (FEMAT) (USDA Forest Service et al. 1993). A detailed account of the status, distribution, and abundance of the northern spotted owl throughout its range can be found in the following documents: 1987 and 1990 FWS status reviews (USDI Fish and Wildlife Service 1987 and 1990b); the 1989 status review supplement (USDI Fish and Wildlife Service 1989); the FEMAT report (USDA Forest Service et al. 1993); and the biological opinion of the FWS on Alternative 9 of the *Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl* (FSEIS) (USDA Forest Service and USDI Bureau of Land Management 1994).

Species description

The northern spotted owl, a medium-sized forest owl, is characterized by dark eyes, a tawny facial disk, and dark- to chestnut-brown feathers. Whitish spots occur on the head and neck, and the abdomen and breast are mottled with white. White bars appear on the tail feathers. The northern spotted owl is distinguished from other subspecies by its darker brown color and smaller white spots and markings.

Plumage characteristics can distinguish several age classes of spotted owls (Forsman 1981). Juvenile (ages 1 day to about 5 months) plumage is downy white; subadult (ages about 6 months to 27 months) plumage is similar to adult plumage, except for white-tipped, pointed tail feathers; adult (about 27 months or greater) tail feathers have rounded tips.

The American Ornithologist Union (1957) recognizes three subspecies of the spotted owl: the California spotted owl (*S. o. occidentalis*); the northern spotted owl; and the Mexican spotted owl (*S. o. lucida*).

Life history

Definition of suitable habitat

The northern spotted owl occurs in most coniferous forest types in the Pacific Northwest. Most observations of spotted owl habitat use are in areas with components of late-successional forests (i.e., mature and old-growth forests). However, spotted owls are observed to use previously logged forests with residual old-forest characteristics (USDI Fish and Wildlife Service 1992a).

Suitable habitat is generally described as: forest stands with multiple canopy layers and a variety of species; moderate to high canopy closure; substantial decadence in the form of live trees with deformities (e.g., cavities, broken tops) and snags; and a large accumulation of logs and woody debris (Thomas et al. 1990). The USDA Forest Service and USDI Bureau of Land Management

(1994) further describe suitable habitat as an area of forest vegetation with the proper conditions (i.e., age class, tree species composition, structure, area, and food source) to meet some or all of the life needs of the northern spotted owl.

Habitat use by the northern spotted owl in California's northern coastal region is described in the SYP/ HCP and in the Final EIS/EIR. In the action area, suitable habitat for the northern spotted owl occurs in California Wildlife Habitat Relationships (CWHR) (Mayer and Laudenslayer 1988) Douglas-fir, montane hardwood-conifer, montane hardwood, and redwood forest types. Suitable habitat is generally described by a combination of vegetational and structural components; data bases limit these components to dominant tree species, tree size, and canopy closure (table 11). Habitat suitability generally increases with increased tree diameter and canopy closure. Moderate and high quality nesting and roosting habitats are generally found in stands with trees greater than 11 inches dbh. Canopy closure of nesting (greater than 60 percent) is greater than that of roosting habitat (greater than 40 percent). Habitat that may be used for foraging includes stands of trees with smaller dbh and sparser canopy closure. These measures of suitable habitat do not address habitat components (i.e., early stages) that provide key habitat areas for the spotted owl's primary prey, the dusky-footed woodrat (*Neotoma fuscipes*).

Table 11. Vegetational and structural components of suitable northern spotted owl habitat on lands owned by PALCO, Humboldt County, California, as described by CWHR habitat types (Final EIS/EIR, appendix P, table 6).

	Vegetation type[1]			
Habitat type	DFR	MHC	MHW	RDW
Nesting:				
High quality	5M[2]	5D	5M	5D
	5D	6	5D	6
	6		6	
Moderate quality	4D	5M	n.a.[3]	4D
				5M
Low quality	n.a.	n.a.	n.a.	5P
Roosting:				
High quality	n.a.	n.a.	n.a.	n.a.
Moderate quality	4M	n.a.	4D	n.a.
Low quality	5P	4M	4M	4M
		4D	5P	
		5P		
Foraging:				
High quality	3D	5S	5S	5S
Moderate quality	3M	4P	4P	3M
	4P			3D
	5S			
Low quality	3P	3M	4S	3P
	4S	3D	3M	4S
		4S	3D	4P

[1] Vegetation type is defined as follows: DFR - Douglas fir; MHC - montane hardwood-conifer; MHW - montane hardwood; and RDW - redwood.

[2] Alpha numeric code indicates tree size and total canopy closure of CWHR habitat type (refer to appendix C). Tree size is defined as follows:

Size	Conifer crown diameter	Hardwood crown diameter	Quadratic mean DBH
3	10-20 feet	10- 30 feet	6-10.99 inches
4	15-30 feet	18- 45 feet	11-23.99 inches
5	20-70 feet	30-100 feet	>24.00 inches
6	n.a.	n.a.	n.a.

Canopy closure is defined as follows: S = sparse cover (10-24.99%); P = open cover (25-39.99%); M = moderate cover (40-59.99%); and D = dense cover (60-100%)

[3] n.a. = not applicable

Reproduction

Spotted owls do not build their own nests; they depend instead upon naturally occurring suitable nest sites. Nests are typically located in tree cavities, or platforms of sticks or other debris on limbs or broken tops of trees (Forsman et al. 1984, La Haye 1988). Of 25 nests checked for 2 or more years, Forsman et al. (1984) observed that 68 percent were used more than 1 year. During an 8-year period, Forsman et al. (1984) found a high attrition rate of nest trees, due to timber harvest, windthrow (i.e., trees being felled by wind), or decay. Platform nests may include abandoned raptor or squirrel nests and clumps of mistletoe or debris. The presence of suitable nest sites is suggested as a possible basis for the use of late successional forests (Forsman et al. 1984). Folliard (1993) and Thome (1997) described nest sites in managed redwood forests in northwestern California; about one-third of nest studied were in stands without old-growth or residual components.

USDI Fish and Wildlife Service (1990a) summarized, in part, the reproductive biology of the northern spotted owl as follows. Female spotted owls are sexually mature in their second year, but most do not breed until their third year. Individual owl pairs do not nest every year. Within the population, both the proportion of territorial pairs attempting to breed and the proportion of pairs successfully breeding vary annually. Fluctuations in the numbers of pairs that breed and/or successfully reproduce may be related to fluctuations in prey populations.

The breeding season of the northern spotted owl lasts several months. The nuptial phase, including copulation, begins in February or early March, usually in the vicinity of the nest used in the previous year. Some pairs use previous nests repeatedly, some select a new site each year, and others use alternate nest sites from year to year. Egg laying (normally one or two eggs, occasionally three eggs, and rarely four) and incubation are initiated during March or April, with the incubation period lasting approximately 30 days. Pairs are unlikely to re-nest if nests fail. Young owls leave the nest approximately 35 days after hatching and remain near the nest tree during summer. As late summer and fall approach, young owls wander farther from the nest tree. Adult owls feed their young until the young disperse in the fall; young owls, however, begin to hunt prey by late summer (Forsman et al. 1984).

Survivorship varies by age class (USDI Fish and Wildlife Service 1992a). Adults have the highest probability (81 to 96 percent) of surviving from one year to the next, followed by subadults and juveniles (7 to 31 percent). Mortality factors include predation, accident, and starvation. Common predators include the great horned owl, barred owls (*Strix varia*), and northern goshawk (*Accipiter gentilis*). Adults live an average of 8 years.

Diet

The northern spotted owl feeds on a variety of forest mammals, birds, and insects. From southern Oregon through northwestern California, the dusky-footed woodrat comprises the majority of prey biomass consumed by the northern spotted owl (Thomas et al. 1990).

Cover requirements

Cover requirements of the spotted owl vary. Forest stands must be open enough to allow owls to fly within and beneath the canopy (Thomas et al. 1990). Roosting and nesting habitats are typically comprised of moderate- to high-canopy closure to protect the spotted owl from weather or predators (USDI Fish and Wildlife Service 1992a).

Dispersal

USDI Fish and Wildlife Service (1992a) described dispersal of the northern spotted owl as follows. Spotted owls disperse to establish a new home range in another area. Juvenile spotted owls begin to disperse from natal areas in September and October. A distance of 9 to 30 miles is traveled during the first autumn. Patterns of juvenile dispersal vary in direction, distance, and survival. The average effective dispersal distance is greater for female juveniles (12 miles) than for males (4 miles).

Dispersal by adults is observed less because adult spotted owls normally form long and stable pair bonds. However, adult spotted owls may leave mates or move from one area to another. The reasons for these movements are unknown.

Thomas et al. (1990) described adequate dispersal conditions as landscapes in which 50 percent of the area was comprised of trees with an average dbh greater than 11 inches and with a canopy closure of at least 40 percent. USDI Fish and Wildlife Service (1992b) described dispersal habitat as stands with tree size and canopy closure adequate to provide protection from predators and at least minimal foraging opportunities.

Special habitat needs

Water is suspected as an important factor in habitat selection. Spotted owls in captivity and in the wild are observed to drink water and bathe (Forsman et al. 1984). Because spotted owls do not build their own nests, decadence (as measured by the presence of trees with broken tops and cavities, or snags) in forest stands may be required to provide suitable nest trees. Berbach et al. (Berbach et al. 1993) reported that over 75 percent of the quarter-townships in the coastal counties of Del Norte, Humboldt, and Mendocino exceeded this standard.

Current legal status

Listing history and current known listed range

The spotted owl was listed as a Federally threatened species on July 23, 1990 (USDI Fish and Wildlife Service 1990a). The northern spotted owl is Federally listed as a threatened species throughout its range in California, Oregon, and Washington. Relative to the recovery strategy of the northern spotted owl, PALCO lands are located within the California Coast Province, which contains all or portions of Del Norte, Humboldt, Mendocino, Trinity, Sonoma, Napa, and Marin Counties. Approximately 92 percent of the province is in non-Federal ownership (USDI Fish and Wildlife Service 1992a).

Reasons for listing

The primary reasons for listing the northern spotted owl were the loss of suitable habitat and the inadequacy of existing regulatory mechanisms (i.e., management plans for Federal lands) pertaining to timber harvest to ensure the long-term viability of the species.

Threats

The USDI Fish and Wildlife Service (1992a) summarized threats to the northern spotted owl to include the following: loss of habitat, limited habitat, declining populations, low populations, distribution of habitat or populations, isolation of populations, predation, competition, lack of coordinated conservation measures, and vulnerability to natural disturbances. These threats were rated according to the following scale:

Severe - Threat may cause province-wide population instability and/or decline.

Moderate - Threat is not severe at the present time but could become so within a few generations (i.e., within decades).

Low - Threat is not anticipated to cause significant adverse impacts on the province-wide population.

The USDI Fish and Wildlife Service (1992a) rated the above threats for the California Coast Province as follows:

Severe - Isolation of populations.

Moderate - Declining habitat, limited habitat, declining populations, and distribution of habitat.

Low - Low populations, predations, competition, and natural disturbances.

The USDI Fish and Wildlife Service (1992a) did not specifically rate conservation measures for the California Coast Province. Although USDA Forest Service and USDI Bureau of Land Management (1994) implemented a conservation strategy for the northern spotted owl on Federal lands in northwestern California, Federal lands subject to the conservation strategy are limited in the California Coast Province.

Hybridization with the barred owl may also pose a threat to the northern spotted owl throughout its range. The barred owl occurs in many parts of the northen spotted owl's range from Washington to northern California.

Conservation needs

The *Final Draft Recovery Plan for the Northern Spotted Owl* (USDI Fish and Wildlife Service 1992a) serves as the basis for the following discussion, since Federal lands managed under the

Northwest Forest Plan (USDA Forest Service and USDI Bureau of Land Management 1994) play a minor role in the California Coast Province. The conservation needs of the northern spotted owl focus on an adequate quantity, quality, and distribution of suitable habitat that contributes to the owl's breeding, feeding, cover, and dispersal requirements in a variety of ecological conditions.

Habitat conditions must be adequate on different geographic scales. On a local level, habitat should provide for clusters of 15 to 20 overlapping or nearly overlapping territories; larger, more closely situated clusters of owls have higher persistence rates than smaller, isolated clusters. Within clusters, stable or improving habitat conditions should be provided to counter the adverse effects of fragmentation. These adverse effects include reduced spotted owl density, decreased productivity, increased susceptibility to windthrow, decreased success of juvenile dispersal, and increased competition or predation. At a provincial level, habitat conditions should provide for an adequate number and distribution of populations. Provinces should not be isolated from each other. Habitat conditions and spacing between local populations must provide for survival (i.e., provide for requirements of breeding, feeding, roosting, and cover) and ensure movement of northern spotted owls. Conservation strategies should account for loss of suitable habitat due to natural disturbances (e.g., fire, windthrow, insects, and disease) at all landscape scales. Effective and coordinated conservation measures are needed on non-Federal lands in the California Coast Province.

The PALCO lands play a role in the conservation of the northern spotted owl on non-Federal lands in southern Humboldt County, California. The ownership contains habitat capable of supporting a cluster of greater than 20 pairs of owls as recommended by the final draft recovery plan. A cluster of owls this size would contribute to the overall size and reproduction of the spotted owl population in the province. In addition, the ownership also contributes adequate dispersal habitat to facilitate the movement and interchange of owls located on the property and on adjacent lands. The *Final Draft Recovery Northern Spotted Owl Recovery Plan* (USDI Fish and Wildlife Service 1992a) recommended that population clusters totaling 60 owl pairs be maintained in the southern Humboldt-northern Mendocino area.

Federal lands outside of the California Coast Province comprise a substantial portion (65 percent, 5,561,400 acres of 8,578,700 acres) of the northern spotted owl's range in California. Management direction and land allocations of the Northwest Forest Plan are expected to constitute the Forest Service and Bureau of Land Management contribution to the recovery of the northern spotted owl on Federal lands (USDA Forest Service and USDI Bureau of Land Management 1994).

Status and distribution

Species

Numbers

The *Final Draft Recovery Plan for the Northern Spotted Owl* (USDI Fish and Wildlife Service 1992a) summarized the population status of the northern spotted owl as follows. Estimates of the historical population size are imprecise due to a lack of previous survey effort, as are estimates of the amount and distribution of suitable habitat. The population size and survival rate of adult owls have declined due to logging over the past 100 years (and mostly within the last 40 years) (USDA Forest Service and USDI Bureau of Land Management 1994).

Population size and density decrease along the northern, eastern, and southern portions of the owl's range. The majority of the owl population occurs in the eastern Oregon Cascades, western Oregon Cascades, Oregon Klamath, California Klamath, and California Coast provinces.

The ability of the northern spotted owl to resist habitat change probably varies as a function of ecological conditions (e.g., quantity, quality, and distribution of suitable habitat; recovery rate of habitat; type, abundance, and availability of prey base) in various portions of its range. Although strong evidence suggests owl populations have declined across substantial portions of the owl's range, the pattern in population change may not be identical everywhere (USDA Forest Service and USDI Bureau of Land Management 1994) HEREAFTER THIS REFERENCE ISN"T HIHGLIGHTED. Spatially explicit models of the relationship of population dynamics to habitat dynamics suggest that northern spotted owl populations can stabilize over the long-term, given a reduction in the amount of suitable habitat and numbers of spotted owls in the short-term (USDA Forest Service and USDI Bureau of Land Management 1994). A similar analysis for non-Federal lands is not completed to date.

Most (approximately 80 percent) owl pairs range-wide occur on Federally managed lands. Distribution of these pairs varies by land ownership, state, and physiographic province. Inventories are least complete in California; however, 40 percent of the State's population and habitat of spotted owls may occur in the California Coast province. The California Coast Province encompasses approximately 40 percent of the northern spotted owl range in California (USDI Fish and Wildlife Service 1992a).

Inventories from 1987 through 1991 (some areas included 1992 surveys) indicated that spotted owls were located at approximately 4,600 sites, including 3,602 pairs and 957 resident single owls (USDA Forest Service and USDI Bureau of Land Management 1994). The estimates covered various ownerships, including Federal, State, County, and private ownerships throughout the owl's range. Current estimates of population are undoubtedly underestimates, since all suitable habitat has not yet been surveyed. The percentage of spotted owl habitat surveyed for owls varied by state and ownership: Forest Service - Washington (40 percent), Oregon (73 percent), and California (44 percent); Bureau of Land Management - Oregon (61 percent) (data were not available for California; Washington was not applicable); and National Park Service, Olympic National Park, Washington (10 percent).

Gould (1995) reported that 978 northern spotted owl activity centers were known in the three California coastal counties of Del Norte, Humboldt, and Mendocino. Sixty-seven percent of these sites were on privately-owned timberlands that had been subject to timber management for decades.

Distribution
The northern spotted owl is currently distributed in varying densities and numbers in suitable habitat throughout its range in Washington, Oregon, and California. Fewer than 20 pairs have been reported to occur in British Columbia (USDI Fish and Wildlife Service 1992a).

Reproduction
A single analysis (meta-analysis) of all demographic data collected from 11 study areas located across much of the owl's range suggests a declining rate (range = 0.9162 to 0.9934; midpoint = 0.9548) of population growth (USDA Forest Service and USDI Bureau of Land Management 1994). A rate (lambda) equivalent to 1.0 indicates a stable (i.e., neither increasing or decreasing) population, and a rate in excess of 1.0 indicates an increasing population. Continued declines in the adult survival rate without offsetting increases in the number of young produced per female or in juvenile survival suggest that the population decline has accelerated. Significant geographic areas, including the California Coast and other provinces, were not included in the analysis. Patterns of population change differed by area: five short-term study areas exhibited a lower average population growth rate, compared to six long-term study areas. The decline in population growth was not significantly different from a rate of 1.0 in one (the Willow Creek area in northwestern California) of the long-term study areas.

Suitable habitat
Acreage
No precise estimate of the total amount of suitable northern spotted owl habitat exists. Current data largely represent estimates of suitable habitat found on Federal, State, County, or tribal lands within the range of the owl; data for all private lands in Washington, Oregon, and California are not available. Federal lands in the range of the northern spotted owl encompass approximately 20.6 million acres of forested habitat (USDA Forest Service and USDI Bureau of Land Management 1994). Of this total, about 7.8 million acres are considered suitable habitat (USDI Fish and Wildlife Service 1992a). About 8.3 million acres of suitable habitat are estimated to occur within the range of the northern spotted owl, given consideration to estimates for other ownerships (e.g., State, City, County, and Tribal) (USDI Fish and Wildlife Service 1992a).

Distribution
Suitable habitat is distributed in varying proportions throughout the range of the northern spotted owl. Gaps in the distribution of suitable habitat occur due to ecological conditions and human influences (e.g., timber harvest). No significant gaps are identified in northwestern California.

Quality
Quality of suitable habitat varies due to ecological conditions (e.g., forest structure, tree species composition, prey species composition, and fire), physiographic features (e.g., elevation and aspect), and human influences (e.g., timber harvest). Suitable habitat generally decreases in quality as elevation increases, in drier portions of the owl's range, or in areas with extensive forest fragmentation or habitat loss due to timber harvest. However, population of northern spotted owls exist in unusually high densities within extensively fragmented managed forests, apparently

in response to high prey populations and to rapid tree growth that facilitates the development of various structural characteristics of suitable habitat.

Bald Eagle

The status, distribution, and ecology of the bald eagle is summarized in the final rule to reclassify the bald eagle from endangered to threatened (USDI Fish and Wildlife Service 1995a) and the *Pacific Bald Eagle Recovery Plan* (USDI Fish and Wildlife Service 1986).

Species description

The bald eagle is a large, brown raptor with a white head and white tail. Young eagles are mostly brown until 4 to 6 years of age (USDI Fish and Wildlife Service 1995a).

Life history

Definition of suitable habitat

The bald eagle is typically associated with aquatic systems (e.g., rivers, large lakes, reservoirs, major rivers, and some coastal habitats). These aquatic areas must have an adequate food base, perching areas, and nest sites to support reproductive pairs. In winter, roost sites are chosen in areas close to water and with adequate perch trees (USDI Fish and Wildlife Service 1995).

The USDI Fish and Wildlife Service (1986) described nesting habitat as follows. Nests are located in the canopy of the larger live trees in forested stands that exhibit a multi-storied structure and contain an old-growth component. A variety of factors (e.g., tree characteristics and distances to water and disturbance) influence nest site selection. A variety of tree species are selected as nest sites. The distance of nests from water averaged 1,584 feet in California. Snags provide perch sites or access to nests.

Wintering habitat and communal roosts are further described by the USDI Fish and Wildlife Service (1986) as follows. Perch trees near water and with a view of the surrounding area apparently are important factors in site selection. A variety of tree species is used in wintering habitat. Isolation from disturbance is an important feature of wintering habitat.

Communal roosts differ from winter perch sites. Communal roosts are typically located near rich food sources and in uneven-aged forests stands containing an old-growth component; forest stands provide protection from inclement weather. Characteristics of roost trees and stands vary.

Reproduction

Eagles construct their own nests of sticks. Eagle pairs use the same territories each year and typically reuse the same nests. Alternate nests are constructed within territories; their use varies from year to year. One to three, typically two, eggs are laid. Pair bonding occurs early in the year (January) followed by egg-laying and incubation. Peak breeding activity is in March to June, with young birds leaving the nest in early summer. The critical period of the breeding season extends from January 1 to August 31.

Diet

The bald eagle's diet varies locally and seasonally. Fish, waterfowl, jackrabbits, and carrion comprise the most common food sources in the eagle's diet (USDI Fish and Wildlife Service 1986).

Cover requirements

Protection from inclement weather may be an important factor in the selection of wintering habitat.

Dispersal

All age classes (adult, subadult, and juvenile) of the bald eagle exhibit some form of movement (USDI Fish and Wildlife Service 1986). Dispersal of juveniles from nests is less defined than that of adults; juveniles wander substantially and disperse in various directions. Eagles breeding in the Pacific Recovery Area probably winter near their nests. Some adults and subadults wander substantial distances, settling in new areas during subsequent years.

Special habitat needs

The bald eagle has several special habitat needs, including isolation from disturbance, large trees with open crowns to support nests and provide access to nests, roost trees, and perch sites.

Current legal status

Listing history and current known listed range

The bald eagle was listed south of the 40th parallel as an endangered species on February 24, 1967 (USDI Fish and Wildlife Service 1967) under the Endangered Species Preservation Act of 1966. On February 14, 1978 (USDI Fish and Wildlife Service 1978), the bald eagle was listed as endangered throughout the lower 48 states, except in Michigan, Minnesota, Wisconsin, Washington, and Oregon, where it was designated as threatened. Survey results at the time indicated that population levels and reproductive success were lower throughout most of the lower 48 states. On August 11, 1995 (USDI Fish and Wildlife Service 1995a), the status of the bald eagle was reclassified as threatened throughout all of the lower 48 states due to continued improvement in population levels and reproductive success.

Population levels and reproductive success of the bald eagle have continued to improve throughout the lower 48 states since 1995, meeting or exceeding most recovery goals in many of the recovery zones. Current efforts are aimed at delisting the bald eagle in the near future.

PALCO lands are located in the Pacific Recovery Region which includes several states: California, Oregon, Washington, Nevada, Idaho, Montana, and Wyoming. In California, the ownership is located within Bald Eagle Management Zone 23, which includes all or portions of the following counties: Del Norte; Humboldt; Mendocino; Lake; Siskiyou; and Trinity.

Critical habitat has not been designated or proposed for the bald eagle.

Reasons for listing
The primary reason for listing the bald eagle was the adverse effect of DDT on the reproductive success of nesting eagles. DDT impaired the release of calcium needed for eggshell formation, resulting in thin eggshells and reproductive failure; the use of DDT in the United States was banned on December 31, 1972 (USDI Fish and Wildlife Service 1995a).

Threats
The following still pose threats to the bald eagle: loss of roosting, nesting, or foraging habitat due to development, logging, and other human activities; shooting; secondary lead poisoning; other environmental contaminants which may be present in the food chain; electrocution; and disturbance of nesting, roosting, or foraging birds due to human intrusion or activity (USDI Fish and Wildlife Service 1986).

Conservation needs
Bald eagles need adequate habitat conditions that meet their breeding, feeding, roosting, and wintering requirements. Isolation from disturbance also appears to be an important factor during the breeding season and at winter roosts.

PALCO lands play a minor role in the conservation of the bald eagle. No nest sites are known to occur on the ownership. The ownership, however, provides habitat conditions for a small number of wintering bald eagles. The recovery goals (e.g., number of nesting pairs, average reproduction rate, and stability of wintering population levels) have been met for the California/Oregon Coast Recovery Zone. Therefore, the PALCO lands are not considered essential to achieve the recovery goal for this recovery zone.

The Northwest Forest Plan is expected to benefit the recovery of the bald eagle on Federal lands by providing an increasing number of potential nest sites and an improved prey base (USDA Forest Service and USDI Bureau of Land Management 1994).

Status and distribution

Species

Numbers

The bald eagle population levels have increased in response to improved conditions in the environment. The following discussion is based data provided by the USDI Fish and Wildlife Service (1995a). Surveys of the lower 48 states documented a total of 417 pairs in 1963. Within approximately 20 years, bald eagles had increased in number to a total of 1,757 pairs in 1984. Ten years later in 1994, a total of 4,452 pairs were observed in the lower 48 states. Survey data from 1997 suggest the bald eagle population is still increasing: a total of at least 5,170 pairs were documented in the lower 48 states (R. Mesta, pers. comm., August 6, 1998; table 12).

Table 12. Status of the bald eagle by recovery region in the lower 48 States during 1997 (R. Mesta, pers. comm., August 6, 1998).

Recovery region	Number of pairs		Reproductive rate[1]	
	Goal	Observed	Goal	Observed
Pacific	759	1,359	1.0	1.1
Southwest	-[2]	-[2]	-[3]	-[3]
Northern	1,200	2,063	1.0	1.2
Southeastern	600	1,259	0.9	1.3
Chesapeake Bay	300-400	489	1.1	>1.1

[1] Reproductive rate is defined as the number of young fledged per pair.
[2] Goal was not expressed as number of pairs. Instead, the goal was to have the population expand into one additional river drainage. In 1997, bald eagles were observed to have expanded into three additional river drainages.
[3] Goal was not expressed as number of young fledged per pair. Instead, the goal was to have 10-12 young produced over a 5-year period. In 1997, bald eagles were observed to have produced more than 10 young each year since 1981.

Distribution
The bald eagle is generally well-distributed throughout its range. Some gaps in its distribution occur as a result of ecological conditions.

Reproduction
Results of surveys to date suggest an increasing trend in the reproduction rate of the bald eagle throughout the lower 48 states. In 1997, The average rate of reproduction was estimated at 1.11 young fledged per pair with 70 percent of the pairs being successful (R. Mesta, pers. comm., August 6, 1998). These rates exceeded the recovery goals of 1.0 and 65 percent, respectively. Reproductive success was based on a 5-year average for the period 1993-1997.

Suitable habitat
Acreage, distribution, and quality
Data on the quantity, quality, and distribution of suitable habitat throughout the range of the bald eagle could not be compiled for the purpose of this consultation.

Marbled murrelet
Species Description
Accounts of the taxonomy, ecology, and reproductive characteristics of the marbled murrelet are found in the following publications: *Ecology and Conservation of the Marbled Murrelet* (Ralph et al. 1995), the *Final Recovery Plan Marbled Murrelet (Brachyramphus marmoratus) Washington, Oregon, and California Populations* (Recovery Plan) (USDI Fish and Wildlife Service 1997), the *Final Supplemental Environmental Impact Statement on Management of Habitat for Late-successional and Old-growth Forest Related Species Within the Range of the*

Northern Spotted Owl (FSEIS) (USDA Forest Service and USDI Bureau of Land Management 1994), the *Status of the Marbled Murrelet in North America: with Special Emphasis on Populations in California, Oregon, and Washington* (Marshall 1988), and in Nelson (1997).

Life history

Definition of suitable habitat

Marbled murrelets generally nest in old-growth forests, characterized by large trees, multiple canopy layers, and moderate to high canopy closure. These forests are located close enough to the marine environment for the birds to fly to and from the nest sites. The furthest known inland occupied site is 52 miles in Washington.

General landscape condition may influence the degree to which marbled murrelets nest in an area. In Washington, detections of murrelets increased when old-growth/mature forests comprised more than 30 percent of the landscape. Raphael et al. (1995) found that the percentage of old-growth forest and large sawtimber was significantly greater within 0.5 mile of sites that were occupied by murrelets than at sites where they were not detected. Raphael et al. (1995) suggested tentative guidelines based on this analysis that sites with 35 percent old-growth and large sawtimber in the landscape are more likely to be occupied. In California, Miller and Ralph (1995) found that the density of old-growth cover and the presence of coastal redwood were the strongest predictors of presence.

Relatively few nests have been located due to the species' small body size, cryptic plumage, crepuscular activity, fast flight speed, solitary nesting behavior, and secretive behavior near nests (Hamer and Nelson 1995). Potential nest trees are generally more than 32 inches dbh with the presence of large branches, deformities, or other formations providing platforms of sufficient size to support adult birds; the average nest tree diameter was 63 inches. The Recovery Plan (USDI Fish and Wildlife Service 1997) summarizes information on 136 known nest trees in North America. The most common tree species used for nests in the Pacific Northwest and British Columbia was Douglas-fir. Nest sites in Oregon and Washington were located in stands dominated by Douglas-fir, western hemlock, and Sitka spruce. California nest sites have been located in stands containing old-growth redwood and Douglas-fir. Hamer and Nelson (1995) summarized characteristics of 10 nest trees in California including 3 trees on PALCO lands. Four of the nest trees were Douglas-fir, one western hemlock, and five coastal redwood. In central and northern California, all nest sites had a higher percentage of redwood trees than Douglas-fir (Hamer and Nelson 1995). The average nest stand size was 509 acres, with stands ranging in size from 7 to 2,718 acres.

Most nests were located on large or deformed, moss covered branches; however, a few nests were located on smaller branches, and some nests were situated on duff platforms composed of conifer needles or sticks rather than moss. The diameter of nest branches, measured at the tree trunk, averaged 11 inches and ranged from 4 to 25 inches. Nests were typically located in the top third of the dominant tree canopy layer and usually had good overhead protection. Such locations seem to allow easy access to the exterior of the forest and provide shelter from potential predators (Nelson 1997). Overhead protection for the nest was provided by overhanging branches, limbs above the nest area, or branches from neighboring trees. In most cases, canopy closure directly above the nest was high, averaging 84 percent.

Murrelets appear able to nest in a variety of unmanaged (i.e., unentered old-growth) and previously altered (i.e., previously harvested or burned) stands if certain habitat characteristics are present. Potential nesting areas may contain fewer than one suitable nesting tree per acre (USDI Fish and Wildlife Service 1996a), and nests have been found in remnant old-growth trees in mature forests in Oregon (USDI Fish and Wildlife Service 1996a). Murrelets are known to nest in stands containing residual old-growth trees on PALCO lands.

Reproduction

Life history information is lacking for the marbled murrelet (USDI Fish and Wildlife Service 1997). However, murrelets probably do not reach sexual maturity until their second year, and most birds probably do not lay eggs until they are 3 years of age or older (USDI Fish and Wildlife Service 1997). Marbled murrelets produce one egg per nest and likely only nest once a year. Nests are not built, but rather the egg is placed in a small depression or cup made in moss or other debris on the limb (USDI Fish and Wildlife Service 1997). In California, egg-laying and incubation span a long period, beginning March 24 and ending August 25, with the nestling period beginning April 23 and ending September 9 (Hamer and Nelson 1995).

Incubation lasts about 30 days, and chicks fledge after about 28 days after hatching. Both sexes incubate the egg in alternating 24-hour shifts. The chick is fed up to eight times daily, and is usually fed only one fish at a time. Adults fly from the ocean to inland nest sites at all times of the day, but most often at dusk and dawn. The young are semiprecocial. Fledglings appear to fly directly from the nest to the ocean, but are sometimes found on the ground, indicating that they may have been unable to sustain flight to reach the marine environment (USDI Fish and Wildlife Service 1997).

Diet

Marbled murrelets are diving seabirds that feed on a wide variety of small fish and invertebrates in near-shore marine waters (mainly within one mile from shore) (USDI Fish and Wildlife Service 1997). Generally they are opportunistic feeders and can exhibit major changes in prey consumption in response to changes in the marine environment. However, adults, subadults, and hatch-year birds feed primarily on larval and juvenile fish, whereas nestlings are most commonly fed larger second-year fish. This restriction forces adults that are feeding chicks to exercise more specific foraging strategies to locate these large fish, focusing on species that are less abundant and distributed differently than adult prey.

Cover requirements

It is believed that successful murrelet nesting requires relatively high levels of horizontal and vertical cover to provide protection from predators (Nelson 1997). Overall canopy closure of most stands were nests were found was moderate to high, averaging 48 percent for 45 nest sites (range 12 to 99 percent) reported by Hamer and Nelson (1995). Canopy closure at 10 stands in California where nests were discovered ranged from 25 to 48 percent and averaged 39 percent (Hamer and Nelson 1995). Cover directly over the nests averaged 84 percent and was provided by adjacent trees or the nest tree itself.

On a landscape basis, forests with a canopy height of at least one-half the site-potential tree height in proximity to potential nest trees are likely to contribute to the conservation of the marbled murrelet. These forests may reduce the differences in microclimate associated with forested and unforested areas, reduce potential for windthrow, and provide a landscape that has a higher probability of occupancy by murrelets (USDI Fish and Wildlife Service 1997).

Site Fidelity and Dispersal

Marbled murrelets, like many alcids, display a high level of site fidelity (Nelson 1997). The tendency to return each season to the same nest site or breeding colony is known as "site fidelity," "site tenacity," or "philopatry." This phenomenon is common in many, and perhaps the majority, of birds. The prevalence of this trait in so many bird species strongly suggests that the behavior confers distinct survival advantages. Scarcity of suitable nest sites may promote site tenacity, but one major advantage of returning to an established breeding site is that familiarity with the site may result in a reduced susceptibility to predation and other adverse conditions (Ehrlich et al. 1988). These and other advantages are so pronounced that many birds imprint on their nesting territories as young chicks and return to them when they are old enough to breed.

Such advantages are important for alcid seabirds (Family Alcidae), most of which exhibit very strong nest site fidelity. The vast majority of individual seabirds return every year to the exact same nest sites within a colony (Nettleship and Birkhead 1985, Kress and Nettleship 1988, Ehrlich et al. 1988). A small percentage of individual seabirds sometimes change nest sites between years, usually due to the death of a mate or failure to successfully fledge young. In addition to adults returning every year to the same nest site, most young seabirds return to breed for the first time at or very close to the nesting areas where they were reared (Nettleship and Birkhead 1985). Repeated use of a nest site is a behavioral property of an individual bird, but specific nest sites may be used over time by successive generations of individuals for a variety of reasons that are inherent properties of the site (Ehrlich et al. 1988). Such properties include physical stability, protection from predators, and proximity to a reliable food source. This phenomenon tends to compound the value of high quality nesting areas.

Scientific information on the breeding behavior of the marbled murrelet is very difficult to collect because the species is secretive during the nesting season, but behavior at known murrelet nest sites suggest that murrelets have high fidelity to specific nesting areas or forest stands (Nelson 1997). The capacity for displaced breeding adults to colonize new territory is unknown and probably low. Immature birds may colonize new areas more readily than established adults, especially if the natal breeding area is fully occupied or eliminated (e.g., due to harvest or fire), and murrelets are capable moving relatively long distances in short periods of time. The Recovery

Plan summarizes the need for further research on the dispersal of juveniles, nest site fidelity, and colonization of unoccupied habitat (USDI Fish and Wildlife Service 1997).

Special habitat needs

To successfully reproduce, marbled murrelets need sufficient numbers of suitable nesting platforms located in forests proximal to adequate food supplies in the marine environment. Suitable nesting platforms include considerations of protection from climate fluctuations and predation at local and landscape scales.

Current legal status

Listing history

The marbled murrelet was Federally listed as a threatened species in Washington, Oregon and California on September 28, 1992 (USDI Fish and Wildlife Service 1992b). The draft recovery plan was released on August 1, 1995 and the final recovery plan was released in 1997 (USDI Fish and Wildlife Service 1997).

Current known listed range

The Washington, Oregon, and California population segment of the marbled murrelet is listed as threatened (USDI Fish and Wildlife Service 1992b). The species is state listed as endangered in California and as threatened in Oregon and Washington (USDI Fish and Wildlife Service 1997).

Reasons for listing

The marbled murrelet was listed due to the loss and modification of nesting habitat primarily due to commercial timber harvesting (USDI Fish and Wildlife Service 1992b). The major factors in the marbled murrelet population decline from historical levels in the early 1800's are loss of nesting habitat and poor reproductive success in the habitat that remains (USDI Fish and Wildlife Service 1997).

Threats

In addition to removal and degradation of nesting habitat, the following are known threats: gill-net fishing operations, oil spills, marine pollution, and changes in prey abundances and distribution (USDI Fish and Wildlife Service 1997). Murrelets have a high vulnerability to oiling, and oil spills have had catastrophic effects when they have occurred in the vicinity of murrelet concentrations (USDI Fish and Wildlife Service 1996a).

Conservation needs

The recovery objectives of the Recovery Plan (USDI Fish and Wildlife Service 1997) are: (1) stabilize and then increase population size, changing the current downward trend to an upward trend throughout the listed range; (2) provide conditions in the future that allow for a reasonable likelihood of continued existence of viable populations; and (3) gather the necessary information to develop specific delisting criteria. The Recovery Plan identifies stabilizing and increasing habitat quality and quantity on land and at sea as the key means to stopping population decline and encouraging future population growth.

The Recovery Plan (pages 138 to142) recommends implementing the following short-term actions to stabilize and increase the population: (1) maintain all occupied nesting habitat on Federal lands administered under the Northwest Forest Plan (USDA Forest Service and USDI Bureau of Land Management 1994); (2) on non-Federal lands, maintain as much occupied habitat as possible and use the HCP process to avoid or reduce the loss of this habitat; (2) maintain potential and suitable habitat in large contiguous blocks; (3) maintain and enhance buffer habitat surrounding occupied habitat; (4) decrease adult and juvenile mortality; and (5) minimize nest disturbances to increase reproductive success.

The Recovery Plan (pages. 142-146) also recommends implementing the following long-term actions to stop population decline and increase population growth: (1) increase the amount and quality of suitable nesting habitat; (2) decrease fragmentation by increasing the size of suitable stands; (3) protect "recruitment" nesting habitat to buffer and enlarge existing stands, reduce fragmentation, and provide replacement habitat for current suitable nesting habitat lost to disturbance events; (4) increase speed of development of new habitat; and (5) improve and develop north/south and east/west distribution of nesting habitat.

The Recovery Plan identifies six Marbled Murrelet Conservation Zones throughout the listed range. These are the Puget Sound Conservation Zone (Zone 1); Western Washington Coast Range Conservation Zone (Zone 2); Oregon Coast Range Conservation Zone (Zone 3); Siskiyou Coast Range Conservation Zone (Zone 4), Mendocino Conservation Zone (Zone 5); and Santa Cruz Mountains Conservation Zone (Zone 6). The Recovery Plan suggests more specific conservation management plans be developed for each of the zones. To allow for the long-term survival and recovery of the murrelet, Zones 1 to 4 must be managed to produce and maintain viable populations that are well distributed throughout the respective zones.

The Siskiyou Coast Range Zone (Zone 4) extends from North Bend, Coos County, Oregon, south to the southern end of Humboldt County, California. This Zone includes known marbled murrelet populations in National and State Parks and PALCO lands and large blocks of suitable habitat critical to the three-state population recovery over the next 100 years (USDI Fish and Wildlife Service 1997, page 128). The amount of suitable habitat protected in parks is probably not sufficient by itself to guarantee long-term survival in this Zone, and the Recovery Plan identifies private lands at the southern end of the Zone as important for maintaining the current distribution of the species. There is already a considerable gap (300 miles) in distribution between this area and the central California population in Zone 6, and the Recovery Plan recommends avoiding the expansion the current distribution gap. The Recovery Plan recommends that actions in Zone 4 should focus on preventing the loss of occupied nesting habitat, minimizing the loss of unoccupied but suitable habitat, and decreasing the time for development of new suitable habitat.

Guidance in the Recovery Plan suggests that maintenance of marbled murrelet populations on private lands is critical in arresting the decline of the species in the next 50 to 100 years. This is especially true where additional nesting habitat is not expected to be available on nearby Federal lands. The demographic bottleneck that the murrelet population may experience during the next

50-100 years makes the maintenance of populations found on non-Federal lands an important component to improve viability and the likelihood for eventual recovery. On non-Federal lands the maintenance of all occupied sites should be the goal where possible.

However, the Recovery Plan (page 139) recognized that through the HCP process there may be some limited loss of occupied sites or unsurveyed suitable habitat, and that HCPs offer the best means for conservation of the species on non-Federal lands if take is minimized and mitigated and long term maintenance or creation of habitat is achieved (page 133). In the short-term (the next 5 to10 years), until additional information is obtained, loss of any occupied sites or unsurveyed suitable habitat should be avoided or the potential impacts significantly reduced through a habitat evaluation process outlined in the SYP/HCP. Short-term trade-offs for long-term benefits should be evaluated very carefully at this early stage of marbled murrelet recovery.

The Recovery Plan identifies PALCO lands as supporting essential nesting habitat under non-Federal management. It recognizes these areas as representing a significant portion of the currently available nesting habitat for the southern part of Zone 4. This area has known nest sites and is situated in a key area, close to the coast, with no Federal lands in the immediate area that are able to provide similar recovery contributions. Maintenance of suitable habitat in this area is also critical to avoid widening the gap between the central California population and southern end of Humboldt County.

Status and distribution

Range-wide (listed population)

Species

Numbers

The size of the listed population in Washington, Oregon, and California has been estimated at 18,550 to 32,000 birds (Ralph et al. 1995, Nelson 1997). The large range in the population estimate is a result of two widely divergent population estimates in Oregon. Varoujean and Williams (1995) used aerial surveys conducted along the entire Oregon coast in August and September 1993, to estimate that 6,600 murrelets occur in Oregon. Strong et al. (1995) used boat surveys to estimate that 15,000 to 20,000 murrelets occur in Oregon.

The most recent estimates of numbers in Washington (Speich and Wahl 1995) indicate a breeding population of approximately 5,500 birds. In Washington, marbled murrelets are considered only locally common during some times of the year. Puget Sound and the northern part of the outer coast are heavily used during the breeding season. The southern portion of the outer coast potentially plays an important role as a wintering area. In addition, there seems to be seasonal movements of murrelets into Puget Sound from British Columbia in the winter.

Ralph and Miller (1995) conducted intensive at-sea surveys in small portions of the murrelets's range in northern California from 1989 to 1993. These multi-year surveys, specifically designed to estimate population size in California, used different methods and assumptions and estimate a total state population of approximately 6,000 breeding and non-breeding birds. Similar to Strong in Oregon, Ralph and Miller (1995) extrapolated results from small areas to estimate numbers of murrelets over much larger areas. Swartzman et al. (1997, page 12) used some of this data to estimate approximately 4,134 murrelets are in northern California. Becker et al. (1997) and Ralph et al. (1995) discuss some of the methodological problems with surveying for murrelets at sea.

The Recovery Team (USDI Fish and Wildlife Service 1997, Appendix B) constructed a demographic model of the murrelet and concluded that the population may be declining at rates of 4 to7 percent per year range-wide, but this estimate is hampered by the possibility that the age-ratio data used in the model are reflective of a relatively temporary decline due to unusual ocean conditions (Ralph et al. 1995). Ralph et al. (1995) summarized some of the reasons for variability in population estimates among researchers, including differences in methodology, assumptions, spatial coverage, and survey and model errors. Nevertheless, both Ralph et al. (1995) and the Marbled Murrelet Recovery Team (USDI Fish and Wildlife Service 1997) have concluded that the listed population appears to be in a long-term downward trend.

Distribution
The distribution of marbled murrelet populations has been significantly reduced as habitat has been removed and populations have declined. Several areas of concern have been identified where only small numbers of murrelets persist or where they have been locally extirpated (USDI Fish and Wildlife Service 1997). These areas include distribution gaps in central California, northwestern Oregon, and southwestern Washington.

The historic distribution of the marbled murrelet within the listed range is believed to have been relatively continuous in near shore waters and in coniferous forests near the coast from the Canadian border south to Monterey County, California (USDI Fish and Wildlife Service 1997). Current breeding populations are discontinuous and generally concentrated at sea in areas adjacent to remaining late successional coniferous forests near the coast (Nelson 1997). At-sea observations of murrelets are rare between the Olympic Peninsula in Washington and Tillamook County in Oregon, a gap of approximately 100 miles. Off the California coast, marbled murrelets are concentrated in two areas at sea that correspond to the three largest remaining blocks of older, coastal forest. These forest blocks are separated by areas of little or no habitat, which correspond to locations at sea where few marbled murrelets are found. A 300-mile gap occurs in the southern portion of the marbled murrelet's breeding range, between Humboldt and Del Norte counties in the north and San Mateo and Santa Cruz counties to the south. Marbled murrelets likely occurred in this gap prior to extensive logging of redwood forests (USDI Fish and Wildlife Service 1997).

Reproduction
As summarized in the Recovery Plan, marbled murrelet populations in California, Oregon, and Washington may be declining at a rate of 4 to 7 percent per year at most locations. The murrelet has a low annual reproductive potential because it only lays one egg and probably nests once a year (Nelson 1997). Recent estimates of nesting success and recruitment suggest that productivity is below levels required to sustain the listed population (Beissinger 1995). Even if the

reproductive potential was fully realized over several years, the population will recover slowly (about 3 percent per year) from declines or disasters. Low productivity likely reflects poor breeding success, although to a lesser extent it could also reflect the development of a larger than normal nonbreeding segment of the population. There is little opportunity for increases in murrelet productivity as a result of forest in-growth in the near future because it takes hundreds of years for suitable habitat to develop. However, habitat conditions in some areas could be improved in shorter time periods with active stand management where large residual trees are present (USDI Fish and Wildlife Service 1997).

Suitable habitat

Acreage

Suitable habitat has declined throughout the range of the marbled murrelet as a result of commercial timber harvest, with some loss attributable to natural disturbance such as fire and windthrow. Timber harvest has eliminated most suitable habitat on private lands within the three state area (USDI Fish and Wildlife Service 1997). In the early to mid-1800s, Western Washington and Oregon are estimated to have been covered with 14 to 20 million acres of old-growth forests, while as of 1991 about 3.4 million acres of old-growth forests remained. This loss represents an approximate 82 percent reduction from amounts prior to logging (USDI Fish and Wildlife Service 1997). Estimates for northwestern California for this same time period suggest there were between 1.3 million and 3.2 million acres of old-growth Douglas-fir/mixed conifer forest. According to the final EIS/EIR, old-growth redwood forest covered approximately 2.7 million acres prior to 1850.

As of 1997, there were an estimated 1,077 known occupied murrelet sites within Washington, Oregon, and California (L. Reigel, USDI Fish and Wildlife Service GIS technician, pers. comm., 1997). The total number of acres of suitable habitat in these three states is unknown. Currently, suitable habitat for the murrelet is estimated at 2,561,500 acres on Federal lands in the listed range of this species (Ralph et al. 1995). Murrelet habitat is protected on Federal land under the Northwest Forest Plan in that no new timber sales will be planned in forested stands known to be occupied by murrelets regardless of whether these stands occur in reserves, adaptive management areas, or matrix areas (USDA Forest Service and USDI Bureau of Land Management 1994). In addition, the system of Federal reserves will not only protect habitat currently suitable to murrelets, but also develop future habitat in larger blocks. Currently there are approximately 56,000 acres of old-growth redwood forest estimated remaining in California, representing approximately 2.5 percent of the original old-growth redwood forest. More detailed descriptions of suitable habitat in the listed range are given in Nelson (1997) and USDI Fish and Wildlife Service (1997) and are incorporated herein by reference.

Likely Occupied Habitat in the Listed Range: Table 13 shows current estimates of the potentially occupied habitat within the listed range of the species. Because a large portion of identified suitable habitat may in fact not be occupied by marbled murrelets and is likely to overestimate the amount of actual murrelet habitat (Perry 1995), the FWS defined occupied habitat as that portion of potentially suitable habitat that is known or expected to be occupied with nesting murrelets, per the criteria in the Pacific Seabird Group survey protocol (Ralph et al. 1994). For example, although almost 200,000 acres of old-growth or late seral Douglas-fir forests remain and are protected on USDA Forest Service land in California, this suitable murrelet habitat occurs at distances further from the coast than the action area. Much of this habitat has been surveyed in recent years and does not contain or provide for murrelets in any significant numbers (Hunter et al. 1998); therefore it is not considered likely to be occupied. These estimates are based on existing survey data and assumptions about areas that have not been surveyed adequately. Where published data were lacking, the FWS solicited professional judgements from local biologists and considers these simple estimates to be the best available information.

Likely Occupied Habitat in Recovery Zone 4: The FWS estimates there are approximately 130,638 acres of likely occupied habitat in Marbled Murrelet Recovery Zone 4. Much of this habitat varies in quality, with good quality habitat in the unentered redwood forest and lower quality habitat in the managed Douglas fir forest in the northern part of Zone 4. There is significantly greater amounts of potentially suitable habitat than the estimated 130,638 acres of occupied habitat, but much of this habitat may not be occupied by murrelets and could be an artifact of our inability to accurately classify murrelet habitat at landscape scales. Comparisons or analyses using the larger amount of suitable habitat may underestimate the potential impacts of the proposed action and therefore are not used in this analysis .

Likely Occupied Habitat in the Southern Humboldt Bioregion: Survey efforts in HRSP and GCSP have identified approximately 6,930 acres of known occupied old-growth residual redwood in HRSP and 388 acres in GCSP (updated information provided by T. Reid, December 16, 1998). Most known occupied stands in HRSP are located in the lowland portions of the park along Bull Creek or other streams, while most surveys in the upland areas of HRSP have not detected occupied behaviors. However, most of the stations have not been surveyed to levels similar to stations on PALCO lands, and it is likely that some of this incompletely surveyed land is occupied by nesting murrelets at lower levels than is the high quality habitat in the lowlands.

Similar to the estimation of occupied habitat in unsurveyed Douglas fir habitat on PALCO lands, the FWS used an occupancy index of 0.05 and applied this to 16,246 acres of inadequately surveyed old-growth redwood/Douglas fir forest in HRSP. Although much of this unsurveyed habitat is redwood-dominant, it is also drier and not of similar quality to the redwood residual on PALCO lands (K. Moore, pers. comm.); preliminary surveys in this habitat had low numbers of detections. Using this calculation method, the FWS estimates that about 817 acres of the 16,346 acres is likely occupied. This 817 acres can be added to the known occupied 6,930 acres for an estimated total of 7,747 occupied acres in HRSP. The FWS acknowledges that this figure is likely an underestimate of potential occupied habitat in HRSP, but this conservative conclusion is justified given available information. Ralph et al. (Section IV, draft SYP/HCP,) attributed greater relative conservation value to HRSP lands, but the FWS believes their calculation methods may have overestimated HRSP usage by murrelets. Additional information on HRSP habitat quality and occupancy levels will further clarify this issue, and the implications of this estimate will be further discussed in the section on Effects of the Action.

Distribution
The Recovery Plan (USDI Fish and Wildlife Service 1997) summarizes the current distribution of suitable habitat and is incorporated herein by reference. Currently, breeding populations of murrelets are not distributed continuously throughout the forested portions of Washington, Oregon, and California. A gap of 100 miles in the north/south distribution of suitable habitat exists in southwestern Washington and northwestern Oregon and a north/south gap of 300 miles exists in central California in the southernmost portion of the species' range. These gaps consist of areas of second-growth and remnant older forests used by murrelets at low levels. The inland distribution of the species is greatest in Washington at approximately 55 miles from the marine environment, narrowing down in Oregon and even further in California to 10 to15 miles from the coast.

Quality
The overall quality of existing marbled murrelet habitat is diminished compared to habitat quality prior to logging (USDI Fish and Wildlife Service 1997). Total habitat area is greatly reduced, and remaining habitat is often fragmented and further from the marine environment. Quality varies across the range, with some excellent old-growth habitat remaining on Federal lands in each of the three states. However, much suitable habitat throughout the range is now lower quality than existed historically, with smaller trees, more roads and clearcut openings, and a greater abundance of predators. Small islands of habitat within a matrix of younger forests provide important habitat; however, they are often considered lower quality because of the vulnerability to wildfire, windthrow and perhaps a higher abundance of avian predators. Although ongoing research should shed more light on the specific factors that affect marbled murrelet nest predation and stand size preferences, the best available information strongly suggests that marbled murrelet reproductive success may be adversely affected by forest fragmentation associated with certain land management practices (USDI Fish and Wildlife Service 1997).

PALCO lands appear to have higher murrelet detection levels relative to other lands in the Southern Humboldt Bioregion (Bioregion) and Zone 4, suggesting that redwood residuals on PALCO lands may support more murrelets than habitats on nearby USFS and BLM further inland or in areas lacking a strong redwood component.

Table 13. Estimates of the acreage of potentially occupied marbled murrelet nesting habitat at various landscape scales within the species' listed range (adapted and updated from Table N1-2, EIS).

Region/Unit	Acres
Pacific Lumber Company Lands 1/	
Headwaters/Elk Head Springs	3,117
Other High Quality 2/	2,022
Low/Moderate Quality 3/	8,419
TOTAL	**13,558**
Southern Humboldt Bioregion (Bioregion)	
Pacific Lumber	13,558
Humboldt Redwoods State Park 4/	7,747
Grizzly Creek State Park 5/	388
TOTAL	**21,693**
Marbled Murrelet Conservation Zone 4 (MMCZ4) 6/	
Bioregion	21,693
Simpson	608
Stimson	91
Yurok	250
Six Rivers National Forest	3,719
Arcata BLM	568
Redwood National and State Parks	38,982
Oregon	64,727
TOTAL	**130,638**
California 7/	
MMCZ4(CA)	65,911
MMCZ5	430
MMCZ6	7,250
TOTAL	**73,591**
3 State (Washington, Oregon and California) 8/	
WA 9/	373,875
OR 9/	254,869
CA	73,591
TOTAL	**702,335**

1/ Habitat estimation method on PALCO lands: contiguous occupied old growth/residual habitat within 0.5-mile radius of occupied survey stations on PALCO lands (excluding Headwaters).

2/ High quality indicates unentered old growth redwood outside Headwaters; assumes remaining inadequately surveyed is 100% occupied.

3/ Low/moderate quality indicates residual redwood and inland Douglas-fir; assumes remaining inadequately surveyed is 5-63% occupied, depending on habitat type.

4/ Habitat estimation method in HRSP: contiguous occupied old growth/residual habitat within 0.5-mile radius of occupied survey stations, as estimated by CDFG, Palco, and USDI Fish and Wildlife Service, is 6,930 ac. Total estimate assumes remaining inadequately surveyed habitat is 5% occupied : (23276 - 6930)(.05) = 817; 817 + 6930 = 7747. (T. Reid, pers. comm., 12/16/98); this figure is likely an underestimate - see text.

5/ Includes all uncut old-growth within the state park

6/ Habitat estimation method in MMCZ4: Bioregion total plus estimates made for lands listed; estimates based on draft HCPs and personal communications with local biologists (OR total explained below)

7/ Habitat estimation method in California: MMCZ4 minus Oregon habitat plus totals for MMCZ5 and MMCZ6. MMCZ5 and MMCZ6 estimates based on L. Roberts, E. Burkett, pers. comm.

8/ WA = 1.5 million potential suitable acres (T. Young, pers. comm.) x 0.25 occupancy index (WDNR HCP, T. Hamer, pers. comm.) excluding 1,125 acres for Quinalt

OR = 2 conservation zones, MMCZ3 and MMCZ4 (Total = 254, 869 likely occupied acres)

MMCZ4 = (1) 20,000 acres, Siskiyou National Forest, Rogue National Forest, and Medford BLM
(USFS GIS, 80,000 acres x 0.25 occupancy index; index derived from Dillingham et al. (1995),
Meyers pers. comm., ODFW marbled murrelet survey database, and S. Livingston, pers. comm.)

(2) 44,727 acres in Coos Bay BLM (J. Heaney, pers. comm.)
MMCZ3 = (1) 137,500 acres, Suislaw National Forest (C. Frounfelker, pers. comm.)
(2) 5,567 acres, Eugene BLM (D. Huber, pers. comm.)
(3) 30,075 acres, Coos Bay BLM (J. Heaney, pers. comm.)
(4) 4,000 acres, northwest Oregon (N. Bentivoglio, pers. comm.)
(5) 13,000 acres, Elliott State Forest HCP
(6) Private lands unknown but likely very small amount

9/ Habitat in Oregon and Washington may have lower murrelet densities than redwood forests, as indicated by detection levels.

Other completed or contemporaneous actions

The listing decision (USDI Fish and Wildlife Service 1992b), designation of critical habitat (USDI Fish and Wildlife Service 1996a), final Recovery Plan (USDI Fish and Wildlife Service 1997), Ralph et al. (1995), and Nelson (1997) discuss other threats to the survival and recovery of the murrelet and are incorporated herein by reference. Marine pollution, catastrophic weather events, and fire continue to pose a risk to the long term survival and recovery of the species. Some recent events, such as the death of at least nine murrelets due to an oil spill in Humboldt Bay, underscore the persistence of these other threats.

Murrelet conservation strategy and other murrelet HCPs: Before evaluating the effects of the proposed HCP on the marbled murrelet, it is necessary to review the overall Federal conservation strategy for the murrelet throughout its listed range. As described earlier in this section, the listed murrelet population may be declining at an annual rate of 4-7 percent (USDI Fish and Wildlife Service 1997). This modeled decline is most likely due to a reduction in nesting habitat that resulted from large scale timber harvest during the last 150 years, although other landscape and marine factors also likely played a role. The Northwest Forest Plan (Forest Plan) was implemented in 1994 to address and rectify this habitat loss on Federal lands and to promote recovery of the marbled murrelet, northern spotted owl, and other species dependent on late-successional forests (USDA Forest Service and USDI Bureau of Land Management 1994). In the biological opinion on the Forest Plan, the FWS concluded that the Forest Plan "should provide for the survival of a marbled murrelet population that is well distributed on Federal lands throughout the planning area" (USDA Forest Service and USDI Bureau of Land Management 1994, Appendix G, page 28). A similar conclusion was reached for the northern spotted owl.

Although the marbled murrelet and the northern spotted owl are different in many important biological respects, as co-inhabitants of much of the same late-successional forest they have experienced some of the same adverse effects of past land management practices. The best available science suggests that both species are experiencing a downward trend in population numbers due to past timber harvest (USDA Forest Service and USDI Bureau of Land Management 1994). Likewise, the overall land management strategy for the two species is similar: Conserve much of the remaining suitable or occupied habitat on Federal lands (and, in certain key areas on non-Federal lands for the murrelet) to provide a system of long term management reserves that will stabilize and eventually recover the declining population. This approach assumes the respective populations have not already declined below an extinction threshold from which they can not recover (USDA Forest Service and USDI Bureau of Land

Management 1994), and that the species will respond positively to a long term reversal in the trend of habitat loss (Raphael et al. 1996). Our technical ability to predict such potential thresholds for murrelets, spotted owls, and many other listed species is still quite crude (National Research Council 1995, page 168); in particular, our ability to estimate murrelet population size and trends is limited (Becker et al. 1997, page 744).

A conservative approach to managing murrelet habitat has been adopted by the Federal agencies that accommodates this inability to identify an extinction threshold. The Forest Plan is designed to enable Federal lands to bear most of the burden for recovering and maintaining late-successional species such as the murrelet. The Plan protects approximately 90 percent of the suitable murrelet habitat on Federal lands (USDI Fish and Wildlife Service 1997), and it places a total prohibition on the loss of occupied murrelet habitat on Federal lands. This prohibition includes a restriction on harvest of occupied sites in so-called "matrix" lands where timber harvest is otherwise allowed.

The Forest Plan and the Marbled Murrelet Recovery Plan (USDI Fish and Wildlife Service 1997) also identified the need for some non-Federal lands to contribute to murrelet recovery where distributional gaps occurred (FEMAT 1993, page IV-164), including the general area of PALCO ownership. It was recognized that some removal of occupied habitat is likely — and potentially permissible — on non-Federal lands assuming enough high quality habitat is protected to maintain well distributed, viable subpopulations throughout the listed range. In cooperating with non-Federal landowners who are developing murrelet HCPs in these important conservation areas, the FWS has followed this recommendation of the Marbled Murrelet Recovery Plan: minimize the loss of occupied murrelet habitat by evaluating and ranking various types of occupied habitat, and balance short-term risks with long term tradeoffs (USDI Fish and Wildlife Service 1997, page 139).

To date the FWS believes it has successfully applied this recommendation. Within this context it should be recognized that incidental take of murrelets associated with known or likely occupied habitat on non-Federal lands has been authorized through the section 7 and section 10 processes. For example, section 7 consultation has permitted incidental take of murrelets in several recent HCPs (Table 14); each of these approved actions retained the highest quality habitat as part of a management strategy that was consistent with the Recovery Plan.

Table 14. Summary of habitat acres addressed in various section 7 consultations involving marbled murrelets on non-Federal lands.

Action	Date	Total Plan Area	Total Suitable Acres	Suitable Acres Harvested	Estimated Occupied Acres Potentially Taken	Relative Habitat Quality	Permit Length
Elliott HCP[1]	10/96	93,000	13,000	3,138	785	L	6 years
WA DNR HCP[2]	1/97	1,600,000	149,000	up to 33,000-126,000, but less expected	up to 18,000-74,000, but less expected	L	70 years
Quinalt BO RPA[3]	1/98	4,885	4,885	1,600	1,125	L/M	NA

[1] Biological Opinion on the Proposed Issuance of an Incidental Take Permit (PRT-803344) for Northern Spotted Owls and Marbled Murrelets to the Oregon Department of Forestry on the Elliott State Forest, Coos and Douglas Counties, Oregon

[2] Intra-FWS Concurrence Memorandum and Biological Opinion on the Proposed Issuance of an Incidental Take Permit (PRT-812521) for Northern Spotted Owls, Marbled Murrelets, et al. and the Approval of the Implementation Agreement for the Washington State Department of Natural Resources Habitat Conservation Plan

[3] Biological Opinion on the Quinalt North Boundary Area Unit Management Plan, Quinalt Indian Nation, January 28, 1998 (USDI Fish and Wildlife Service 1998).

Marbled murrelet critical habitat

Current legal status

Designation history

Critical habitat was initially proposed on January 27, 1994 (USDI Fish and Wildlife Service 1994a). A revised critical habitat proposal was published August 10, 1995 (USDI Fish and Wildlife Service 1995). A final critical habitat rule was published May 24, 1996 (USDI Fish and Wildlife Service 1996a).

Primary constituent elements

Description

The following five paragraphs quote directly from the final rule designating critical habitat for the marbled murrelet (USDI Fish and Wildlife Service 1996a).

The FWS has determined that the physical and biological habitat features (referred to as the primary constituent elements) associated with the terrestrial environment that support nesting roosting and other normal behaviors are essential to the conservation of the marbled murrelet and require special management considerations

Within areas essential for successful marbled murrelet nesting, the FWS has focused on the following primary constituent elements: (1) individual trees with potential nesting platforms; and (2) forested areas within 0.5 miles of individual trees with potential nesting platforms, and with a canopy height of at least one-half the site potential tree height. This includes all such forest, regardless of contiguity. These primary constituent elements are essential to provide and support suitable nesting habitat for successful reproduction of the marbled murrelet.

Individual nest trees include large trees, generally more than 32 inches dbh with the presence of potential nest platforms or deformities such as large or forked limbs, broken tops, dwarf mistletoe infections, witches brooms, or other formations providing platforms of sufficient size to support adult murrelets. Because marbled murrelets do not build nests, moss or detritus may be important to cushion or hold the egg. Platforms should have overhead cover for protection from predators and weather, which may be provided by overhanging branches, limbs above the nest area, or branches from neighboring trees. Based on current information from Washington, Oregon, and California, nests have been found in Douglas-fir, coastal redwood, western hemlock, western red cedar, or Sitka spruce (Hamer and Nelson 1995).

On a landscape basis, forests with a canopy height of at least one-half the site potential tree height in proximity to potential nest trees are likely to contribute to the conservation of the marbled murrelet. These forests may reduce the differences in microclimates associated with forested and unforested areas (Chen et al. 1992, Chen et al. 1993), reduce potential for windthrow during storms (Chen et al. 1992), and provide a landscape that has a higher probability of occupancy by marbled murrelets (Raphael et al. 1995). The site-potential tree is the average maximum height for trees given the local growing conditions, and is based on species-specific site index tables. Nest trees may be scattered or clumped throughout the area.. Potential nesting areas may contain fewer than one suitable nesting tree per acre.

Within the boundaries of designated critical habitat, only those areas that contain one or more primary constituent element are, by definition, critical habitat. Areas without any primary constituent elements are excluded by definition.

Threats

Activities that disturb or remove primary constituent elements may adversely affect marbled murrelet critical habitat. Examples of these activities include, but are not limited to, (1) forest management activities which greatly reduce stand canopy closure, appreciably alter the stand structure, or reduce the availability of nesting sites; (2) land disturbance activities and road building, and (3) harvest of certain types of commercial forest products (USDI Fish and Wildlife Service 1996a).

Status and distribution

In the following discussion, to the extent possible, the estimated amount of habitat that contains the primary constituent elements and that therefore is actually designated as critical habitat will be distinguished from the total area encompassed within the critical habitat units (CHUs). As a result of natural factors and past timber harvest, marbled murrelet habitat often occurs in a patchy distribution. This habitat was encompassed in CHUs designated by legal descriptions. Therefore, many CHUs contain areas that do not include primary constituent elements, and thus, the actual acreage of designated critical habitat is often substantially less than the total acreage encompassed within the boundaries of the units.

Designated critical habitat within Washington, Oregon, and California includes 32 CHUs encompassing about 3,887,000 acres. Twenty-two of these units include non-Federal lands; non-Federal lands comprise about 22 percent of the total acreage. In most cases the exact amount of habitat that contains the primary constituent elements within these units is unknown. Critical habitat is primarily based on the LSRs identified in the Northwest Forest Plan (approximately 3 million of the 3.9 million acres, or 78 percent). The Federal LSRs reserves were designed to respond to the problems of fragmentation of suitable murrelet habitat, potential increases in predation due to fragmentation, and reduced reproductive success of murrelets in fragmented habitat. The LSR system identifies large, contiguous blocks of forest that are to be managed for the conservation and development of these older forest features required by the murrelet, and as such, serve as an ideal basis for murrelet critical habitat. Where the LSRs were not sufficient to provide habitat considered critical for the survival and recovery of the murrelet, other lands were identified, including state (21 percent), private lands (1.2 percent), county (0.2 percent), and city (0.003 percent)(USDI Fish and Wildlife Service 1996a).

The Marbled Murrelet Recovery Team identified six Conservation Zones in the 3-state range of the species (USDI Fish and Wildlife Service 1997). Conservation Zone 4, which includes the project area, extends from North Bend, Oregon, to the southern end of Humboldt County, California, and includes portions of CHUs OR-04, OR-06, OR-07, CA-01, CA-02, CA-03, CA-04, and CA-11. This zone has large blocks of suitable habitat critical to the three-state murrelet population recovery over the next 100 years. Most of these large blocks are located in Redwood National Park and state parks. State parks in the park complex were designated as critical habitat, but because national parks are generally managed by statutory requirements to protect natural ecosystems for the benefit of wildlife, they may not require special management consideration or protection, which was one of the criteria for designation of critical habitat. Redwood National Park was considered for designation, but the park's statutory authority and general management goals were considered adequate to conserve the species without the additional designation of critical habitat. In effect, the park thus functions as de facto critical habitat in Conservation Zone 4 because of those statutory protections (USDI Fish and Wildlife Service 1996a). The acreage within the Conservation Zone 4 CHU units is 900,389, with another 75,451 acres located in Redwood National Park for a total of 975,840 acres. Approximately 552,751 of these acres, including the Redwood National Park acreage, are in California.

The amount of acreage within the CHUs that actually contains the primary constituent elements and therefore constitutes critical habitat is uncertain. Because most Northwest Forest Plan LSRs within the range of the murrelet were designated as critical habitat, and the LSRs are believed to contain about 1,295,000 acres of marbled murrelet nesting habitat (USDA Forest Service and

USDI Bureau of Land Management 1994), that figure is regarded as a minimum amount of actual critical habitat within the 3-state range. A somewhat more precise estimate can be derived for Conservation Zone 4. In CHUs within the Oregon portion of Conservation Zone 4, there are approximately 116,500 acres that appear to be suitable for marbled murrelets (FWS GIS data). On the Six Rivers National Forest in northwestern California, there are an estimated 106,984 acres of apparently suitable habitat within critical habitat (K. Schmidt, pers. comm., January 20, 1999). About 19,640 acres within Redwood National Park consists of old-growth redwood, and another 19,342 acres of old-growth are found on the associated state parks in northern Humboldt and Del Norte Counties (USDI National Park Service 1998). All of these acres are believed to contain the primary constituent elements and thus constitute either de facto or designated critical habitat. Including the habitat listed in Table 15 below, the total amount of habitat containing primary constituent elements within CHUs in Conservation Zone 4, including Redwood National Park, is estimated at approximately 308,294 acres.

The amount of habitat within critical habitat units in the southern portion of Conservation Zone 4, in proximity to the action area, is summarized in table 15.

Table 15. Marbled murrelet critical habitat in proximity to action area.

Unit	Total acres	Est. acres suitable Or with PCE	Ownership
CA-03-a	40,417	12,306	PALCO & other private
CA-04-a	54,081	23,663	State Parks (HRSP & GCSP)[1]
CA-04-b	574	574	State Parks (HRSP)
CA-05-a	38,698	7,956	BLM (King Range)[2]
CA-11-b	1,111	179	BLM (Iaqua portion of larger unit)
CA-11-c	2,731	1,150	BLM (Larabee)
TOTAL	**137,612**	**45,828**	

[1] Based on FWS GIS and Final EIR Table N2-3B

[2] Based on FWS GIS and Hawks, S. Personal Communication, USDI, Bureau of Reclamation. February 3, 1999.

It should be remembered that large portions of designated critical habitat are apparently not currently occupied by the species, even where habitat appears suitable or contains primary constituent elements. For instance, in CHU-CA-04-a, on Humboldt Redwoods State Park, over 23,000 acres appear to be suitable, but less than 8,000 acres are currently believed to be occupied. Although the CHUs near the project area (listed in Table 15 above) all contain the primary constituent elements in the form of large trees with apparent nesting platforms, and appear otherwise suitable for use by murrelets, surveys have determined that only CHUs CA-03-a and CA-04-a are occupied by murrelets at this time. Reasons for this are unknown. The most obvious factor is that the two areas occupied by murrelets are dominated by coastal redwood forest, while the others are dominated by Douglas-fir forest.

Another difficulty in assessing the amount of existing critical habitat for the marbled murrelet derives from the inclusion in designated critical habitat of any tree within CHUs that contains a suitable nest platform. Large-scale assessments based on remote sensing cannot identify scattered individual trees with these characteristics that are not within identifiable timber stands. Therefore, for the purposes of this evaluation, it is assumed that an unquantifiable amount of critical habitat exists within all CHUs in excess of the acreage reported above, that this factor applies proportionally at all scales of analysis, and that such habitat is if relatively low value because of the low amount of nesting substrate.

Western snowy plover

Species description

The snowy plover is a small, pale, migratory shorebird of the family Charadriidae that occurs over much of the North American coast and at some inland sites in the United States and Mexico. Two subspecies of snowy plover occur in North America. The Pacific coast population belongs entirely to the subspecies *C. a. nivosus.* This subspecies breeds along the Pacific coast from southwestern Washington to mainland Mexico and Baja California and at some interior sites of California, Oregon, and other western states. On the Pacific coast, larger concentrations of breeding birds occur in the south than in the north, suggesting that the center of the plover's coastal distribution lies closer to the southern boundary of California. For a complete life history and taxonomic description of this species, refer to Page et al. (1995).

The Pacific coast population is genetically isolated from western snowy plovers breeding in the interior. Intensive banding and monitoring studies have documented only two isolated instances of intermixing between coastal and interior populations of nesting birds. Snowy plovers tend to be site faithful, with the majority of birds returning to the same nesting location in subsequent years.

Life history

Definition of suitable habitat

This subspecies nests on barren to sparsely vegetated sand beaches, dry salt flats in lagoons, dredge spoils deposited on beach or dune habitat levees and flats at salt-evaporation ponds, and, in at least one area, river gravel bars (Tuttle et al. 1997). Suitable habitat is characterized by a nearly complete absence of vegetation and other structure.

Distribution

The subspecies' Pacific population occurs from southwest Washington into Baja Mexico. The species is most numerous in southern portions of its range (southern California).

Reproduction

Snowy plovers may make up to three nesting attempts per year, depending on local conditions and the success of previous attempts. Nesting occurs in loose colonies from March or April through August or September, which coincides with the season of greatest human use in their habitats. Adult birds tend to remain close to the nest (Page et al. 1977) and are known for their fidelity to specific nesting areas from year to year (Warriner et al. 1986). Plover chicks are precocial, leaving the nest to search for food within hours of hatching, and rarely remain in the immediate nest vicinity until fledging.

Nest success ranges from 0 to 80 percent for coastal snowy plovers. Instances of low nest success have been attributed to a variety of factors, including predation, human disturbance, and inclement weather conditions. Reproductive rate ranges from 0.05 to 2.40 young fledged per female, pair, or nest. Page et al. (1977) estimated that snowy plovers must fledge 0.8 young per female per year to maintain a stable population. Although recovery attempts have been successful in some areas of this species range, many birds continue to be subjected to disturbance during nesting season.

Diet

Snowy plovers forage on invertebrates.

Cover requirements

Cover requirements seem limited to small debris (e.g., shells, aquatic wrack, small driftwood) that accumulates near tidal lines on beaches.

Dispersal

Birds nesting inland normally migrate to coastal sites, and coastal nesting birds may move northward or southward along the coast from breeding sites to winter sites. Along the Eel River, near the action area, plovers may form loose groups on gravel bars during late summer. Little is known of the species' use of these gravel bars during winter months.

Special habitat needs

The primary habitat need of the snowy plover is open beaches or beach-like habitats that provide a broad view of surrounding areas, so that predators can be detected. In addition, sparse wrack from kelp, seaweed, small driftwood, or other organic debris contributes to local roost and feeding sites. Freedom from human disturbance at these sites, including indirect adverse effects from increased predator numbers, would probably substantially improve reproductive success. Abundant food sources (e.g., invertebrates) are likely needed for successful nesting and brood rearing.

Current legal status

Listing history

The western snowy plover was listed on March 5, 1993 as a Federally threatened species (USDI Fish and Wildlife Service 1993), and is also a California species of special concern (CDFG

1998a). Critical habitat was proposed on March 2, 1995 (USDI Fish and Wildlife Service 1995c); no final rule was published due to a moratorium on listing actions. Currently, the FWS is under court order to publish a final rule for critical habitat for the species before December 1, 1999.

Reasons for listing

The western snowy plover was listed under the Act due to declining population levels caused by habitat loss from urban development and the invasion of European beachgrass (*Ammophila arenaria*), as well as disturbance and direct mortality from a variety of factors, including off-highway vehicles, humans, and their pets.

Threats

The most important form of habitat loss to coastal breeding plovers has been the encroachment of European beach grass and other introduced plant species, resulting in stabilized, heavily vegetated dunes. This stabilization eliminates sparsely vegetated beach above the tideline, decreases the width of the beach, and increases the slope. These changes reduce the amount of potential snowy plover nesting habitat on many beaches and may hamper brood movements. The beachgrass community also provides habitat for snowy plover predators, resulting in predation that historically would have been minimized by the lack of cover in the open beach habitat.

In the habitat remaining for snowy plover nesting, human activities are a key factor in the ongoing decline in snowy plover coastal breeding sites and breeding populations in California, Oregon, and Washington. The nesting season of the western snowy plover coincides with the season of greatest human use on beaches of the west coast. Snowy plovers are highly susceptible to disturbances caused by the human use of their breeding sites. The current level of human encroachment upon remaining nest sites results in a disruption of nesting activities that far exceeds what plovers experienced historically; this likely results in lost nests, eggs, and chicks due to direct harm and failure to adequately incubate eggs and brood young. Human activities detrimental to nesting snowy plovers include unintentional disturbance (e.g., walking, jogging, horseback riding, pets, off-road vehicles, and beach raking) and direct mortality (e.g., unintentional trampling of eggs and chicks by people, unleashed pets, and off-road vehicles). Gravel mining in particular has been noted as a concern for birds that may be nesting in the vicinity of the action area.

An additional factor affecting net productivity of plovers, indirectly, is the increased predation on nests associated with increased populations of crows (*Corvus brachyrhynchos*), ravens (*Corvus corax*) and other predators. Populations of these predatory species, known to prey on plover eggs and chicks, are likely greater due to the availability of supplemental food sources from human trash.

The subspecies may be susceptible to contaminants in its habitat (e.g., offshore oil spills), but the magnitude of that threat has not been well documented. During 1997 and 1998, three oil spills occurred in showy plover habitat along the California coast, resulting in oiled plovers.

Conservation needs

The primary habitat need of the snowy plover is open beaches or beach-like habitats free from human disturbance. Adequate food sources (e.g., invertebrates) are needed for successful nesting and brood rearing. Human activities are a key factor in the ongoing decline in snowy plover coastal breeding sites and breeding populations. Human activities detrimental to nesting snowy plovers include unintentional disturbance (e.g., walking, jogging, running pets, horseback riding, off-road vehicles, and beach raking) and direct mortality (e.g., unintentional trampling of eggs and chicks, by people and their unleashed pets and by off-road vehicles). Therefore, the primary conservation needs of the western snowy plover are habitat restoration through the removal of invasive exotic plant species (primarily European beach grass) that cause the loss of open beach habitats, protection of nesting and brood-rearing sites from human disturbance, and protection from elevated levels of predation. Currently, no plovers have been detected on any PALCO ownership in the action area, and no plovers have been detected on any PALCO "vested interests" lands within the action area. Therefore, current PALCO lands do not play a role in the recovery of the western snowy plover. However, should the species expand its range to include lands under PALCO control, or should PALCO acquire lands or vested rights that includes habitat for plovers, PALCO lands may be important for future recovery of the species.

Status and distribution

Species

Numbers and distribution

Historic records indicate that nesting western snowy plovers were once more widely distributed on the Pacific coast than they currently are. In coastal California, snowy plovers bred at 53 locations prior to 1970; since that time, no evidence of breeding birds has been found at 33 of those 53 sites, a 62 percent decline in breeding sites (Page and Stenzel 1981).

The plover breeding population in California, Oregon, and Washington declined 17 percent between 1977 and 1989 (Page et al. 1991). In 1981, the coastal California breeding population of snowy plovers was estimated to be 1,565 adults (Page and Stenzel 1981). In 1989, surveys revealed 1,386 plovers (Page et al. 1991), an 11 percent decline in the breeding population.

Suitable habitat

Acreage and distribution

The most recent quantification of potential breeding habitat for the western snowy plover indicates that upwards of 145 potential breeding and/or wintering sites may be available to the plover within its historic range along the Pacific coast in California, Oregon and Washington. These sites include approximately 43,464 acres of potential habitat along 453.4 miles of coastline. In addition to this beach habitat, an additional 21 sites in California (including salt ponds, river levees, airports, and coastal marshes) with an undisclosed number of acres are potentially suited to plover breeding and/or wintering.

Quality

Virtually all snowy plover nesting habitat has been affected by invasive exotic plant species, resulting in more densely vegetated beach habitats for nesting. Plovers tend to avoid habitats with more than just sparse vegetation. Nearly all nesting habitats have been affected by human disturbance, including actual human presence, their vehicles and equipment, and human-associated pets, especially dogs. Some nesting habitats may be of lower quality due to the presence of elevated levels of predators, including Common Raven, American Crows, and mammalian predators.

Southern Oregon/Northern California Coast ESU coho salmon

Species description

The coho salmon is an anadromous salmonid species that was historically widely distributed throughout the North Pacific Ocean from Central California to Point Hope, Alaska; through the Aleutian Islands, and from the Anadyr River, Russia, south to Hokkaido, Japan. Coho are very similar in appearance to chinook salmon (*O. tshawytscha*) while at sea (blue-green back with silver flanks), but they are smaller than chinook salmon. Coho salmon adults can be distinguished from small chinook salmon by the lack of spots on the lower portion of the tail. During this century, naturally-producing populations of coho salmon have declined or have been extirpated in California, Oregon, and Washington. The coho salmon status review (Weitkamp et al. 1995) identified six distinct population segments (Evolutionarily Significant Units - ESUs) in these three states and noted that natural runs in all ESUs are substantially below historical levels (Weitkamp et al. 1995). The action area is within the Southern Oregon/Northern California Coast (SONCC) ESU.

Life History

General life history information for coho salmon is summarized below. Further information is available in the status review (Weitkamp et al. 1995), the proposed rule for listing coho salmon (50 FR 38011), and the final rule listing the SONCC coho salmon ESU (62 FR 24588).

Most coho salmon exhibit a three-year life cycle. They spend approximately 18 months in fresh water and 18 months in salt water (Gilbert 1912, Pritchard 1940, Briggs 1953, Shapovalov and Taft 1954, Loeffel and Wendler 1968). The primary exception to this pattern is 'jacks', which are sexually mature males that return to freshwater to spawn after only 5 to 7 months in the ocean. Most coho salmon enter rivers between September and February and spawn from November to January. Coho salmon river entry timing is influenced by many factors, one of which appears to be river flow. In addition, many small California systems have sandbars which block their mouths for most of the year except during the winter. In these systems, coho salmon and other salmon species are unable to enter the rivers until sufficiently strong freshets break the sandbars (Sandercock 1991). Migration normally occurs when water temperatures are between 44.6° and 60.1°F, minimum water depth is seven inches and streamflow velocity does not exceed 8.0 feet per second (Reiser and Bjornn 1979). Once coho salmon have entered the river, they must navigate past waterfalls, debris jams, culverts, high water velocities, and other barriers in order to access spawning areas upstream.

Coho salmon spawn between November and January (Hassler 1987) and occasionally into February and March (Weitkamp et al. 1995). Coho salmon populations in northern California may spend 1 or 2 months in fresh water before spawning (Flint and Zillges 1980; Fraser et al. 1983). In larger river systems, coho salmon have a broad period of fresh water entry spanning from August until December (Leidy and Leidy 1984). In general, earlier migrating fish spawn farther upstream within a basin than later migrating fish, which enter rivers in a more advanced state of sexual maturity (Sandercock 1991).

Coho salmon generally build their redds at the head of riffles where there is good intra-gravel flow and oxygenation. Coho salmon appear to favor areas where the stream velocity is 1.0 to 1.8 ft/s (Gribanov 1948) and stream depth is greater than 7.1 inches (Thompson 1972, cited in Bjornn & Reiser 1991). Water quality can be clear or heavily silted with varying substrate of fine gravel to coarse rubble. Bell (1986) indicated that substrate for anadromous salmonids should range from 0.5 to 4.0 inches in diameter. In California, coho salmon spawn in water temperatures of 42.08° to 55.94°F (Briggs 1953). Coho salmon build redds averaging about 30 ft^2, but the spatial area required per spawning pair is much larger, about 126 square feet (Burner 1951; cited in Bjornn and Reiser 1991).

Coho salmon eggs incubate for approximately 35 to 50 days between November and March. The duration of incubation may change depending on ambient water temperatures (Shapovalov and Taft 1954). Successful incubation depends on several factors including dissolved oxygen levels, temperature, substrate size, amount of fine sediment, and water velocity. Fry start emerging from the gravel two to three weeks after hatching (Hassler 1987). Young fry hide in gravel and under large rocks during daylight hours. After several days growth, fry move into shallow areas near the stream banks, seeking out quiet backwaters, undercut banks, side channels, and small creeks, especially those with overhanging riparian vegetation (Gribanov 1948). Citing several studies, Bjornn and Reiser (1991) concluded that newly emerged fry require velocities of less than 0.33 feet per second. As coho salmon fry grow larger, they disperse upstream and downstream, moving into areas with less cover and higher velocity flows (Lester and Genoe 1970), where they establish and defend territories (Hassler 1987). Fry feed mainly on aquatic and terrestrial insects (Mundie 1969; cited in Meehan and Bjornn 1991).

In California, fry move into deep pools in July and August, where feeding is reduced and growth rate decreased (Shapovalov and Taft 1954). During the summer, coho salmon fry prefer pools and riffles featuring adequate cover such as large woody debris, undercut banks, and overhanging vegetation. High summer water temperatures can affect juveniles. Brett (1952) found that juvenile coho salmon had an upper lethal temperature of 77°F but that optimal temperatures appeared to be between 54 and 57°F. In smaller California streams, water levels may drop so low during the summer that the pools are the only viable rearing habitat. No passage between pools can occur until river levels rise with the onset of the rainy season. Therefore, juvenile salmonids rearing in isolated summer pools are extremely vulnerable to disturbance or water quality impacts. Daytime temperatures in summer rearing pools may be near lethal levels; riparian shading and the presence of sub-surface cold water seeps are often essential to maintain pool temperatures at tolerable levels.

Between December and February, winter rains result in increased stream flows. Juvenile coho salmon prefer to over-winter in large mainstem pools, backwater areas, and secondary pools with large woody debris and undercut bank areas (Heifetz et al. 1986; Hassler 1987). These protected areas serve as velocity refugia from high winter flows. As they grow larger, juveniles tend to move away from shore into mid-stream and higher velocity areas. Coho salmon rear in fresh water for up to 15 months, then migrate to the sea as smolts between March and June (Weitkamp et al. 1995). Peak outmigration generally occurs in May, about a year after fry emerge from the gravel. Most smolts measure 3.5 to 4.5 inches, although Klamath River Basin smolts tend to be larger; this is possibly due to influences of off-station hatchery plants.

After entering the ocean, immature coho salmon initially remain in near-shore waters close to the parent stream. In general, coho salmon remain closer to their river of origin than do chinook salmon (Weitkamp et al 1995). Nevertheless, coho salmon have been captured several hundred to several thousand kilometers away from their natal stream (Hassler 1987). Coho salmon typically spend two growing seasons in the ocean before returning to their natal streams to spawn as three-year-olds.

Current Legal Status

Listing history

The SONCC coho salmon ESU was listed as threatened under the Act on May 6, 1997 (62 FR 24588). This ESU includes populations of coho salmon between Cape Blanco, Oregon, and Punta Gorda, California. An interim rule under section 4(d) of the Act was published on July 18, 1997 (62 FR 3847) applying the prohibitions contained in section 9(a) of the Act to the California portion of the ESU. Critical habitat was proposed for the SONCC ESU and the Central California Coast ESU on November 25, 1997 (62 FR 62741).

Threats

The SONCC ESU of coho salmon was listed as threatened due to numerous factors including several long-standing, human-induced factors (e.g., habitat degradation, harvest, water diversions, and artificial propagation) that serve to exacerbate the adverse effects of natural environmental variability (e.g., floods, drought, poor ocean conditions). Habitat factors that may contribute to the decline of coho salmon in the SONCC ESU include changes in channel morphology, substrate changes, loss of instream roughness and complexity, loss of estuarine habitat, loss of wetlands, loss and/or degradation of riparian areas, declines in water quality, altered streamflows, impediments to fish passage, and elimination of habitat. The major activities identified as responsible for the decline of coho salmon in Oregon and California include logging, road building, grazing, mining, urbanization, stream channelization, dams, wetland loss, beaver trapping, water withdrawals, and unscreened diversions for irrigation.

Tribal harvest is not considered a major factor in the decline of coho salmon in the SONCC ESU. In contrast, overfishing in non-tribal fisheries is believed to have been a significant factor. Disease and predation are not believed to be major causes in the species decline, however, they may have substantial impacts in local areas. For example, Higgins et al. (1992) and CDFG (1994) reported that Sacramento River squawfish have been found in the Eel River basin and are considered to be a major threat to native coho salmon. Furthermore, California sea lions and Pacific harbor seals, which occur in most estuaries and rivers where salmonid runs occur on the west coast, are known predators of salmonids. Harbor seals are present year-round near Cape Mendocino. California sea lions are present in the near Cape Mendocino in the fall and spring. At the mouth of the Eel River, harbor seals haul-out in large numbers (600-1050 seals). More than 1,200 harbor seals have been counted in the vicinity of Trinidad Head. Coho may be vulnerable to impacts from pinniped predation. In the final rule listing the SONCC ESU, NMFS indicated that it was unlikely that pinniped predation was a significant factor in the decline of coho salmon on the west coast, although they may be a threat to existing depressed local populations. The NMFS (1997)has recently determined that although pinniped predation did not cause the decline of salmonid populations, in localized areas where they co-occur with salmonids (especially where salmonids concentrate or passage may be constricted), predation may preclude recovery. Specific areas where predation is/may preclude recovery cannot be determined without extensive studies.

Existing regulatory mechanisms, including land management plans (e.g., National Forest Land Management Plans, State Forest Practice Rules), Clean Water Act section 404 activities, urban growth management, and harvest and hatchery management all contributed to varying degrees to the decline of coho salmon due to the lack of protective measures, the inadequacy of existing measures to protect coho salmon and/or its habitat, or the failure to carry out established protective measures. Finally, artificial propagation is a factor in the decline of coho salmon due to the genetic impacts on indigenous, naturally-reproducing populations, disease transmission, predation of wild fish, depletion of wild stock to enhance brood stock, and replacement rather than supplementation of wild stocks through competition and the continued annual introduction of hatchery fish. Since the listing of the SONCC ESU, these threats have remained constant and no new threats have been identified.

Conservation needs

A recovery plan has not yet been developed for listed coho salmon ESUs. Therefore the conservation needs for coho salmon discussed here are derived from the final rule listing the SONCC ESU, the proposed designation of critical habitat for the Central California Coast ESU and the SONCC ESU, and Spence et al. (1996).

Conservation needs for coho salmon include habitat conditions that contribute to meet the spawning, rearing, migrating, feeding, and sheltering needs of the species. Parameters that affect the ability of the habitat to provide for these conservation needs include water quality and quantity, habitat access, physical habitat elements, channel condition, hydrology, and upslope conditions. These essential habitat features must be healthy, or in properly functioning condition (PFC), in order for the conservation needs of coho salmon to be met.

Water quality factors essential to coho salmon include cool temperatures, low turbidity, and pollutant-free water. The ability of coho salmon to access various habitats during different life stages is also essential. Physical structural elements such as the presence of LWD, clean, properly sized substrate, large, deep pools, and the presence of side channels and off-channel habitats are also essential for coho salmon. Many of the physical and water quality elements vital to coho salmon are provided by the riparian vegetation adjacent to streams. Riparian buffer integrity is therefore also an essential habitat feature. This element includes a mature, well stocked riparian forest to provide large trees for recruitment into the stream, overstory canopy to provide shade, downed wood and an undisturbed humic layer to filter overland sediment flow, snags, and stable banks. Details of how these essential habitat elements provide for the conservation needs of coho salmon and the other Pacific salmonids are discussed in the analysis of suitable habitat.

In order to conserve coho salmon, an adequate number of healthy wild populations must be maintained. Therefore, the proper management of hatchery operations and ocean harvesting is necessary such that they will not negatively impact the species, affecting the continued survival and recovery of coho salmon.

Status and Distribution

Available historical and recent coho salmon abundance information is summarized in the status review (Weitkamp et al. 1995). In the recent past, the majority of the SONCC ESU coho salmon production has been from the Oregon portion, in the Rogue River. Recent run-size estimates (1979-1986) have ranged from 800 to 19,800 naturally-produced adults, and from 500 to 8,300 hatchery-produced adults (Cramer 1994). Adult passage counts at Gold Ray dam provide a long-term view of coho salmon abundance on the upper Rogue River. During the 1940s, counts averaged about 2,000 adult coho salmon per year. Between the late1960s and early 1970s, adult counts averaged fewer than 200. During the late 1970s, dam counts increased, corresponding with returning coho salmon produced at the Cole River Hatchery. Coho salmon run size estimates derived from seine surveys at Huntley Park near the mouth of the Rogue River have ranged from approximately 450 to 19,200 naturally-produced adults between 1979 and 1991. In Oregon, south of Cape Blanco, the American Fisheries Society (AFS) Endangered Species Committee (Nehlsen et al. 1991) considered all but one coho salmon population to be at "high risk of extinction", while Nickelson et al. (1992) rated these coho salmon populations as "depressed."

In the northern California region of this ESU, CDFG (1994) reported that coho salmon stocks, including hatchery stocks, could be less than six percent of their abundance during the 1940s and have experienced at least a 70 percent decline in numbers since the 1960s. The Klamath River Basin (including the Trinity River) historically supported abundant coho salmon runs. In both systems, runs have greatly diminished and are now composed largely of hatchery fish, although small wild runs may remain in some tributaries (CDFG 1994). CDFG (1994) further reported that coho salmon populations have been virtually eliminated in many streams, and that adults are observed only every third year in some streams, suggesting that two of three brood cycles may already have been eliminated. Brown and Moyle (1991) estimated that naturally-spawned adult coho salmon returning to California streams were less than one percent of their abundance at mid-century, and indigenous, wild coho salmon populations in California did not exceed 100 to 1,300 individuals. Further, they stated that 46 percent of California streams which historically supported coho salmon populations, and for which recent data were available, no longer supported runs.

Of the 396 streams within the SONCC ESU identified as once having coho salmon runs, recent survey information is available for 117 streams (30 percent) (Brown et al. 1994). Of these streams, 73 (64 percent) still support coho salmon runs while 42 (36 percent) have lost their coho salmon runs (Weitkamp et al. 1995).

The rivers and tributaries in the California portion of this ESU were estimated to have average recent runs of 7,080 natural spawners and 17,156 hatchery returns, with 4,480 identified as native fish occurring in tributaries having little history of supplementation with non-native fish. Combining recent run-size estimates for the California portion of this ESU with the Rogue River estimates provides a run-size estimate for the entire ESU of about 12,000 natural coho salmon and 21,000 hatchery-produced coho salmon.

Coho salmon from this ESU are captured primarily in ocean fisheries off California. Coded-wire tagged (CWT) coho released from hatcheries south of Cape Blanco have a southerly recovery pattern: primarily in California (65-92 percent), with some recoveries in Oregon (7 to 34 percent) and almost none (less than 1 percent) in Washington or British Columbia (percent data represent range of recoveries for five hatcheries by state or province) (Wietkamp et al., 1995). Ocean exploitation rates for SONCC coho are based on the exploitation rate on Rogue/Klamath hatchery stocks and have only recently become available. For both 1996 and 1997, the estimated ocean exploitation rates were 5 percent. The estimated rate for 1998 was 12 percent.

According to the status review (Weitkamp et al. 1995), significant blockages of freshwater habitat were identified in every ESU and freshwater and estuarine habitats were degraded throughout the species' range. Data are limited for the SONCC ESU. Currently, many river systems are no longer suitable for coho salmon or support only depressed populations due to degraded habitat, including high, sometimes lethal, water temperatures, blockages preventing access to spawning and juvenile rearing areas, increased levels of fine sediment smothering eggs and hindering emergence of fry from gravels, loss of instream complexity and roughness, dewatering of stream reaches, changes in the flow regime, and loss of riparian vegetation that provided shade, cover, bank stability, and nutrients.

Information on salmonid presence within the action area has been gathered using various protocols and with variable effort. Most studies provide only information on species presence, and cannot be used to establish population trends. Furthermore, many of the studies are several years old, so their information may no longer be accurate. Nevertheless, the studies do provide some indication of the presence and distribution of salmonids within the action area, if not accurate population and trend data. Information for this discussion was taken from the July 1998

Draft SYP/HCP(PALCO 1998) and the KRIS Coho CD-ROM, a computer database developed by the Institute for Fisheries Resources (IFR) based on the Klamath Resource Information System computer program (Derksen 1997). KRIS Coho (IFR 1998) contains data tables, charts, photographs, maps, and bibliographic material from the public domain related to watersheds within the Plan area. The information from the Draft SYP/HCP and IFR (1998) focuses on watersheds within the Plan area, rather than the larger action area. Several assumptions have been made. For example, chinook salmon, coho salmon, and steelhead are known to occur in the Mattole River basin, but have not been documented on PALCO lands. It is important to note, however, that many areas (e.g., North Fork Mattole, portions of which are on PALCO lands) have not been surveyed for these species. In those unsurveyed areas, we have presumed the presence of salmonids if habitat for them exists (see table 3.8.5 of the Final EIS/EIR).

PROPOSED SPECIES/CRITICAL HABITAT:

Southern Oregon and California Coastal ESU chinook salmon

Species description

The chinook salmon is an anadromous salmonid easily distinguished from other *Oncorhynchus* species by its large size. Adults weighing over 120 pounds have been caught in North American waters. Historically, chinook salmon ranged as far south as the Ventura River, California, and as far north as the Russian Far East. Destruction and modification of habitat, overutilization for recreational purposes, and natural and human-made factors have been identified as causing the significant decline of chinook salmon populations throughout its range. The chinook salmon status review (Myers et al. 1998) identified 15 chinook salmon ESUs throughout Washington, Oregon, Idaho, and California. The action area is within the Southern Oregon and California Coastal (SOCC) ESU.

Life history

General life history information for chinook salmon is summarized below. Further detailed information on chinook salmon ESUs are available in the NMFS listing of winter-run chinook as threatened under emergency provisions of the Act (54 FR 32085), the NMFS formal listing of the winter-run chinook salmon (55 FR 46515), the NMFS reclassification of the winter-run chinook salmon as an endangered species (59 FR 440), the NMFS status review of chinook salmon from Washington, Oregon, Idaho, and California (Myers et al. 1998), and the NMFS proposed rule for listing several ESUs of chinook salmon (63 FR 11482).

Chinook salmon exhibit diverse and complex life history strategies. Healey (1986) described 16 age categories for chinook salmon and seven total ages with three possible freshwater ages. Two generalized freshwater life-history types were described by Healey (1991): "stream-type" chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" chinook salmon migrate to the ocean within their first year. For the most part, chinook salmon in the SOCC ESU exhibit an "ocean-type life history."

Chinook salmon mature between 2 and 6+ years of age (Myers et al. 1998). Freshwater entry and spawning timing of chinook salmon are generally thought to be related to local temperature and water flow regimes. For fall run chinook salmon, migration begins when stream temperatures range between 51 and 67°F. For spring run chinook salmon, temperatures between 38 and 56°F trigger freshwater entry (Bell 1986, cited in Bjornn and Reiser 1991). For both runs, chinook salmon require a minimum of 0.79 feet of water for upstream migration and a maximum velocity of 8 feet per second (Thompson 1972, cited in Bjornn and Reiser 1991).

Chinook salmon runs are designated on the basis of adult migration timing, however, distinct runs also differ in the degree of maturation at the time of river entry, the thermal regime and flow characteristics of their spawning site, and the actual time of spawning (Myers et al. 1998). Spring-run chinook salmon typically enter freshwater as immature fish, migrate upriver between March and July, and finally spawn in the late summer and early autumn with a peak in September. This run timing appears adapted to gaining access to the upper reaches of river systems, 1,500 to 5,200 feet in elevation, prior to the onset of high water temperatures and low flow that would inhibit access to these areas during the fall. In contrast, fall-run chinook salmon enter freshwater at an advanced stage of maturity between June and December, with a peak in September and October. They move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991). Chinook salmon in the Eel, Rogue, and Upper Klamath Rivers return to freshwater in August and September and spawn in late October and early November (Stone 1897, Snyder 1931; Nicholas and Hankin 1988, Barnhart 1995, cited in Myers et al. 1998).

Once adult chinook salmon reach spawning areas, they need cold pools to stage in prior to spawning to conserve energy and maintain egg viability as they mature for spawning (Berman and Quinn 1991). Maximum temperatures for holding adults are 59.0 to 60.0°F, but better egg viability is achieved at 55.0 to 56.0°F (Boles 1988).

Adult female chinook salmon prepare redds in stream areas with suitable gravel composition, water depth, and velocity. Spawning generally occurs in swift, relatively shallow riffles or along the edges of fast runs at depths greater than 9.5 inches. Both fall and spring runs spawn in temperatures between 42.1 to 57.0°F. Redds vary widely in size and location within the river. Preferred spawning substrate is clean, loose gravel, mostly sized between 0.5 and 4.0 inches, with no more than 5 percent fines. Gravels are unsuitable when they have been cemented with clay or fines or when sediments settle out onto redds, reducing intergravel percolation (NMFS 1997). Minimum intragravel percolation rate depends on flow rate, water depth, and water quality. The rate must be adequate to maintain oxygen delivery to the eggs and remove metabolic wastes. Chinook salmon have the largest egg size of the *Oncorhynchus* species and therefore their eggs have a small surface-to-volume ratio (Rounsefell 1957). Chinook salmon eggs are more sensitive to reduced oxygen levels and require a more certain rate of irrigation. The chinook salmon's need for a strong, constant level of subsurface flow may indicate that suitable spawning habitat is more limited in most rivers than superficial observation would suggest. After laying eggs in a redd, adult chinook salmon guard the redd from 4 to 25 days before dying.

Chinook salmon eggs incubate for between 90 and 150 days, depending on water temperatures. Successful incubation depends on several factors including dissolved oxygen levels, temperature, substrate size, amount of fine sediment, and water velocity. Maximum survival of incubating eggs and pre-emergent fry occurs at water temperatures between 42.0 and 56.0°F with a preferred temperature of 52°F. Emergence of spring and fall-run chinook salmon fry begins in December and continues into mid-April (Leidy and Leidy, 1984 Bell 1991). Emergence can be hindered if the interstitial spaces in the redd are not large enough to permit passage of the fry. In laboratory studies, Bjornn (1968) observed that chinook salmon and steelhead fry had difficulty emerging from gravel when fine sediments (0.25 inch) exceeded 30 to 40 percent by volume. At the time of emergence from the redd, there is usually an extensive downstream dispersal of fry, although some fry are able to remain within the natal stream. For populations that spawn near tidal areas, this downstream migration may take the fry directly to estuarine rearing areas. In other populations, this migration serves to disperse the fry to suitable freshwater rearing habitat.

After emergence, chinook salmon fry seek out areas behind fallen trees, back eddies, undercut banks and other areas of bank cover (Everest and Chapman 1972). As chinook salmon fry grow larger, habitat preferences change. Juveniles move away from stream margins and begin to use deeper water areas with slightly faster water velocities, but continue to use available cover to minimize the risk of predation and reduce energy expenditure. Fish size appears to be positively correlated with water velocity and depth (Chapman and Bjornn 1969, Everest and Chapman 1972). Optimal temperatures for both chinook salmon fry and fingerlings range from 53.6 to 57.2°F, with maximum growth rates at 55°F (Boles 1988). Chinook feed on small terrestrial and aquatic insects and aquatic crustaceans.

Chinook salmon in the SOCC ESU exhibit an "ocean-type" life history; smolts outmigrate predominantly as subyearlings, generally during April through July (Myers et al. 1998). The low flows, high temperatures, and sand bars that develop in smaller coastal rivers during the summer months favor an ocean-type life history (Kostow 1995). In large rivers, fry tend to migrate along the margins of the river rather than in the higher velocity water near the center of the channel. When the river is deeper than about three meters, chinook salmon fry tend to prefer the surface waters (Healey and Jordan 1982). Along the emigration route, submerged and overhead cover in the form of rocks, submerged aquatic vegetation, logs, riparian vegetation, and undercut banks provide food, shade, and protect juveniles from predation. The "ocean-type" chinook salmon in California tend to use estuaries and coastal areas more extensively than stream-type chinook salmon for rearing. The brackish water areas in estuaries moderate the physiological stress that occurs during parr-smolt transitions.

Chinook salmon in the SOCC ESU generally remain in the ocean for two to five years (Bell 1991, Healey 1991). Available information on California chinook salmon populations indicates that the fish tend to stay along the California and Oregon Coasts while in the ocean. After this time, adult chinook salmon return to their natal stream to spawn. Some chinook salmon return from the ocean to spawn one or more years before full-sized adults return, and are referred to as jacks (males) and jills (females).

Current Legal Status

<u>Listing history</u>

On March 9, 1998, the NMFS proposed listing eight chinook salmon ESUs as either threatened or endangered (63 FR 11482). The SOCC ESU was proposed for listing as threatened. This ESU includes all naturally spawned coastal spring and fall-run chinook salmon from Cape Blanco, Oregon, to the southern extent of the species' current range at Point Bonita, the northern landmass marking the entrance to San Francisco Bay. According to the proposed rule, there is a general downward trend in populations within this ESU. Of particular concern is all populations in California and spring-run chinook salmon throughout the ESU. South of the Klamath River, coastal chinook salmon populations are "extremely depressed." Critical habitat was also proposed concurrently with the proposed listing.

<u>Threats</u>

The following discussion is taken from the proposed rule. The California Advisory Committee on Salmon and Steelhead Trout (1988) identified habitat blockages, fragmentation, logging and agricultural activities, urbanization, and water withdrawals as the predominant threats facing anadromous salmonids in California. The proposed rule also noted that CDFG (1965) reported that the most vital habitat factor for coastal California streams was "degradation due to improper logging followed by massive siltation, log jams, etc." CDFG (1965) also cited road building as another cause of siltation in some areas. NMFS (1996) concluded that destruction and modification of habitat, overutilization for commercial and recreational purposes, and natural and human-made factors were the primary reasons for the decline of west coast steelhead and other salmonids, including chinook salmon.

The proposed rule notes several factors that threaten chinook salmon. These include water diversions for agriculture, flood control, domestic supply, and hydropower purposes that have greatly reduced or eliminated historically accessible habitat. Forestry, agriculture, mining, and urbanization have degraded, simplified, and fragmented habitat. Sedimentation, from extensive and intensive land use activities such as timber harvesting, road building, livestock grazing, and urbanization, was identified as a primary cause of habitat degradation in the range of chinook salmon. Ocean harvesting was also identified as having contributed to the decline of some chinook salmon populations. Chinook salmon still support tribal, commercial, and recreational fisheries throughout their range. Predation by introduced species and marine mammals was identified as a concern in areas where chinook salmon run sizes are dwindling, but the proposed rule, citing several studies, noted that salmonids appear to be a minor component of the marine mammal diet. The NMFS (1997) has recently determined that although pinniped predation did not cause the decline of the chinook salmon populations, in localized areas where they co-occur with chinook salmon (especially where they concentrate or passage may be constricted), predation may preclude recovery. Specific areas where predation is/may preclude recovery cannot be determined without extensive studies.

Land and water management policies (Northwest Forest Plan, PACFISH, CALFED) were identified in the proposed rule as probably beneficial to chinook salmon populations, but the confined scope of these management plans limit their effectiveness. Current state forestry rules in California, Oregon, and Washington were identified as not adequately protecting chinook salmon or providing for PFC. Other problems identified in the proposed rule include dams with no passage facilities, water diversions, mining activities, artificial propagation programs, and recent major flood events. Over the range of the species, NMFS proposed listing eight ESUs due to destruction and modification of habitat, overutilization for recreational purposes, and other natural and human-made factors. Since the proposal to list the SOCC ESU was published, these threats have remained constant and no new threats have been identified.

Conservation needs

The conservation needs for chinook salmon are similar to those identified for coho salmon, above.

Status and Distribution

Available historical and recent SOCC ESU chinook salmon abundance information is summarized in the status review (Myers et al. 1998). Following are some excerpts from this document.

Based on cannery packing data in the range of this ESU, a run size of about 225,000 fish existed around 1917. Estimated escapement of the California portion of this ESU was estimated at about 88,000 fish, predominantly in the Eel River (55,500) with smaller populations in the Smith River (15,000), Redwood Creek, Mad River, Mattole River (5,000 each), Russian River (500), and several small streams in Del Norte and Humboldt Counties. Based on the 1968 angler catch records for the Oregon portion of this ESU, the average escapement for the entire ESU in the 1960s was estimated to be 178,000 fish.

Dam counts of upstream migrants are available on the South Fork Eel River (1938 to 1975), and at Gold Ray Dam on the Rogue River (1944 to present). In 1953, Oregon began using catch report cards to report angler catch in rivers and estuaries, and this system provides estimates on catch on a river-by-river basis, which can be expanded to provide estimates of terminal run-size. Expanded angler catch data produced a 5-year geometric mean spawning escapement of 132,000 (run-size of 148,000) for the Oregon portion of this ESU. The majority of this escapement (126,000) has been the spring and fall-runs in the Rogue River. No total escapement estimates are available for the California portion of this ESU, although partial counts indicate that escapement in the Eel River exceeds 4,000 fish.

Data available to assess trends in abundance are limited. Recent trends have been mixed, with predominantly strong negative trends in the Rogue and Eel River Basins, and mostly upward trends elsewhere. Longer-term trends, where data are available, are flatter (e.g., Rogue River). Previous assessments of stocks within this ESU have identified several stocks as being at risk or of concern. The AFS Endangered Species Committee (Nehlsen et al. 1991) identified seven stocks as at high extinction risk and seven stocks as at moderate extinction risk. Higgins et al. (1992) provided a more detailed analysis of some of these stocks, and identified nine chinook salmon stocks as at risk or of concern. Four of these stock assessments agreed with Nehlsen et al. (1991) designations, while five fall-run chinook salmon stocks were either reassessed from a moderate risk of extinction to stocks of concern (Redwood Creek, Mad River, and Eel River) or were additions to the Nehlsen et al. (1991) as stocks of special concern (Little and Bear Rivers). In addition, two fall-run stocks (Smith and Russian Rivers) that Nehlsen et al. (1991) listed as at moderate extinction risk were deleted from the list of stocks at risk by Higgins et al. (1992), although the U.S. Fish and Wildlife Service reported that the deletion for the Russian River was due to a finding that the stock was extinct. Nickelson et al. (1992) considered 11 chinook salmon stocks within the ESU, of which four (Applegate River fall-run, Middle and Upper Rogue River fall-runs, and Upper Rogue River spring-run) were identified as healthy, six as depressed, and one (Chetco fall-run) as of special concern due to hatchery strays.

Proposed coho salmon critical habitat

The term "critical habitat" is defined in the Act (16 U.S.C. 1532) to mean: (1) the specific areas within the geographic area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of this Act, on which are found those physical or biological features (a) essential to the conservation of the species and (b) which may require special management consideration or protection; and (2) the specific areas outside of the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of this Act, upon a determination by the Secretary that such areas are essential to the conservation of the species.

The definition also states, "Except in those circumstances determined by the Secretary, critical habitat shall not include the entire geographical area which can be occupied by the threatened or endangered species."

By this definition, critical habitat includes those areas that are essential to the "conservation" of a threatened or endangered species. The Act defines the term "conservation" as: ". . . to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary." (16 USC 1532).

Coho salmon critical habitat has been proposed for all river reaches accessible to listed coho salmon between Cape Blanco, Oregon, and Punta Gorda, California. Critical habitat for coho salmon would consists of the water, substrate, and adjacent riparian zone of estuarine and riverine reaches within this area. In the SONCC ESU, critical habitat has been proposed for the following watersheds:

- Mattole River, California
- Mad River, California
- Klamath River, Oregon and California
- Salmon River, California
- Shasta River, California
- Winchuck River, Oregon and California
- Illinois River, Oregon and California
- Applegate River, Oregon and California
- Elk River, Oregon
- Eel River, California
- Redwood Creek, California
- Trinity River, California
- Scott River, California
- Smith River, California and Oregon
- Chetco River, Oregon
- Rogue River, Oregon
- Pistol River, Oregon

Current Legal Status

Designation history

On November 25, 1997, NMFS proposed the designation of critical habitat for the Central California Coast and the SONCC coho salmon ESUs (62 FR 62741).

Primary Constituent Elements

Description

Proposed critical habitat for the SONCC ESU coho includes all spawning sites, food resources, water quality and quantity, and riparian vegetation in riverine and estuarine reaches below longstanding, naturally impassable barriers and below dams that currently block access to habitats historically occupied by coho salmon. The adjacent riparian zone is defined as those areas within a horizontal distance of 300 ft from the normal high water line of a stream channel or adjacent off-channel habitats. Within these fresh water tributaries, habitat features identified in the proposed rule as essential to the survival and recovery of coho salmon include adequate (1) substrate; (2) water quality; (3) water quantity; (4) water temperature; (5) water velocity; (6) cover/shelter; (7) food; (8) riparian vegetation; (9) space; and (10) safe passage conditions.

Threats

Management activities that have been identified as potentially affecting the essential habitat features include water and land management actions of Federal agencies, including related or similar actions of other federally regulated or permitted projects. Activities that may require special management considerations include but are not limited to: land management, timber harvest, point and non-point water pollution, livestock grazing, habitat restoration, irrigation water withdrawals and returns, mining, road construction, dam operation and maintenance, and dredge and fill activities (including bank stabilization activities).

Status and Distribution

The proposed designation for the SONCC ESU includes all accessible reaches of rivers between the Elk River in Oregon and the Mattole River, California, including estuarine habitats and tributaries. Critical habitat does not include oceanic or nearshore habitats. Areas accessible to listed coho salmon are reaches below specific dams, listed below, or naturally impassable barriers. The dams identified by NMFS within the SONCC ESU are:

- Scott Dam (Lake Pillsbury), Eel River
- Matthews Dam (Ruth Lake), Mad River
- Lewiston Dam (Lewiston Reservoir), Trinity River
- Dwinnell Dam (Dwinnell Reservoir), Shasta River
- Irongate Dam (Irongate Reservoir), Klamath River
- Applegate Dam (Applegate Reservoir), Applegate River
- Lost Creek Dam (Lost Creek Reservoir), Rogue River

Proposed chinook salmon critical habitat

Critical habitat has been proposed for all river reaches accessible to listed chinook salmon within the proposed ESUs between San Francisco Bay, California and Puget Sound, Washington. Critical habitat for chinook salmon consists of the water, substrate, and adjacent riparian zone of estuarine and riverine reaches within this area. In the SOCC ESU, critical habitat has been proposed for the following watersheds:

- Tomales Bay, California
- Drakes Bay, California
- Bodega Bay, California
- Russian River, California
- Gualala River, California
- Salmon Creek, California
- Big River, California
- Navarro River, California
- Garcia River, California
- Albion River, California
- Noyo River, California
- Ten Mile River, California
- Mattole River, California
- Eel River, California
- Mad River, California
- Redwood Creek, California
- Lower Klamath River, California
- Smith River, California and Oregon
- Winchuck River, Oregon and California
- Chetco River, Oregon
- Illinois River, Oregon and California
- Rogue River, Oregon
- Applegate River, Oregon and California
- Pistol River, Oregon
- Elk River, Oregon

Current Legal Status
<u>Designation history</u>
On March 9, 1998 (63 FR 11482), NMFS proposed to designate critical habitat for chinook salmon in California, Oregon, and Washington, concurrently with the proposal to list several ESUs.

Primary constituent elements
<u>Description</u>
Proposed critical habitat for the SOCC ESU includes all spawning sites, food resources, water quality and quantity, and riparian vegetation in riverine and estuarine reaches below longstanding, naturally impassable barriers and below dams that currently block access to habitats historically occupied by chinook salmon. The adjacent riparian zone is defined as those areas within a horizontal distance of 300 ft from the normal high water line of a stream channel or adjacent off-channel habitats. Within these fresh water tributaries, habitat features identified in the proposed rule as essential to the survival and recovery of chinook salmon include adequate (1) substrate; (2) water quality; (3) water quantity; (4) water temperature; (5) water velocity; (6) cover/shelter; (7) food; (8) riparian vegetation; (9) space; and (10) safe passage conditions.

<u>Threats</u>
Activities that may affect the essential habitat requirements of chinook salmon include water and land management actions including livestock grazing, hydropower sites, dams, logging, road construction, mining, dredge and fill, and bank stabilization. Additionally, pesticide use, even according to labeling restrictions, could affect chinook salmon critical habitat.

Status and Distribution
The proposed designation for chinook salmon critical habitat consists of the water, substrate, and adjacent riparian zone of accessible estuarine and riverine reaches within all ESUs proposed for listing. Accessible reaches are those within the historical range of the ESU that can still be occupied by any life stage of chinook salmon. Inaccessible reaches are those above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years) and specific dams within the historical range of each ESU. Within the SOCC ESU, critical habitat is designated to include all river reaches and estuarine areas accessible to chinook salmon in the drainages of San Francisco and San Pablo Bays, westward to the Golden Gate Bridge, and includes all estuarine and river reaches accessible to chinook salmon on the California and Southern Oregon coast to Cape Blanco (inclusive). Excluded are the Klamath and Trinity Rivers upstream of their confluence. Also excluded are areas above longstanding naturally impassable barriers or above specific dams identified below:

- Kent Lake Dam/Nicasio Reservoir- Nicasio Creek
- Lake Mendocino - Russian River
- Lake Pillsbury - Eel River
- Applegate Dam - Applegate River

UNLISTED SPECIES:

Bank swallow

Species description

The bank swallow is a small swallow with a dark back and white underparts with a dark breast band.

Life history

Definition of suitable habitat

The bank swallow breeds in lowland country with appropriate soft banks or bluffs and requires soft soil or fine sand for digging nest burrows. It generally avoids developed or forested areas and requires fresh, steep banks. Typical nest sites are found along low-gradient rivers (USDA Forest Service 1994). Preferred habitats for feeding include annual and perennial grasslands and lacustrine and riverine habitats (USDA Forest Service 1994).

Reproduction

Bank swallows typically nest in colonies, which can involve up to several hundred pairs of birds or thousands of burrows. They dig burrows along river banks, in sandy soils and clay banks (USDA Forest Service 1994). Birds may begin to arrive in breeding areas as early as late March and begin to disperse in late August (CDFG 1992).

Diet

These birds are completely insectivorous and feed by hawking insects in flight. They tend to be solitary feeders (USDA Forest Service 1994).

Cover requirements

Refer to the **Definition of suitable habitat** above.

Dispersal

Most yearlings return to the same colony or a nearby colony to breed. Site fidelity increases with age and past breeding success, with adults showing a strong tendency to return to the previous year's nest site (USDA Forest Service 1994). Breeding habitat may not persist for long periods in a single location, however, suggesting an ability to colonize new areas.

Special habitat needs

Banks with friable soils suitable for construction of burrows are essential to reproduction.

Current legal status

Listing history

The bank swallow is not currently a Federal candidate, proposed, or listed species. This species was listed as a threatened species by the State in 1989.

Threats

The channelization of rivers, erosion-control efforts, and bank stabilization projects destroy existing colonies and potential nesting habitat. Disturbance to colonies can occur as a result of recreation or other management activities (Remsen 1978).

<u>Conservation needs</u>
Pre-project surveys to locate colonies should be conducted prior to any activity which may impact colonies. Nest substrate at known colonies should not be altered. Disturbance buffers should be placed around active colonies from April 1 through August 1 (CDFG 1995). Unoccupied but suitable nesting habitat should be maintained for possible future colonization. Neither Federal lands nor PALCO lands figure prominently in the conservation needs of this species because it is not known to occur on these lands in northwestern California.

Status and distribution

Species

Numbers

No data exist on the California (USDA Forest Service 1994) or overall range-wide population size.

Distribution

Bank swallows are summer visitors and breed throughout North America except in Arizona, Arkansas, Texas, Louisiana, Alabama, Mississippi, Georgia, Florida, North Carolina, and South Carolina. The breeding range for this species is greater than 494,200,000 acres, however, the distribution is patchy. Bank swallows winter in central and eastern Panama, and in South America (USDA Forest Service 1994).

Reproduction

Range-wide Breeding Bird Survey data for 1966 to 1996 indicate a statistically non-significant trend of -1.3 percent (Sauer et al. 1997). However, the species has been extirpated as a breeder in many areas such as in southern California (CDFG 1992, Remsen 1978).

Suitable habitat

Acreage, distribution, and quality

No data exist on the amount or quality of suitable habitat range-wide. Within the range, habitat distribution is patchy and localized (USDA Forest Service 1994).

<u>Pacific fisher</u>

Species description

The fisher is a medium-sized carnivorous mammal, and a member of the family Mustelidae. Fishers have dark brown fur, and a general body build of a large stocky weasel. Adult males generally weigh between 7.7 and 12.1 pounds and are between 35 and 47 inches long. Adult females weigh between 4.4 and 5.5 pounds and are between 30 and 37 inches long (Powell 1993). Additional information on the description of the species can be found in Strickland et al. (1982).

The Pacific fisher is one of three subspecies in North America recognized by Goldman (1935) and Hall (1981). Hagmeier (1959) and Powell and Zielinski (1994), however, questioned the validity of these subspecies. Recent surveys indicate disjunct populations in the western states, therefore this analysis will treat the fisher populations on the west coast as a separate subspecies, and analyze impacts only to the western subspecies (Pacific fisher).

Life history

Definition of suitable habitat

Fishers are typically found in landscapes dominated by older successional stages of coniferous forest, and they use riparian areas disproportionally more than their occurrence (Powell and Zielinski 1994). Buck et al. (1983, 1994) noted that this subspecies appears to avoid areas with low (less than 40 percent) canopy closure. In northern California, however, fishers have been detected in open areas and in second growth-forests (Higley 1993, Self and Kerns 1995). Fisher use of these atypical areas is generally attributed to individuals foraging where prey availability may be higher.

Characteristics at resting and den sites are usually associated with older forests. Rest sites used by fishers include the canopies and cavities in large trees and snags, large down logs, deformities such as "witches brooms," and old squirrel and raptor nests (Powell and Zielinski 1994). In five studies in California, mean dbh for live trees and snags used for resting ranged from 24 to 46 inches (Buck et al. 1983, Seglund 1995, Zielinski 1995, Zielinski and Barrett 1995, Higley 1998). The Hoopa study found that live hardwoods ranging from 17 to 33 inches dbh were used most often (Higley 1998). Seglund (1995) reported the mean diameter for logs used for rest sites was 34 inches. Of 15 natal and maternal dens found in live trees, dbh ranged from 21 to 54 inches (Buck et al. 1983, Seglund 1995, Zielinski 1995, Zielinski and Barrett 1995, Higley 1998). Of five dens found in snags, dbh ranged from 29 to 58 inches (Buck et al. 1983, Seglund 1995, Zielinski 1995, Zielinski and Barrett 1995). Of the two maternal dens found in down logs on the Six Rivers National Forest, one was in a 39 inch (maximum diameter) white fir (*Abies concolor*) log, and the other was in a 79 inch (maximum diameter) sugar pine (*Pinus lambertiana*) log (G.A. Schmidt, pers. comm., January 8, 1999).

Fishers are sensitive to forest fragmentation (Rosenberg and Raphael 1986). In northern California, optimum habitat was reported to be comprised of 60 to 80 percent mature coniferous forest, 20 to 30 percent young mixed conifer and hardwood forest, and 2 to 5 percent pole-sapling forest (Buck et al. 1983). Klug (1996) found that fishers used redwood stands significantly less than Douglas-fir stands, and Douglas-fir stands used by fishers had significant hardwood components. Mast-producing hardwood species may be important providers of food to potential prey species (Klug 1996). In addition to possibly having a smaller prey base, Klug (pers. comm., January 15, 1999) hypothesized that redwood habitats also have fewer rest and den opportunities because fewer cavities and other deformities occur in redwoods relative to other tree species. Approximately one-half of the nine den sites found by Klug (pers. comm., January 15, 1999) in coastal northwestern California were in hardwood trees. Based on this information, Higley (1998) and Klug (pers. comm., January 15, 1999) concluded that the retention of large hardwoods is important in some habitat types for rest and den sites. Klug (1996) also speculates that hardwoods probably provides mast for fisher prey species (Klug 1996).

Home range sizes for fishers can vary substantially and are related to site-specific conditions such as topography, prey species diversity and density, and distribution of suitable rest and den sites. Using telemetry locations and minimum convex polygon methods, mean home ranges for male and female fishers in four California studies were 6,693 and 1,274 acres, respectively (Buck et al. 1983, Self and Kerns 1995, Zielinski 1995, Zielinski and Barrett 1997). These study areas were located in mixed conifer and Douglas-fir habitat types.

Reproduction

Females first breed at one year of age. Breeding typically takes place in March and early April, with young born the following year in early February or March. Fishers have a reproductive adaptation referred to as delayed implantation. This adaptation allows fishers to retain within the uterus a fertilized egg that becomes inactive for several months, allowing them to breed in early spring and not bear young until the following year. Females probably breed again within 10 days of giving birth. Fishers produce an average of three young per litter. Females use one to three dens per litter and often move kits from natal to maternal dens at 8 to 10 weeks. The female and young separate sometime between late summer and the first snows, with the males taking no part in caring for the young (Powell and Zielinski 1994, Strickland et al. 1982).

Diet

Fishers are known to eat small to medium-sized mammals, birds, and carrion (reviewed by Powell 1993). Fecal material collected at den and rest sites in southwest Oregon included remains of porcupine (*Erethizon dorsatum*), snowshoe hare (*Lepus americanus*), California ground squirrel (*Citellus beecheyi*), Douglas squirrel (*Tamiascurus douglasii*), northern flying squirrel (*Glaucomys sabrinus*), black-tailed deer (*Odocoileus hemionus*), pileated woodpecker (*Dryocopus pileatus*), hairy woodpecker (*Picoides villosus*), northern flicker (*Colaptes auratus*), and ruffed grouse (*Bonasa umbellus*) (Aubry et al. 1997). Stomach contents of eight carcasses from Trinity County, California, included false truffle (*Rhizopogon* sp.), bovine, brush rabbit (*Sylviagus bachmani*), black-tailed deer, broad-handed mole (*Scapanus latimanus*), and western gray squirrel (*Sciurus griseus*). While no porcupine remains were found in these carcasses, two of the specimens had quills embedded in their hides (Grenfell and Fasenfest 1979). Woodrats (*Neotoma* sp.) have also been detected in fisher scat collected in redwood types in northwestern California (R. Klug, pers. comm., January 15, 1999).

Cover requirements

A majority of the studies conducted in northern California show a preference of coniferous forests with high canopy cover. Carroll (1997), conducted a landscape-level spacial analysis and found fisher detections highly correlated to canopy cover and tree size. Refer to **Definition of suitable habitat** above and **Dispersal** below for additional information.

Dispersal

While independent from females by fall, young do not disperse from their mothers' home ranges until mid- or late winter. Fishers are thought to use riparian corridors and forested saddles between drainages for dispersal (Buck et al. 1983, Powell and Zielinski 1994). An aversion to open areas may limit population expansion and colonization of unoccupied habitat (Powell and Zielinski 1994). Klug (1996) suggested that due to the rapid growth of vegetation in the redwood region of northern California, 3 to 5 years may be enough time to allow sufficient regeneration in harvested stands so they no longer constitute a barrier to fisher movements.

Special habitat needs

Refer to **Definition of suitable habitat** above for specific habitat components needed for rest and den sites.

Current legal status

Listing history

The fisher is not currently a Federal candidate, proposed, or listed species. A petition to list the Pacific fisher as Federally endangered in California, Oregon, and Washington was found not to be warranted because substantial information supporting the requested action was not presented (USDI Fish and Wildlife Service 1991). A negative finding on an additional petition to list the fisher as Federally threatened in the western United States was made because substantial information indicating that Pacific Coast and northern Rocky Mountain populations constitute distinct vertebrate population segments was not presented (USDI Fish and Wildlife Service 1996b). The Pacific fisher is listed as endangered by the State of Washington, and as a species of special concern by the State of California

Threats

Historically, over-harvest (trapping) of fishers has resulted in population reductions and extirpations over much of their original range (Strickland et al. 1982, Aubry and Houston 1992, Powell and Zielinski 1994). Currently, the primary threat to the fisher is the reduction and fragmentation of late-successional forests, and the associated loss of habitat components necessary for resting and denning (Aubry and Houston 1992, Powell and Zielinski 1994). Increased fragmentation may cause fishers to travel long distances through unfamiliar or unsuitable habitat, thus increasing possible predation by coyotes, mountain lions, and other predators (Powell and Zelinski 1994). Based on the review of recent survey efforts, Pacific fisher populations may become increasingly genetically isolated throughout the western states. The apparent gap between populations can be as much as 500 to 600 miles long as in the case of the Southern Sierra population and the Klammath Mountains population in California.

Conservation needs

Additional research is needed on habitat use, food habits, and other aspects of fisher ecology (Powell and Zielinski 1994). Prohibition of legal harvest and efforts to reduce incidental trapping need to be continued (Powell and Zielinski 1994).

On Federal lands in Washington, Oregon, and northern California, the Northwest Forest Plan provides a network of large blocks of LSRs and interconnecting riparian reserves. Under this management regime the fisher was given a rating of 85 percent likelihood of viability, where it currently exists on Federal lands under the management of Northwest Forest Plan.

A majority of this subspecies range within the Sierra Nevada mountains is on Federal lands managed by the USFS. A regional management strategy to provide connectivity of late-seral habitat within the Sierra Nevada and between the Sierra Nevada and the Klammath mountain ranges is needed to provide for sustainable populations of fishers.

The coastal belt in California contains little Federal land. Historic trapping records indicate that Pacific fishers were not considered numerous in the coastal redwood belt of California, but few surveys have been conducted in recent years to determine the population status in this area. Based on historic data and indications from recent surveys (Beyer and Golightly 1996, Klug 1996) the role this coastal belt (including PALCO lands) plays in the conservation of the Pacific fisher is likely to be insignificant.

The amount and contiguity of late successional forests within the current and historical range needs to be improved, and important elements such as large trees, snags, and down logs need to be retained (Powell and Zielinski 1994). Habitat within the coastal redwood belt is likely to be low to moderate quality habitat for fishers. The following guidelines have been recommended for moderate quality habitat (Freel 1991, Heinemeyer and Jones 1994):

1. Maintain at least 40 percent of suitable habitat within a subdrainage as mature or older forests in patches of at least 80 acres in size.

2. Maintain riparian corridors at least 300 feet wide with at least 60 percent canopy closure.

3. Maintain 3 to 6 trees per acre with deformities or cavities that are at least 30 inches dbh.

4. Maintain 9 to18 live trees per acre in suitable habitat that are at least 20 inches dbh.

5. Maintain 1 to 2 snags per acre at least 30 inches dbh.

6. Maintain 2 to 3 snags per acre at least 20 inches dbh.

7. Maintain 2 to 3 down logs per acre at least 20 inches in diameter at the large end and 15 feet long.

8. Limit density of "open-to-public roads" to no more than 2 miles per square mile.

In addition to the guidelines suggested by Freel (1991) and Heinemeyer and Jones (1994), the following are additional guidelines based on review of recent fisher research conducted in California:

9. To provide adequate cover and potential foraging habitat for fishers, maintain at least 60 percent of each WAA in a vegetation seral stage classified under the CWHR system as CWHR 3M or larger (CWHR 3D, 4M, 4D, 5M, 5D, and 6). Refer to Appendix 3 for a description of the CWHR vegetation classification system.

10. In areas where hardwoods are prevalent on the landscape, retain a hardwood component in the larger size classes present on the site.

Status and distribution

Species

Numbers

Based on trapping records and surveys most fisher populations are thought to have decreased range-wide since the late 1800s. There is no specific information available on the current number of fishers within the remaining areas occupied by fishers.

Distribution

In the 1800's, Pacific fishers were found in coniferous and coniferous-hardwood forests throughout Washington, Oregon, and California. The range of the Pacific fisher has contracted considerably from its original extent. In Washington, this subspecies only rarely occurs in the Cascade Range, Olympic Mountains, and in portions of the Okanogan Highlands (Aubry and Houston 1992). However, the Olympic Peninsula has been surveyed fairly extensively in more recent years, with no detections or confirmed sightings of fisher recorded (K. Aubry, pers. comm., November 5, 1998). They are also very rare in Oregon, although no thorough evaluation of their status and distribution has been conducted (Powell and Zielinski 1994). Limited surveys have been conducted in the coastal forests south of the Olympic Peninsula to Gold Beach, Oregon, but there have been no detections or confirmed sightings in this area (K. Aubry, pers. comm., November 5, 1998). Currently, Pacific fisher in California are only known to occur in the northwestern part of the state (northern Coast Range and Klamath Mountains) and in a disjunct population in the southern Sierra Nevada mountains of California (Zielinski et al. 1995).

The FEMAT (USDA Forest Service et al. 1993) lists the range of the Pacific fisher within the range of the northern spotted owl in Washington, Oregon, and northern California as covering 20,957,700 acres. This figure does not include the range of the fisher in the Sierra Nevada. A majority of this subspecies range is on Federal lands.

Reproduction
While the distribution of populations have decreased from historic levels, there are no specific data on range-wide Pacific fisher population trends.

Suitable habitat

Acreage
No precise estimate of the total amount of Pacific fisher habitat range-wide exists. Using northern spotted owl habitat combined with late-successional west-side Sierra Nevada mixed conifer and white fir as surrogates, there are an estimated 11,768,000 acres of Pacific fisher habitat in Washington, Oregon, and California (USDI Fish and Wildlife Service 1992a, Sierra Nevada Ecosystem Project Science Team 1996). Given the limited number of detections in several areas of the subspecies range, this is certainly an overestimate of the actual habitat occupied by this subspecies.

Distribution
Given the exceedingly low number of recent fisher detections in Oregon and Washington (Powell and Zielinski 1994), estimating the distribution of suitable fisher habitat in Oregon and Washington is difficult. No published descriptions of the distribution of fisher habitat in Oregon and Washington exist. Using spotted owl habitat as a surrogate for fisher habitat, more than 95 percent of the habitat in Oregon and Washington is found on federally managed lands (USDI Fish and Wildlife Service 1992a). In Oregon and Washington, suitable fisher habitat is probably discontinuously distributed throughout the Cascade Range, the Olympic Mountains, and the Coast Ranges.

Carroll (1997) mapped habitat suitability with a geographic information system (GIS) for fisher in northwestern California. He developed a multiple logistic regression model created by using data from survey locations and satellite imagery. Suitable habitat was predicted to be well distributed throughout northwestern California, including PALCO lands. This model predicted the largest concentrations of suitable habitat occurred on Federal lands administered by the USFS.

Late successional forests occur throughout the Sierra Nevada, however the major concentrations of high-quality late successional forest occur within National Parks and canyons of major river drainages along the western edges of National Forests (Sierra Nevada Ecosystem Project Science Team 1996).

Quality
Throughout their range, fishers display variation in habitat use. For example, in the eastern United States fishers occur in various age-classes of both hardwood and conifer forests, while in the Pacific States they appear to prefer late successional coniferous forests (Powell and Zielinski 1994). Not all habitats used, however, should be considered of equal quality without habitat-specific information that allows comparisons of survivorship and fecundity (Powell and Zielinski 1994). While coniferous LSH is generally considered suitable fisher habitat in the Pacific States, other habitats are undoubtedly of value to fishers as long as suitable canopy closure and specific

habitat elements (refer to **Definition of suitable habitat** above) are present. For example, Zielinski and Barrett (1997) found that Pacific fishers rested most frequently in stands classified as CWHR 4D, 5D, and 6. Zielinski and Barrett (1997) also found a presumed natal den in a stand classified a CWHR 3D. Using telemetry, Self and Kerns (1995) found fishers used CWHR 3D, 4D, 5P, and 5M stands disproportionally more than their availability, and that they avoided CWHR 3S and 4S. Klug (pers. comm., January 15, 1999) also thought that large expanses of LSH were not required by fisher, and that younger stands with residual old trees, LWD, and hardwoods would provide suitable habitat. Accordingly, the use of LSH to define fisher habitat should be considered conservative.

In the Pacific States, most fishers have been detected in low to mid-elevational forests up to 8,200 feet (Powell and Zielinski 1994). Low snow accumulation, and habitat characteristics that reduce snow depth such as high canopy closure, are thought to improve habitat quality (Powell and Zielinski 1994).

Fisher reaction to humans is one of avoidance; disturbance may cause fishers to move kits from dens (Powell and Zielinski 1994). Dark (1977) had more fisher detections in areas with low use roads than in areas of high use roads, and found that 83 percent of fisher locations were greater than 325 feet beyond human disturbance.

Within northern California, fishers are thought to be less common in coniferous forests dominated by redwood than they are further inland where Douglas-fir and hardwoods becomes more prevalent in coniferous forests (Beyer and Golightly 1996, Klug 1996). Early biologists also thought that Pacific fishers were rare in the redwood belt (Grinnell et al. 1937).

Red tree vole

Species description

The red tree vole is a small, microtine rodent. Females of the species tend to be slightly larger than males. Individual weight varies from 0.9 to 1.8 ounces (Hayes 1996). Its pelage is cinnamon to rusty brown in color.

Taxonomy: The red tree vole *(Arborimus longicaudus)*, formerly classified as *(Phenacomys longicaudus)*, is endemic to Oregon and possibly northern California. Its exact distribution is uncertain, but this species is believed to be restricted to mesic forest communities. The extent of its range in southern Oregon and northern California is in question. Until recently, the populations distributed throughout California and Oregon have been considered one species. In 1991, the California populations were proposed as a separate species, *Arborimus pomo* (Johnson and George 1991). The species *A . longicaudus* is believed to be isolated geographically and genetically from its sibling species *A. pomo* by the Klamath Mountains. However, recent DNA evidence suggests that the range for *A. longicaudus* may extend into Del Norte County in northern California (Murray 1995). This analysis will treat the populations of red tree voles in Oregon and California as two separate species, and analyze impacts on *A. pomo*.

Life history
Little site-specific information on habitat use or population numbers has been gathered within the range of *A. pomo*. The voles in California are found in different forest types than members of the same genus in Oregon. Since little work has been done on the habitat associations of the vole in California, much of what is known has been derived from studies in Oregon forest types. For the purpose of this analysis it is assumed that habitat use, population structure, and reproduction, of *A. pomo* is similar to that of *A. longicaudus*. Many of the references listed below are from study sites in Oregon.

Definition of suitable habitat
In California, red tree voles are most commonly found in coniferous stands which have a component of Douglas-fir, though they are also found in stands with grand fir (*Abies grandis*), Sitka spruce (*Picea sitchensis*), and western hemlock (*Tsuga heterophylla*) (Huff et al. 1992). The species is nocturnal, and voles may spend the majority of their lives in the forest canopy, moving from tree to tree through the canopy (Carey 1991). Although they are almost exclusively arboreal, some terrestrial activity does occur; and occasionally individuals have been captured on the ground (Corn and Bury 1991, Raphael 1988).

Red tree voles build conspicuous nests, predominately in Douglas-fir tress wherever there is a suitable foundation and readily accessible food supply (Carey 1991). These nests are inhabited year-round and provide shelter, protection from predators, and micro-climates suitable for rearing young. Nests are constructed of resin ducts of fir needles, lichen, feces, urine, conifer needles, and small twigs (Carey 1991). The resin ducts are definitive indicators of tree vole use of a nest structure. Multiple generations of voles may use the same nest, continually enlarging it; a large nest may have several chambers and tunnels.

Nest sizes are variable, ranging from fist-sized to as large as 3 feet in diameter. Nest size varies with the size and limb structure of the tree supporting the nest. Some nests are found on large single branches or whorls of branches, and some are against the bole. Biswell (1996, cited in Behan et al. 1996), working in the Oregon Coast Range, found that approximately 40 percent of nests were on single large branches. Single branches supporting nests averaged greater than 4 inches in diameter. In trees with very large branches, tree vole nests can be 10 to16 or more feet from the bole of the tree.

The home range size for this species is not well known and is likely to vary depending on habitat quality. However, Biswell (1996, cited in Behan et al. 1996) found individual adult red tree voles, radio-tracked for 35 to 106 days, used 2 to 7 (median = 5) nest trees having independent non-interconnected canopies. The greatest straight-line distance traveled between consecutively occupied nest trees was an overnight move of 248.7 feet. The mean distance moved between consecutive nest trees for males and females combined was 112.8 feet (SE = 21.3). When moving to a new nest tree, adult voles re-occupied previously constructed nest structures at least 68 percent of the time. Thirty-six percent of nest trees located via telemetry (n=39) contained more than a single nest, and one tree contained seven nest structures.

Reproduction
Reproduction in this species is characterized by a long reproductive period, small litter size, and slow development of young (Carey 1991). Red tree voles can breed throughout the year, but generally litters are produced from February through September (Carey 1991). Litters range in size from one to four (Carey 1991, Maser 1966), but average two (Howell 1926). Gestation is approximately 28 days but may extend to 48 days if the female is lactating in support of an earlier litter (Carey 1991). The species is believed to exhibit sexual segregation except for the purposes of reproduction. Adult males and females rarely occupy the same nest at the same time (Whitaker 1998).

Diet
Red tree voles feed primarily on Douglas-fir needles, although they will occasionally feed on grand fir, white fir, Sitka spruce, and western hemlock needles (Carey 1991). Douglas-fir needles have resin ducts along each edge which the vole discards, eating the fleshy portions of the needles. Water is obtained from dew, rain or condensation on foliage (Carey 1991).

Cover requirements
Biswell (1996, cited in Behan et al. 1996) found nest trees generally had independent, non-overlapping canopies requiring the voles to move on the ground between some nest trees. Old-growth habitat appears to provide optimum habitat for red tree voles because it functions as a climatic buffer and has a high water-holding capacity, which maximizes food availability and free water (Gillesberg and Carey 1991).

Dispersal
Young start to venture from the nest at about 4 weeks of age (Howell 1926). Eventually juveniles will leave the nest to establish their own nests. The greatest distance moved by a red tree vole was by a dispersing male that was followed for 40 days. This individual was located in five different trees and reached a maximum straight-line distance from his natal nest tree of 1,115 feet (Biswell 1996, cited in Behan et al. 1996). While moving far greater distances than adults, subadults have extremely low survival rates. Telemetered red tree voles crossed small forest roads, small streams, or canopy gaps while traveling between nest trees.

Special habitat needs
Information on the special habitat needs can be found under the **Diet** section above.

Current legal status
Listing history
The California red tree vole is not a Federal candidate, proposed, or listed species under the Act, and is classified by the CDFG as a mammal species of special concern. The red tree vole in Oregon (*A. longicaudus)* was designated as a "Survey and Manage Species" on Federal lands within the range of the northen spotted owl under the Northwest Forest Plan. Due to the

uncertainty of the taxonomy of red tree voles at the time the Northwest Forest Plan was developed, *A. pomo* was not listed as a "Survey and Manage Species".

Threats

A majority of the species' range is on private land which is intensively managed for timber production. Its apparent affinity for coastal old-growth and late-seral forests with a Douglas-fir component, has increased the level of concern for this species.

Huff et al. (1992) rated the red tree vole as the most vulnerable of the arboreal rodents to local extirpations resulting from the loss or fragmentation of old-growth Douglas-fir forests. The California red tree vole is classified by the CDFG as a mammal species of special concern (Williams 1986) because of its affinity for coastal conifer forests and the potential negative impact of large-scale timber harvest.

Conservation needs

The red tree vole is one of the least studied of the arboreal rodents occurring in Douglas-fir forests in the Pacific Northwest (Carey 1991). Most of what is known comes from anecdotal observations and a few limited studies. Little information is available on the major aspects of this species life history (longevity, demography, or population density). Additional research on the effects of landscape characteristics (seral stage mix and habitat fragmentation) and distribution and abundance of red tree vole populations is needed to develop a scientifically based conservation strategy. Based on the level of information available on the range-wide status and distribution of this species, the importance of the role PALCO lands play in the conservation of the California red tree vole is unknown.

Based on the research conducted to date on the California red tree vole and its close relative (*A. longicaudus*), the following should be considered when developing management guidelines for the conservation of the species:

1. Provide an interconnecting network of blocks of LSH and opportunities for dispersal of young and movement of adults between the LSH blocks.

a. Little information on the relationship of patch size and habitat suitability for red tree voles is available. Of the research conducted to date, information collected from the Oregon coast range is most similar to PALCO lands, in terms of habitat type. Based on stand sizes recorded in Huff et al. (1992), patches of suitable habitat should be a minimum of 75 acres in size, and preferably greater than 475 acres in size. These habitat patches should contain an element of older trees with a limb structure adequate to support large vole nests .
b. Red tree voles are thought to spend a majority of their life within the canopy of coniferous forests, moving from tree to tree through the canopy. To increase the likelihood of successful movement between colonies of red tree voles, dispersal habitat

between patches of suitable habitat should consist of coniferous forest with canopy cover of at least 60 percent.

Status and distribution

Species

Numbers and Distribution

The California red tree vole is endemic to California. Approximately 78 percent of the species range occurs on non-Federal lands (USDA Forest Service et al. 1993). There is little information available on the current population size or status of the California red tree vole. The CDFG is in the process of gathering information on the status and distribution of red tree voles in California. Their records indicate that the range extends from San Francisco Bay north along the coast and east as far as the Klammath Mountains in Sonoma, Mendocino, Trinity, Humboldt, and Del Norte Counties.

The CDFG has recorded approximately 561 red tree vole nest locations and 388 trapped individuals within the range of the California red tree vole. The sites in this database represent a small portion of the potentially suitable habitat within the species range. The CDFG database includes records dating back to 1984, with a majority of the sighting information collected since 1994. The distribution of locations currently in their database indicate that red tree voles are more numerous along the coast than inland, and that their distribution inland may be limited (CDFG 1997).

Based on the information contained in the CDFG database, the overall distribution of red tree voles has not changed significantly, although the apparent limited mobility and dispersal capability of the species is of concern. The continued decrease and fragmentation of late-seral habitat within the species range is likely to reduce population sizes and limit the species' ability to recolonize areas.

Reproduction

There is no information available on the reproductive trends of the California red tree vole. Surveys indicate that late-seral forests contain larger populations than younger stands. Larger populations have a higher likelihood of persistence and may equate to higher levels of reproductive success.

Suitable habitat

Acreage

Acres of potentially suitable habitat within the range of the California red tree vole are discussed **in the Environmental Baseline (in the action area)** section of this document.

Distribution

No specific information is available on the distribution of potentially suitable red tree vole habitat. Based on CDFG (1997) sighting records of red tree voles and red tree vole nests, potentially suitable habitat exists in Sonoma, Mendocino, Del Norte, Humboldt, and Trinity Counties.

Quality

Little is known about the number or size of Douglas-fir trees, or the stand structural characteristics required to sustain a local population of red tree voles. Voles have been found in all seral stages of Douglas-fir forests from closed sapling/pole stands to older stands (Corn and Bury 1986) but tend to be significantly more abundant in mature and old-growth stands (Corn and Bury 1986, Aubry et al. 1991, Huff et al. 1992). Individuals were captured in clearcuts (Corn and Bury 1986), young second-growth Douglas-fir stands, and old-growth (Corn and Bury 1986, 1991, Gomez 1993, Gillesburg and Carey 1991, Zentner 1977). Capture rates were significantly higher in old-growth Douglas-fir forests than in young (40 to 60 year old) or natural mature forests (Gomez 1993, Corn and Bury 1991). In northern California, Zentner (1977), found old-growth Douglas-fir stands contained more red tree vole nests and larger colonies than did second-growth stands. The youngest stand in which red tree voles were captured in the Oregon Coast range was 62 years old (Huff et al. 1992). In Mendocino County, California, Meiselman (1996) found red tree vole nests significantly more abundant in old-growth stands (greater than 200 years) than in mature (100 to 200 years) or young stands (less than100 years), despite the fact that the difficulty in detecting nests in the upper canopy of old-growth stands may have resulted in an underestimate in old-growth forest.

In a random sample of stands in the central Coast Range of Oregon, red tree vole nest tree densities averaged 2.29 per acre (range 0.8 to 33.6 per acre) in 150 to 300 year old stands, and 0.16 per acre (range 0 to 4.8 per acre) in 25 to110 year old stands (Biswell 1996, cited in Behan et al. 1996).

The relationship between number of nests and number of individuals is largely unknown (Carey et al. 1991). As the size of a tree and its branches increase, the amount of suitable habitat within the tree also increases, making it more likely the tree will be used for nesting by red tree voles (Gillesberg and Carey 1991). The large limbs of old-growth trees provide the structural support for large nests, as well as escape routes. However, vole populations are often patchily distributed in forests.

The presence of Douglas-fir clearly is important to maintaining viable populations of red tree voles. Huff et al. (1992) found that even though basal area and density were highly variable among stands, the basal area of Douglas-fir was greater than 40 percent of the total stand basal area in 15 of the 18 stands where red tree voles were captured in Oregon. In the Oregon Coast and Cascades Ranges combined (Huff et al. 1992) found that stands with red tree voles had a mean of 12 large (greater than 39 inches dbh) Douglas-fir trees per acre, whereas those without voles had significantly fewer large Douglas-firs (6 per acre; P=0.02).

Red tree voles were captured in stands ranging in size from 75 to 1,280 acres (mean = 475 acres) in the Oregon Coast Range and were not captured in stands less than 75 acres in size (Huff et al. 1992). There is no conclusive information available concerning the minimum size stand necessary to support a population of red tree voles. Factors such as the number of suitable nest trees, canopy closure, and past and present disturbances may be more important to the suitability of a stand than its acreage.

Northern red-legged frog

Species Description

The northern red-legged frog (*Rana aurora aurora*) is a moderate sized, brown or reddish-brown frog usually marked with small black flecks and spots on the back and sides, with dark bands across the legs. A dark mask is generally present, with a light upper jaw strip extending nearly to the shoulder. They have smooth, moist skin, with eyes oriented to the sides. The ventral surface of the hind legs are reddish in color, often extending onto belly and sides (Leonard et al. 1993). Captive northern red-legged frog have been reported to live 12 to 15 years.

Two subspecies of red-legged frogs occur in California; the northern red-legged frog and the California red-legged frog (*Rana aurora draytonii*). While the genetic relationship between the two is unclear, some morphological differences are evident. Davidson (1996) reviewed literature on the two subspecies. The most obvious differences include the larger size of the California red-legged frog which calls above water and lays its eggs in contact with the water surface. The northern subspecies is smaller, the male typically calls under the water, and eggs are submerged.

Life History

Definition of suitable habitat

Key elements for the northern red-legged frog include both aquatic habitats for breeding and terrestrial habitats for foraging and overwintering. Breeding habitats include vegetation-lined marshes, bogs, swamps, ponds, lakes, and slow-moving streams. Outside of the breeding season, adults are highly terrestrial and are frequently encountered in forested stands adjacent to streams (Leonard et al. 1993). Nussbaum et al. (1983) reported finding northern red-legged frogs 650 to 975 feet from water. Zeiner et al. (1988) reported red-legged frogs found "considerable distances" from breeding sites during rainy periods.

The specific habitat parameters needed for overwintering and foraging in forested environments are not well understood, however some correlations have been made with coarse woody debris, canopy closure, and stream attributes within and adjacent to breeding sites. Along the west slope of the Cascades, Bury and Corn (1988) found northern red-legged frogs more abundant in mature and old-growth habitats compared to young stands or clear-cuts, but these authors indicate the proximity of slow-moving creeks or ponds may have influenced the presence of the subspecies in adjacent terrestrial habitat. The authors also surmised the location of northern red-legged frogs in young stands could be attributed to the presence of closed canopy and coarse woody debris within those stands. In southern Washington, Aubry and Hall (1991) found the subspecies most frequently in mature stands and least frequently in young stands, but reasoned that their presence may be more correlated with instream downed wood and pools than with stand age. In the coastal redwood zone, northern red-legged frogs are commonly found on stream side benches with dense sword fern undergrowth (Twedt 1993). There may be competitive advantages to inhabiting isolated perennial pools within intermittent stream reaches (Hayes and Jennings 1988) if water temperatures are suitable.

Reproduction
Males are known to arrive at breeding sites at least 1month prior to females, with water temperatures as low as 35.6 degrees Fahrenheit (Licht 1969, cited in Jennings and Hayes 1994). Breeding usually occurs in February and March. Eggs are laid in clutches of 700 to 4,000 (Zeiner et al. 1988) and are attached to underwater vegetation at least 2 to 3 feet from the water's edge, at a depth of at least 18 inches (Licht 1971). Egg development can vary from 1 week to over 8 weeks depending on temperature (Storm 1960 and Licht 1971, cited in Jennings and Hayes 1994). Lethal minimum and maximum embryonic temperatures are 39 and 70 degrees Fahrenheit respectively (Licht 1971). Aquatic larvae take up to 4 to 5 months to metamorphose, and are about 0.75 inches long when they become terrestrial. Nussbaum et al. (1983) refer to limited evidence from western Oregon that indicates sexual maturity is achieved in the second year following metamorphosis. Leonard et al. (1993) indicate 3 or 4 years likely are required for the subspecies to reach sexual maturity.

Diet
The diet of the red-legged frog species is reported to be highly variable (Hayes and Tennant 1985, cited in Davidson 1996). The northern subspecies specifically, is noted as being primarily insectivorous (Licht 1986, cited in Jennings and Hayes 1994). Jennings and Hayes (1994) note that northern red-legged frog tadpoles can significantly reduce the standing crop of epiphytic algae under certain conditions.

Cover requirements
Refer to Jennings and Hayes (1994) for a review of the published literature. In summary, the northern red-legged frog utilizes aquatic vegetation bordered by dense grassy or shrubby vegetation. In terrestrial areas, patches of vegetation such as willow thickets and dense sedge swales are used. Their escape strategy from birds and land predators is to flee directly into the water and swim to the deepest part of the channel or pool (Gregory 1979). As described by Twedt (1993), the northern red-legged frog in northwestern California has been found in dense undergrowth of sword ferns, and sedges.

Dispersal
Information on dispersal distances or specific dispersal habitat requirements was not available.

Special habitat needs
The presence of instream downed wood and pools at least 18 inches deep appear to be important for northern red-legged frogs. See **Definition of suitable habitat** above for additional information.

Current legal status
Listing history

The northern red-legged frog is not currently proposed or listed as Federally threatened or endangered. It is currently identified as a California species of special concern and is recognized by the USFS as a Sensitive Species in the Pacific Southwest Region. Red- legged frogs found from southern Del Norte to northern Marin county exhibit intergrade characteristics of both subspecies (Hayes and Krempels 1986, cited in USDI Fish and Wildlife Service 1996c). Northern Marin county is considered the approximate dividing line between the Federally listed California red-legged frog and the intergrade zone along the coastal range (Mark Jennings, pers. comm., 1993, cited in USDI Fish and Wildlife Service, 1996c). The project area occurs within the zone of intergrade of the two subspecies. The Final Rule for the listing of the California red-legged frog does not include the intergrade zone, and does not include the following areas: the State of Nevada, Humboldt, Del Norte, Trinity, and Mendocino counties, California; Glenn, Lake, and Sonoma counties west of the Central Valley Hydrological basin, California; or Sonoma and Marin counties north and west of the Napa River, Sonoma Creek, and Petaluma River drainages, which drain into San Francisco Bay, and north of the Walker Creek drainage, which drains into the Pacific Ocean, California.

Threats

All life stages are susceptible to competition and/or predation from introduced fish and bullfrogs (*Rana catesbiana*) (see Davidson (1996) for a review of the literature). The FWS has been unable to locate studies or data to indicate how serious the competition and predation may be, or what trend may be emerging in the forested portion of the species range. As with many other amphibian species, the northern red-legged frog is also vulnerable to the effects of cattle grazing due to the removal of protective stream-side vegetative cover and vulnerability to egg mass trampling. Additionally, habitat removal caused by timber harvest adjacent to or within riparian areas poses a threat to the subspecies since it is dependent on terrestrial vegetation for much of its life cycle. Welsh et al. (1998) suggest that aside from habitat destruction, the use of forest herbicides may be the single greatest threat to the northern red-legged frog in Humboldt County.

Conservation needs

Jennings and Hayes (1994) recommend systematic surveys of the northern red-legged frog are needed to further understand how serious impacts on this taxon are and what trends may be evolving. Welsh et al. (1998) recommend forested and riparian areas, including all standing water bodies, be managed as if they currently have the potential to support breeding northern red-legged frogs. These areas should be free of introduced predators. Wide buffer widths which restrict all habitat removal and alteration from riparian and adjacent forested areas would likely result in long-term maintenance of northern red-legged frog populations (Welsh et al. 1998). Potential impacts to northern red-legged frogs from herbicide and pesticide run-off should be investigated (Nussbaum et al.1983).

Status and Distribution

Species

Numbers

Range-wide population data are not available for the northern red-legged frog.

Distribution
The northern red-legged frog is found in streams in forested areas from Sullivan Bay, British Columbia, south along the Pacific coast (west of the Cascade range) to northern Humboldt county, CA (Stebbins 1985), or northern Del Norte county as described by USDI Fish and Wildlife Service (1996c). It interbreeds with the California subspecies along a 40 to 60 mile wide diagonal band that runs from southwestern Del Norte county to northern Marin county (range map, Stebbins 1985). The action area is within the interbreeding zone, where frogs exhibit primarily features associated with the northern red-legged frog (Jennings and Hayes 1994). The northern red-legged frog is generally limited to elevations below 3,936 feet (Zeiner et al. 1988).

Range-wide data on the northern red-legged frog were not summarized in the FEMAT (USDA Forest Service et al. 1993) analysis. However, range maps (e.g., Corkran and Thoms 1996) indicate the range of the northwestern salamander (*Ambystoma gracile*) (summarized in FEMAT) overlaps the northern red-legged frog range by 85 to 90 percent in Oregon, Washington and California. The noticeable difference is that the range of the northwestern salamander extends to higher elevations along the Cascade crest.

Suitable habitat
Acreage, distribution, and quality
Specific range-wide data on suitable habitat is not available for the northern red-legged frog. However, the range of the northwestern salamander is similar to the range of the northern red-legged frog. We can use the similarity of range with the northwestern salamander as described in FEMAT (USDA Forest Service et al. 1993) as a proxy for the northern red-legged frog. The FEMAT (USDA Forest Service et al. 1993) data for the northwestern salamander are as follows. The portion of the species range in the United States is approximately 37.18 million acres in size, of which approximately 38 percent (14.13 million acres) is Federal land. Federal lands in this species range consist of approximately 25 percent Matrix (3.5 million acres), 7 percent Adaptive Management Area (988,870 acres), and 68 percent reserved or withdrawn from management (9.6 million acres). The Northwest Forest Plan estimated 2.63 million acres of Riparian Reserves occurred within Matrix land allocations. Mapped wetlands were likely included in these figures. This number excludes the acres of Riparian Reserves in other land allocations, but based on a sample, an estimated 40 percent of other land allocations is comprised of Riparian Reserves on Federal land throughout the range of the northern spotted owl (Northwest Forest Plan Record of Decision, page B-12). Using this percentage, an estimated 5.65 million acres of Riparian Reserves occur within the range of the northwestern salamander, and for the purposes of this analysis, the northern red-legged frog. An unknown portion of this acreage is probably unsuitable, especially near high-gradient waters.

The following figures are estimated based on adaptations from FEMAT (USDA Forest Service et al. 1993) and describe miles of fish bearing (Class I) and non-fish bearing streams (Class II) on National Forests and BLM lands within the range of the subspecies: 16,400 miles of Class I and 32,860 miles of Class II occur within the range of the northern red-legged frog. The following physiographic provinces were included in the above estimate: Western Cascades, Western

Lowlands and Olympic Peninsula of Washington; Western Cascades, Coast Range and Klamath Range of Oregon; and the California Coast and Klamath Ranges.

Data on how much overlap of habitat occurs where streams converge is not available at this scale, and therefore overestimates potentially suitable habitat. Conversely, these figures do not consider potentially suitable habitat on private ownership, therefore, the acreages described above likely underestimate potentially suitable habitat for the northern red-legged frog.

Foothill yellow-legged frog

Species description

The foothill yellow-legged frog is a small to medium sized frog found in lower gradient, rocky and gravelly streams. It has grainy skin with colors ranging from olive to light or dark gray or brownish, with variable amounts of brick red. The underside is white or cream, with light or bright yellow along the sides of stomach and undersides of thighs. A comparative study of ranid frogs (Duelmann and Trueb 1986) indicates that the lifespan may be a dozen years or more.

Life history

Definition of suitable habitat

The foothill yellow-legged frog is closely associated with shallow areas of permanent streams and is most common in and near streams with rocky, gravelly, or sandy bottoms (Leonard et al. 1993). The species is also occasionally found in other riparian habitats including moderately vegetated backwaters, isolated pools, and slow moving rivers with mud substrate. No information was found on specific water temperature needs, and all life stages throughout the species range appear to occur in highly variable water temperatures. Cover immediately adjacent to the water's edge can be somewhat sparse and patchy (Ashton et al. 1998). The species occurs in many types of mediterranean ecosystems. Zeiner et al. (1988) identified the following California vegetation communities adjacent to streams as potentially suitable habitat for foothill yellow-legged frogs: valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, coastal scrub, mixed chaparral and wet meadow types. Little is known about the areas used for overwintering habitat. Foothill yellow-legged frogs are known to leave the stream channel during high flows and hibernate in the forest, sheltering in animal burrows and under logs. They have been captured up to 328 feet from the South Fork Eel River (Welsh et al.1998).

Reproduction

Courtship and breeding occurs on gravel, pebble and cobble bars along shallow, low-gradient reaches of major streams (Ashton et al. 1998). Foothill yellow-legged frogs may breed from early April into early June. A combination of environmental variables such as water temperature, air temperature, and spring runoff (to avoid both late season flooding and recession of waters) likely influence the timing of egg laying (Lind et al. 1992). If flooding occurs, eggs are susceptible to washouts by high flows. If waters recede prematurely, eggs are susceptible to desiccation. The species is known to interrupt egg laying during periods of rain, which is possibly an adaptive response to the threat of late season flooding (Kupferberg 1996). Some authors have observed breeding activity to occur only over a 2 week period within one season (Nussbaum et al. 1983, Leonard et al. 1993). Observations along the Trinity River in California indicate breeding activity can occur over a 3 month period, from April through late June (Ashton et al. 1998).

The most successful egg laying sites are downstream from and within 328 feet of the confluences of lower order tributaries (Kupferberg 1996). Egg laying sites typically are on the lee side of larger rocks, with velocities significantly lower than ambient flow (Kupferberg 1996). The Trinity River study found the majority of egg masses occurred in backwater pools, edgewater pools, and glides adjacent to main channel low gradient riffles and runs (Lind et al. 1992). Egg masses are laid in late spring or early summer, in cobble and pebble substrates, at depths of less than 20 inches, within quiet scour pools or riffles in gentle-gradient streams. Developmental rates vary greatly with water temperature. Eggs in the Trinity river were found to hatch in 27 to 36 days, but may hatch in as little as 5 days (Ashton et al. 1998). Tadpoles attach themselves to the egg mass initially, then to rocks with their specialized enlarged mouths (Corkran and Thoms 1996). Nussbaum et al. (1983) note tadpoles in California metamorphose in 3 to 4 months. Sexual maturity likely occurs in the second spring or summer (Nussbaum et al. 1983). Reproductive success is highly dependent on year-to-year hydrologic variation (reviewed in Ashton et al. 1997).

<u>Diet</u>
Tadpoles forage by scraping algae and diatoms off rock surfaces. They have also been observed feeding on dead tadpoles and dead, open bivalves (Ashton et al. 1998). Adults and juveniles are known to forage on aquatic and terrestrial invertebrates.

<u>Cover requirements</u>
Some shading (>20 percent) seems to be preferred by sub-adults and adults (Ashton et al. 1998). No information is available on canopy closure requirements for wintering habitat.

<u>Dispersal</u>
Little is known about movement and dispersal of the foothill yellow-legged frog (Jennings and Hayes 1994). Observations along the Trinity River indicate adults congregate around breeding pools in late spring and early summer, but later in summer adults were scarce in pools. This may be due to dispersal into vegetation or into tributaries, or just reduced diurnal activity (Ashton et al. 1998). Upstream migration has been observed in recently metamorphosed frogs (Twitty et al. 1967 cited in Ashton et al. 1998), but the overall dispersal range for tadpoles or juveniles is not well understood.

<u>Special habitat needs</u>
It appears rocky, gravelly and sandy river substrates for breeding, and vegetated adjacent terrestrial habitat for dispersal and overwintering is important for the species. See discussion in **Definition of Suitable Habitat** section for more information.

Current legal status
<u>Listing History</u>

The foothill yellow-legged frog is currently identified by the CDFG as a Species of Special Concern throughout the state of California. State endangered status has been recommended in coastal counties south of the Salinas River; State threatened status has been recommended in west slope drainages in the Sierra-Cascade ranges east of the Sacramento and San Joaquin rivers (Jennings and Hayes 1994). It is considered a Federal Species of Concern, but is not currently a Federally listed, proposed or candidate species.

Threats

The primary threats to the foothill yellow-legged frog appear to be altered flow regimes and effects of introduced species. The timing of dam releases or heavy precipitation can wash away egg masses and tadpoles, and disrupt reproduction (Kupferberg 1996, Lind et al. 1996). Other actions such as mining or grazing can also result in significant changes to channel morphology, thereby affecting local populations. All life stages are susceptible to competition and/or predation from introduced fish stocks and bullfrogs (*Rana catesbiana*) (see Ashton et al. 1998 for a review of the literature). Kupferberg (1996) notes the reproductive strategy is clearly linked with predictable winter-floods, summer-droughts, and selection of distinctive channel morphologies: the timing of egg laying appears to be correlated with the end of the seasonal flooding period, and eggs are placed where dessication is less likely to occur.

Conservation needs

Mechanisms which maintain natural flow regimes and do not alter channel morphology should be implemented. Spring water release in dammed river systems should be timed to correspond with high water levels in early spring to avoid the flushing of egg masses and loss of suitable microsite environment selected by adults. Changes in channel morphology can reduce suitable habitats for native species, while increasing suitability for non-natives, typically resulting in increased predation or competition with native species. This has been observed in the main stem of the Trinity River system (Lind et al. 1996). In managed landscapes, the structural diversity of aquatic systems are benefitted by snag and log retention provisions which allow input of these structures into the system. Use of overwintering habitats needs to be investigated.

Status and Distribution

Species

Numbers

Range-wide population data are not known for the foothill yellow-legged frog. However, populations have experienced significant declines, especially in the southern and inland parts of the range (G. Fellars pers. comm., cited in Kupferberg 1996). In southern California, the species has not been observed in or south of the Transverse Ranges since before 1978, and in the southern Sierra Nevada, the species has not been observed for at least 20 years in at least 19 historical localities. Populations appear to be widely scattered along the western slope of the northern Sierra Nevada and the extreme southern Cascades. In the Coast Ranges, north of the Salinas River, significant numbers of this species occur in some coastal drainages, but are still at risk due to various anthropogenic and environmental threats (Ashton et al. 1998).

Distribution
The foothill yellow-legged frog occurs in most Pacific drainages west of the Sierra-Cascade crest from the Santiam River, Marion county, Oregon to Kern county, California. In coastal areas it is found from Douglas county, Oregon to the San Gabriel drainage in Los Angeles county, California. There are records of an isolated population in the Sierra San Pedro Martir, Baja California, Mexico (Leonard et al. 1993). The species range maps for California (Zeiner et al. 1988) overlap portions of fourteen National Forests. The foothill yellow-legged frog is found from sea level in coastal drainages to 6,000 feet in the Sierra Nevada range (Zeiner et al. 1988).

Reproduction
Range-wide reproductive trend data are not available. As discussed above, habitat alterations and increases in predation and competition from introduced species combine to lower reproductive success and recruitment capability for this species.

Suitable habitat
Acreage and distribution
Estimates were made of gross land acreage and perennial stream miles within the portion of the species range addressed by the Pacific Northwest Forest Plan. The total landbase in that area, public and private combined, is 26,802,251 acres, of which 64 percent is in California and 36 percent is in Oregon. The estimate is based on species range maps in Csuti et al. (1997), and Ziener et al. (1988); data on stream mileage were not available. A second estimate was made, within that area, for lands managed by the USFS and BLM in Oregon and California; with estimates based on Table V-G-4 in FEMAT (USDA Forest Service et al. 1993), and on the range maps identified above. Acreage and perennial stream mileage in Table V-G-4 were adjusted by the estimated percentage of each administrative unit (USFS or BLM District) lying within the species' mapped range. The agency totals for both states are 11,478,711 gross acres and 30,916 miles of perennial streams; of which California agency lands account for 43 percent of the acreage and 30 percent of the stream mileage. An unknown portion of this acreage and stream mileage may be unsuitable for the species.

Quality
Habitat quality throughout much of the species range has declined because of artificial changes in river and stream morphologies. Refer to discussion of **Threats** to the species above.

<u>**Northwestern pond turtle**</u>
Species Description
The western pond turtle is a fresh water turtle which occurs in the Pacific States of North America. Two subspecies are recognized: the southwestern pond turtle *(Clemmys marmorata pallida)*, and the northwestern pond turtle (*Clemmys marmorata marmorata*). Western pond turtles are described as a relatively long-lived aquatic habitat generalist occurring in a wide variety of permanent and ephemeral habitats ranging from sea level to over 4,500 feet, with few sightings in upper elevations.

Life history

Definition of suitable habitat

Unless otherwise noted, information in this section was obtained from Holland (1991) or (1994). The subspecies uses upland terrestrial habitat and various aquatic habitats (e.g., rivers, streams, lakes, ponds, vernal pools and other seasonal and permanent wetlands). Favorable habitat is characterized by deep, slow-flowing pools of cool and/or warm water with subsurface cover and emergent basking sites (Holland 1991, 1994; Reese 1996). Reese (1996) found juveniles closely associated with warmer, more lentic waters than adults. These areas may be either permanent or intermittent, with permanent streams supporting larger populations. Along intermittent streams, pools are often used when the stream course dries. In some areas, turtles may be restricted to areas near river banks or in quiet backwaters where the water is slow moving and basking sites and refugia are available. Areas lacking refugia are avoided. Basking sites consist of partially submerged logs, rocks, mats of floating vegetation, or exposed mud banks. In Oregon, the subspecies is found primarily along rivers, large order streams, and wetlands. Sighting records for the coastal Oregon region are approximately equally divided between river, stream, and lake habitats.

The subspecies also uses altered habitats such as farm ponds, canals, mill ponds, and sewage treatment plants. Holland, however, suggests these habitats may not support viable populations of turtles and the populations at these sites may be displaced from other habitats.

Terrestrial habitats are essential for overwintering, estivation, nesting (discussed in section below), and overland movement between aquatic habitats throughout the year. The duration of overwintering, type of habitat used, and the distance of that habitat from water is highly variable. Some individuals may not overwinter, while others may overwinter from October through March or April (Holland and Bury in press). Reese and Welsh (1997) found movement increased in September for upland use, and began again in February, lasting as late as June. Two turtles in Oregon were documented as spending at least 8 months in or near an overwintering site (Holland 1994). Overwintering habitat has been found in undercut areas or holes along watercourse banks, upland grassland, conifer or hardwood habitats, under logs, or duff/litter layers within wooded areas, or in the bottom mud of streams or ponds (Holland 1991, Reese and Welsh 1997). Reese (1996) found percent slope of overwintering locations varied from 0 to 55 percent. Some turtles will not stay in one location during the winter season and will change locations numerous times (Holland 1994, Reese 1996, Reese and Welsh 1997).

Reese and Welsh (1997) found terrestrial movements most commonly occurred during summer and winter along the Trinity River in California. Both sexes, most notably gravid females, exhibited frequent and prolonged use (7 months) of terrestrial habitat. Overwintering locations in this study were all found in upland habitats beyond riparian zones, ranging from approximately 213 to 1,640 feet (mean distance of 666 feet) from the water. Reese (1996), found overwintering distances ranging from 143 to 1,387 feet (mean of 496 feet). Elevations of overwintering sites are variable as well: range from 0 to 521 feet (mean of approximately 140 feet) above the stream. Individuals of the southern subspecies were observed to move over 1,500 feet into upland habitat

(Rathbun et al. 1992, Holland and Bury, in press). Overland movement between watercourses is highly variable and is not well understood (Holland 1994). Some turtles may regularly move distances of over 3 miles within a stream and up to 3 miles overland (Holland 1991, 1994).

Reproduction

The natural history of the northwestern pond turtle varies throughout its range. Sexual maturity in females may vary geographically, but they typically reproduce between 7 to 11 years of age. Clutch sizes varies from 1 to 13 eggs, with clutch size positively correlated with carapace length (Holland 1991, 1994). Females are highly sensitive to disturbance during nesting. Eggs can be laid every year, two clutches in one year, or every other year. Most eggs are laid in June or July (Holland 1994). The time required to excavate a nest site is variable, ranging from 2 hours to multiple efforts over a 24 hour period (Holland 1994). Distance from water to nests is also variable. Of 252 nest sites located in Trinity County, California; Lane, Douglas, Wasco, Counties in Oregon, Holland (1994) found the mean distance of nests to water was approximately 160 feet (range = < 10 feet to 1,318 feet). The majority of these sites were less than 230 feet from the water. Mean distance from water in broad river valleys in this study were found to be further than in narrower river canyons. For example, mean nest to water distance in the Willamette drainage was 282 feet, compared with 94 feet in the South Umpqua. Along the Trinity River, Reese (1996) found nest sites and potential nest sites were located at a mean of 253 feet (range 6.5 to 476 feet) from the water's edge. Reese and Welsh (1997) documented one nest which was located approximately 100 feet from the water's edge. Nest sites are typically on south or south west facing slopes dominated by grasses or herbaceous annuals in dry, well-drained soils with significant clay/silt content and low slopes between 0 and 60 percent, with most nests on slopes 25 percent. Hatchlings require shallow water habitat characterized by relatively dense submergent or short emergent vegetation for foraging and basking (Holland 1985, Jennings and Hayes 1994). Reese (1996) reported higher proportion of juveniles/adults in ponds rather than riverine habitats.

Diet

The diet of the species is variable, and dominant items in the diet may vary from area to area. Literature was summarized in Holland (1994) and Holland and Bury (in press). The species consume primarily aquatic insects and crustaceans, fish, and small amphibians. These items are taken as carrion or prey. Pond turtles also eat aquatic vegetation, but use of plants appears to be relatively infrequent.

Cover requirements

Pond turtles favor aquatic habitats with an abundance of basking sites, underwater refugia, and vegetative canopy. A high correlation between turtle abundance and number of basking sites such as logs and boulders was observed along a northern California stream (Bury 1972, Holland and Bury in press). Aquatic vegetation such as tule, cattails, or algae are often used for resting or hiding (refer to **Definition of suitable habitat**). Reese (1996) found that turtle locations are associated with vegetated banks with greater frequency than expected from their availability and that the majority of overwintering sites exceeded 50 percent canopy closure.

Dispersal

Dispersal of individuals is primarily restricted to aquatic habitats. Post-emergence terrestrial movements of hatchlings are not well known, however hatchlings are known to overwinter in the nest (Holland 1994, Reese and Welsh 1997). Juveniles sampled on the Trinity River traveled a mean weekly distance of 65 feet.

The amount and distance of movement by adults is highly varied. Environmental stress, disturbance, or local conditions such as the amount and type of available habitat may influence the movement of adults (Holland 1994). Reese and Welsh (1997) found the size of traditionally protected buffer zones along rivers did not sufficiently incorporate areas used by dispersing turtles. Turtles use terrestrial areas ranging from 213 to 1,640 feet from water.

Special habitat needs

The presence of suitable nesting and overwintering habitat, vegetatively linked wetlands, basking sites, and underwater refugia appear to be important for the northwestern pond turtle. Refer to **Definition of suitable habitat** and **Reproduction** sections for more information.

Current legal status

Listing history

The northwestern pond turtle is a Federal species of concern, USFS sensitive species, and State species of special concern and protected species (CDFG 1998a, USDA Forest Service 1998). It is not currently Federally recognized as a candidate, proposed, or listed species.

Threats

Populations of the subspecies are currently threatened by the following factors: habitat destruction and fragmentation due to agriculture, timber management, livestock grazing practices, damming, and water diversions, and other human-related disturbance. These factors vary in magnitude within different portions of the subspecies' range (Holland 1994, Jennings and Hayes 1994, Reese 1996, Reese and Welsh 1998). Other human related factors such as collisions with vehicles, hunting, shooting, and water contamination have resulted in mortalities throughout the range. Introduced predatory and/or competitor species including bullfrogs, sunfish, and bass can threaten young turtles in the aquatic environment. Terrestrial predation by racoons, skunks, and coyotes has been observed to significantly affect nest sites (Holland 1994).

The relatively long period of time (about 7 to 11 years in California) required to reach reproductive maturity makes the population's growth rate particularly vulnerable to changes in juvenile and adult survival (Jennings and Hayes 1994). A range-wide concern for northwestern pond turtles involves juvenile recruitment, as many populations are composed primarily of aging adults (Holland 1991, 1994, Reese and Welsh 1997). This situation is most severe in the upper Klamath River, Oregon (D. Holland, pers. comm., October 21, 1998). While populations may appear stable, in the long-term, they may not be. Without adequate recruitment into the population, adults that are lost from the population may not be replaced.

Conservation needs

Holland and Bury (in press) summarize the conservation needs of the northwestern pond turtle. Protection of existing populations and suitable habitat, and continuation or expansion of current ecological monitoring programs are the primary conservation needs. Wetlands should be linked to facilitate dispersal and limit population fragmentation (Burke and Gibbons 1995, cited in Reese 1996). Implementing management strategies which address the functioning of entire watersheds have a higher likelihood of providing adequate protection for the northwestern pond turtle (Reese and Welsh 1997).

Mitigation should not rely on translocation and captive breeding programs for a number of reasons, discussed in detail in Holland (1994). Translocated turtles have been known to return to original sites, thereby subjecting them to increased stress and risk of mortality. The effectiveness of these efforts has been questioned (Dodd and Seigel 1991). The translocations of genetically different individuals into a different population may result in an elimination or dilution of gene pools adapted to specific conditions (Holland 1994); or these efforts can lead to disease transmission, either to the resident or translocated population.

The Northwest Forest Plan clearly will contribute to improvements in riparian systems and it is expected benefits to the turtle will be achieved where they exist on Federal land. However, because many turtles are found in low-lying areas, much of their range occurs on private lands not subject to the provisions of the Northwest Forest Plan; therefore, long-term protection measures on private lands will play a significant role in the conservation of this subspecies.

Status and distribution

Species

Numbers

The western pond turtle is declining in numbers throughout its range, with significant declines noted in the northern and southernmost portions (Holland 1991, 1994, Holland and Bury in press). Although the turtle was formerly widespread and abundant in many aquatic habitats on the west coast, it is now common in only a small fraction of its original range (Holland and Bury, in press). Many populations throughout its range contain a significantly higher proportion of adults to juveniles (Holland 1991, 1994; Reese 1996). Population levels and trends are difficult to determine with certainty for the following reasons: habitat use varies geographically; distribution within habitats varies within or between seasons; many populations are adult-dominated; and historical baseline populations for some areas are not available.

Population estimates for the northwestern subspecies are not available, but some estimates of population size are available for certain areas. For example, Holland (1991, 1994) estimates the total population in the state of Washington is only as high as 110 individuals, and the Willamette River drainage in Oregon contains between 1,500 and 2,400 individuals. Holland indicates the Willamette population represents a decline of 96 to 98 percent from levels conservatively estimated to be present in the late 1800's. In northern California, Reese (1996) estimates a population of 1,318 pond turtles in all 16 study reaches in the Trinity River system.

Distribution
The northwestern pond turtle ranges west of the Sierra/Cascade Crest, from approximately the American River in California, north to the vicinity of Puget Sound (Stebbins 1985). In some areas, disjunct and isolated populations are known to occur (Holland 1991). The taxon also includes three distinct evolutionary groups, based on morphological variation (Holland 1992, cited in Holland and Bury in press): Columbia River form; Puget Sound-Willamette River to central California form; and the central coast of California to Baja California form.

Most northwestern pond turtles occur in major river drainages such as the Klamath, Rogue, Umqua, Willamette, and Columbia River systems, but is uncommon or absent along the north and central coast of Oregon, and the north coast of California (Holland 1991, 1994). Dense, local concentrations may occur in slow moving streams, ponds, or shallow lakes, but in most areas the turtle is uncommon or occurs in clusters of individuals along segments of streams (Holland and Bury, in press).

Specific to northern California, Holland (1991) noted that northwestern pond turtles are widely distributed at low densities, primarily within lowland areas of the Klamath River and tributaries such as the Eel, Russian, Gualala, and Mad Rivers. Within this system, they are found in watercourses of all sizes, but are most abundant in small to medium-sized, shallow, warm streams. These tributaries contain up to a few hundred individuals with clusters of turtles more likely to occur inland from the coast. The Hayfork system may have several thousand individuals, a uniquely high population level (Holland, pers. comm., October 21, 1998). Along the northern Pacific coast, the northwestern pond turtle occurs in relatively low numbers in lower reaches of river drainages. Densities tend to increase inland along upper reaches which contain more suitable habitat elements (B. Bury, pers. comm., August 4, 1998, D. Holland, pers. comm., October 21, 1998).

Suitable habitat

Acreage, distribution, and quality
Data on the range-wide quantity, quality, or distribution of habitat are not available for the purpose of this consultation. Suitable aquatic habitat today, however, is currently highly fragmented and disjunct, compared to historic conditions in the subspecies' range. In some areas, Holland (1991) notes large areas of apparently suitable habitat that are unoccupied, which indicates that the increasing distances between suitable habitat areas are becoming an impediment to dispersal. In FEMAT (USDA Forest Service et al. 1993) table V-3 shows the 50-year declines in the frequency of large, deep pools (>50 square yards and > 6 feet deep) in selected river basins with initial surveys in 1935-40, and recent surveys in 1987-92. From that table we selected the seven rivers, with a total sample of 110.8 survey miles, in coastal Washington and Oregon for separate analysis. This subset was most similar to the action area in terms of climate, coastal location and land use history. Reductions in pool frequency (pools per stream mile) among the seven rivers diminished from zero to 94 percent in the 50-year period, with a weighted mean pool loss of 74.0 percent. Two of the seven rivers had less than a 50 percent reduction; and they accounted for only 14.7 percent of the total survey mileage.

<u>Tailed frog</u>

Species description

The tailed frog is endemic to cold, fast-flowing water in perennial, mostly non-fish-bearing, streams in the Pacific northwest (Welsh et al. 1993), and is the only North American frog highly specialized for life in cold, clear mountain streams (Nussbaum et al. 1983). Larvae range in size from 0.2 to 1.0 inches snout-vent length; adults range from 0.9 to 2.0 inches snout-vent length (Corkran and Thoms 1996). The tail-like appendages on males are the genitalia (Nussbaum et al. 1983). Larvae are fully aquatic. Adults are strongly aquatic, but are known to forage upland up to 100 yards from water during rainy periods (Noble and Putnam 1931).

Life history

(1) <u>Reproductive Potential</u>. The species has the longest larval period (2 to 4 years) and longest timespan to sexual maturity (7 years from hatching to breeding) of any North American frog species. Lifespan is estimated at 15 to 20 years (Daugherty and Shelton 1982a). However, Wallace and Diller (1996) have observed larvae that metamorphosed in 1 year in northwestern California. In coastal areas, females lay eggs annually; in inland areas they lay eggs every other year (Nussbaum et al. 1983). Metter (1964) reported clutch sizes of 37 eggs per female in coastal areas and 68 eggs per female in inland areas.

(2) <u>Habitat Specificity</u>. The tailed frog is associated with highly specialized habitat features. Welsh et al. (1993) identified eleven habitat attributes at three hierarchical scales: (a) landscape; (b) macrohabitat (adjacent land vegetation attributes), and (c) microhabitat (aquatic attributes). Landscape variables included (a1) latitudinal, (a2) longitudinal, and (a3) elevational limits that define the species range within the study area. Macrohabitat variables associated with frog presence are as follows (with mean, minimum and maximum observed levels for occupied habitat patches): (b1) mature to old-growth structure, with a mean stand age of 335 years (range 12 to 941 years); (b2) presence of large trees greater than 21 inches dbh with a mean of 34 trees-per-acre (range of 0 to 97 trees-per-acre); (b3) mean tree canopy closure is 86 percent (range 50 to 97 percent); and (b4) ground-level cover is a combination of low grass cover plus high cover percent of mosses, herbs, ferns and rock. Sites with suitable macrohabitat are very limited in size and isolated from other patches of suitable habitat.

Aquatic microhabitat variables associated with frog presence are as follows (with mean, minimum and maximum observed levels for occupied habitat patches): (c1) mixture of scour pools (mean 14 percent, range 0 to 44 percent cover), stream edge (mean 2.5 percent, range 0 to 12 percent) and stream run, or thalweg (mean 9.6 percent, range 0 to 34 percent) in perennial, cold water streams; (c2) coarse substrates are a mix of boulders (mean 15 percent, range 0 to 76 percent cover), gravel (mean 11 percent, range 2 to 24 percent) and decayed vegetation (mean 5 percent, range 0 to 20 percent); (c3) fine substrates are non-filamentous algae (mean 49 percent, range 2 to 88 percent), and moderate- to low- sediment embeddedness (mean 35 percent, range 5 to 95 percent); (c4) fast-moving streams (mean discharge 72.45 cubic feet per second, range 1.1 to 410.0 cubic feet per second), with mean channel width of 10.5 feet and a range of 2.6 to 36.3 feet. (c5) Water temperature was not measured by Welsh et al. (1993); the b2 and b3 variables above were used as surrogates, which correlate directly to riparian zone soil temperature and indirectly to adjacent water temperature. The species is known to have the narrowest thermal tolerances and lowest maximum temperature limits of any North American frog (Davidson 1993). Published thermal tolerances, measured in the field, by life stage are: eggs (41 to 65°F), larvae (up to 66°F), and adults (32 to 61°F), with incipient lethal temperatures for adults in the range of 74 to 75°F (reviewed in Davidson 1993). Several interactions among the presence variables, above, are also statistical predictors of abundance on occupied sites. Taken together, all the presence variables indicate a species for which sites with suitable macrohabitat are very limited in size and isolated from other patches of suitable habitat. The authors did not provide statistics for the mean area of suitable sites they evaluated, but they are mostly on the order of several square yards to several tens of square yards each (L. Ollivier, pers. comm., 1998).

(3) Dispersal and Site Fidelity. No information was available on larval dispersal. Adults are highly sedentary. Year-to-year mark-recapture data for adults show a statistically significant decrease in movement with increasing age. Annual movement rates were (males) 102 feet per year at age 5, declining to 31 feet at age 9; and (females) 154 feet per year at age 5, declining to 26 feet at age 11 (Daugherty and Shelton 1982b). Most of the movement (both sexes) was upstream. This movement pattern is consistent with a scenario of restricted gene flow and a highly fragmented population (Daugherty and Shelton 1982b).

(4) Population Structure. Tailed frogs live in highly subdivided populations and are considered a metapopulation (Welsh et al. 1998). Refer to the discussions above on dispersal, and below on genetic variability.

(5) Genetic Variability. Metter (1967) and Metter and Pauken (1969) report that tailed frogs exhibit a progressive reduction in gene flow between subpopulations that has probably been occurring throughout the last 10,000 years. They attribute this to climate warming since the last ice age, followed by a shrinking habitat base and progressive disjunction of subpopulations throughout the species range. Isolated sub-populations are highly susceptible to population decline and local extirpation due to "founder effects" and diminished intra-population genetic diversity. They are even more susceptible, at the genetic and population levels, to human-caused reductions in habitat. For a discussion of the implications of genetic variability in animal populations, see Allendorf and Leary (1986). For a discussion of how small populations and low gene variability interact in extinction processes see Gilpin and Soule (1986).

(6) Food Web Position. Nussbaum et al. (1983) identify Pacific giant salamanders (*Dicamptodon tenebrosus*) as common predators of tailed frogs. Aquatic microhabitat associations for the two species overlap (Welsh et al. 1993). Some of the habitat associations for tailed frog (e.g., sediment embeddedness) are considered a compromise between preferred attributes and predator avoidance strategies (Welsh et al. 1993). Dispersal capability of the tailed frog is probably constrained by predation.

Current legal status

Listing history

The species is currently identified as a species of special concern by the CDFG.

Current Known Range

Within the tailed frog's range in British Columbia, Washington and Oregon, it occurs in forested areas between the Cascade crest and the Pacific coast, as well as a disjunct population in the Blue Mountains. In Idaho it occurs in forested areas north of the Snake River. In Montana it occurs in forested areas west of the continental divide. In California, it occurs in forested areas in Del Norte, Humboldt, Siskiyou, Trinity, Shasta, Tehama, and Mendocino Counties (Zeiner et al. 1988, Nussbaum et al. 1983).

Threats

The primary threat to the tailed frog is the loss of suitable habitat, resulting in further fragmentation of an already subdivided population. Daugherty and Shelton (1982b) have reported that movement patterns indicate a fragmented population. Metter (1967) and Metter and Pauken (1969) have reported that the species is also genetically fragmented throughout its range. These attributes suggest that the species would have limited success in colonizing "unfilled" suitable habitats in an intensively managed forest environment. A comparison of presence/absence data between forest age classes by Welsh et al. (1993) indicates that this recolonization is limited. Progressive losses of habitat patches exacerbate the problem. With fewer suitable habitat patches available, average distance between patches becomes greater and eventually exceeds the dispersal capability of the species. Over time, disproportionately fewer patches are occupied.

The suitability of a habitat patch is a function of numerous physical attributes (outlined in the **Life history** section above), some with relatively narrow tolerances so degradation of any single attribute can cause a loss of the patch. Below are some proposed mechanisms for habitat loss.

(1) Loss of stream channel features: This species is highly dependent on coarse streambed substrates (e.g., rock, cobble, and especially boulders and gravel). In functional channel morphological processes, these substrates are collected largely by instream blockages caused by downed trees. Over time these coarse substrate features are lost due to, for example, decomposition and abrasion of the downed wood, or sedimentation, or flood scouring. Recruitment levels of instream coarse woody debris (CWD) must be sufficient to replace these substrate features at a rate greater than, or equal to, the rate at which they are lost (Sedell et al. 1988, Welsh et al. 1998). CWD depletion in upland riparian areas can interrupt this feature-forming process and cause long term declines in suitable habitats downstream.

(2) Obliteration by debris flows: Habitat patches are obliterated directly and entirely by debris flows from mass failures upslope (L. Ollivier, pers. comm., 1998).

(3) Sediment infusion: Habitat utility can be lost, almost immediately, by fine sediment infusions. Welsh and Ollivier (1998) found marked (and highly significant) reductions in tailed frog larvae in streams recently impacted with sediments. They concluded that the suspended sediment scoured

freshwater diatoms from the rocky substrate and eliminated the primary food source for grazing tailed frog larvae. Sediments fill interstitial spaces in the coarse substrates and obliterate rearing habitat for larvae (Welsh et al. 1998), even though the high-velocity stream features they use (step-runs and riffles) are more resistant to sediment accumulation (Welsh and Ollivier 1998). Intensive timber harvesting combined with inadequate riparian protection upstream will threaten any downstream habitat patches.

(4) Degradation of microclimate: Favorable conditions of air temperature and humidity in streamside areas can be disrupted by losses of adjacent forest canopy cover. Tailed frogs have a low tolerance (Welsh et al. 1993) for canopy closures of less than around 80 percent (as measured by spherical densiometer).

(5) Degradation of water temperature: The tailed frog has the narrowest thermal tolerances and the lowest maximum temperature levels of any North American frog species (reviewed in Davidson 1993). Warm water infusions that may result from harvesting, or other disturbances, combined with inadequate riparian protection in upstream reaches may negate the suitability of a habitat patch that is suitable in every other respect.

Conservation Needs

(1) Long-term maintenance of favorable recruitment levels of instream CWD. This is needed to maintain desired channel morphological processes in which new coarse substrate features are created, over time, to replace those lost to sedimentation and/or the decomposition and weathering of existing reservoirs of instream CWD (see Threats, item 1).

(2) Mass-wasting prevention measures, including limitations on harvest around headwalls, inner gorges and unstable areas, and where mass wasting hazard is high to extreme (see Threats, item 2).

(3) The sediment storage capability of all streams (perennial, intermittent, ephemeral, fish-bearing and non-fish-bearing) must be maintained at favorable levels in perpetuity by maintaining adequate CWD recruitment sources in riparian areas. Road management (construction, use limits, repair, and upgrades) should be geared to minimize sediment runoff (see Threats, item 3).

(4) Maintenance of favorable levels of canopy closure in riparian management zones (see Threats, item 4).

(5) Maintenance of favorable water temperatures, not only in stream reaches where suitable habitats are found (mostly Class II reaches), but upstream as well in all potential warm water source areas (see Threats, item 5).

Status and distribution

Species

Numbers

No range-wide census data are available for this species.

Distribution
Populations are known to be highly subdivided due to specialized habitat associations and other population and community-level factors (see Metter 1967, Metter and Pauken 1969, Daugherty and Shelton 1982b, Corn and Bury 1989, Welsh et al. 1993, Welsh et al. 1998). There is strong converging evidence among various studies that, in the absence of significant mitigation measures, intensive land management practices are exacerbating the fragmentation of populations.

Reproduction
No range-wide reproductive data are available for this species, but see the discussion on reproductive potential in the **Life history** section, above.

Suitable Habitat
Suitable stream habitats are found in montane forestlands of western and north-central Oregon, western and south-central Washington, western British Columbia, northern Idaho, western Montana and northwestern California (Stebbins 1985, Corkran and Thoms 1996), comprising approximately 33.46 million acres (52,286 square miles). Under the FEMAT (USDA Forest Service et al. 1993) analysis, approximately 56 percent (18.74 million acres, or 29,280 square miles) of the species range is on Federal land. Twenty-four percent of the Federal land (4.5 million acres, or 7,027 square miles) is matrix; seven percent (1.31 million acres, or 2,050 square miles) is in Adaptive Management Areas; the remainder (23.09 million acres, or 36,077 square miles) is in reserved or withdrawn status.

Acreage, Distribution and Quality of Habitat
No range-wide data are available on quantities, distribution and quality of suitable habitat patches. However, FEMAT (USDA Forest Service et al. 1993) notes that ranges of numerous aquatic and forest floor amphibian species in the Pacific northwest have been reduced.

Southern torrent salamander

Species description Four separate torrent salamander species (including the southern torrent salamander) are currently recognized (Good and Wake 1992) that were formerly classified as Olympic salamander (*Rhyacotriton olympicus*). All four torrent salamander species are characterized by their small adult size (1.2 to 2.2 inches snout-vent length) (Corkran and Thoms 1996), extended juvenile life stage, and highly specific habitat associations (Welsh and Lind 1996). Larvae are fully aquatic, adults are semi-aquatic and both are highly sedentary.

Life history
Several population-level and community-level factors probably contribute to this species' apparent vulnerability. These include reproductive potential (see 1, below), site fidelity (see 3, below), specialization and insularization of habitats (see 2 and 4, below), spatial and genetic structure of populations (see 4 and 5 below), and food web niche (see 6, below). Major issues of concern at the population and community levels are: (a) the apparent vulnerability of this species and its

habitats to intensified forest management regimes; and (b) the limited ability of this species to exploit available and suitable habitats in an intensively managed forest landscape.

(1) Reproductive Potential. Embryos (eggs) require approximately one year to hatch. Aquatic larvae require 3.0 to 3.5 years to metamorphose. Metamorphosed subadults require an additional 1.0 to 1.5 years to reach sexual maturity (Nussbaum and Tait 1977). The total time span from conception to sexual maturity is 5.0 to 6.0 years. Total lifespan is not known. Behler and King (1979) and Good and Wake (1992) report clutch sizes of 2 to15 eggs. However, Welsh and Lind (1992) found clutch sizes of only 2 and 6 eggs in the two gravid females they captured in a population study in northwestern California. Juvenile-to-adult ratios ranged from 4 to 1 in the spring to 7 to1 in the fall (Welsh and Lind 1992), though it should be recognized that the juvenile cohorts, at any given time, represent three years of reproductive effort. Suitable habitats for the southern torrent salamander are frequently unoccupied. Occupancy rates on suitable habitats can range from almost 80 percent in relatively pristine parklands to less than 20 percent on intensively managed timberlands (Welsh et al. 1998).

(2) Habitat Specificity. Welsh and Lind (1996) developed a habitat association model for this species and identified thirteen variables at three hierarchical scales: (a) landscape, (b) macrohabitat (adjacent land vegetation attributes), and (c) microhabitat (aquatic attributes). Landscape variables included (a1) latitudinal, (a2) longitudinal and (a3) elevational limits that define the species range within the study area. Macrohabitat variables associated with salamander presence, and their threshold (minimum) levels, are as follows (ranges, when given, are at the 95 percent confidence level): (b1) vegetation series is Douglas-fir or redwood dominated forest; (b2) seral stage is mature to old-growth structure, except coastal areas; (b3) large trees, range from 9 to 15 trees per acre, or more, greater than 21 inches dbh; (b4) total tree canopy closure is 83 to 95 percent; and (b5) ground-level cover is a combination of low numbers of stumps plus low cover percent of grasses plus high cover percent of mosses. Because of the number of correlated habitat features, occupied habitat patches are very limited in size and isolated from other patches of suitable habitat, ranging from a few square yards in extent to several tens of square yards (L. Ollivier, pers. comm., 1998). Microhabitat variables are as follows (ranges are also at the 95 percent confidence level, except water temperature): (c1) aquatic types are cold-water springs and seeps along first-through-third order streams (roughly equivalent to middle and upper reaches of Class II streams); (c2) coarse substrates are cobble mixed with pebble and gravel (25 to 36 percent surface coverage); (c3) fine substrates are sand and other fine particles mixed with organic material (18 to 33 percent surface coverage); (c4) aquatic condition is shallow, slow-flowing stream or seepage with cold, clear water; and (c5) water temperature is in the range of 15.0 to 43.7 °F. Taken together, all of the thirteen variables were found to be reliable predictors of presence, and two microhabitat variables (coarse substrates and fine substrates) were found to be correlated with abundance on occupied sites.

(3) Dispersal and Site Fidelity. The species is highly sedentary, but larvae are significantly more mobile than adults. Mark-recapture data show that larvae move an average of 0.6 to 7.0 feet per year between captures; and adults move 0.3 to 3.3 feet per year. The directions of larval

movement are downstream (52 percent of all observations), upstream (32 percent) and stationary (16 percent); while the directions of adult movement are upstream (50 percent), downstream (38 percent) and stationary (13 percent) (Welsh and Lind 1992). The data suggest that larval dispersal is the most likely means of gene flow between local populations. However, since extant populations are highly subdivided and insularized, it is probable that significant dispersal events are episodic and only occur during the rainy season, when habitats are more interconnected by high water (Welsh and Lind 1992).

(4) Population Structure. Southern torrent salamanders live in highly subdivided populations and are considered a metapopulation. Welsh and Lind (1992) examined the frequency of suitable habitats, and the frequency of occupied habitats, throughout the species range in northwestern California. They located suitable microhabitats at a rate of 0.18 microhabitat sites per stream mile and occupied suitable microhabitats at a rate of 0.11 occupied habitat areas per stream mile.

(5) Genetic Variability. Good and Wake (1992) report that torrent salamanders exhibit some of the highest inter-population genetic diversity ever observed between proximate populations of a vertebrate species. Taken with the population structure studies in (4) above, Welsh et al. (1998) suggest that fragmentation and isolation have long been part of their evolutionary history. However, small, isolated sub-populations are highly susceptible to population decline and local extirpation due to "founder effects" and diminished intra-population genetic diversity. For a discussion of the implications of genetic variability in animal populations, see Allendorf and Leary (1986). For a discussion of how small populations and low gene variability interact in extinction processes, see Gilpin and Soule (1986).

(6) Food Web Position. Nussbaum et al. (1983) identify Pacific giant salamanders as common predators of southern torrent salamanders. Both species are proximate and have an affinity for cold, highly oxygenated water, but the giant salamander is much more a habitat generalist and readily uses forest floor habitat. However, little overlap exists in aquatic microhabitats between the two species. The giant salamander is mostly associated with intermixed cobble, gravel and woody debris substrates (using the latter for stalking cover), where the torrent salamander is found in intermixed cobble, gravel and sand substrates with no woody debris (Welsh and Ollivier 1998). The authors suggest that this habitat partitioning may be part of a predator-avoidance strategy by torrent salamanders. If true, this places severe constraints on the ability of southern torrent salamanders to emigrate out of degraded habitat patches in search of unoccupied suitable habitats.

Current legal status

Listing history

The species is currently identified by CDFG as a species of special concern. Listing petitions have been submitted to the State and the FWS. The CDFG has recommended against State listing (Brode 1995). The FWS, in their 90-day petition finding, concluded there was substantial evidence indicating that listing may be warranted. The agency initiated a 12-month status review which was delayed by the listing moratorium, and is now in progress (USDI Fish and Wildlife Service 1995d).

Current Known Range

The current known range is as follows: in Oregon is from the southern fringe of Tillamook County (northern extent of range), southward through Lincoln, Benton, Lane, Douglas, Coos and Curry Counties (Corkran and Thoms 1996, Nussbaum et al. 1983, Stebbins 1985); and in California through all of Del Norte and Humboldt counties, the western fringes of Siskiyou and Trinity Counties, and the northwestern two-fifths of Mendocino County (southern extent of range) (Zeiner et al. 1988, Brode et al. 1997).

Threats

The primary threat to the species is the loss of suitable habitat localities, resulting in further fragmentation of an already subdivided population. Suitable habitat patches are small (on the order of a few square yards each), and widely dispersed (0.18 patches per stream mile in one estimate by Welsh and Lind 1992). Interactions between subpopulations are apparently very weak as indicated by movement data (3.3 to 7.3 feet per year for adults and larvae, respectively) from Welsh and Lind (1992) and by gene distributions that indicate a long history of isolation of subpopulations throughout the species range. Good and Wake (1992) report low variability within subpopulations combined with high variability between subpopulations. These population-level attributes suggest that the species would have limited success in colonizing "unfilled" suitable habitats, which is corroborated by the field observations of Welsh and Lind, 1992. Progressive losses of habitat patches exacerbate the problem through the following proposed mechanisms: fewer suitable habitat patches are available, average distance between patches becomes greater and exceeds the dispersal capability of the salamander, and, over time, disproportionately fewer patches are occupied (Welsh et al. 1998).

The southern torrent salamander has a highly subdivided population, low dispersal capability, and (apparently) a relatively low reproductive potential. One generalization about this set of attributes is that the species is highly susceptible to further fragmentation of its habitat and population. As habitat patches are lost and remaining patches become isolated, it becomes increasingly difficult for sedentary species to recolonize unoccupied patches of suitable habitat (see Wiens, 1996; Hanski, 1997).

Welsh et al. (1998) provide a test of this prediction by comparing four "presence/absence" data sets on suitable habitats in northern California. The four databases were: (a) a systematic sample of public and private forestlands in Humboldt, Trinity and Del Norte Counties used in Welsh and Lind (1996); (b) reserves and parklands in Mendocino County (Welsh, 1990); and (c) & (d) private industrial timberlands in the Mattole River watershed of Humboldt County (Welsh and Hodgson, unpublished data, reviewed in Welsh et al. 1998) and throughout Mendocino County (unpublished reports from landowners). The results are shown as the percentage of suitable sites that are occupied, and are as follows: Systematic Sample – 62.3 percent (n = 53); Mendocino Reserves – 76.9 percent (n = 13); Mattole Industry Land – 29.0 percent (n = 31); and Mendocino

Industry Land – 18.9 percent (n = 53). The results are consistent with the test prediction; reserved lands have the highest occupancy rates, intensively managed lands have the lowest, and the systematic sample of public and private lands have an intermediate rate greater than the mean. Q-test results showed that all differences were statistically significant (Welsh et al. 1998).

The suitability of a habitat patch is a function of numerous physical attributes (see the **Life history** section for this species), some with relatively narrow tolerances so degradation of any single attribute can cause a loss of the patch. Five mechanisms for habitat loss are proposed and are discussed more fully under the corresponding section on the tailed frog. They are: (1) loss of stream channel features; (2) obliteration by debris flows; (3) sediment infusion; (4) degradation of microclimate; and (5) degradation of water temperature.

Conservation Needs

Five conservation needs, related to the five mechanisms for habitat loss are listed below (also see the corresponding discussion on the tailed frog). They are: (1) long-term maintenance of favorable recruitment levels of instream CWD; (2) prevention or minimization of mass wasting events; (3) maintenance of sediment storage capability of all streams; (4) maintenance of favorable levels of canopy closure in riparian management zones; and (5) maintenance of favorable water temperatures, in suitable habitat areas and in potential warm water sources upstream.

Status and distribution

Species

Numbers

No range-wide census data are available for this species.

Distribution

Populations are known to be highly subdivided due to specialized habitat associations and other population and community-level factors, but this inference is based on localized studies (e.g., Corn and Bury 1989, Welsh 1990, Welsh and Lind 1992). There is strong converging evidence among various studies that, in the absence of significant mitigation measures, intensive land management practices are exacerbating the fragmentation of populations.

Another hypothesis for low rates of habitat occupancy (by the southern torrent salamander) has been proposed by Diller and Wallace (1996); that the species is associated with steep-gradient streams. However, the same stream survey at Prairie Creek Redwoods State Park, cited by Welsh, et al. (1998) and described in the tailed frog discussion, also included experimental controls for stream gradient, and revealed no correlation with salamander abundance or presence. Again, the FWS gives greater weight to the alternative explanations (Welsh, et al., 1998) that steep gradients and consolidated parent geology are more resistant to perturbation, so if the species is found predominantly on these sites, then it is an indication that suitable habitat is being lost on the more vulnerable low-gradient and unstable stream reaches. Further support for this interpretation was found in Corn and Bury (1989) who studied southern torrent salamander distribution in harvested and unharvested stream reaches in the Oregon Coast Range. They found that salamander presence was restricted to steep gradients only on the harvested reaches, but found no correlation of gradient and presence on the unharvested reaches.

Reproduction
No range-wide reproductive data are available for this species, but see the discussion on reproductive potential in the **Life history** section, above.

Suitable Habitat
Suitable stream habitats are found in montane forestlands of western Oregon and northwestern California, comprising approximately 10.45 million acres (16,325 square miles). According to the FEMAT (USDA Forest Service et al. 1993) analysis, approximately 37 percent (3.87 million acres, or 6,040 square miles) of the species range is on Federal land. Twenty-five percent of the Federal land (0.97 million acres, or 1,510 square miles) is matrix; six percent (0.23 million acres, or 362 square miles) is in Adaptive Management Areas; and the remainder (2.67 million acres, or 4,168 square miles) is in reserved or withdrawn status.

Acreage, Distribution and Quality of Habitat
No range-wide data are available on quantities, distribution and quality of suitable habitat patches. However, FEMAT (USDA Forest Service et al. 1993) notes that ranges of numerous aquatic and forest floor amphibian species in the Pacific northwest have been reduced.

Northern California ESU steelhead

Species description
The steelhead is a salmonid native to the Pacific drainages of North America and Asia. It is the anadromous form of the rainbow trout (also called "redband" or "golden"), but its ocean-going behavior differentiates steelhead from the resident form of *O. mykiss*. Steelhead also attain a larger size (more than 30 pounds) than rainbow trout. In coastal populations, it is unusual for the two forms (steelhead and rainbow) to coexist; they are usually separated by a migration barrier. In inland populations, co-occurrence of the two forms appears to be more common (Busby et al. 1996). Steelhead are heavily spotted with irregularly shaped spots both above and below the lateral line (Behnke 1992). They are presently distributed from the mouth of Malibu Creek, California, north and west along the Pacific coast to the Kamchatka Peninsula. In some years, steelhead may be found as far south as the Santa Margarita River, in San Diego County (McEwan and Jackson 1996). Historically, steelhead were distributed throughout the North Pacific Ocean from the Kamchatka Peninsula in Asia to the northern Baja Peninsula in North America. However, during this century, over 23 indigenous, naturally reproducing stocks of steelhead are believed to have been extirpated, and many more are thought to be in decline in coastal and inland streams in Washington, Oregon, Idaho, and California. The steelhead status review (Busby et al. 1996) identified 15 distinct ESUs in these four states. The action area is within the Northern California ESU.

Life History

General life history information for steelhead is summarized below. Further detailed information is available in the status review of West Coast steelhead from Washington, Idaho Oregon, and California (Busby et al. 1996), the NMFS proposed rule for listing steelhead (61 FR 41541), the NMFS status review for Klamath Mountains Province steelhead (Busby et al. 1994), the NMFS final rule listing the Southern California Coast, South Central California Coast, and the Central California Coast ESUs (62 FR 43937), and the NMFS final rule listing the Lower Columbia River and Central Valley ESUs (63 FR 13347).

Biologically, steelhead can be divided into two reproductive ecotypes, based on their state of sexual maturity at the time of fresh water entry and the duration of their spawning migration. Stream maturing, commonly called summer steelhead, enter fresh water in a sexually immature condition and require several months to mature before spawning. Ocean maturing, or winter steelhead, enter fresh water in a sexually mature state and spawn soon after river entry. The most widespread run type of steelhead is the winter (ocean maturing) steelhead, while summer (stream maturing) steelhead (including spring and fall steelhead in southern Oregon and northern California) are less common. South of Cape Blanco, Oregon, summer steelhead are known to occur in the Rogue, Smith, Klamath, Trinity, Mad, and Eel Rivers, and in Redwood Creek (Busby et al. 1996).

Summer steelhead enter fresh water between May and October in the Pacific Northwest (Busby et al. 1996). They require cool, deep holding pools during summer and fall, prior to spawning (Nickelson et al. 1992). Summer steelhead migrate inland toward spawning areas, overwinter in the larger rivers, they resume migration in early spring to natal streams where they spawn (Meehan and Bjornn 1991; Nickelson et al. 1992). In contrast, winter steelhead enter freshwater between November and April in the Pacific Northwest (Busby et al. 1996), migrate to spawning areas, and spawn in late winter or spring (Nickelson et al. 1992). Some winter steelhead adults do not enter coastal streams until spring, just before spawning (Meehan and Bjornn 1991).

There is a high degree of overlap in spawn timing between populations, regardless of run-type (Busby et al. 1996). California steelhead generally spawn earlier than steelhead in northern areas. Both summer and winter steelhead in California generally begin spawning in December, whereas most populations in Washington begin spawning in February or March. Among inland steelhead populations, Columbia River populations from tributaries upstream of the Yakima River spawn later than most downstream populations.

The timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. Unusual stream temperatures during spawning migration periods can alter or delay migration timing, accelerate or retard mutations, and increase fish susceptibility to diseases. The minimum stream depth necessary for successful upstream migration is seven inches (Thompson 1972, cited in Bjornn and Reiser 1991). Reiser and Bjornn (1979) indicated that steelhead preferred a depth of 9.5 inches or more. The maximum velocity, beyond which upstream migration is not likely to occur, is 8.0 cubic feet per second (Thompson 1972, cited in Bjornn and Reiser 1991).

Steelhead may spawn more than once before dying, in contrast to other species of the *Oncorhynchus* genus. It is relatively uncommon for steelhead populations north of Oregon to have repeat spawning, and more than two spawning migrations is rare. In Oregon and California, the frequency of two spawning migrations is higher, but more than two is unusual.

Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity. Intermittent streams may be used for spawning (Barnhart 1986, Everest 1973). Reiser and Bjornn (1979) found that steelhead preferred gravels of 0.5 to 4.7 inches in diameter and Smith (1973) found that flows of approximately 1.3 to 3.0 cubic feet per second were preferred by steelhead. The survival of embryos is reduced when fines of less than 0.25 inches (6.4 mm) comprise 20 to 25 percent of the substrate. Studies have shown a higher survival of embryos when intragravel velocities exceed 20 cm/hour (0.00018 ft/sec) (Phillips and Campbell 1961, Coble 1961). Steelhead eggs generally incubate between February and June (Bell 1991). The number of days required for steelhead eggs to hatch varies from about 19 days at an average temperature of 60°F to about 80 days at an average of 42°F. Fry typically emerge from the gravel two to three weeks after hatching (Barnhart 1986).

After emergence, steelhead fry usually inhabit shallow water along perennial stream banks. Older fry establish territories which they defend. Streamside vegetation and cover are essential. Steelhead juveniles are usually associated with the bottom of the stream. In smaller California streams, the water levels may drop so low during the summer that pools are the only viable rearing habitat. No passage between pools can occur until river levels rise with the onset of the rainy season. Juvenile steelhead rearing in isolated summer pools are therefore extremely vulnerable to disturbance or water quality impacts. Daytime temperatures in summer rearing pools may also be near lethal levels; riparian shading and the presence of sub-surface, cold water seeps are often essential to maintain pool temperatures at tolerable levels. In winter, juvenile steelhead become inactive and hide using any available cover, including gravel or woody debris.

Juvenile steelhead migrate little during their first summer and occupy a range of habitats featuring moderate to high velocity flows and variable depths (Bisson et al. 1988). They feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. Water temperatures influence the growth rate, population density, swimming ability, ability to capture and metabolize food, and ability to withstand disease of these rearing juveniles. Rearing steelhead juveniles prefer water temperatures of 45° to 58°F and have an upper lethal limit of 75°F.

Dissolved oxygen (DO) levels of 6.5 to 7.0 parts per million affected the migration and swimming performance of steelhead juveniles at all temperatures (Davis et. al. 1963). Reiser and Bjornn (1979) recommended that DO concentrations remain at or near saturation levels with temporary reductions no lower than 5.0 parts per million for successful rearing of juvenile steelhead. Low DO levels decrease the rate of metabolism, swimming speed, growth rate, food consumption rate, efficiency of food utilization, behavior, and ultimately the survival of the juveniles.

During rearing, suspended and deposited fine sediments can directly affect salmoides by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). Bell (1973) found that silt loads of less than 25 parts per million permit good rearing conditions for juvenile salmoides.

Juvenile steelhead live in freshwater between one and four years (usually one to two years in the Pacific Southwest) and then become smolts and migrate to the sea from November through May with peaks in March, April, and May. The smolts can range from 5.5 to 8.0 inches in length. Steelhead spend between one and four years in the ocean (usually two years in the Pacific Southwest) (Barnhart 1986), but variations on this pattern do occur (Busby et al. 1996). Some steelhead, termed "half-pounders," return to freshwater after only a few months at sea. Half-pounders generally spend the winter in fresh water then return to sea for several months before returning to fresh water to spawn. Half-pounders occur over a relatively small geographic range in southern Oregon and northern California, including the Rogue, Klamath, Mad and Eel Rivers (Kesner and Barnhart 1972, Barnhart 1986).

Except for half-pounders, West Coast steelhead typically spend two years in the ocean before entering freshwater to spawn. The distribution of steelhead in the ocean is not well known. Coded wire tag recoveries indicate that most steelhead tend to migrate north and south along the Continental Shelf (Barnhart 1986). Steelhead stocks from the Klamath and Rogue rivers probably mix together in a nearshore ocean staging area along the northern California before they migrate upriver (Everest 1973).

Current Legal Status

Listing history

The NMFS has received numerous petitions regarding the listing of West Coast steelhead. The most comprehensive petition was submitted by the Oregon Natural Resources Council and 15 co-petitioners.(Oregon Natural Resources Council et al. 1994). In response to this petition, the NMFS established a Biological Review Team that conducted a coast-wide status review for West Coast steelhead (Busby et al. 1996). The status review identified 15 steelhead ESUs, including the Northern California ESU. Based on the results of the status review and other information, NMFS published a proposed listing determination on August 9, 1996 (61 FR 56138), proposing to list 10 ESUs in California, Oregon, Washington, and Idaho as threatened or endangered. The Northern California ESU was proposed as threatened. This ESU includes populations of steelhead between Redwood Creek in Humboldt County to the Gualala River in Sonoma and Mendocino Counties.

In a final rule published on March 19, 1998 (63 FR 13347), the NMFS determined that the Northern California ESU did not warrant listing at that time. This ESU is currently classified as a candidate species.

Threats

General threats identified in the proposed rule (61 FR 56138) include destruction and modification of habitat, overutilization for recreational purposes, and natural and human made factors. Forestry, agriculture, mining, and urbanization degrade, simplify, and fragment habitat. Water diversions and dams greatly reduce or eliminate historically accessible habitat. Sedimentation from land use activities is a primary cause of habitat degradation. The introduction of non-native species increases the level of predation. Predation by marine mammals was also identified as a concern in the proposed rule, but this was considered to be insignificant contributing factor to current declines. The NMFS (1997) has recently determined that although pinniped predation did not cause the decline of the chinook salmon populations, in localized areas where they co-occur with chinook salmon (especially where they concentrate or passage may be constricted), predation may preclude recovery. Specific areas where predation is/may preclude recovery cannot be determined without extensive studies. Natural climatic conditions may exacerbate existing habitat problems by affecting already limited spawning, rearing, and migration habitat and causing reduced ocean productivity. Hatchery programs also can threaten steelhead through competition, genetic introgression, and disease transmission.

The status review (Busby et al. 1996) specifically identified threats to the Northern California ESU. Habitat deterioration from sedimentation and flooding, apparently resulting in part from poor land management practices, was identified as a concern. Sacramento squawfish introduced in the Eel River was also noted as a possible threat. The influence of hatchery stocks, particularly in the Mad River, was considered to be a threat, both in terms of genetic introgression and of potential ecological interactions between native and introduced stocks.

Conservation needs

Although the steelhead Northern California ESU is currently a candidate species, NMFS remains concerned about the status of steelhead in this area. According to the final rule (63 FR 13347), the status of this ESU will be reevaluated in four years to determine whether listing is warranted. In the interim, the conservation needs of coastal cutthroat trout are similar to those identified for coho salmon, above.

Status and Distribution

The Northern California steelhead ESU occupies river basins from Redwood Creek in Humboldt County, California to the Gualala River, Sonoma and Mendocino Counties. Steelhead within this ESU include both winter and summer steelhead, including what is presently considered to be the southernmost population of summer steelhead, in the Middle Fork Eel River. The status review (Busby et al. 1996) noted the occurrence of half-pounder juveniles in the Mad and Eel Rivers, although Cramer et al. (1995) suggest that adults with the half-pounder life history may not spawn south of the Klamath River Basin. Several of the larger rivers in this area, including the Rogue and Klamath Rivers, are known to have migrating steelhead year-round, and seasonal runs have been identified.

Higgins et al. (1992) identified 11 summer steelhead stocks as being at risk or concern in this area. The FWS (1993) identified most stocks on U.S. Forest Service lands in this region as either depressed or critical, with only the Little Van Duzen River winter steelhead identified as stable. The status review (Busby et al. 1996) provides a detailed discussion of historical (pre-1960s) abundance of steelhead in the Northern California ESU. Based on dam counts, in the upper Eel River there was an annual average of 4,400 adult steelhead in the 1930s at Cape Horn Dam, Benbow Dam on the South Fork Eel River had an annual average of 19,000 adult steelhead in the 1940s (McEwan and Jackson 1996), and Sweasey Dam on the Mad River had an annual average of 3,800 adult steelhead in the 1940s (Murphy and Shapovalov 1951, CDFG 1994). The following discussion and description of historic abundance of the northern California ESU is excerpted from the status review (Busby et al. 1996).

In the mid-1960s, CDFG (1965) estimates of steelhead spawning populations for many rivers in this ESU totaled 198,000, broken down as follows: Redwood Creek, 10,000; Mad River 6,000; Eel River, 82,000; Mattole River, 12,000; Ten Mile River, 9,000; Noyo River, 8,000; Big River, 12,000; Navarro River, 16,000; Garcia River, 4,000; Gualala River, 16,000; and other streams (Humboldt and Mendocino Counties), 23,000. Light (1987) estimated the total run size for all major stocks in California (entire state) in the early 1980s as approximately 275,000. Of these, 22 percent were of hatchery origin, resulting in a naturally-produced run size of 215,000 steelhead for the entire state. Roughly half of this production was thought to be in the Klamath River Basin (including the Trinity River). The only current run-size estimates for this area are dam counts on the Eel River (Cape Horn Dam 115 total and 30 "wild" adults; McEwan and Jackson 1996), and summer steelhead snorkel surveys in a few tributaries that provide no total abundance estimate. Statewide adult summer steelhead abundance is estimated at about 2,000 adults (McEwan and Jackson 1996), but this estimate may refer only to early-summer steelhead entering the rivers in May, June and July, and not include the more numerous "fall-run" steelhead. While the status review (Busby et al. 1996) did not provide an overall recent estimate of abundance for this ESU, the authors interpreted the substantial declines in run sizes from historic levels at major dams in the region to be indicative of a probable overall decline in abundance from historical levels.

The status review identified two habitat blockages from dams in this ESU (Matthews Dam on the Mad River and Scott Dam on the Eel River, McEwan and Jackson 1996), and speculated that other minor blockages (impassable culverts, etc.) were likely throughout the region. Habitats throughout the northern coast of California were severely impacted by catastrophic flooding in 1964, and damages from this flooding were likely exacerbated by poor land us practices prior to this event (McEwan and Jackson 1996).

Forest practices have also contributed to the incremental degradation of stream habitats (Higgins et al. 1992, McEwan and Jackson 1996) and excessive sedimentation and unstable spawning gravels have been cited as major habitat problems (CDFG 1991, Higgins et al. 1992).

A high abundance of non-native Sacramento squawfish (*Ptychocheilus grandis*) have been reported recently in the Eel River Basin (Brown and Moyle 1991, Moyle and Yoshiyama 1992), suggesting increased risks of predation on juvenile steelhead.

The status review provides a computation of trends for seven stocks within the northern California steelhead ESU based on adult escapement information. Of these seven, five stocks were found to exhibit declines and two stocks suggested increase over the available data series, (ranging from a 5.8 percent annual decline to a 3.5 percent annual increase). Three (all decreasing) of these trends were significantly different from zero (see Appendix C, status review). Analysis of one long data set representing counts from the Eel River and Cape Horn Dams, suggested that the major, and more significant, stock declines occurred prior to 1970.

Hatchery fish are widespread within this ESU and are reported to spawn naturally throughout the region. Past and present hatchery practices present a major threat to the genetic integrity for steelhead in this ESU. The status review cites McEwan and Jackson (1996), as concluding "despite the large number of hatchery smolts released, steelhead runs in north coast drainages are comprised mostly of naturally produces fish." However, very little information was available to the BRT on the actual contribution of hatchery fish to natural spawning, or present total run sizes for this ESU.

The primary steelhead hatchery within the range of this ESU is Mad River Hatchery, established in 1971 by CDFG for fishery enhancement reasons (McEwan and Jackson 1996). The Mad River Hatchery winter steelhead stock was founded with steelhead eggs from the Eel River and the San Lorenzo River and is reviewed by Cramer et al (1995). Eel River steelhead eggs are still being transferred to the Mad River hatchery for rearing and subsequent release back into the Eel River. CDFG (1994) estimates that approximately 233,000 juvenile steelhead of various stock origins are released annually into Mad River. Cramer et al. (1995) estimates that all other basins in this area together receive about 75,000 steelhead per year, for a total annual hatchery release of at least 404,000 steelhead within the range of the northern California steelhead ESU (Busby et al. 1996)

<u>**Southern Oregon/California Coasts ESU coastal cutthroat trout**</u>

Species description

The coastal cutthroat trout is one of 14 extant subspecies of cutthroat trout distributed throughout western North America. The cutthroat trout was historically one of the most broadly distributed salmoides in western North America. They were found in many lakes and streams throughout the coastal and interior American west as far east as the Rio Grande drainage (Rio Grande cutthroat trout) and the eastern slope of the Rocky Mountains (Yellowstone and greenback cutthroat trout). Approximately one million years ago, cutthroat trout are believed to have diverged into a coastal group with 68 or 70 chromosomes and an interior group (Westslope cutthroat trout) with a 66 chromosome set. While the interior group continued to diverge into a 64 chromosome set (Lahontan and Yellowstone cutthroat trout, and more recent "minor" subspecies), the coastal cutthroat trout has remained essentially intact. Further discussion about the evolution and systematics of cutthroat trout can be found in Behnke (1992).

Coastal cutthroat trout differ from other cutthroat trout not only in its chromosome set but in its diverse life history. It is the only cutthroat subspecies with an anadromous form. Coastal cutthroat trout range from Prince William Sound, Alaska, south to the lower Eel River, California. Inland, the subspecies' range rarely extends farther than 100 miles and is usually less than 62 miles. In California, Oregon, and Washington, eastern distribution is limited by the Cascade Mountains. Coastal cutthroat trout belong to the same genus as Pacific salmon and steelhead, but are generally smaller. In freshwater, coastal cutthroat can be distinguished by a bright red slash under the jaw and dark, irregular spots over the entire body. Coastal cutthroat trout are believed to have the healthiest populations of all the cutthroat trout, as they have experienced the least habitat destruction, hybridization, or over fishing (reviewed in Pauley et al. 1989, Trotter 1989, and Trotter et al. 1993). Nevertheless, the AFS Endangered Species Committee identified all populations of anadromous cutthroat trout as being at some risk of extinction (Nehlsen et al. 1991).

Life History

General life history information on coastal cutthroat trout is summarized below. Further information on this species can be found in Hall et al. (1997), and the petition to list sea-run (coastal) cutthroat trout (Oregon Natural Resources Council et al. 1997). Information for this discussion was also taken from the Status review of Coastal Cutthroat Trout from Washington, Oregon, and California" (Johnson et al. 1999).

The life history of coastal cutthroat trout may be the most complex of any Pacific salmonid (Northcote 1997). Coastal cutthroat trout exhibit a range in the timing of life-history events such as migrations and spawning. Furthermore, coastal cutthroat trout are mostly iteroparous, spawning three to five times during their life cycle. Finally, many populations have both migratory and nonmigratory fluvial and lacustrine populations as well as anadromous forms. All populations with access to the ocean are believed to have anadromous members, but not all members migrate to the sea every year (reviewed in Trotter 1997).

Johnson et al. (1999) identified four life history forms based on migratory behavior: anadromous (sea-run or coastal-type), resident (non-migratory or "cascade"), potamodromous (river-migrating or fluvial), and adfluvial (lake-dwelling or lacustrine). The anadromous form migrates from freshwater spawning areas to feed during the summer in marine environments, returning to fresh water in the winter to feed, seek refuge, or spawn, typically returning to the ocean the next spring. The resident form is usually found in upper headwater tributaries and is generally considered to be nonmigratory and to maintain small home territories. Resident cutthroat trout apparently grows more slowly than other forms, are smaller at maturity, and rarely live longer than 2-3 years (Wyatt 1959; Nicholas 1978; June 1981). The potamodromous form migrates within large river basins, but does not move out to sea. This form is rarely found below barriers or in locations with access to anadromous fish. The adfluvial form lives and feeds within lake systems and may spawn either in the shallows of the lake or migrate up tributaries to suitable spawning habitat.

The distinction between these life-history forms can be ambiguous. Adfluvial fish may also exhibit anadromy if they have access to the sea (Armstrong 1971). Fish considered to be resident in one year may migrate to the ocean the next year (Sumner 1962; Giger 1972). Conversely, anadromous fish do not necessarily return to the ocean after spawning, but may remain in freshwater for a year (Giger 1972; Tomasson 1978). The distinctions between forms can be further blurred where multiple forms are found in sympatry, because they are often morphologically indistinguishable, particularly as juveniles (Fuss 1982).

Regardless of life history form, coastal cutthroat trout spawning typically starts in December and continues through June, with peak spawning in February (reviewed in Pauley et al. 1989; Trotter 1989). In California, spawning begins in November, with peak spawning in late December in the larger river basins and late January and February in the smaller coastal rivers and streams (reviewed in Johnson 1999). Spawning occurs in small tributaries with low gradients and low summer flows, usually less than 10 cubic feet per second. Redds are primarily built in the tails of pools (Johnston 1982), in gravel sized from 0.2 to 2 inches (pea to walnut-size) (Cramer 1940), and at depths of 6 to18 inches (Jones 1978). Generally, coastal cutthroat trout spawn upstream of coho salmon or steelhead. It is believed that this choice of spawning sites has evolved to reduce competitive interactions between young-of-the-year cutthroat trout and other salmoides (Johnson et al. 1999). This may be important as coastal cutthroat trout typically emerge later and are smaller in size than other salmonid species.

Coastal cutthroat trout are iteroparous and have been documented to spawn each year for at least five years, although some fish do not spawn every year and some do not return to seawater after spawning (Giger 1972). Spawners may experience high post-spawning mortality due to weight loss (Sumner 1953) and other factors (Cramer 1940, Sumner 1953). Still, Sumner (1953) observed in one Oregon stream that over 39 percent of one year's spawning population returned to spawn the following year, 17 percent returned for a third year, and 12 percent returned for a fourth year. In contrast, in another Oregon stream that had an intense sport fishery, Giger (1972) noted that only 14 percent of spawners returned to spawn the following year. This heavy mortality of first year spawners may have implications for the health of these populations, as the fecundity of female coastal cutthroat trout increases with age. The eggs of older females, those that have spawned two or three times, are more numerous and larger than the eggs of first-time spawners (cited in Trotter 1997). Larger eggs develop into larger alevins, which have size advantages in subsequent growth and survival (reviewed in Trotter 1997).

Coastal cutthroat trout eggs hatch within six to seven weeks after spawning. Citing several studies, Trotter (1997) reported that the eggs of coastal cutthroat trout require between 362 and 500 degree-days to hatch (expressed in units of days above a threshold temperature of 32°F). Depending on water temperatures, alevins emerge between March and June, with peak emergence in mid-April (Giger 1972, Scott and Crossman 1973). Fry quickly move to channel margins and backwaters.

The literature is conflicting over habitat preferences for juvenile coastal cutthroat trout. This disagreement in the literature has been explained by some researchers as evidence that habitat preference by coastal cutthroat trout is affected by inter-species competition. When they are the only salmonid in the stream, Glova (1984) found that juvenile coastal cutthroat trout were more abundant in pools, but use riffles and glides as well. When coho salmon fry and sculpins are present, the coastal cutthroat trout juveniles are more evenly distributed (Glova 1987). Studies of summer rearing habitat preferences found that where coho salmon are also present, the majority of coastal cutthroat trout found in pools were age one or older. June (1981), Bisson and Sedel (1984), and Mitchell (1988) report that juvenile coastal cutthroat trout prefer shallower, swifter-water habitats such as low-gradient riffles and pool tailouts. Glova and Mason (1976, cited in Trotter 1997), in contrast, reports that in allopatric situations, coastal cutthroat trout young-of-the-year select pools and other slow water habitats. Where juvenile steelhead are also present, they also dominate the young-of-the-year cutthroat trout in riffles (reviewed in Trotter 1997). Older (age 1+) coastal cutthroat trout select pools, particularly those with root wads or other LWD (Bisson and Sedel 1984). Water temperatures are probably a factor in habitat selection; coastal cutthroat trout do not fare well when water temperatures exceed 72°F (Pauley et al. 1989).

The segregation between species is not limited to habitat; food preferences also differ between species. Glova (1984) observed that coho salmon fry ate more adult insects, Dipthera and Hemiptera, while coastal cutthroat trout ate more larvae and pupae, mostly chironomids. The author further suggested that coastal cutthroat trout were more generalists, utilizing both benthic and drift, while salmon ate only drift. Martin (1984, cited in Trotter 1997) also noted that coastal cutthroat trout were generalists; in a study spanning several months (February through November), the author observed that all age classes of coastal cutthroat trout ate the same small items throughout the study, but that prey shifted from aquatic to terrestrial organisms as these became more abundant in the autumn.

The territoriality between species decreases in the winter. Deep pools, particularly those with log jams, root wads, and overhanging banks, are preferred (Bustard and Narver 1975) by coastal cutthroat trout, along with pools with cobble and boulder substrate. Off-channel habitats are used by coastal cutthroat trout during winter months, as are lakes, if they are present in the drainage and accessible to cutthroat trout (Armstrong 1971). Coastal cutthroat trout usually remain in upper tributaries of watersheds until they are one year of age, when they may begin moving more extensively throughout the river system. Giger (1972) observed that downstream movement by juveniles in the Alsea River, Oregon, began with the first spring rains, usually mid-April with peak movement in mid-May. Giger (1972) also noted that many of these fish did not smolt, rather they remained in the estuary over the summer. The first winter rains apparently triggers an opposite migration. In Oregon, Washington, and British Columbia, the upstream movement of juveniles with parr marks (indicating they had not undergone smoltification) from estuaries and mainstems up into the tributaries of river systems begins with the onset of winter freshets during November (Giger 1972, Moring and Lantz 1975, Cederholm and Scarlett 1982, Hartman and Brown 1987, and Garrett 1998), and continues through the spring, frequently peaking during late winter and early spring (Cederholm and Scarlett 1982, Hartman and Brown 1987, Garrett 1998).

Differentiating between juveniles and smolts is more difficult with coastal cutthroat trout than with other Pacific salmoides. Because coastal cutthroat trout migrate extensively within river systems it is difficult to determine which fish are seaward bound and which are simply moving from one freshwater location to another. In general, for anadromous cutthroat trout, smoltification occurs after two to four years in freshwater (Sumner 1962, Lowry 1965, Giger 1972, Michael 1980. Fuss 1982). In Alaska, the initial saltwater entrance occurs at between four and six years of age (Armstrong 1971, Jones 1978). Saltwater entry typically occurs between March and July, but varies depending on location. In California, smolt emigration begins in March and continues through June and July, with peak migration occurring in April and May (Redwood National Park 1983, 1988-1993, 1997, 1998, unpublished data, Brown 1988, Shaw and Jackson 1994, Simondet 1997, Voight and Hayden 1997). This is about a month earlier than spawned-out adults that are returning to salt water. In Oregon and Washington, spawned-out adults will return to salt water beginning in late March through early April (Trotter 1997).

Once in the ocean, coastal cutthroat trout remain in nearshore waters and do not stay in salt water for very long. Studies by Giger (1972) and Jones (1973, 1974, 1975) indicated that coastal cutthroat trout, whether first time or seasoned migrants, stayed close to shore, rarely crossed bodies of water larger than 5.6 miles wide, and remained at sea for an average of 91 days, with a range of 5-158 days. Some studies indicate that coastal cutthroat trout prefer areas with freshwater influence while in saltwater (Loch and Miller 1988, Pearcy et al. 1990).

Most anadromous coastal cutthroat trout return to freshwater for winter, but not necessarily to spawn. Sexually immature anadromous coastal cutthroat trout will overwinter in freshwater, return to saltwater the following summer to forage, then return to freshwater the following winter to spawn (Trotter 1997). In Alaska, the percentage of sexually immature fish returning to freshwater was nearly 50 percent (Jones 1972-1976), but in Oregon, Sumner (1953) found that about 95 percent of migrants, including first-time migrants, were sexually mature. It has been suggested that non-spawning migrants are more likely to wander during their first return to freshwater than sexually mature fish. Jones (1975, 1976) reported that tagged fish from Petersburg Creek in southeastern Alaska were captured in 13 nearby streams the following year, but during the second year, a much higher portion of tagged fish were captured back in Petersburg Creek. Johnston (1982) also suggested that sexually immature first-year migrants may conduct feeding runs to non-natal rivers, but Johnston also proposed that these fish would return to their natal stream the following year, when they were sexually mature.

The timing of freshwater entry varies widely throughout the species range, from late June through the following April. Some river systems appear to have two distinct freshwater entry times (Sumner 1972, Johnston 1982). Sumner (1972) noted that in several Oregon rivers that had well-developed estuary systems, some coastal cutthroat trout entered the estuary in July and remained there through the rest of the summer before moving upriver with the first fall freshets. A second group of fish entered the same rivers in the fall, moving immediately upstream. In California, when there is year-round access to the ocean, coastal cutthroat trout immigration beginning in late July and continuing through December, with peak migration in September and October (CDFG annual seining results, unpublished data 1980-1989, USFS annual observation counts, unpublished data 1992-1997). In smaller rivers where seasonal sand bars block access, adult immigration begins with the opening of the sand bar, usually with the first winter freshets in November or December, and continues through March, with peak migration occurring in January and February (Redwood National Park annual reports, unpublished data 1983, 1988-1993).

Current Legal Status

Listing history

The NMFS originally initiated a review of the status of coastal cutthroat trout after receiving a petition from the Oregon Natural Resources Council, the Wilderness Society, and the Umpqua Valley Audubon Society (Oregon Natural Resource Council et al. 1993) to list the North and South Umpqua River sea-run cutthroat trout as threatened or endangered. The status review concluded that the Umpqua River coastal cutthroat trout did constitute an ESU (Johnson et al. 1994), and NMFS subsequently listed the Umpqua River coastal cutthroat trout as an endangered species on August 9, 1996 (61 FR 41514).

In response to a petition received by NMFS from the Oregon Natural Resources Council and others on December 5, 1997, to "list the sea-run cutthroat trout as threatened or endangered throughout its range in the states of California, Oregon, and Washington" (Oregon Natural Resources Council et al. 1997), the NMFS recently conducted a status review on coastal cutthroat trout throughout the Pacific Northwest (Johnson et al. 1999). The draft status review has identified six coastal cutthroat trout ESUs, including the (SOCC) ESU.

Threats

General threats identified in the draft status review (Johnson et al. 1999) include oceanic and climatic changes, threats to genetic integrity such as artificial propagation of coastal cutthroat trout and hybridization between coastal cutthroat trout and steelhead, and recreational fisheries. Within the SOCC ESU, the draft status review noted that severe habitat degradation, due to logging, road construction, and some local development, has contributed to a reduction in habitat capacity relative to historical population levels. Water withdrawals have also affected the size and habitat quality of some estuaries in larger river basins. The risks due to interactions with hatchery cutthroat trout are considered to be low in this ESU, but interactions with naturally occurring or hatchery produced coho salmon and steelhead are considered deleterious. The incidental capture of coastal cutthroat trout in sport fisheries targeting steelhead and coho salmon was also noted as a possible threat to coastal cutthroat trout in the SOCC ESU.

Conservation needs

The status review for the coastal cutthroat trout SOCC ESU states that although populations within this ESU are below historical levels, this ESU is not presently endanger of extinction, nor is it likely to become so in the foreseeable future. In general, the conservation needs of coastal cutthroat trout are identical to those identified for coho salmon, above.

Status and Distribution

Available historical and recent coastal cutthroat trout abundance information is summarized in the status review for this species (Johnson et al. 1999). The following discussion is taken from that document and from Hall et al. (1997).

In California, coastal cutthroat trout have been observed in 182 named streams, about 71 percent of which are within the species' California range. Reproducing populations occur throughout most of the Humboldt Bay tributaries, the Smith and Little Rivers, the lower portions of Redwood Creek, Klamath, Mad, and Eel Rivers, and numerous small named and unnamed coastal tributaries (Gerstung 1997). Coastal cutthroat trout also occur in five coastal lagoons and ponds - Big, Stone, and Espa lagoons, and the Lake Earl-Talawa complex (Gerstung 1997). In California, almost 46 percent of coastal cutthroat trout occupied habitats in the Smith and Klamath River drainages. Electroshocking data from a number of California streams suggest that densities of juvenile or smolting cutthroat trout (50-200mm) are consistently between 15 and 30 fish per kilometer of stream below barriers to anadromy (Gerstung 1997). Densities of coastal cutthroat trout in the same size range above the barriers were much higher, ranging from 60-400 fish per kilometer. Adult densities below barriers in the Smith River were 3-12 cutthroat trout per kilometer; 6-12 adults per kilometer were found in the Little River. In contrast, researchers in Redwood Creek only found 0.5 adults per kilometer (Gerstung 1997).

Trends in smolt abundance from Mill Creek, a tributary to the Smith River, have been increasing since 1994 (Howard and Albro 1995, 1997). Estimated smolt numbers in this tributary have ranged from 750 to nearly 4,000 fish over a four-year sampling period. Data from the lower Klamath River between 1980 and 1991 showed a variable but relatively stable trend in the number of coastal cutthroat trout caught per seine haul (Gerstung 1997). In contrast, data from the Klamath River estuary indicated a dramatic increase in the mean number of cutthroat trout caught per minute between 1991 and 1995 (Gerstung 1997).

In Oregon, coastal cutthroat trout are widespread west of the Cascade Mountain crest. All life-history forms - resident, fluvial, adfluvial, and anadromous - are present in coastal streams within the SOCC ESU. Trends in smolt abundance in the Winchuck River have been declining over the past three years; from 1996 to 1998, 2,800, 1,990, and 1,400 smolts have been trapped (T. Confer, Oregon Department of Fish and Wildlife, unpublished data). Coastal cutthroat trout sampled in a downstream weir on Jack Creek, a tributary to the Chetco River, were stable in numbers from 1989-91, ranging from 643-667 total cutthroat trout (T. Confer, Oregon Department of Fish and Wildlife, unpublished data). Historically, the Rogue River had a substantial recreational cutthroat trout fishery, suggesting a high abundance of coastal cutthroat trout in that basin. There is only one known recent estimate of smolt abundance in the Rogue

River: from March-May, 1998 a downstream migrant trap on Lobster Creek, a tributary to the lower Rogue River, caught 146 smolts, 66 juveniles, and four adult cutthroat trout (T. Confer, Oregon Department of Fish and Wildlife, unpublished data). Correcting for trap efficiency, ODFW biologists estimated that 838 cutthroat trout smolts migrated past the trap.

Over the whole SOCC ESU, coastal cutthroat trout are thought to be widely distributed in many small populations. Two possible exceptions are populations in the Rogue and Smith River basins, where the abundance of cutthroat trout may be comparatively high, although the lack of information on smolt-to-adult survival makes interpreting smolt abundance estimates in these rivers difficult. Population sizes in other streams throughout this ESU are thought to be small, in part because it is the southern limit of the coastal cutthroat trout subspecies. The draft status review notes that severe habitat degradation has occurred in this region due to logging and some local development, which probably have contributed to reduction in habitat capacity. In addition, seasonal dewatering of stream mouths naturally occurs in northern California, but the extent to which human activities have altered the natural cycles of river mouth blockages in this area is unknown.

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ENVIRONMENTAL BASELINE (in the action area)

The Long-term Sustained Yield (LTSY) projections used to establish the environmental baseline and evaluate impacts on covered species include some differing assumptions regarding the Grizzly Creek complex than what is assumed in these biological and conference opinions. The LTSY projections assume that the 250 acres of the core habitat in the Grizzly Creek complex will be purchased and not available for harvest. For the purposes of analyzing impacts to all covered species except the marbled murrelet, these biological and conference opinions assume that all of the Grizzly Creek complex would be harvested after 5 years.

Baseline common to all species

Factors affecting species and suitable habitat in the action area

Other completed or contemporaneous actions

Other completed and contemporaneous actions include approved HCPs and THPs. The Simpson Timber Company (Simpson) HCP and its associated ITP (Simpson Timber Company 1992) has been approved in the action area. The permit area covers approximately 456,000 acres of land, of which 29,069 acres are in the action area. The ITP , approved in 1992 for the incidental take of northern spotted owls, will extend for 30 years. The Simpson HCP is expected to result in take of 50 owl sites, due to loss of suitable habitat in the first 10 years of the permit. Simpson anticipates a harvest rate of about 3,000 to 5,000 acres per year, with clearcutting as the primary harvest method.

Two measures are expected to mitigate the effect of take: measures to maintain owl habitat; and regrowth of habitat on previously cut areas. At least 40,000 acres of suitable spotted owl habitat will be maintained for at least 10 years. This acreage includes a special management area of over 30,000 acres which contain a cluster of at least 16 known owl sites, and an additional 13,000 acres of widely scattered lands which currently contain over 35 nest sites or activity centers. A small net gain in suitable owl habitat is expected to occur during the first 10 years of the permit, offsetting some, if not all, of the anticipated take. The amount of suitable owl habitat at the end of the 30-year permit period will be over twice the present amount, due to ingrowth of suitable habitat.

A number of approved or pending THPs occur in the action outside of the PALCO lands (California Department of Forestry and Fire Protection 1999). Data on the acreage of these THPs is only available for three of 19 Calwater watersheds found in the action area: Scotia, Eureka Plain, and Mattole River watersheds. Approved or pending THPs encompass a total of 20,341 acres in these watershed, the majority (15,706 acres, 77 percent of total) being attributed to either clearcut or shelterwood prescriptions (table 16). These THPs generally encompass a small percent of the watershed area found in the action areas: Scotia - 3 percent; Eureka Plain - 20 percent; and Mattole River - 9 percent.

Table 16. Approved (Appr.) and pending (Pend.) THPs within the action area outside of the PALCO lands.

Watershed			Harvest prescriptions						
			Clearcut		Shelterwood		Selection		
	Total ac.	Ac. in action area	Appr.	Pend.	Appr.	Pend.	Appr.	Pend.	Total
Scotia[1]	123,533	77,406	145	0	70	0	114	0	329
Eureka[1] Plain	52,450	12,813	4,730	81	7,250	4	3,091	5	15,161
Mattole[2] River	238,481	52,862	1,480	188	1,718	40	1,304	121	4,851
Subtotal:			6,355	269	9,038	44	4,509	126	
Total:			6,624		9,082		4,635		

[1] Based on data from 1988 to 1999.
[2] Based on data from 1983 to 1998.

HRSP and GCSP both occur in the action area and are directly adjacent to PALCO lands. These parks are expected to provide large blocks of LSH throughout the life of the permit. The parks consist primarily of coastal coniferous forests and total approximately 52,068 acres. HRSP is the larger of the two parks, and currently contains approximately 21,534 acres of old-growth habitat. GCSP is approximately 268 acres in size, most of which is considered to be LSH.

Baseline common to Pacific salmonids

Based on GIS information provided by PALCO and additional information supplied by CDFG, preliminary estimates in the Final EIS/EIR identify approximately 264 miles of Class I waters, 752 miles of Class II waters, and 576 miles, possibly as high as 3200 miles, of Class III waters within the action area. The Headwaters Forest Preserve contains less than 61 miles of streams of all stream classes. Using the CFPR definition of a watercourse and lake protection zone (WLPZ) to compute total acres within this zone, the Final EIS/EIR calculated that there are 18,172 WLPZ acres (including Elk River property) out of 209,803 total acres (9 percent) of PALCO lands and 39,754 WLPZ acres out of 949,963 total acres (4 percent) in the six watersheds of which PALCO property is a part (Final EIS/EIR, table S-15). The WLPZ-based measurements were calculated in the Final EIS/EIR using widths ranging from 75 to 150 ft for Class I waters, from 50 to 100 on Class II waters, and a standard 25 ft buffer for Class IIIs.

At a broad scale, coho salmon, chinook salmon, steelhead, and coastal cutthroat trout (hereafter referred to as Pacific salmonids) utilize similar habitat. Therefore, the status and distribution of habitat for these fish will be discussed collectively with additional, species-specific data provided where available.

Essential Habitat Features for Pacific Salmonids

The four Pacific salmonids, proposed to be covered under the ITP, have similar habitat requirements. The habitat factors that affect salmonid life cycle requirements include, but are not limited to, water quality variables such as temperature and turbidity, and physical habitat elements such as the presence and abundance of LWD, pool frequency and quality, channel condition, access, and riparian vegetation. During development of the draft and proposed final SYP/HCP, and draft and Final EIS/EIRs an interagency team, lead by NMFS developed a method of evaluating the functional potential and current conditions of individual environmental factors and watersheds necessary for salmonid life history requirements. This method is based on the March 20, 1997 Draft Aquatic PFC Matrix (Matrix; NMFS Draft 1997), which includes a set of aquatic, riparian, upland, and watershed elements with corresponding "properly functioning" values (Final EIS/EIR, appendix K). These values represent the best available information, at the time of development, for defining the biological requirements of Pacific salmonids in terms of environmental factors necessary for sufficient pre-spawning survival, egg-to-smolt survival, and upstream/downstream migration survival rates to ensure survival and recovery of the Pacific salmonids in northern coastal California. The Matrix also includes values for limiting factors, also referred to as threats, to functioning habitat, such as watershed disturbance, roads, and physical barriers. The discussion on threats to habitat appears later in this document. Refer to the Matrix for further discussion of the scientific basis for the PFC values. These PFC elements also closely correspond to the essential habitat features identified for proposed coho and chinook salmon critical habitat. The following information are brief discussions of the general habitat requirements of Pacific salmonids.

Water quality

Favorable water quality is an important component of a properly functioning aquatic system. Changes in water quality can affect the survival and production of many fish and other aquatic species. Key water quality parameters affecting fish survival include water temperature, DO, turbidity, and nutrients. Specific information on water temperature from the action area and surrounding areas are available (Final EIS/EIR, table 3.4-5); however there is little or no consistent information on DO, turbidity, or nutrient levels. For properly functioning habitat, cool water temperatures, clear water, adequate DO, and low levels of turbidity and nutrients are vital.

Water Temperature

Water temperature is perhaps the most influential water quality variable on salmonids (Spence et al. 1996). Stream temperature is influenced by many factors including latitude, altitude, season, time of day, water flow, channel width and depth, groundwater flow, stream shading from topography or vegetation, and coastal fog (MacDonald et al. 1991). The climate along the coast (i.e. Humboldt WAA) is cooler due to the fog influence, which also helps maintain cooler water in these areas (National Weather Service 1998).

Increased water temperatures can obstruct adult migration and limit spawning success, trigger early juvenile out migration resulting in decreased survival rates (Beschta et al. 1987), change juvenile sheltering behavior (Taylor 1988), reduce disease resistance, and increase metabolic requirements (Beschta et al. 1987). Water temperature fluctuations and their relationship to dissolved oxygen can affect all aspects of salmon and trout life histories in freshwater, from incubation and egg survival in stream gravels to the emergence, feeding, and growth of fry and juvenile fish, to adult migration, holding, and resting pre-spawning and spawning activities, and out migration of young fish. A rise in water temperature increases the metabolic rate of aquatic species such as salmon and trout, and temperatures in the range of 70□F or greater can cause death within hours or days (DEQ 1995).

For salmonids within the action area, water temperatures should be no higher than 53.2□-58.2□F to meet late summer juvenile rearing needs. Temperatures have been measured in the five main WAAs on PALCO's land and are provided in the Final EIS/EIR, table 3.4-5.

Sediment/Turbidity

Turbidity and suspended solids in surface water affects the primary productivity on which salmonids depend by influencing phytoplankton abundance, algal productivity, and plant species composition. Values for sediment are broken down into fine sediment less than 0.03 inches and sand particles less than 0.25 inches. For healthy salmonid habitat, the percent of particles less than 0.03 inches should be less than 11-16 percent. The percent of particles less than 0.25 inches should be less than 20-25 percent.

Excessive levels of fine sediment (<0.03 inches) can infiltrate redds and increase intergravel mortality of salmonid embryos (reviewed in Spence et al. 1996). Excessive levels of sand particles less than 0.25 inches can cap redds, reducing embryo survival and impeding the emergence of alevins (reviewed in Bjornn and Reiser 1991). Siltation reduces the diversity of aquatic invertebrates by reducing the interstices in the substrate (Spence et al. 1996). Excess sedimentation diminishes pool quality and quantity, increases turbidity, smothers salmon eggs and larvae, causes gravel embeddedness, and disrupts social and feeding behavior (Hicks et al. 1991, Spence et al. 1996).

Nutrients

Nutrient levels should remain within the natural range for specific areas and seasons in order to sustain normal levels of primary productivity to ensure adequate food resources for salmonids. Various inorganic constituents of surface water are nutrients required for biological processes. Nitrogen and phosphorus are the most important nutrients affecting productivity in stream systems (Spence et al. 1996). A summary of the literature on natural sources of nitrogen and phosphorus in stream systems can be found in Spence et al. (1996).

Nitrogen, phosphorus, and other nutrients can also enrich surface waters if concentrations are in excess of the natural range. Enrichment can lead to high phytoplankton and benthic invertebrate production. Too much enrichment can cause algal blooms, which may lead to oxygen depletion in the water which can inhibit growth and development of salmonids and also be lethal to all life stages.

Physical Habitat Elements

The physical structural elements of a stream system, such as LWD, substrate, pools, and lateral habitats (side channels, off-channel habitats) provide suitable aquatic habitat for salmonids as well as many organisms on which the salmonids depend. Substrate provides spawning habitat for salmonids. For successful spawning, egg incubation, and fry emergence, salmonids require an adequate amount of substrate within a specific size range and with a minimum amount of fine sediments (Spence et al. 1996). Woody debris regulates sediment and flow routing, influences stream channel bedform and bank stability, and provides hydraulic refugia and cover within stream systems (Bilby 1984, Gregory et al. 1987, Hogan 1987, Keller and Swanson 1979, Keller et al. 1995, Lisle 1983, Nakamura and Swanson 1993, Sedell and Beschta 1991). Woody debris creates and influences pool-riffle bedforms, backwater and edgewater habitats, and cover that provide adult spawning and holding habitat, juvenile summer and overwintering habitat, and refuge habitat from high velocities and predation (Bisson et al. 1992; Sullivan et al. 1987). Pool habitats are used by salmonids for both summer and winter rearing. Pools, especially those created by LWD, provide cover from predators, cooler temperatures, and refuge habitats during storm events (Everest et al. 1985). Off-channel habitats, where they exist, are also important rearing habitat for juvenile salmonids (Spence et al. 1996).

Substrate

A certain amount of bedload material is necessary to provide substrate for cover and spawning habitat for fish. For example, anadromous salmon typically use gravels ranging from 0.5 to 4 inches, whereas steelhead and resident trout may use smaller substrates ranging from 0.25 to 4 inches (Bjornn and Reiser 1991). Excessive amounts of sediment lead to instability, pool filling by coarse sediment, or introduction of fine sediment to spawning gravel (Spence et al. 1996). The quality of spawning substrate is ascertained by determining the median particle size (D50). Knopp (1993) suggests a D50 of 2.6 to 3.7 inches for northern California coastal substrates.

According to study results and summaries from Peterson et al. (1992) and Chapman (1988), substrates should contain less than 11 to 16 percent particles smaller than 0.03 inches to be suitable, and therefore functioning salmonid habitat. Field information collected by CDFG (1997) and PALCO (1998) shows a wide range of fine sediment levels for streams within the Action Area (R2, 1998). Sites that had greater than 20 percent fines (particles smaller than 0.033 inch) were found in majority of the planning watersheds studied. In laboratory studies, a substrate containing 20 percent fines was found to reduce emergence success of young salmon and trout by 30 to 40 percent (Phillips et al. 1975, MacDonald et al. 1991).

Fine sediment (0.004 to 0.033 inches in diameter) can reduce substrate suitability by restricting sunlight penetration, and filling pores between the gravel, thus preventing the flow of oxygen-rich water to fish eggs that may be deposited in the gravel. Fine sediments and larger particles (up to about 0.27 inch or sand-sized fractions) can also smother fish eggs and developing young in the gravel. In addition, they may also clog pores or breathing surfaces of aquatic insects, physically smother them, or decrease available habitat (Spence et al. 1996, Nuttall and Bielby 1973, Bjornn et al. 1974, Cederholm et al. 1978, Rand and Petrocelli 1985). Decreases in quality and quantity of suitable substrates has been influenced by the excessive delivery of sediment to a stream include from erosion and mass-wasting events, and the presence of adequate streamside vegetation to filter fine sediment derived from hillslopes and road erosion.

Large woody debris
LWD includes trees and tree pieces greater than 4 inches in diameter and 6 feet long (Keller and Swanson, 1979, Bilby and Ward, 1989). LWD is one of the most important components of high quality fish habitat (Marcus et al. 1990) and is known to provide food and building materials for many aquatic life forms, provide cover for juvenile and adult fish, and is the primary channel-forming element in some channel types (Marcus et al. 1990). Woody debris also plays a key role in the retention of salmon carcasses (Cedarholm and Peterson 1985), a major source of nitrogen and carbon in stream ecosystems (Bilby et al. 1996). The value of LWD in providing aquatic habitat depends on stream size, tree species, and numerous other factors (discussed in detail in the Final EIS/EIR).

LWD affects many aspects of streams, including channel morphology, sediment storage, water retention, stream nutrient cycling, macroinvertebrate productivity, and fish habitat (Marcus et al. 1990, Lisle 1986, Swanson et al. 1984, Martin et al. 1998). More specifically, LWD also regulates sediment and flow routing, influences stream channel bedform and bank stability, and provides hydraulic refugia and cover within stream systems (Bilby 1984, Gregory et al. 1987, Hogan 1987, Keller and Swanson 1979, Keller et al. 1995, Lisle 1983, Nakamura and Swanson 1993, Sedell and Beschta 1991), thus influencing the formation of the spatial template within with salmonids exist (Sullivan et al. 1987, Vannote et al. 1980). This template includes pool-riffle bedforms, backwater and edgewater habitats, and cover that provide adult spawning and holding habitat, juvenile summer and overwintering habitat, and refuge habitat from high velocities and predation (Bisson et al. 1992, Sullivan et al. 1987). Pools formed by stable accumulations of LWD provide important habitat for rearing salmonids, particularly in winter (Heifetz et al. 1986; Murphy et al. 1986). LWD loadings are also important for salmonid survival at high flows (Robison and Beschta 1990). Coho salmon have been shown to benefit directly from the habitat cover and pools formed by LWD, particularly during juvenile rearing. Juvenile salmonid abundance is often directly related to the amount of LWD in a stream (Murphy et al. 1986).

LWD may also be beneficial to adult salmonids that use it for resting sites and escape cover. It can form areas of deposition as well as scour, which can enhance spawning through gravel sorting (Flosi and Reynolds 1994). In addition, it can trap and hold post-spawned fish carcasses, enabling more effective recycling of nutrients into the aquatic system (compared to carcasses that are washed downstream)(Cederholm and Peterson 1985). Increased numbers of coho salmon have been directly related to the amount of LWD available for use in a stream (Bisson et al. 1987; Murphy 1995). Large accumulations of LWD in streams in the form of logging slash, however, may be undesirable and may block fish passage in extreme cases. Logging slash may include larger tree branches and short sections of wood without rootwads. Much of this type of LWD floats and, therefore, can be unstable (Bryant 1980). Unstable accumulations of LWD can wash out and destabilize streambanks, potentially causing reductions in fish habitat and overall stream productivity.

The actual number of LWD pieces an size that would provide properly functioning habitat conditions depends highly on site-specific factors. Bilby and Ward (1989), describe the relationship between channel width to size, and number of LWD pieces in coastal streams. For example, a 15 foot wide channel should have 16 pieces of LWD per 100 feet, with a mean debris piece volume of 13 cubic feet. In contrast, a 50 foot wide channel would be expected to have only four pieces of LWD per 100 feet, with a mean debris piece volume of 100 cubic feet. Generally, to obtain or maintain adequate levels of LWD, the stream buffer conditions must provide recruitment through process including toppling, windthrow, and bank undercutting. Large wood, in the north coast streams, is also contributed from upslope and upstream areas by processes such as mass wasting and other erosion events (McGarry 1994). During attempts to account for the sources of LWD, McDade et al. (1990) could not account for the source of more than 47 percent of the LWD pieces in 39 stream reaches, which suggests that the source was from upslope or upstream.

The actual number of LWD pieces that would provide properly functioning habitat conditions depends highly on site-specific factors. NMFS views recruitment as the key to obtaining properly functioning levels of LWD instream. The goal is to maintain streamside buffers conditions that have a high potential to recruit LWD. NMFS (1997) identified generalized streamside buffers that should have at least 23.8 redwood trees per acre greater than 32 inches dbh, of which 17.4 trees should be greater than 40 inches. The numbers are slightly lower for Douglas-fir. These numbers were derived from Eyre (1980), Bingham (PSW, in. litt., 1991), and the California Board of Forestry (in litt. 1992) for tree sizes and numbers associated with old-growth conditions.

Pool frequency/quality

Pool quality and quantity are both important for properly functioning aquatic habitat. Beschta and Platts (1986) suggest that pool size, frequency, distribution and quality are dependent on the mechanism which form the pools, such as large wood or bedrock, and other physical characteristics, such as substrate, bank erodibility and stream depth. Keller et al. (1995) found in streams in northern coastal California that pools comprise greater than 20 percent of the total surface area for gradients less than 3 percent. Of these pools, over 90 percent are associated with LWD in a large wood controlled stream system. For steeper gradients, over 25 percent of the total stream surface area should be pool habitat, with greater than 50 percent associated with LWD. Generally, good quality pools are greater than one meter deep, provide good cover and cool water, and their volume is only minimally reduced by fine sediment.

Channel condition & dynamics
The condition and dynamics of the stream channel in which Pacific salmonids live affects the suitability of the aquatic habitat. Stream channel variables important to salmonids include the condition of the streambank, the condition of and connectivity with adjacent floodplains, and the channel width/depth ratio. Streambanks frame the stream channel; their dimensions and stability influence and are influenced by the flow of water and the erosional debris produced by the watershed (Rosgen 1996). Undercut streambanks provide habitat and cover for aquatic species. Unstable banks often result in increased sediment inputs from bank erosion, a loss of undercut bank habitat, and an overall increase in the instability of the stream channel. This instability may express itself in changes to the width/depth ratio of the channel. Wider, shallower streams lead to water temperature increases, increased vulnerability of salmonids to predation, a possible increase in the carrying capacity for age-0 fish, but a reduced carrying capacity for age-1+ fish (Hicks et al. 1991). Adjacent floodplains provide off-channel habitat for juvenile and adult salmonids and dissipates the energy of water during high flow events.

Off-channel areas that are hydrologically linked to the main channel should be maintained, in addition to overbank flows to maintain wetland functions and vegetative succession (NMFS 1996). Existing backwaters with cover and low energy areas should also be maintained to provide refugia for juvenile salmonids. Generally, at least 90 percent of the streambanks should be naturally stable; only 10 percent of banks should show signs of active erosion and the natural range of width/depth ratios should be maintained.

Flows & hydrology
Specific flow requirements for the four proposed covered salmonids vary with each species, life history stage, and time of year. Generally, if peak flows, base flow and flow timing characteristics are comparable to the natural range of flows in an undisturbed state, then the stream is expected to be functioning properly relative to flows. In order to accomplish function, the watershed should have no to a minimal increase in the drainage network due to human activities (NMFS 1996).

Habitat access
The ability of salmonids to access various habitats during different life stages is essential to completion of their life history. Anadromous salmonids migrate upstream to spawn. Juveniles move between habitats during summer and winter months as conditions change (i.e., to escape high summer temperatures or avoid high winter flows). Smolts migrate downstream into estuaries and salt water where the majority of growth occurs. Barriers, both human-caused and natural, interfere with the ability of salmonids to access particular habitats at certain life stages, and can affect the species survival. For habitat to function properly all human-made barriers present in the watershed should allow for upstream and downstream fish passage of all life stages.

Riparian Vegetation and Function
The riparian zone acts as the interface between the aquatic and terrestrial ecosystems. It provides critical functions such as LWD, shade, bank stability, organic inputs and nutrients, wildlife habitat,

microclimate, and sediment control, but also moderates the effects of upslope processes (Spence et al. 1996). Riparian buffer integrity is therefore considered an essential habitat feature for properly functioning aquatic habitat. An important product of riparian vegetation is shade, which moderates water temperatures, as discussed previously. Riparian vegetation increases bank stability through root strength and by moderating current velocity during high flow events (Spence et al. 1996). Woody roots also promote the formation of undercut banks, an important habitat for many salmonids (Murphy and Meehan 1991). Riparian vegetation provides the majority of the energy for the food web in heterotrophic systems by providing the allocthonous inputs supporting aquatic macroinvertebrates (Cummins et al. 1983) and influencing the rate of nutrient spiraling (Gregory et al. 1987, Newbold et al. 1982). LWD is provided to stream systems from hillslope processes such as debris torrents (McGarry 1994), but predominantly from adjacent and upstream riparian vegetation. Riparian vegetation can also act to control sediment inputs from surface erosion (Spence et al. 1996). Depending on site features such as slope, soil type, and drainage characteristics, riparian vegetation and associated downed debris, duff, and litter can filter overland flows from adjacent hillslopes. Megahan and Ketcheson (1996) determined that overland sediment movement in the Idaho batholith was inversely proportional to obstructions (downed vegetation) on the hillside.

The ability of riparian areas to provide for essential habitat requirements decreases in proportion to increasing distance from the streambank. Air temperature and relative humidity are not significantly altered if buffer strips exceed 45 m (150 ft) in width in old-growth conditions (Chen et al. 1995, Ledwith 1996, Brosofske et al. 1997). Both McDade et al. (1990) and Van Sickle and Gregory (1990), reported that more than 90 percent of instream wood identified as coming from adjacent riparian sources came from within approximately one site potential tree height for Douglas-fir. Streambank stability is maintained if riparian stands are undisturbed within a distance of 0.5 to 1 site potential tree height (Sedell and Beschta 1991). Nutrient input and retention, litter fall (Gregory et al. 1987), and shade functions (Beschta et al. 1987) are also controlled by conditions within 0.5 to 1 site potential tree height from the channel. At distances greater than approximately one site potential tree height, the ability of riparian vegetation to provide these essential habitat requirements declines sharply.

To avoid adversely affecting salmonids activities within riparian areas adjacent to and above salmonid habitat mush provide for adequate canopy, streambank and near-stream stability, and allocthonous inputs (woody debris, litter, and nutrients). In addition, activities within the upstream reaches of the watershed must not significantly increase the amount of sediment delivered downstream or modify the rate and timing of runoff.

Existing Habitat Conditions in the Action Area

Based on aquatic WLPZ width, there are 18,172 WLPZ acres (including Elk River property) out of 209,803 total acres (9 percent) of PALCO lands and 39,754 WLPZ acres out of 949,963 total acres (4 percent) in the six watersheds of which PALCO property is a part. Most of PALCO's ownership has been used for commercial timber production of primarily redwood and Douglas-fir for the last 120 years. Lands adjacent to PALCO's property include large commercial timber operations, small commercial timber operations and other private parcels, public parks and reserves, and other government lands. Other uses of private lands include grazing, agriculture, and residential development.

Based in part on the boundaries of "planning watersheds" delineated by the State of California, stream systems in the action area have been divided into six major Watershed Assessment Areas (WAAs) encompassing approximately 854,900 acres (Final EIS/EIR, figure 3.4-2). Overall, PALCO owns approximately 209,834 acres or about 24 percent of the land in these six WAAs. A major portion of the ownership is in the Yager Creek drainage. The WAAs comprise 19 Hydrologic Units (HUs) and are further divided into 94 planning watersheds. Since most of the available information on habitat conditions is at the scale of HU or WAA, the following descriptions are presented at the WAA level. Additional information at the HU level that is pertinent to this Opinion is provided where available. Future watershed analyses will be required to accurately describe conditions at the planning watershed scale.

Data on the condition of salmonid habitat within the action area are incomplete, but the data that are available can provide some indication of habitat status. Data points cited herein roughly indicate only the upper and lower parameters for each habitat variable. Averages for watersheds or WAAs are provided where available. The information summarized here is not complete, but is provided to establish a basic understanding of the environmental baseline. In some instances, the data are several years old, therefore they may not be representative of current habitat conditions. Natural and human-caused events such as floods, fires, and continued timber harvesting and road construction have occurred since much of the data were collected. Many of these events impacted or continue to impact the aquatic habitat, therefore the actual baseline habitat condition is probably below what is represented by the information presented here. The methods for collecting the data were not assessed for this comparison. Further information on habitat conditions within the action area can be found in the Final EIS/EIR.

Existing stream habitat conditions on PALCO lands are currently affected by a wide range of factors including geophysical changes (e.g., earthquakes and associated uplifting), extremes of flow (e.g., flooding and low flow), existing geological conditions (e.g., erodible soils), and land use practices (e.g., timber harvest, grazing, urban development, road construction and operation, and gravel mining). Since 1989, the CDFG has conducted surveys of stream habitat conditions and fish populations within the five main WAAs in the action area. A summary of these data is provided in Table 5-2 of the Final EIS/EIR.

Mad River WAA
The Mad River watershed is the northernmost drainage in the action area (Final EIS/EIR, figure 3.4-2) and has its headwaters in the Six Rivers National Forest. In this watershed, the elevation ranges from sea level to about 5,000 feet. There is one dam on the Mad River, Mathews Dam at Ruth Reservoir, located at river mile 69. Precipitation at the headwaters of the Mad River averages about 60 inches per year, while at the mouth, near Arcata, the average precipitation is 40 inches per year. Estimates for the 100-year flood event are about 100,000 cubic feet per second,

while 2-year flood is estimated at about 18,000 cubic feet per second. Diversions for municipal and industrial uses occur near the mouth, just above Arcata. Two HUs within this WAA contain PALCO lands: Butler Valley and Iaqua Buttes. PALCO owns approximately three percent or 1,805 acres of the Butler Valley HU, and four percent or 1,465 acres of the Iaqua Buttes HU. Drainage density, an indicator of stream vulnerability to sediment influx, is 3.8 and 5.6 miles per square mile for the Butler Valley and Iaqua Buttes HU respectively.

Soil types in both HUs in the Mad River WAA are primarily composed of soils considered as moderate to highly erodible and sensitive to disturbances. Approximately six percent are classified as highly erodible soils. The Butler Valley HU is identified as potentially the most erodible watershed in the Project Area, with almost 8 percent in the high category and about 33 percent in the moderate erosion category. Within the action area, the erosion hazard is considered high, about 10 percent; 39 percent of PALCO land is in the moderate erosion hazard category. The Iaqua Buttes watershed is also highly erodible, with 5 percent erosion hazard, and 35 percent moderate hazard. PALCO lands within the action area are notably more erodible than the basin average, containing about 11 percent high-erosion hazard and 59 percent moderate-erosion hazard.

Stream aquatic habitat limitations within this WAA are not described in the Final EIS due the small size of PALCO's ownership within it (3,586 acres), and the dispersed nature of the small parcels. The streams in this WAA are mainly either Class II or III, although approximately 0.6 and 2.9 miles are present in the Butler Valley and Iaqua Buttes HUs respectively. These streams flow into the Mad River, which is listed under section 303(d) of the Clean Water Act for sediment and turbidity problems. The stream miles on PALCO's ownership within the Mad River WAA are presented below in Table 17.

Table 17: Stream Miles on PALCO Lands within the Mad River WAA (from Final EIS/EIR).

Hydrologic Unit	Class I	Class II	Class III	Total
Butler Valley	0.6	6.1	3.9	10.6
Iaaqua Buttes	2.9	9.5	5.7	18.1
Totals	3.5	15.6	9.6	28.7

Humboldt WAA

This WAA is composed of four major south-east-northwest trending HUs that drain into Humboldt Bay (Final EIS/EIR, Figure 3.4-2). These HUs include from north to south: Jacoby Creek, Freshwater Creek, Elk River, and Salmon Creek. The upper portions of the Little South Fork Elk River and Salmon Creek watersheds form the proposed Headwaters Reserve. The elevation range within each watershed is similar, from sea level to about 1,900 feet. The total area of the Humboldt WAA is 128,448 acres, with about 30 percent in PALCO's ownership.

Because of it's proximity to the coast and the orientation of the valleys, the Humboldt WAA is affected more by coastal fog than other WAAs.

The rivers in this WAA are typified by relatively high gradients and large flows. Average annual precipitation ranges from 40 inches near Humboldt Bay to 60 inches in the higher elevations. The discharge records for these rivers are incomplete or missing altogether. Stream gages were located on Jacoby Creek and on the Elk River for a short time in the 1950s and 1960s. Based on similarity in climate, vegetation, and topography, runoff characteristics are believed to be comparable to similar-sized tributaries in other WAAs. The drainage density is approximately 3.7 miles per square mile.

Most soil types within the Elk River watershed are considered to represent a moderate surface erosion hazard. Only two percent of Jacoby Creek's watershed is owned by PALCO, whereas most of the headwaters of Freshwater Creek is under PALCO ownership. Freshwater Creek contains the highest percentage of soils (14 percent) in the Action Area considered to have a high potential for surface erosion. The erosion hazard rating for PALCO lands within Jacoby Creek is relatively low with 47 percent in the low category, and 52 percent in the moderate category. The erosion hazard rating within most of Freshwater Creek (79 percent) is also low, however 1 percent is classified as high or extreme hazard. The dominant geomorphic features in Jacoby Creek is debris slide/slope amphitheaters (80 percent), followed by translational/rotational slides (9 percent). In Freshwater Creek, the predominant feature is also debris slopes, but the proportion is much less at 38 percent.

Within the Elk River HU, PALCO and Elk River Timber Company own almost all of the upper four planning watersheds. The combined erosion hazard rating for both watersheds is relatively low, with 85 percent in the low-hazard category, and 14 percent of moderate hazard. The dominant geomorphic features in the Elk River drainage are debris slides, while the Salmon Creek watershed is composed almost entirely of debris slide slopes (93 percent).

Approximately 66 percent of the Elk River hydrounit, 56 percent of the Freshwater Creek hydrounit, and less than 5 percent of the Salmon Creek hydrounit are owned by PALCO. The stream miles on PALCO's ownership within the Humboldt WAA are presented below in Table 18.

Table 18: Stream Miles on PALCO Lands within the Humboldt WAA (from Final EIS/EIR).

Hydrologic Unit	Class I	Class II	Class III	Total
Elk River	21.5	49.2	49.4	120.1
Freshwater Creek	21.8	56.7	38.7	117.2
Jacoby Creek	0.0	1.6	0.9	2.5
Other	0.0	0.1	0.2	0.3
Salmon Creek	0.7	1.8	1.5	4.0
Totals	44.0	109.4	90.7	244.1

In the Humboldt WAA, the SYP/HCP reports that sediment particles less than 0.03 inches in size comprised from 15.2 percent to 48.1 percent of the substrate in Freshwater Creek. Sediment particles less than 0.18 inches comprised from 26.9 percent to 66.8 percent of the substrate in Freshwater Creek. Similar figures were found for Salmon Creek and Elk River. On average across the Humboldt WAA, particles less than 0.03 inches made up 26.6 percent of the substrate. Particles less than 0.18 inches made up 42.7 percent of the substrate. According to the SYP/HCP, average high temperatures during summer months ranged from 59.8□F in the South Fork Elk River to 66.3□F at the station in the Scout Camp planning watershed (North Fork Elk River). The seven-day average high temperature averaged 61.6□F across the Humboldt WAA. Road densities in this WAA vary widely. The Little South Fork of Elk River has 1.4 mile per square /mile of roads, while Graham Gulch, a tributary to Freshwater Creek, has 7.9 miles per square mile. According to the Final EIS/EIR, there are a total of 299.1 miles of existing roads within this WAA. IFR (1998) provides information on vegetation types based on Landsat images taken in 1994 and analyzed by the Humboldt State University Spatial Analysis Lab. According to IFR (1998), vegetation in the Humboldt WAA is mostly early to mid succession, except for a few sub-watersheds with a late-seral or old-growth component. In contrast, the SYP/HCP and Final EIS/EIR report that vegetation in the Humboldt WAA is in a mid to late-seral stage. This difference could be partially based on the dissimilar definitions for seral stages. Within the WLPZ's, there are 369 acres of young forest, 1,026 acres mid-seral, 1,128 acres late-seral, and 105 acres of old-growth forest in the Humboldt WAA (Final EIS/EIR, Table 3.7-8).

Within this WAA, both Freshwater Creek and Elk River have been listed under section 303(d) of the Clean Water Act as water quality limited due to sediment problems. Freshwater Creek and Elk River have also been listed by CDF as cumulatively affected for sediment problems. Instream habitat limitations include shallow mean pool depth, low instream cover levels, and a high level of fine sediment. Essential habitat features that are currently not properly functioning include sediment and temperature. There is inadequate information to draw conclusions on the condition of other essential habitat features.

Eel WAA

The Eel WAA is the largest WAA in the action area, consisting of 427,468 acres, with about 74,000 acres in PALCO ownership (Final EIS/EIR, figure 3.4-2). The PALCO lands are mostly within the middle and lower portions of the Eel River watershed, downstream of the junction with the South Fork Eel River. It should be noted that the WAA, as delineated in the Final EIS/EIR, does not include significant portions of the actual river basin. The entire river basin is 2 million acres. Elevations range from sea level to about 6,000 feet at the headwaters of the Middle Fork of the Eel River. Rainfall averages 60 inches per year at lower elevations, and reaches 110 inches per year at high elevations.

The headwaters of the Eel River are in the interior coast ranges in Mendocino and Trinity counties, and include three main forks plus the mainstem Eel River. An extensive study of sediment discharge within the Eel River watershed (Brown and Ritter 1971) determined that the suspended sediment discharge increases downstream, unlike most rivers. The average annual suspended sediment load is 10,000 tons per square mile (Brown and Ritter 1971), which is one of the highest sediment yields in the world.

Soils within this WAA are highly diverse, with the most erodible soils occurring within the Eel Delta HU (19 percent classified as highly erodible). Within the Lower Eel HU, a large debris flow emanated from harvested PALCO lands in 1997, destroying several homes. This HU has a relatively high proportion of erodible soils, with 3 percent in the high and extreme categories, and 41 percent in the moderate category. A study by Brown and Ritter (1971) estimated that approximately 68 percent of the annual sediment yield came from the middle sections of the Eel River, mostly upstream of PALCO's ownership.

Approximately 17 percent of the WAA is owned by PALCO. The stream miles on PALCO's ownership within the Eel WAA are presented below in table 19.

Table 19: Stream Miles on PALCO Lands within the Eel WAA (from Final EIS/EIR).

Hydrologic Unit	Class I	Class II	Class III	Total
Eel Delta	12.6	39.7	27.4	79.7
Giants Avenue	1.2	4.9	4.3	10.4
Larabee Creek	21.5	62.7	43.9	128.1
Lower Eel River	30.9	130.8	91.5	253.2
Sequoia	13.7	42.1	30.8	86.6
Totals	**79.9**	**280.2**	**197.9**	**558.0**

In the Eel WAA, the SYP/HCP reports that sediment particles less than 0.03 inches comprised 13.5 percent of substrate in Larabee Creek and 45.3 percent in Strongs Creek. Sediment particles less than 0.18 inches comprised 29.35 percent of substrate in Larabee Creek and 60.2 percent of substrate in Nanning Creek. The average level of fine sediment particles was 23.4 percent for particles less than 0.03 inches and 39.5 percent for particles less than 0.18 inches in the Eel WAA. According to the SYP/HCP, the maximum weekly average temperature (MWAT) for the Eel WAA ranged from 57.4□F in Strongs Creek to 74.0□F in Larabee Creek, with an average of 63.2□F across the whole WAA. Using data collected by the Humboldt County Resource Conservation District (RCD), IFR (1998) analyzed how many hours per week temperatures exceed 61□F, which was used as the upper threshold for temperature tolerance for coho salmon. Using this analysis, IFR (1998) reported that during the first week of August, 1997, 102 hours of above threshold temperatures were recorded in Jordan Creek. In Bear Creek, from the second week in July until the end of August 1997, temperatures were above threshold almost all the time (>155 hours per week), indicating that these streams may not be suitable for coho salmon. Woody debris surveys were completed for some streams within the Eel WAA. Surveyors found an average of 862 cubic feet per 100 feet of stream. The amount of pools was also reported the SYP/HCP. In the Eel WAA, the percent of pool habitat ranged from 14 percent in Monument Creek to 57 percent in North Fork Strongs Creek. The average for pools across the WAA was 26 percent. Because the gradient of the water where these measurements were taken is not noted in the SYP/HCP, it is difficult to judge the value of these data points. WLPZ acreage within the Eel WAA include 881 acres of young forest, 2,315 acres of mid-seral, 1,964 acres of late-seral, and 105 acres of old-growth forest (Final EIS/EIR, table 3.7-8).

Within this WAA, the Eel River has been listed under section 303(d) of the Clean Water Act as water quality limited due to sediment and water temperature problems. Bear, Jordan, and Stitz creeks, tributaries of the lower Eel River, have also been listed by CDF as cumulatively affected for sediment problems. Essential habitat feature limitations include high water temperatures, low instream cover levels, high sediment levels and low LWD abundance. There is inadequate information to draw conclusions on the condition of other essential habitat features.

Van Duzen WAA

The Van Duzen River is a tributary to the Eel River (Final EIS/EIR, figure 3.4-2). Its mouth is about 4 miles downstream from Scotia. As defined in the Final EIS/EIR, the WAA excludes the headwaters of the Van Duzen, and consists of about 55,400 acres. However, the total area of the Van Duzen watershed is about 189,000 acres; 25,000 acres is owned by PALCO. The Van Duzen River flows northwest from its headwaters, then turns west and flows through deeply incised valleys that have an average slope of 59 feet per mile (1.1 percent). Bank cutting and slides are common along the Van Duzen River between Carlotta and Bridgeville. Although the elevation of the entire watershed ranges from near sea level to 5,000 feet, the portion on PALCO lands is relatively low. Some planning watersheds within the Van Duzen WAA include Cummings, Hely, Stevens, Root, and Grizzly creeks.

Average annual precipitation in the Van Duzen WAA is 64 inches, while average annual runoff is 995,000 acre-feet at Bridgeville. The average annual suspended sediment load is 6,760 tons per square mile (1941 to 1975). Stream density is 3.4 miles per square mile.

Soils in this WAA are more diverse, but include about eight percent of highly erodible soils in the Hely Creek watershed. Kelsey (1980) demonstrated that small areas can be significant contributors of sediment and may be more important than the areal extent of geomorophic features. For example, Kelsey (1980) demonstrated that 73 percent of the sediment input to the stream comes from fluvial surface erosion of hillslopes on 4.5 percent of the Van Duzen River watershed. While this study was located in the Van Duzen watershed, the similarity of parent materials and geomorphic features within the action area suggests that similar natural denudation rates are occurring elsewhere.

Approximately 45 percent of the Van Duzen WAA is owned by PALCO. The stream miles on PALCO's ownership within the Van Duzen WAA are presented below in Table 20.

Table 20: Stream Miles on PALCO Lands within the Van Duzen WAA (from Final EIS/EIR).

Hydrologic Unit	Class I	Class II	Class III	Total
Van Duzen River	30.4	83.3	65.7	179.4

The SYP/HCP reports that fine sediment less than 0.03 inches comprised 16.7 percent of substrate in Hely Creek, but up to 36.0 percent of substrate in Root Creek. For particles less than 0.18 inches, Hely Creek again had the least amount of fine sediment, 29.5 percent, compared to Root Creek, which had 48.2 percent. On average across the WAA, fine sediment less than 0.03 inches comprised 29.0 percent of substrate, while particles less than 0.18 inches comprised 43.4 percent. Temperature measurements in the Van Duzen WAA come from multiple sources. The SYP/HCP reports temperature data from Cummings Creek and Root Creek only. For those subwatersheds, the average MWAT was 59.7□F, and the seven-day average high was 62.6□F. Using data collected by the Humboldt County RCD, IFR (1998) noted that in Cummings Creek in August 1997, temperature gauges recorded up to 115 hours per week of temperatures above the threshold. In Grizzly Creek, during July, August, and September, temperatures were sustained above the threshold nearly 24-hours a day for eight straight weeks. Woody debris measurements from the Van Duzen WAA in the SYP/HCP are from Grizzly, Hely, and Root Creek. Across the watershed, PALCO found an average of 499 cubic feet of LWD per 100 feet of stream. Information on pools also comes from the SYP/HCP. On average, pools only make up 17 percent of the stream surface area in the Van Duzen WAA. Road densities in this watershed are variable, from 2.9 miles per square mile of road in the Cummings Creek watershed to 5.5 mi/mi^2 in both Root and Grizzly Creek watersheds. Current WLPZ acreage within the Van Duzen WAA includes165 acres of young forest, 1,179 acres of mid-seral, 378 acres of late-seral, and six acres of old-growth forest (Final EIS/EIR, table 3.7-8).

Within this WAA, the Van Duzen River has been listed under section 303(d) of the Clean Water Act as water quality limited due to sediment problems. Essential habitat feature problems include high levels of sediment, low percent of pools, high water temperatures, and low instream cover levels. There is inadequate information to draw conclusions on the condition of other essential habitat features.

Yager WAA

Yager Creek is a tributary to the Van Duzen River (Final EIS/EIR, Figure 3.4-2). The area of the WAA is approximately 85,000 acres, and over one-third is under PALCO ownership. Yager Creek flows from its headwaters, mostly in prairie lands, generally westward through deep valleys, with vegetation changing to redwood forest. Like many rivers in the Coast Range, it is entrenched and flows along small meanders. Two main forks, the North Fork and South Fork of Yager Creek, are present in the east portion of the watershed and are mostly outside of PALCO's ownership. Another tributary of equal importance is Lawrence Creek, which flows north to south and joins Yager Creek downstream of the junction of the North and South forks.

Larger HUs within the WAA include Lawrence Creek and the North, Middle, and South forks of Yager Creek; some planning watersheds include Strawberry, Blanton, Allen, and Cooper Mill creeks. Elevations range from near 400 feet to about 3,200 feet. Stream density is relatively high, at 3.8 miles per square mile. Being farther inland, the Yager Creek WAA is influenced very little by coastal fog. There are very little water and sediment discharge data for Yager Creek. However, based on the general physiography, climate, and location of the creek, it can be assumed to be hydrologically analogous to similar-size watersheds in the vicinity (e.g., Bear River).

Soil types in this WAA are fairly similar across HUs and are considered to represent a moderate to high surface erosion hazard. The lower sections of this WAA contain a nearly unbroken string of debris slides and shallow slumps along the inner gorge of the mainstem. Lawrence Creek is estimated to have 90 percent low erosion hazard ratings, and is considered one of the most relatively stable HUs in the action area with only 32 percent of the land being designated as having geomorphic features related to landslides. On the other hand, even though the North Fork Yager Creek have a 76 percent low and 22 percent moderate erosion hazard rating, and the HU has the lowest percentage of landslide-related geomorphic features in the action area, gullying in the prairie lands within the watershed is extensive. The Middle Fork Yager Creek (of which only 3 percent is owned by PALCO) is rated as low (93 percent) to moderate (7 percent). Lower Yager, which is owned mostly by PALCO, contains approximately 83 percent debris slide slopes, three percent earth flows, two percent inner gorges, and is considered to have a high erosion hazard rating relative to the other HUs.

PALCO owns approximately 40 percent of the land within the Yager WAA. The stream miles on PALCO's ownership within the Yager WAA are presented below in Table 21.

Table 21: Stream Miles on PALCO Lands within the Yager WAA (from Final EIS/EIR).

Hydrologic Unit	Class I	Class II	Class III	Total
Lawrence Creek	25.6	55.9	41.7	123.2
Lower Yager River	19.6	51.6	46.7	117.9
Middle Yager River	7.2	6.2	6.3	19.7
North Yager River	3.5	9.2	7.5	20.2
Totals	55.9	122.9	102.2	281.0

The SYP/HCP reports that in the Yager WAA, fine sediments less than 0.03 inches ranged between 7.1 percent of substrate in Booths Run planning watershed and 26.9 percent in Shaw Creek. The average for the whole WAA was 16.3 percent. For sediment particles less than 0.18 inches, the SYP/HCP reports sediment levels between an average 23.9 percent of substrate in Booths Run planning watershed and an 44.7 percent in the Bald Jessie (South Fork Yager) planning watershed. On average across the WAA, particles less than 0.18 inches comprised 36.1 percent of the substrate. Using data collected by the Humboldt County RCD, IFR (1998) noted that in Lawrence Creek in 1997, from the last week in June through the first of September, temperature gauges recorded over 150 hours per week of temperatures above the threshold. The SYP/HCP has only a few temperature data points for the Yager WAA. In Bell Creek, the seven-day average high was 60.4□F and the MWAT was 58.8□F. In the Lawrence Creek planning watershed, the seven-day average high was 68.4□F and the MWAT was 63.0□F. The SYP/HCP also provided information on pools for the Yager WAA. Pools made up 45 percent of the stream surface area in Lawrence Creek, but only 16 percent of the Bald Jessie planning watershed. Road densities within the Yager Creek watershed range from 4.9 miles per square mile to 6 miles per square mile, with one station in the Bell Creek drainage with 7 miles per square mile. Vegetation types from IFR (1998) were based on Landsat images taken in 1994 and analyzed by the Humboldt State University Spatial Analysis Lab. For Booths Run planning watershed, the analysis shows a large medium and small tree component, with a very high shrub component, probably from clearcuts. The Bell Creek watershed exhibits similar composition. Lawrence Creek, in contrast showed a substantial medium and large tree component. Current WLPZ acreage within the Yager WAA includes 1,023 acres of young forest, 1,117 acres of mid-seral, 392 acres of late-seral, and 221 acres of old-growth forest (Final EIS/EIR, table 3.7-8).

Within this WAA, Yager Creek has been listed under section 303(d) of the Clean Water Act as water quality limited due to sediment problems. Essential habitat feature problems include low instream cover levels, high summertime water temperatures, and a high level of fine sediment. There is inadequate information to draw conclusions on the condition of other essential habitat features.

Bear/Mattole WAA

The Bear-Mattole WAA lies between the Eel River WAA and the coast. This WAA contains two major watersheds: the Bear River and the Mattole River. The area of the WAA is approximately 160,000 acres, of which PALCO owns 25 percent of the Bear River watershed and 7.5 percent of the Mattole River watershed. Both watersheds have a mixture of prairie and forest and are not significantly influenced by coastal fog due to their orientation relative to the coastline.

The Mattole River has two major forks: the mainstem and Bear Creek. Both flow northwesterly. The watershed is unique in that its headwaters (both forks) are a short distance from the ocean. The total length of the mainstem Mattole is 63 miles. The total area of the Mattole watershed is about 319,360 acres. Elevation ranges from sea level to 4,200 feet. In the upper reaches, the river flows through an open alluvial plain. Much of its length, however, is in entrenched meanders. Downstream of the junction with the North Fork Mattole River, the channel and valley narrow, and the river flows southwest toward the sea. PALCO's property is located within the North Fork Mattole River and the Upper North Fork Mattole HUs. The North Fork flows west and southwest in deep canyons of the Coast Range. The river and its tributaries are entrenched in their valleys and have numerous small meander ends. The Upper North Fork Mattole River flows roughly north-south, through deeply entrenched valleys, joining the Mattole at Honeydew.

Average annual precipitation in the Mattole River watershed is 40 inches near Cape Mendocino and reaches 90 inches near Shelter Cove. A small amount of water is diverted for irrigation. The Mattole River has an estimated 100-year flood of 99,000 cfs, while the two-year flood is about 40,000 cfs. Annual suspended sediment yield averages 9,517 tons per square mile. Stream density across the entire WAA is approximately 3.4 miles per square mile.

The Bear River is 24.3 miles long; it has a 66,000-acre drainage area and flows westward across the Coast Range to the Pacific Ocean. Elevation in the watershed ranges from sea level to just under 3,000 feet. There are not data on water or sediment discharge on the Bear River. However, its headwaters are underlain by a shear zone that is part of the Mendocino Triple Junction. It is likely that natural sediment production is high and probably similar in nature to the Mattole River.

In October 1996, the Mattole Sensitive Watershed Group nominated the Mattole River watershed for classification as a sensitive watershed under Title 14 of the California Code of Regulations. Their reasons included seasonally high water temperatures that have resulted in recorded mortalities of juvenile chinook salmon in the lower river, excessive fine sediments in streams, and depletion of late-seral forests in the watershed below minimum levels (i.e., less than 15 percent of total area). The nomination, which attributed these conditions to extensive timber harvest an road building in the watershed, was not accepted by the Board of Forestry.

With the assistance of professional geologists, 23 Mattole watershed residents performed their own erosion surveys and mapping. They found that roads, including logging haul roads and skid trails, were the source of 76 percent of all erosion problems mapped in the watershed (see

Mattole Restoration Council 1989). Elements of recovery: an inventory of upslope sources of sedimentation in the Mattole River Watershed with rehabilitation prescriptions and additional information for erosion control prioritization (MRC, Petrolia, CA).

The Bear-Mattole WAA contains a variety of soil types. Soils classified to have a moderate to high surface erosion hazard occur primarily in the North Fork Mattole and Bear River watersheds and Mattole Delta HU. The distribution of geomorphic features and erosion hazard ratings in this WAA is in concordance with the high rate of sediment production. On the North Fork Mattole, the main geomorphic feature is debris slide slopes (38 percent); the erosion hazard rating is eight percent extreme or high and 47 percent moderate. On the Upper North Fork, the main geomorphic feature is debris slide slopes (44 percent), followed by disrupted ground, inner gorges, and translational/rotational slides (each about 4 percent). The erosion hazard potential is 14 percent extreme and high and 49 percent moderate.

The Bear River has a 15 percent extreme and high erosion hazard rating and 43 percent moderate rating, making it the most erodible HU in the action area. Analysis of aerial photographs between 1941 and 1988 showed very few landslides in the areas that were not harvested. Most of these landslides were associated with roads. The dominant geomorphic features are debris slide slopes (34 percent), and translational/rotational slides (5.8 percent).

Approximately 19 percent of this WAA is owned by PALCO. Twenty-five percent of the Bear River hydrounit and 9 percent of the Mattole River hydrounit are owned by PALCO. The stream miles on PALCO's ownership within the Bear-Mattole WAA are presented below in table 22.

Table 22: Stream Miles on PALCO Lands within the Bear/Mattole River Watershed Area (from Final EIS/EIR).

Hydrologic Unit	Class I	Class II	Class III	Total
Bear River	22.6	58.8	45.6	127.0
Mattole Delta	5.0	10.2	9.9	25.1
North Fork Mattole River	5.0	17.7	15.0	37.7
Upper North Fork Mattole River	9.6	31.2	25.0	65.8
Totals	**42.2**	**117.9**	**95.5**	**255.6**

As reported in the SYP/HCP, fine particles less than 0.03 inches comprised 10.7 percent of substrate in Rattlesnake Creek and 22.3 percent in the North Fork Mattole River. In the Bear River drainage, particles less than 0.03 inches comprised 14.1 percent of the substrate. The average for this particle size was 16.7 percent across the whole WAA. For particles less than 0.18 inches, Bear River reported 26.4 percent. From the Mattole River drainage, values for this particle size ranged from 29.4 percent in Rattlesnake Creek to 39.9 percent in the Tent City watershed. The average for particles less than 0.18 inches across the whole WAA was 33.9

percent. As a measure of instream temperature values within this WAA, IFR (1998) noted that in 1996, temperatures in the mainstem Mattole River exceeded the threshold temperature for more than 150 hours a week from the last week in June through the end of August. The SYP/HCP reports that the seven-day average temperature in the Bear River drainage was 71.3□F and the MWAT was 64.0□F. For the Mattole River drainage, data were only reported for the Rainbow watershed in the North Fork Mattole. The seven-day average for that drainage was 72.0□F and the MWAT was 64.3□F. As reported in the SYP/HCP, the percentage of surface area covered by pools ranged from 11 percent of the stream surface area in the Tent City watershed to 34 percent of the stream surface in the Beer Bottle watershed. Within the whole WAA, pools covered an average of 16 percent of the stream surface area. Road densities throughout the WAA ranged from 1.9 miles per square mile in the Rattlesnake Creek drainage to 3.9 miles per square mile in the Green Ridge watershed. The vegetation type analysis from IFR (1998) shows that in 1994, the Rainbow watershed (East Branch North Fork Mattole River) had a substantial medium and large tree component, but also some shrub and grass areas that could indicate either clearcuts or natural meadows. IFR (1998) notes that there are substantial natural grass areas along ridgelines in this watershed. The Long Ridge watershed (North Fork Mattole River) had a high medium and large tree component, but also a substantial shrub and grass component. Again this could be either recent clearcuts or the natural meadows. The very large tree component for both watersheds was minimal. Current WLPZ acreage within the Bear/Mattole WAA includes 68 acres of young forest, 1,929 acres of mid-seral, 89 acres of late-seral, and 366 acres of old-growth forest (Final EIS/EIR, table 3.7-8).

Within this WAA, the Mattole River has been listed under section 303(d) of the Clean Water Act as water quality limited due to sediment and water temperature problems. In addition, due to sediment levels, CDF and CDFG have maintained a policy of "zero net discharge" of sediment to watercourses in the Mattole River watershed since 1992. The Mattole Sensitive Watershed Group (1996) also proposed the Mattole River as a sensitive watershed under the Forest Practice Rules because of excessive fine sediment and high water temperatures. Along with elevated water temperature and high sediment levels, essential habitat feature limitations in the Bear-Mattole WAA include high embeddedness, low percent canopy, low percent pools, and low percent instream cover. There is inadequate information to draw conclusions on the condition of other essential habitat features within this WAA.

Known or Suspected Factors Affecting Salmonid Habitat

Timber Harvest

Past and present timber harvest on both public and private lands have contributed to the degradation and destruction of salmonid habitat. Past harvest, on both public and private lands, has left a legacy of altered habitats that still require considerable time for recovery, and the Final EIS/EIR estimates that the return to historical conditions will probably never occur on a large proportion of the forest landscape. Timber harvest practices were not regulated in riparian zones until the 1970s; thus, there were more than 120 years of human activity and 50 to 70 years of intensive harvest before mandated consideration of streamside protection. Forest practices that contributed to the decline of riparian habitat include timber harvest to streambank; railroad and road building along the riparian corridors; and splash damming. Additionally, removal of LWD was a biologically recommended practice until the mid-1970s. All of these practices led to a considerable reduction in riparian zone function.

Timber harvest in the action area began with relatively simple, non-mechanized techniques at a fairly low rate of harvest. Until the turn of the century, river flats and adjacent slopes were clearcut using livestock and manpower. Around the turn of the century, steam-powered engines were used to drag logs to collection areas and little regard was given to the processes of erosion and mass wasting. Virtually no protection was given to fish or fish habitat. As a result, trees in the action area were knocked down by the dragging of other logs, and deep furrows were made by dragging the logs long distances across hillslopes.

Since streambeds and/or valley bottoms were commonly used as routes for moving these logs, removal of large woody debris from the streams, combined with extensive filling of the channels to make an even grade for train tracks, caused heavy damage to the streams. In other areas, "splash dams" were constructed by temporarily damming streams, and then dynamiting the dams sending a torrent of logs, debris, and water downstream. The resulting flood surge caused extensive damage to streams and riparian areas which persist in some areas.

Timber harvest rates increased dramatically in the 1960s involving clear-cutting techniques and creating widespread disturbances across entire watersheds. By the 1970s cable-yarding techniques were more prominent and clearcutting remained the dominant silvicultural practice. After passage of the Z'berg Nejdley Foresty Practices Act in 1972, forest practice rules were developed to help reduce the effects to sensitive watersheds, as a result some of the most damaging practices, such as splash dams and tractor use on steep slopes, were severely limited or curtailed. Even with these improvements to timber harvesting the forest practices of today still result, in many cases, in adverse effects to salmonid habitat and contribute to the overall problem of cumulative effects affecting the rate at which salmonid habitat may or may not improve.

Road Management

Roads have adversely affected salmonid habitat by increasing sediment loads, altering channel morphology and destablizing streambanks, modifying the drainage network, creating barriers to movement, and increasing the potential for chemical contamination (Furniss et al. 1991). Construction of road network networks has greatly accelerated erosion rates within watersheds (Beschta 1978, Reid and Dunne 1984, Swanson and Dyrness 1975, Swanston and Swanston 1976). Cederholm et al. (1981) reported that the percentage of fine sediments in spawning gravels increased above natural levels when more than 2.5 percent of a basin area was covered by roads. Roads and other areas of intentional surface disturbance are a chronic source of sediment to streams (Swanston 1991). Roads and related ditch networks are often connected to streams via surface flowpaths, providing a direct conduit for the sediment. Where these roads and ditches are maintained by periodic grading, chronic sediment delivery may be temporarily increased as bare soil is exposed and ditch roughness features which store and route sediment are removed. In steeper terrain, road construction has triggered landslide processes that deliver large amounts of sediment directly into streams, destabilize streambanks, and constrain the natural geomorphological migration of the stream channel (Furniss et al. 1991). Improperly maintained roads have failed or may fail, years after construction (Furniss et al. 1991). Road networks have affected hillside drainage; intercepted, diverted, and concentrated surface and subsurface flows, and increased the drainage network of watersheds (Hauge et al. 1979, Wemple et al. 1996). This has and can lead to changes in peak and base flows in streams. Steam crossings have restricted channel geometry and prevented or interfered with migration of adult and juvenile salmonids (Furniss et al. 1991). Crossings have also be a source of sedimentation, especially when they have failed or become plugged with debris, causing debris torrents and significant cumulative impacts downstream (Furniss et al. 1991, Murphy 1995).

Hagans and Weaver (1987) found that fluvial hillslope erosion associated with roads in the lower portions of the Redwood Creek watershed produced about as much sediment as landslide erosion between 1954 and 1980. Similar results are reported by Best et al. (1995), attributing most of the sediment to stream diversions at crossings.

Since roads are a major source of sediment, the miles of road per unit area (equal to road density) and number of stream crossing per mile provides a crude estimate of the potential condition of a watershed. Road densities in the action area are presented in table 3.6-18 of the Final EIS/EIR. These numbers do not include skid trails or older roads that are not currently used. Seven of the HUs have road densities higher than 5 miles per square mile, and only two have road densities under 2 miles per square mile. Stream crossings per mile on PALCO's ownership range from a low of 3.1 in the North Fork Mattole River HU to a high of 17.7 in the Eel Delta HU, with an average for the ownership of 11.8 stream crossings per mile. Although PALCO has an ongoing program for road maintenance and drainage modification on their property, most logging roads in the action area are susceptible to road crossing failure, particularly older roads built under different standards than are employed today. In addition, there is generally a lack of road surfacing. When heavy trucks drive on the road surface, gravel surfacing is ground into the road, and fine sediment from the underlying soil is forced to the surface. Thus, if road surfacing is not maintained, the road-generated sediment may approach pre-surfacing levels on roads with high traffic levels.

The road system in the action area is provided in Volume V, Map 8 in the Final EIS/EIR. Existing CFPRs require that during the wet season, only rocked roads may be used. Limited field reconnaissance has indicated that surfacing on some mainline roads is currently deteriorated from use within the action area.

Roads are one of the greatest sources of habitat degradation. Roads have significantly elevated on-site erosion and sediment delivery, disrupted subsurface flows essential to the maintenance of baseflows, and contributed to increased peakflows. Roads within riparian zones have resulted in reduced shading and disrupted the input LWD for the life of the road. These effects have caused a degradation of salmonid habitat by increasing fine sediment levels, reducing pool volumes, increasing channel width, exacerbating seasonal temperature extremes, and contributed to the lack of LWD.

Mass Wasting and Other Erosional Processes

Mass wasting is part of a watershed's natural disturbance regime and is sometimes beneficial to salmonids, providing coarse sediment and LWD into stream systems (Reeves et al. 1995). Nonetheless, increases in mass wasting events above natural levels are not beneficial for salmonids. Tectonic activity, erodible soils and naturally unstable parent material, high precipitation, and steep slopes characterize much of the landscape along the California Coast. This combination leads to a landscape dominated by mass movement processes (Chatwin et al. 1994) and high levels of sediment in streams. It is indicative of a landscape that is abnormally sensitive to destabilization by management activities. Streams in the Coast Range of northern California, for example, annually export 7,422.9 tons of sediment per square mile, compared to 151.3 to 291.1 tons of sediment per square mile in Oregon's Coast Range (Hawkins et al. 1983). Mass failures are a major source of sediment into streams. In the Redwood Creek basin, approximately 80 percent of the landslides occur on slopes of 50 percent gradient or more (Harden et al. 1995). In sediment-poor streams, mass wasting may bring in needed rubble and LWD (Everest and Meehan 1981), but sediment impoverishment is not a significant issue in managed basins of northwest California. Usually, mass movements bring sediment into higher-gradient channels, and the sediment is then carried downstream into deposition zones, potentially impairing rearing and spawning functions (Chamberlin et al. 1991). Depending on the amount of material transported, the velocity, and the channel gradient, mass failures that deliver sediment to streams can increase sediment loads, partially or completely block channels, scour streambeds, creating significant cumulative impacts downstream (Swanston 1991).

Mass movement frequency has been strongly linked to the type and intensity of land management within watersheds (Chamberlin et al. 1991, Harden et al. 1995, Rood 1984). In Redwood Creek, the number of streamside landslides increased from 100 in 1947 to 415 in 1976, due mostly to debris sliding following periods of intensive timber harvest, road construction, and large storms (Harden et al. 1995). Timber management activities that undercut hillslopes, increase surface weight, alter surface and subsurface flows, and reduce root strength strongly influence slope and soil stability (Chatwin et al. 1994). In some areas, management-related mass wasting events are primarily associated with roads and their drainage systems, while in other areas landslides are common on open slopes after logging activities (O'Loughlin 1972, Pacific Watershed Associates 1998). Impacts to salmonids may occur if mass failures caused by timber management activities deliver sediment to salmonid habitat or block or impair migration.

Erosion in the Coast range province of Northern California is dominated by mass movement processes. Mass movement is translocation of material by the force of gravity as opposed to movement of material by water. Six categories of landslides are identified and discussed in the Final EIS/EIR: deep-seated landslides (including earthflows and translational-rotational slides), and shallow, rapid mass wasting (including geomorphic features designated as inner gorges, debris slide slope/amphitheaters, debris slides, and debris flows. Each have different characteristics, modes of failure, and management prescriptions. Since the base of many earthflows is at a stream, the overall movement of an earthflow can generate large amounts of sediment through debris slides into streams. For example, Kelsey (1978) estimated that earthflows contributed 63,600 tons/mi^2 of sediment from 1941 to 1975 in a portion of the Upper Van Duzen watershed. This equates to approximately 3.9 feet of surface lowering per century, undoubtedly one of the highest denudation rates on the continent. Movement can be triggered by seasonal moisture accumulation in the soil, which increases pore water pressure and decreases the strength (effective stress) of the soil. While loss of root strength due to timber harvest probably does not affect deep-seated landslides, the increase in soil moisture caused by the decrease in evapotranspiration could cause increased movements (Bedrossian 1983). Effects are likely to be highly specific to each landslide.

Loss of Large Woody Debris

Past and present timber harvest practices have eliminated large trees, large logs, and other woody debris from streamside areas within the action area which could have otherwise been recruited to the channel. This is particularly a concern for California redwoods, which take many decades to decay and could have provided long term benefits to fish habitat and watershed stability. From the 1950s through the 1970s, forest management practices often included removal of LWD from streams based on the belief that it was detrimental to salmon migration. This resulted in major changes in the amount of cover habitat available and often changed stream habitats to a single, cobble-bed channel lacking pools and LWD or to bedrock channels lacking gravel, woody debris, and other channel features (Murphy 1995). This decrease in LWD corresponds to a reduction in salmonid use (House and Boehne 1987). Due to the time required for streamside trees to grow and mature to potential LWD, there may be a considerable lag period (e.g., greater than about 50 years and up to 300 years) before additional LWD is contributed to a cleared stream (Gregory and Bisson 1997). Stream clearing with accompanying replacement of structures (e.g., wood and large rocks) continued into the 1990s in the action area.

LWD from coniferous trees is an important component of freshwater salmonid habitat. It is provided to stream systems from hillslope processes such as debris torrents (McGarry 1994), but predominantly from adjacent and upstream riparian vegetation. Woody debris regulates sediment and flow routing, influences stream channel bedform and bank stability, and provides hydraulic refugia and cover within stream systems (Bilby 1984, Gregory et al. 1987, Hogan 1987, Keller and Swanson 1979, Keller et al. 1995, Lisle 1983, Nakamura and Swanson 1993, Sedell and Beschta 1991), thus influencing the formation of the spatial template within with salmonids exist (Sullivan et al. 1987, Vannote et al. 1980). This template includes pool-riffle bedforms, backwater and edgewater habitats, and cover that provide adult spawning and holding habitat, juvenile summer and overwintering habitat, and refuge habitat from high velocities and predation (Bisson et al. 1992, Sullivan et al. 1987). Reduction in the quantity or quality of any of these habitats may result in reduced survival of salmonids during the life history stages in which those habitats are used (Bisson et al. 1992, Hicks et al. 1991, Rhodes et al. 1994).

Juvenile salmonid abundance is often directly related to the amount of LWD in a stream (Murphy et al. 1986). Woody debris also plays a key role in the retention of salmon carcasses (Cedarholm and Peterson 1985), a major source of nitrogen and carbon in stream ecosystems (Bilby et al. 1996). Forest management activities within the aquatic protection zone have the potential to change the distribution, size, and abundance of LWD in streams (Hicks et al. 1991; Ralph et al. 1994) and to simplify stream channels (Bisson et al. 1992).

Large accumulations of LWD in streams in the form of logging slash, however, may be undesirable and may block fish passage in extreme cases. Logging slash may include larger tree branches and short sections of wood without rootwads. Much of this type of LWD floats and, therefore, can be unstable (Bryant 1980). Unstable accumulations of LWD can wash out and destablize streambanks, potentially causing reductions in fish habitat and overall stream productivity.

CDFG has collected limited information on LWD during its stream habitat surveys in the WAAs of the action area. These data, which are summarized in R2 (1997), provide values for LWD on PALCO lands ranging from less than 1 piece of LWD per 100 feet of stream (e.g., some streams in the Eel River drainage) to over 15 pieces per 100 feet (e.g., portions of the South Fork of Freshwater Creek).

Loss of Riparian Vegetation and Function

As described previously, vegetation within the riparian zone greatly influences the biological and physical processes that provide freshwater habitat for salmonids. These ecosystem roles include maintenance of shade and cover, water quality and flow routing, the aquatic food web, sediment routing and composition, stream channel bedform and stability, and linkages to floodplain (Beschta 1991, Gregory et al. 1991, Naiman et al. 1992, Schlosser 1991, Sullivan et al. 1987). Riparian vegetation produces habitat for salmonids, and its roles vary with the position of the stream reach in the fluvial network (Vannote et al. 1980).

An important product of riparian vegetation is shade, which moderates water temperatures. Reduced shade leads to increased water temperatures, which reduces the success or survival of salmonids during adult upstream migration, juvenile rearing, and downstream migration of smolts. Increased water temperatures have also obstructed adult migration and limited spawning success, triggered early juvenile outmigration resulting in decreased survival rates (Beschta et al. 1987), changed juvenile sheltering behavior (Taylor 1988), reduced disease resistance, and increased metabolic requirements (Beschta et al. 1987).

Timber harvest practices occurring upstream of salmonid habitat may also adversely affect salmonids. Perennial reaches upstream of salmonid habitat influence instream temperatures in larger reaches downstream. The loss of shade from riparian vegetation above salmonid habitat may increase instream temperatures downstream. Upstream reaches, including intermittent and emphemeral streams, carry sediment, nutrients, and woody debris from upper portions of the watershed down to salmonid habitat. The quality of salmonid habitat is determined, in part, by the timing, speed, and amount of organic and inorganic materials transported downstream from reaches above salmonid habitat (Chamberlin et al. 1991). Management activities that increase sediment inputs upstream of salmonid habitat may impair important habitat components, such as deep pools and clean spawning gravels, in downstream reaches. Woody debris in upstream reaches meters sediment and organic debris inputs downstream; the loss of LWD in these upstream reaches may increase the efficiency of sediment and debris transport into salmonid habitat. A paucity of LWD in these upstream reaches also means less LWD available for movement downstream into salmonid habitat.

Forestry practices have affected and have the continued potential to affect freshwater habitat for salmonids through changes in the characteristics of, and inputs from, streamside vegetation (Gregory et al. 1987, Ralph et al. 1994). The NMFS believes that within riparian areas, forest management activities within, adjacent to, or above streams containing salmonid habitat may cause changes in stream temperatures, increase sediment levels, alter species composition and abundance of macroinvertebrates, destabilize streambanks and streamside areas, reduce in-stream structural complexity, reduce LWD recruitment, and alter peak and base flows. Furthermore, the presence and use of roads within this area may contaminate water, create barriers to migration, reduce stream shading, reduce large wood recruitment to the stream, and increase sediment levels. All of these impacts to habitat may harm salmonids.

The current riparian habitat conditions in the action area have been shaped by over 100 years of timber harvest, as well as recent floods, such as the 1964 floods, which reshaped most of the stream channels in the Humboldt area. It is well documented that a considerable portion of riparian ecosystem has been altered or lost since the mid-1850s. Logging on both public and private lands has left a legacy of altered habitats that still require considerable time for recovery, and the return to historical conditions will probably never occur on a large proportion of the forest landscape. Timber harvest practices were not regulated in riparian zones until the 1970s; thus there were more than 120 years of human activity and 50 to 70 years of intensive harvest before mandated consideration of streamside protections. Forest practices which contributed to the decline of riparian habitat include timber harvest to streambank; railroad and road building along the riparian corridors; and splash damming. Additionally, removal of LWD was a biologically recommended practice until the mid-1970s. All of these practices led to a considerable reduction in riparian zone function within the action area.

Loss of Habitat Complexity and Connectivity

Loss of habitat complexity has also contributed to the decline salmonids and suitable habitats. For example, in national forests in Washington, there has been a 58 percent reduction in large, deep pools due to sedimentation and loss of pool-forming structures, such as boulders and large wood (USDA Forest Service et al. 1993). Similarly, in Oregon, the abundance of large, deep pools on private coastal lands has decreased by as much as 80 percent (USDA Forest Service et al. 1993). Sedimentation from land-use activities is recognized as a primary cause of habitat degradation. Site-specific information about habitat complexity and connectivity is not available for PALCO lands.

Changes in Stream Flows and Hydrology
Streamflows and hydrology in northern California have been altered by timber harvest activities. Timber harvest has altered normal streamflow patterns, particularly the volume of peak flows (maximum volume of water in the stream) and base flows (the volume of water in the stream representing the groundwater contribution). The degree these parameters have changed and the area affected depends on the percentage of total tree cover removed from the watershed and the amount of soil disturbance caused by the harvest, among other things. For example, when harvest activities remove a high percentage of tree cover and cause light soil disturbance and compaction, rain falling on the soil infiltrates normally. However, due to the loss of tree cover, evapotranspiration (the loss of water by plants to the atmosphere) is generally much lower than before. Thus, the combination of normal water infiltration into the soil and greatly decreased uptake and loss of water by the tree cover results in substantially higher, sustained streamflows. Hence, this type of harvest has resulted in higher base flows during dry times of the year because infiltration has not decreased and evapotranspiration is low. On the other hand, when the harvest activities caused high soil disturbance and compaction, little rainfall penetrates the soil and recharge groundwater. This has resulted in higher surface runoff and equal or slightly higher base flows during dry times of the year. During wet times of the year, the compacted soils deliver high amounts of surface runoff, substantially increasing peak flows. In general, timber harvest on a watershed-wide scale has resulted in water moving more quickly through the watershed (i.e., higher runoff rates, higher peak and base flows) because of decreased soil infiltration and evapotranspiration. This greatly simplified model only partly illustrates the complex hydrologic response to timber harvest (Chamberlain et al. 1991, Gordon et al. 1992).

Watershed Degradation
Watershed-level variables, such as the drainage network, presence of roads and disturbance history all have affected salmonid habitat. The cumulative effects of numerous roads and other disturbances within watersheds has increased sediment levels, altered hydrology, changed the drainage network, and altered the timing and magnitude of flows. Watershed conditions are additive, that is individual impacts that are perhaps by themselves relatively minor at a watershed scale have been damaging when combined with the impact from one or more other impacts that have occurred with the watershed (Spence et al. 1996). Five watersheds, Bear, Jordon, Stitz and Freshwater Creeks, and Elk River are listed by CDF as being cumulatively impaired due to sediment problems resulting from past forestry activities.

Forest Chemicals and Nutrients
Chemicals used in forest management activities, including pesticides, herbicides, insecticides, fertilizers, fire retardants, petroleum products, and heavy metals can enter streams directly or be carried by runoff water. All of these chemicals can affect salmonids by their direct toxicity or by altering primary and secondary production and influencing the amount and type of food available (Norris et al. 1991). When chemicals are transported across or adjacent to streams, a chemical-spill hazard exists (Furniss et al. 1991). Chemicals may also indirectly impact salmonids through habitat alteration (e.g., changes in riparian plant community). Even at sublethal levels, chemicals may alter neurological, endocrine, and behavioral functions in fish (reviewed in Spence et al.

1996). Excess nitrogen, phosphorous, and other nutrients can enrich surface waters. Enrichment can lead to high phytoplankton and benthic invertebrate production. Too much enrichment can cause algal blooms, which may lead to oxygen depletion in the water. For healthy aquatic habitat, watersheds should have low levels of chemical contamination from agricultural, industrial and other sources and be in compliance with the North Coast Water Quality Basin Plan (NCRWQCB 1996).

The aerial application of fire retardants on or near streams can alter water chemistry and impact salmonids. Norris et al. (1991) summarize the results of an earlier study which showed that direct application of fire retardants to aquatic systems temporarily increased levels of ammonia, nitrogen, and phosphorus to potentially lethal levels. They also noted that some commercial fire retardants contain ferrocyanide as a corrosion inhibitor. The ferrocyanide decomposes under sunlight, then reacts with water to form highly toxic cyanic acid (HCN).

Wildfires also directly affect water quality by destroying vegetative cover and altering the physical properties of surface soil. Fire exposes bare mineral soil to increased surface erosion and runoff. Increases in landslide potential can also occur up to five years after a wildfire event due to the decay of root systems (Swanston 1974 cited in Swanston 1991). Wildfire events can also result in increased inputs of wood and other debris into streams, elevated streamflows, heightened stream temperatures, and increased nutrient levels. Young (1994) noted increased debris transport following wildfires as a result of increased flows and decreased bank stability. Suppression activities associated with wildfires can also impact aquatic and riparian resources through the application of fire retardants, and the construction of fire lines, base camps, and staging areas.

PALCO began large-scale use of herbicides in 1994 as part of a shift towards intensive forest management. PALCO currently uses only EPA "unrestricted herbicides" Oust, Atrazine, Roundup, Accord, Garlon 3A, and Garlon 4 (SYP/HCP). PALCO's existing use of herbicides is subject to all applicable federal and state laws and presently does not employ aerial applications.

At present PALCO is currently engaged in a multi-year reforestation program, reclaiming hardwood areas from older unmanaged clearcut harvests. Herbicides are used as part of this reforestation effort. The current rate of reforestation is 2,000 acres per year and is expected to continue at that rate for another ten years. The reforestation area plus ongoing clearcut harvest amounted to approximately 4,850 acres in 1997. Similar activities were underway in 1998, with the substitution of Oust for most of the Aatrex application in an effort to reduce groundwater contamination.

Current water quality monitoring has not shown measurable levels of herbicides near any of PALCO's ground-based applications, but present monitoring data do not cover Class III ephemeral drainages or some of the streamside environments so effects due to baseline conditions are uncertain.

Grazing

In general, livestock grazing has deteriorated significant areas of the western States. Since the 1930s, rangelands in the Pacific Northwest have benefitted from less intensive grazing; however, the majority of western rangelands are in deteriorated conditions (Spence et al. 1996). Poor upland conditions may increase sediment loads to streams and alter hydrologic regimes, leading to channel incision, channel widening, and further deterioration of riparian zones. Hydrologic changes may occur in response to loss of vegetation or change in soil permeability brought on by reduced organic content, splash erosion, and trampling by livestock. Similarly, sediment transport processes are linked to vegetation cover and the routing of water from the hillslope to the stream (Spence et al. 1996). Since livestock tend to concentrate in areas near water, shade, preferred vegetation, salt and a relatively level topography, essential riparian areas for salmonids may be heavily utilized and become over grazed and trampled, leading to erosion and hydrologic disruptions.

Cattle and sheep grazing has occurred within the action area since the early 1900s. In the 1920s PALCO was actively converting forested land into pastures. Approximately 1,000 head of cattle and sheep were grazed on 15,000 to 25,000 acres of logged and open land. Presently, about 5,700 acres is leased to private cattle operations and about 600 head of cattle graze on PALCO's ownership. This number has decreased from a historical use of 2,000 to 3,000 head of livestock. PALCO has estimated that approximately 6 to 10 acres of pasture land is needed per animal unit across all of PALCO's leased properties. At present, 15 different areas are leased for grazing with 1.3 to 18 acres per animal unit month across PALCO's ownership, averaging 10 acres per unit. According to PALCO (1998), most of these areas have exclusion measures or have inherent site features that limit livestock access to riparian streams. The extent of grazing and effects on salmonid habitat in the action area are currently unknown.

Gravel mining

Sand and gravel mining in riparian areas may have substantial effects of stream channels and hydraulic characteristics of areas essential for salmonids. In addition to the immediate morphological changes in stream channels caused by excavation, channels continue to exhibit instability, accelerated erosion, and altered substrate composition and structure after erosion has ceased (Spence et al. 1996). The associated downcutting of stream channels which frequently follows gravel mining may involve 13.1 to 19.7 feet of depth, resulting in increased flood peaks, increased sediment transport, increased temperatures, and decreased base flows. The most direct impact to salmonids are degradation and simplification of spawning and rearing habitats and increased turbidity (Spence et al. 1996).

Existing gravel and rock extraction activities in the action area include near-stream gravel mining, borrow pits, and rock quarrying. Near-stream gravel mining includes surface-mining operations (paddle wheel skimming from river bars) on the Eel River above the Van Duzen River. Eleven gravel operations are currently located along an eight mile stretch of the lower Eel River, and two additional operations are located on the lower reaches of the Van Duzen River. These gravel operations are under the jurisdiction of Humboldt County, the California Coastal Commission (for those activities conducted within the Coastal Zone) and the COE. Gravel operations are conducted under a Letter of Permission (LOP) adopted by the COE for all navigable waters of the United States within Humboldt County. Under the LOP, the number of operators, location of gravel operations, and amount of material removed varies from year to year, based on annual cross-section surveys and other information, as determined by the County of Humboldt Extraction Review Team (CHERT). The annual maximum amount of gravel permitted to be to extracted by the 13 gravel operations in this area is estimated by CHERT to be approximately 1,480,000 cubic yards. Actual extraction is generally much lower (e.g., less than 400,000 cubic yards in 1995) (California Coastal Commission 1998). Take of SONCC coho salmon is permitted under an Incidental Take Statement issued to the COE on July 9, 1997 for activities involving the near-stream gravel mining. The Incidental Take Statement expires five years from issuance.

Utilization

Commercial, Recreational, and Tribal Harvest

Coho salmon from the action area are contacted by ocean fisheries primarily off California. Coded-wire tagged coho released from hatcheries south of Cape Blanco have a southerly recovery pattern; primarily in California (65-92 percent), with some recoveries in Oregon (7-34 percent) and almost none (1 percent) in Washington or British Columbia (percent data represent range of recoveries for five hatcheries by state or province) (Weitkamp et al. 1995). Ocean exploitation rates for SONCC coho are based on the exploitation rate on Rogue/Klamath hatchery stocks and have only recently become available. The estimated ocean exploitation rates were 5 percent in 1996 and 1997 and 12 percent in 1998 (Pacific Fisheries Management Council 1997, 1998). The extent to which coded-wire tagged recovery patterns of these hatchery stocks coincide with the distribution patterns of wild coho is not known.

Steelhead are not generally caught by commercial or recreational anglers in the ocean. However, although little documented evidence exists, high seas driftnet fishing has been implicated as a cause for decline of steelhead from coastal streams along the North American Pacific Coast (Light et al. 1988). Based on recoveries of marked and tagged North American steelhead, high seas steelhead distribution and driftnet fisheries overlap (Light et al. 1988, Burgner et al. 1992) and recent declines in steelhead abundance may be partially attributed to the harvest of steelhead in high seas driftnet fisheries (reviewed in NMFS 1996). Relatively recent observations of returning steelhead to Rowdy Creek Fish Hatchery on the Smith River in 1992 (just north of the action area) showed healed gillnet scars on 30 of 155 adults (Higgins et al. 1992).

The authorized high seas driftnet and squid fisheries which are thought to have significantly contributed to the decline of listed salmonids have been severely restricted, although unauthorized fisheries are likely to continue at reduced levels.

Sport and commercial fishing restrictions ranging from severe curtailment to complete closures in recent years may be providing an increase in numbers of adult coho spawners in some streams, but trends cannot be established from the existing data. California State fishing regulations prohibit retention of coho in all marine and freshwater fisheries. Some incidental coho mortality likely occurs in association with the release of coho in chinook directed freshwater fisheries but that level take is believed to be low.

Historic estimates of harvest in California's rivers by sport anglers are based on limited monitoring. In the early 1960s, there was an estimated harvest of 122,000 adult steelhead per year and an unknown quantity of harvested juvenile steelhead (CDFG 1965). Harvest rate estimates for the Klamath River for the 1977-78 through the 1982-83 seasons ranged from 7.4 percent to 19.2 percent and averaged 12.1 percent. Preliminary estimates for 1993 show that an estimated 40,500 steelhead were harvested state-wide in California, with 71 percent of the effort occurring along the northern California coast, primarily in the Smith, Klamath, Trinity, and Mad Rivers (T. Jackson, pers. comm., cited in NMFS 1996). Sport fishing catch rates are presently at low levels in the state, indicating declining steelhead population numbers, irrespective of reliable steelhead population estimates (McEwan and Jackson 1996) Illegal harvest can be a serious problem for salmonids on their spawning beds and on their summer rearing/holding habitats. Roelofs (1983) cited poaching as a serious problem on summer steelhead in northern California streams. Large numbers of spring run chinook salmon and summer steelhead seek deep pools as resting or holding sites during periods of sustained flow (e.g., summer steelhead may spend several months in freshwater before spawning). They seek the cover provided by the deep pools and the potentially cooler water temperatures that may be found in these pools during the summer (Nielson et al. 1994, Moyle et al. 1995). During this holding period, the fish are conspicuous, congregate in the pools, and are often unable to leave the pools due to low stream flows. Moyle et al. (1995) has indicated that one of the most immediate threats to adult summer steelhead (and likely other salmonids that may rest in these deep pools) is poaching. Both snagging of fish from the bank and spearing by divers have been reported. Rivers considered to have a serious poaching problem within the action area include the Middle Fork Eel river and Redwood Creek.

Brown et al. (1994) estimated that approximately 90 percent of the Klamath-Trinity basin coho salmon are of hatchery origin. The average annual tribal harvest of coho salmon over the past 5 years has been 670 fish (NMFS 1997), of which 70 may have been naturally spawning. If the minimum population of naturally spawning SONCC coho is about 10,000 fish (Weitkamp et al. 1995), the Tribal impact on listed SONCC coho salmon has been relatively small, on average less than 100 fish per year during the past 5 years and less than 1 percent of the SONCC ESU. Maximum tribal harvest rates on Klamath Basin coho salmon averaged 5 percent from 1992-1997. Tribal harvest rates for chinook salmon on the Eel River and elsewhere within the SOCC chinook salmon ESU are similar. There are no tribal fisheries on coho populations in the Rogue, Smith, Eel or Mattole rivers.

In California, steelhead are taken during the Yurok tribe's fall chinook salmon subsistence fishery in the Klamath river. From 1984 through 1992, an estimated 2,350 steelhead were captured, with a range of 472 in 1984 to 68 in 1992, and an estimated mean of 260 steelhead per year (Craig and Fletcher, 1994). No data is available on the Hoopa or Klamath tribes net fisheries in the Klamath Basin.

Scientific Utilization
Section 10 (a)(1)(A) of the Act authorizes NMFS to issue permits for scientific purposes or to enhance the propagation or survival of listed species. The permitted activity must not operate to the disadvantage of the species and must be consistent with the purposes and policy set forth in section 2 of the Act. The direct and indirect take considered in previous NMFS biological opinions for scientific research permits are considered part of the environmental baseline. Since the SONCC coho salmon ESU was listed, NMFS has completed one programmatic consultation on the issuance of section 10 (a)(1)(A) permits. As of the date of this Opinion, 25 permittees have been covered under the programmatic scientific permit consultation. Under this consultation, take, in the form of kill, harm, and harassment has been authorized for of 265,145 coho salmon adults, juveniles, and adult carcasses. The majority of this take (approximately 98 percent) is in the form of observation or capture and release, and has a minor or moderate effect. Authorization of limited lethal take has been issued for research-associated accidental mortality and direct sampling for eight adults, 2,547 juveniles, and 600 adult carcasses. Effects considered in the issuance of the scientific permits were for the most part, non-lethal in nature and have involved mainly take by harassment (i.e., observation and/or capture/handle/ release actions). The NMFS concluded that the effect of the take authorized by issuance of this scientific permit would not appreciably reduce the survival and recovery of the SONCC ESU coho salmon in the wild.

Disease or Predation
Infectious diseases constitute one of the many factors that can influence adult and juvenile survival in salmonids. Salmonids are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment. Specific diseases, such as bacterial kidney disease, ceratomyxosis, columnaris, furunculosis, infectious hematopoietic necrosis virus, redmouth and black spot disease, erythrocytic inclusion body syndrome, and whirling disease, among others are present and are know to affect salmonids (63 FR 13347). Very little current or historical information currently exists on the occurrence of these diseases in salmonids considered in this Opinion, much less within the action area. Studies have shown, however, that naturally spawned fish tend to be less susceptible to pathogens than hatchery-reared fish (Buchanon et al. 1983, Sanders et al. 1992).

Introductions of non-native species and habitat modifications have resulted in increased predator populations in numerous river systems, thereby increasing the level of predation experienced by salmonids. A high abundance of non-native Sacramento squawfish has been reported recently in the Eel River Basin (Brown and Moyle 1991, Moyle and Yoshiyama 1992), suggesting increased risks of predation.

Predation by marine mammals is also of concern in some areas. NMFS has recently published a report describing the impacts of California sea lions and Pacific harbor seals upon salmonids and on the coastal ecosystems of Washington, Oregon, and California (NMFS 1997). This report concluded that in certain cases where pinniped populations co-occur with depressed salmonid populations, salmon populations may experience severe impacts due to predation. Pinniped predation on small populations of salmonids may be a concern in areas of restricted fish passage, such as the mouth of rivers or below dams. Predation by pinnipeds was identified as a threat in the final rule listing the coho salmon SONCC ESU and the proposed rule for the chinook salmon SOCC ESU, but NMFS concluded in both rules that the threat is minor, overall.

Hatcheries

The impact of hatcheries on the Pacific salmonids has been extensive. Because Pacific salmon have a moderately high fecundity (typically several thousand eggs per female) and a high natural mortality through the early life-history stages, successful fish hatcheries can generally produce many more juveniles than are produced in the wild. Increased juvenile production may (but does not always) result in increased returns of adult fish. However, the efficacy of artificial propagation as a tool for conserving natural salmon populations has not been clearly demonstrated. In fact, the success of artificial propagation for supplementation (i.e., the use of hatchery fish to increase the abundance of naturally spawning fish), is highly controversial (Miller et al. 1990, Steward and Bjornn 1990, Cuenco 1991). Past management practices have resulted in widespread propagation and transplantation of non-local stocks of these fish (Mathews 1980; Washington 1985; Lichatowich and McIntyre 1987), and the impacts of these practices are largely unknown. Although artificial propagation may contribute to the conservation of declining and listed populations, it is unclear whether or how much artificial propagation during the recovery process will compromise the distinctiveness of natural populations. Also unclear is whether or how much ongoing hatchery programs for unlisted species will affect the recovery of listed species or the viability of other unlisted species.

The Mattole Restoration Council (1992) reports that 250,000 salmonids were released in the Mattole watershed between 1980 and 1990. The council's experience with chinook and coho salmon is informative since they were released into tributary streams where chinook or coho salmon were previously extirpated and they now occupy these streams once again. For example, from 1986 to 1991 there have been coho salmon reported in the Lower Mill Creek, where they were previously extirpated. Coho salmon have also re-occupied the North Fork of Honeydew Creek from 1989 to 1991. The population is thought to be self-sustaining in Lower Mill Creek, but introductions continue in Honeydew Creek, Squaw Creek, Thompson Creek, Bear Creek, and the mainstem of the Mattole River.

Within the action area, and in connection with existing programs, PALCO has conducted surveys for certain federal- and state-listed species. PALCO currently operates a fish-rearing facility within the action area at its Yager Logging Camp and at Scotia. There are also two acclimatization tanks at remote sites in the Yager Creek basin. The facilities are used to capture, raise, and release the young of wild anadromous fish from Yager Creek basin. PALCO's fish rearing facilities are presently not covered by section 10(a)(1)(A) of the Act. Only non-listed species are currently being raised in these facilities.

Hydropower Development

Hydropower development has impacted listed salmonids in a variety of ways which have led to the existing conditions under the environmental baseline. Range-wide, construction of dams has blocked access to miles of previously productive habitats. Modification of natural flow regimes has resulted in increased water temperatures, changes in fish community structure, and increased travel time by migrating adult and juvenile salmonids. Sublethal effects (e.g., stress, injury, descaling, and delay) can also occur and affect survival (Hawkes et al. 1991, Johnson et al. 1990). Physical features of dams such as turbines, have resulted in increased mortality of adults and juvenile salmonids as well and attempts to mitigate adverse impacts of these structures have to date met with limited success (NMFS 1986). In California, most hydroelectic development projects have not been required to construct fish bypass facilities; further, projects that have been required to provide fish passage have met with limited success. Dams within the range of the SONCC ESU, such as Copco Dam on the Klamath River, and Scott Dam and Cape Horn Dam on the Eel River, have eliminated or severely hindered access to historical spawning and rearing habitats and have altered the natural flow regimes within the basins. No estimates are available for salmonid mortalities associated with dams in California, however, it has been estimated that adult upstream passage mortalities may range from 5 to 10 percent loss per hydroelectric project in the Columbia and Snake Rivers results in 3 to 5 percent mortality (Kaczynski and Palmisano 1993). These estimates include mortalities which may result from delayed mortalities or possibly poaching. Additional mortalities occur due to "fall back" of migrating adults through turbine structures. Research in the Pacific Northwest has indicated that mortality rates for steelhead that fall back through turbines may range from 22 to 41 percent (Wagner and Ingram 1973).

The salmonid species considered in this Opinion tend to experience different types of direct and indirect physical impacts as a result of existing dam configuration and operations under the environmental baseline. These effects are discussed in NMFS (1996).

Water Diversions

In California, water withdrawals, conveyance and diversion has resulted in the loss of a significant amount of suitable salmonid habitat. Diversion and transfer of water has resulted in depleted river flows necessary for migration, spawning, rearing, flushing of sediment from the spawning gravels, gravel recruitment and transport of large woody debris (Botkin et al. 1995, California Advisory Committee on Salmon and Steelhead Trout 1988, Reynolds et al. 1993). These effects have contributed to the decline of the species considered in this Opinion rangewide and in the action area.

On the Eel River, upstream of the action area, as part of the Potter Valley Project, Pacific Gas and Electric Company (PG&E) currently diverts up to 100 percent of the flow at Cape Horn Dam. This water is exported to the Russian River system. Except for some minor accretion below the project, during summer months, the Eel River is dewatered between Cape Horn Dam and Outlet Creek. The relative contribution of Project water to flow in the Eel River is 61 percent at the confluence with Outlet Creek and seven percent at the ocean, but the relative contribution of water from the Project to at the action area is unknown.

On the Mad River, the Humboldt Bay Municipal Water district operates two surface diversions to supply water to pulp mills. Flows in the Mad River are regulated at Ruth Reservoir in order to provide adequate water for these diversions. The maximum allocation from these two diversions is 60 million gallons per day.

Outside of the action area, but within the range of SONCC coho salmon, the Bureau of Reclamation's Klamath Project diverts water for irrigation from the Klamath River upstream of Iron Gate Dam. Releases below Iron Gate Dam vary annually depending on water year type (e.g. drought or wet year). Since 1996, the annual maintenance regimes were modified to include consideration of downstream salmonid populations. The Bureau of Reclamation is currently consulting with NMFS and USFWS on impacts of the Klamath Project operations on listed species.

The Bureau of Reclamation also exports water to the Sacramento River from the Trinity River. Since 1964, up to 80 percent of the annual flow has been diverted out of the Trinity River. A 1992 Department of the Interior Secretarial Order required a minimum 340,000 acre feet annual allocation to remain in the Trinity River. The Bureau of Reclamation has not yet consulted with NMFS and USFWS on the effects of this water allocation on listed species.

Other Natural and Human-Caused Factors

Natural Events

A series of six large floods occurred within the action area from 1950 to 1975. In particular, the historic flood of December 1964 caused extensive landsliding and gullying, particularly on harvested land (Kelsey 1980, Janda 1978). The combination of unusually high flow events and large inputs of sediment of all sizes produced substantial changes in stream channels that persist in some areas. Channels aggraded up to 12 feet and widened as much as 100 percent (Hickey 1969, Kelsey 1980, Lisle 1981). Channel courses were changed and many became braided. As a result, riparian corridors were stripped, and large volumes of woody debris were introduced by landslides and eroding banks.

Riparian vegetation in widened channels became more isolated from streams in summer, resulting in increased stream temperatures. Since that flood, newly formed banks and riparian vegetation in some stream channels have remained vulnerable to erosion at high flows (Sullivan et al. 1987). The absence of large floods since 1975 and 1986 (depending on the WAA) has helped to stabilize channel conditions so that riparian stands are increasingly less vulnerable to high flows. Most small channels have recovered to the point where riparian trees are reestablished and new debris is accumulating. This riparian vegetation has assisted in the reconstruction of banks by trapping and stabilizing fine sediment. The more recent 1996 "New Years Day" flood was also considered significant by many and demonstrated the susceptibility of some drainages and riparian areas to catastrophic storm events.

Environmental changes in both marine and freshwater habitats can have important impacts on salmonid abundance. For example, a pattern of relatively high abundance in the mid-1980s followed by (often sharp) declines over the next decade occurred in steelhead populations from most geographic regions of the Pacific Northwest. This result was most plausibly explained by broad-scale changes in ocean productivity. Similarly, 6 to 8 years of drought in the late 1980s and early 1990s adversely affected many freshwater habitats throughout the region. These natural phenomena put increasing pressure on natural populations already stressed by anthropogenic factors, such as habitat degradation, blockage of migratory routes, and harvest (NMFS 1996).

Human-Caused Factors

Since the SONCC ESU was listed, the NMFS has issued over 65 incidental take statements on federal activities which may affect the threatened coho salmon and its habitats. These activities have involved a wide range of activities including forest and/or resource area-wide routine and non-routine road maintenance, hazard tree removal, watershed and instream restoration, special use permits (e.g., gravel mining, ingress/egress), timber sale programs (e.g., green tree, fuel reduction, thinning, regeneration, and salvage), water diversions, culvert repairs, and bank stabilization. While few of these activities occurred or will occur within the action area, several of these activities are ongoing and/or will occur contemporaneously with the proposed action, so their effects are part of the baseline conditions experienced by the SONCC ESU and the other salmonids. The effects of these activities include the incidental take of listed SONCC ESU coho salmon due to increased sedimentation to streams, diversion of flows, destruction of riparian vegetation, modification of channel geomorphology, and increases in water temperature. In most cases, the effects of these activities on SONCC salmon have not been quantified. The incidental take statements issued with these consultations have identified reasonable and prudent measures to minimize the effects of any incidental take of SONCC ESU coho salmon for each of these activities, and monitoring of the actions has occurred. Since the effects of these activities are expressed in habitat functions, the ongoing effects of these activities on proposed and candidate salmonids are likely to be similar to those identified for SONCC ESU coho salmon to the extent that their distributions overlap. The overall effects of these activities on the environmental baseline for the species considered in this Opinion is however, uncertain.

Although most of PALCO's lands are closed to the general public, some recreational use does occur. Employees are allowed to hunt on the property, and the lands are used for recreation by a boy scout camp, a church camp, an archery club, and other organized groups.

Campgrounds, boating, swimming, trail construction and use, and other recreational activities can affect fish and fish habitat. Streams, streambanks, riparian vegetation, and spawning redds can be disturbed wherever human use is concentrated. Campgrounds can impair water quality by elevating coliform bacteria and nutrients in streams. Construction of summer dams to create swimming holes causes turbidity, destroys and degrades habitat, and blocks migration of juveniles between summer habitats. Recreational boaters remove snags and debris from rivers to improve aesthetics and safety, affecting habitat structure. Hiking trails can have similar effects as roads on aquatic habitat, especially if they are not maintained.

Federal Land Management

A very small percentage of the land ownership in action area is comprised of federal lands that are primarily managed by the USFS, BLM, USFWS, and USDI National Park Service. All BLM and

USFS lands in the action area currently receive timber harvest management prescriptions under the Northwest Forest Plan. One of the primary goals of the Northwest Forest Plan is to restore currently degraded habitats and maintain the ecological health of watersheds and aquatic ecosystems, including salmon habitat conservation (USDA Forest Service and USDI Bureau of Land Management 1994). The effectiveness of the Northwest Forest Plan in the action area is limited by several factors: 1) federal land ownership is not uniformly distributed in watersheds. For example, most of the federal lands are distributed at higher elevations and further inland (with the exception of Humboldt Redwoods State and National Parks) than private land ownerships, which tend to be at lower elevations and more coastal. Thus, existing protections provided for salmonids on federal lands under the environmental baseline are not sufficient to conserve listed species, and 2) in other areas, particularly BLM lands, federal lands are distributed in a checkerboard fashion, resulting in fragmented landscapes. These factors combined are currently limiting the ability of the Northwest Forest Plan to fully achieve its aquatic habitat restoration objectives at a watershed or river basin scale under the environmental baseline. Although these Federal lands within the action area are limited, NMFS has concluded that biological risks associated with habitat modifications and degradation on Federal lands have declined in this ESU due to implementation of the Northwest Forest Plan, coupled with the completion of numerous section 7 consultations.

Non-Federal Land Management

The CDF enforces the CFPRs on private and State managed forests. Northern California river basins (i.e, Redwood Creek, Mad River, Eel River, Mattole River, Bear River, Ten Mile River, Noyo River, Big River, Albion River, Navarro River, Garcia River, and Gualala River) are composed of private forest lands where timber harvest is managed by CDF. In these 11 river basins, private forest lands average about 75 percent of the total acreage, with a range of 42 percent (Eel River) to 94 percent (Gualala River). NMFS has reviewed the CFPRs to determine their adequacy for protecting anadromous salmonids in California (NMFS 1998). Specifically, the review determined that, although the CFPRs mandate protection of sensitive resource such as salmonids, the CFPR provisions and their implementation and enforcement, fall short of accomplishing this objective. Specific problems with the CFPRs identified by NMFS (1998) include 1) the inclusion of many protective provisions that are not supported by or with scientific literature; 2) provisions that are scientifically inadequate to protect salmonids; 3) inadequate and ineffective cumulative effects analysis; 4) dependency upon registered professional foresters who may not possess the necessary level of multi-disciplinary technical expertise to develop appropriate THPs that do not adversely affect salmonids; 5) dependency by CDF on other State agencies to review and comment on THPs for aquatic resource protection; 6) failure of CDF to incorporate recommendations from other agencies, and 7) inadequate enforcement due to staffing limitations. In 1997 CDF issued guidelines for the protection of listed coho salmon, *Coho Salmon Considerations for Timber Harvesting Under the California Forest Practice Rules* April 1997. Although these "coho considerations" are an improvement over CFPRs, they are only voluntary and therefore are not applied consistently. Even if applied fully and consistently throughout the SONCC coho ESU, the level of protection in the coho considerations, generally, is not adequate to avoid significant adverse effects to coho salmon or their habitat.

Habitat Enhancement

Several projects are currently underway to assess and restore stream habitat conditions for salmonids within the action area. The CDFG Fisheries Habitat Restoration Program plans and implements salmonid habitat restoration projects, or solicits proposals from outside of CDFG for development and implementation in cooperation with CDFG. Activities include placement of boulder clusters, root wads, wing-deflectors, digger logs, and spawning gravel, but could also involve slide stabilization, revegetation, culvert improvements, and installation of fishways. Activities implemented through this program must follow the California Salmonid Stream habitat Restoration Manual, Third Edition (Flossi et al. 1998). The effects of the CDFG Fisheries Habitat Restoration Program on listed salmonid species were analyzed in an August 6, 1998 biological opinion to the COE. Effects considered included temporary impacts from short-term increased levels of turbidity. The Incidental Take Statement permitted a minimal level of incidental take, but this level was determined to be unquantifiable. Habitat enhancement projects are generally considered beneficial to salmonids, but short-term effects can occur, usually in terms of increased turbidity during placement of new structures. Long-term adverse effects can also occur if enhancement activities are not properly planned and executed.

Some projects that have been completed or are currently under way within the action areal include: 1) Numerous stream enhancement/restoration projects undertaken by PALCO since 1987. These efforts have included access improvements, bank stabilization structures, and in-stream channel enhancements. About 50 projects are completed each year; 2) operation of a weir on Freshwater Creek and stream restoration activities conducted by the Humboldt Fish Action Committee; and 3) an extensive stream assessment and restoration activities in the Mattole River watershed conducted by the Mattole Watershed Salmon Support Group.

In the Mattole River, many sites along the 62-mile length of the river have been the subject of a well-focused restoration effort. Although the Mattole Restoration Council has not delineated specific ecological criteria for success, it is clear that restoration of self-perpetuating native salmonid populations continues to be a major goal. Quantitative data are lacking on the extent of watershed and bank treatment and returns of native fish.

PG&E's Potter Valley hydroelectric project is a major diverter of water from the mainstem Eel River. As the result of consultations with the FWS, NMFS, and CDFG, PG&E recently constructed a $14 million fish screen facility at the Cape Horn Dam diversion on the Eel River and will also increase project flows to the Eel River by an additional 15 percent. These additional instream flows combined with the new fish screening facilities are expected to improve habitat quality and benefit all salmonids in this system. As part of a proposal being carried forward to Federal Energy Regulatory Commission, PG&E is funding efforts to suppress Sacramento squawfish in the Eel River as well as other monitoring activities.

Several efforts are in the planning and/or implementation stage by federal, state, local, and tribal interests to promote the conservation of declining stocks of salmonids. Many of these efforts will directly and indirectly benefit the Pacific salmonids within the action area. Progress on these efforts, and estimates of timing for their implementation are summarized in NMFS (1996).

As part of the Salmon, Steelhead Trout, and Anadromous Fisheries Program, the CDFG has produced a draft plan which outlines management activities for the restoration and maintenance of California's steelhead populations. Further, in recognition of the need to protect the genetic integrity and habitats of all steelhead stocks, the CDFG Commission has recently updated and amended it's Steelhead Rainbow Trout policy. These, and other ongoing and future efforts to recover steelhead stocks are discussed in NMFS (1996).

Integration and Synthesis of the Environmental Baseline

The decline of Pacific salmonids is not the result of a single factor, and to search for the single cause is a misleading oversimplification. Multiple factors have contributed to the decline, and multiple factors may still be preventing recovery. The identification of one such factor does not rule out the possibility that others are also acting, perhaps synergistically, to prolong the decline. Furthermore, the causes for the decline appear to include both natural and anthropogenic influences.

- Coho salmon stocks in the northern California region of the SONCC ESU could be less than six percent of their abundance during the 1940s and have experienced at least a 70 percent decline in numbers since the 1960s. This decline prompted the NMFS to list the SONCC ESU as threatened. Likewise, populations of chinook salmon, steelhead, and coastal cutthroat trout have declined severely to levels that have warranted their consideration for listing

- Current riparian habitat conditions in the action area have been degraded and/or modified by over 100 years of timber harvest, as well as recent floods, such as the 1964 floods, which reshaped most of the stream channels in the action area. It is well documented that a considerable portion of riparian ecosystem has been altered or lost since the mid-1850s. Existing freshwater habitat conditions in the action area do not fully meet the essential habitat requirements of salmonids.

- Timber harvest activities have altered watershed conditions within much of the action area by changing the quantity and size distribution of sediment, leading to stream channel instability, pool filling by coarse sediment, or introduction of fine sediment to spawning gravels. These conditions have led to a reduction in the presence of suitable spawning areas within the action area. While current forestry management under the Northwest Forest Plan is considered to be generally protective of Pacific salmonids, timberland managed under this system makes up only a very small percentage of the action area. On non-federal timberlands, existing CFPRs fall short of providing adequate protections for salmonid habitats. Ongoing forest activities on non-federal lands are likely to continue to degrade essential salmonid habitat values.

- The ability of riparian ecosystems to control sediment inputs from surface erosion has been severely reduced in several areas within the action area due to timber harvest practices such as harvest to streambanks. The resulting loss of vegetation or organic litter (including LWD), combined with slope, soil type and drainage characteristics have reduced the ability of riparian buffers to trap sediments by determining the infiltration rate of water and the velocity of overland flow. These factors have combined to increase the delivery of fine sediments to several streams in the action area, significantly reducing the suitability of stream conditions for listed salmonids. Bear, Jordan, Stitz and Freshwater Creeks, and Elk River within the action area are currently listed by CDF as cumulatively impacted by sediment due to past forestry practices.

- Geomorphological characteristics of several WAAs proposed for harvest activities within the action area have high erosion hazard ratings, posing significant risks for mass wasting events following harvest activities, which could severely affect salmonids.

- Several watersheds within the action area have been identified as having sediment and/or water temperature problems. The EPA has listed the following river systems under the Clean Water Act section 303(d) as "water quality limited": Mad River (sediment and turbidity), Freshwater Creek (sediment), Elk River (sediment), Yager Creek (sediment), Eel River (sediment and temperature), Van Duzen River (sediment), Mattole River (sediment and temperature).

- Past and present timber harvest practices have eliminated large trees, large logs, and other woody debris from streamside areas within the action area which could have otherwise been recruited to the channel. Removal of LWD from streams on the belief that LWD was detrimental to salmon migration resulted in major changes in the amount of cover habitat available and often changed stream habitats to a single, cobble-bed channel lacking pools and LWD or to bedrock channels lacking gravel, woody debris, and other channel features (Murphy 1995). Due to the time required for streamside trees to grow and mature to potential LWD, there may be a considerable lag period (e.g., greater than about 50 years and up to 300 years) before additional LWD is contributed to a cleared stream (Gregory and Bisson 1997).

- Commercial, recreational, and tribal fisheries continue to incidentally take listed SONCC ESU coho salmon and proposed SOCC chinook salmon. Ocean harvest rates for coho remain at approximately 12 percent.

- Poor/uncertain hatchery practices in the past continue to have lingering adverse effects on natural populations of Pacific salmonids within the action area.

- Predation from non-native Sacramento squawfish in the Eel River basin remains uncontrolled. Marine mammal predation will continue.

- Gravel Mining activities continue to modify streambed structure and hydrologic flows.

- Grazing activities have degraded riparian areas within the action area and will continue.

- Ongoing federal activities which result in direct and indirect take (e.g. water diversions, culvert repairs) will occur contemporaneously within the range of the salmonids considered in this Opinion. Since much of the incidental take associated with these projects has been unquantifiable, the overall contribution of the effects of these actions to the environmental baseline is uncertain.

- Natural events (i.e., floods, earthquakes, fires) have caused significant modifications to habitats in the past and are likely to recur. The action area experiences frequent seismic activity.

In the face of all these changes and influencing factors, the SONCC coho salmon, SOCC chinook salmon, Northern California steelhead, and SOCC coastal cutthroat trout ESUs do not appear to be able to maintain themselves. The available evidence suggests that a significant part of the problem is lack of properly functioning habitat. Observations of salmonid abundances since the 1950s illustrate that severe declines of salmon have occurred.

LISTED SPECIES/CRITICAL HABITAT:

American peregrine falcon

Species

Numbers and distribution

Twenty-five peregrine nest sites (including 5 alternate sites) are known to occur within a subregional area that includes Humboldt, Del Norte and western Trinity counties. Annual monitoring of these sites has been incomplete, with some sites not being monitored for several recent years.

Three peregrine nest sites are known to occur in the action area; one of which is known to occur on PALCO lands. The three known sites in the action area represent 15 percent of the known sites (not counting alternate sites) in the three-county subregional area. The single known site on PALCO lands represents five percent of the known sites (not counting alternate sites) in the subregional area. The two sites not located on PALCO lands may be within 0.5 mile of PALCO lands. Actual distance has not been measured.

Reproduction
Productivity and occupancy of the sites in the 3-county area are incompletely known, due to lack of systematic and complete monitoring surveys. However, as many as 12 of these sites have been occupied during a single year based on limited monitoring.

Suitable habitat
Landscape comparison
Since peregrines use a wide variety of terrestrial habitats (including associated aquatic habitats) during their annual life cycle, no estimate of suitable foraging habitat is available for the species on a local (three county), regional, or range-wide basis. Similarly, no estimate exists of the number of potential nest cliffs and other ledge sites that might be available for peregrine nesting at any of these landscape scales. No landscape comparison of the amount of suitable habitat between the action area and any larger scales is available. However, the FWS has previously indicated that suitable habitat is not considered to be a limiting factor in the recovery of this species (USDI Fish and Wildlife 1998).

Factors affecting species and suitable habitat in the action area
Other completed or contemporaneous actions
At the present time, the FWS is involved in one consultation involving the potential take of peregrine falcons within the action area. During January and February, 1998, the North Coast Railroad Authority requested a permit from the COE to repair portions of the track that had slumped into the Eel River at Scotia Bluffs; the repair involved placement of riprap within the waters of the U.S. The COE issued a permit under Nationwide Permit 13 (bank stabilization) to cover the completed work. Consultation related to this project has not been completed to date; the COE is still attempting to secure the necessary information from the North Coast Railroad Authority. Since this project involved the use of equipment that creates noise in excess of ambient conditions, and is within 0.5 mile of a known nest site, the FWS anticipates that adverse effects to peregrine falcons may have occurred from this project. No suitable habitat was removed or degraded as part of this project, so adverse effects due to habitat loss are not expected to have occurred.

The FWS is also involved in a second consultation involving peregrine falcons along Highway 96 near Hoopa in Trinity County (within the three county subregional area, but not within the action area). Under emergency consultation authorization, Caltrans used explosives to remove a large boulder above the highway that was an immediate threat to human safety. This project occurred during the nest season and within 0.25 miles of a known peregrine nest site. Hence, the project may have resulted in adverse impacts to the species near the nest site. Caltrans has initiated formal consultation on this project; FWS has not completed the analysis or the biological opinion for this action.

Other protective measures
The peregrine falcon is currently protected as a bird of prey under section 3503.5 of the CDFG Code. This section of the code protects the species from the take, possession, or destruction of

nests or eggs. The species is also a "fully protected species" under section 3511 of the Fish and Game Code. Section 3511 prohibits the take or possession of this species or any part thereof. This code further prohibits the issuance of any permit or license issued for such take or possession, except as authorized by the commission for collection for scientific purposes, or for the live capture and relocation such species pursuant to a permit for the protection of livestock.

Northern spotted owl

Species

Numbers

A total of 156 northern spotted owl sites (122 pairs; 28 resident singles; 6 status unknown) occur on PALCO lands, based on surveys conducted during the period 1992 to 1998 (table 23; based on table 3.10-7 of the Final EIS/EIR. The stated number of pairs includes those identified as "Pair, Status Unknown" in table 3.10-7; "pair status unknown" was defined as a pair whose nesting status could not be determined but was included in the total number of pairs (S. Chinnici, pers. comm., Wildlife Biologist, PALCO, December 1, 1998). Pair and resident single owls on PALCO lands account for approximately 2 percent and 3 percent of the total number of pair and resident singles, respectively, throughout the owl's range. An additional 259 sites (221 pairs and 38 resident singles) are known to occur outside of PALCO lands and in the action area (source: CDFG Northern Spotted Owl Database). Most of the PALCO lands have been surveyed, however, the precise amount of area surveyed could not be quantified for the purpose of this consultation. The density of owl sites on PALCO lands (10 to 19 sites per township) is among the highest reported for the species (Gould 1995).

Distribution

Spotted owl sites are generally distributed throughout the action area, consistent with the distribution of suitable habitat. The distribution of known spotted owl sites is further described as follows, relative to key locations in the action area: MMCAs – 10 pairs and 2 resident singles; and Headwaters Forest – 5 pairs and 1 resident single.

Reproduction

During the survey period from 1992 to 1998, an average of 33.5 percent (range = 18.0 to 64.9 percent) of pairs detected were confirmed as nesting pairs on PALCO lands (Final EIS/EIR table 3.10-7). These nesting pairs produced an average of 27.2 total young per year (range = 11 to 40 young). An average of 1.2 young (range = 0.5 to 1.9 young) were produced per nesting pair (i.e., reproductive output). Data on productivity (i.e., number of fledged young per pair producing young) and on fecundity (i.e., female young fledged per female), as described by Franklin (1998a), could not be derived from the available information. All demographic data (e.g., survival rates) needed to calculate the growth rate or decline of the owl population on PALCO lands have not been collected.

Table 23. Comparison of number of owl sites and acres of suitable habitat found on PALCO lands, Humboldt County, California to those found at different landscape levels. Percentages shown represent the percentage of the total at each level that is attributed to PALCO lands. Data for PALCO lands are included in other landscape levels

	Owl numbers		Acres of
Landscape level	Pairs	Resident singles	suitable habitat
PALCO lands [1]	122	28	170,404
Action area [2]	343 (36%)	66 (42%)	771,782
Regional [3]	1,109 (11%)	238 (14%)	2,695,629
Recovery unit [4]	846 (14%)	171 (18%)	-[5]
Range wide [6]	3,602 (3%)	957 (3%)	8,300,000

[1] Owl numbers were based on Final EIS/EIR, table 3.10-7. Habitat data was based on PALCO (1999).
[2] Owl numbers were based on CDFG Northern Spotted Owl Database. Habitat data was based on The Resources Agency of California (1993).
[3] Owl numbers were based on the CDFG Northern Spotted Owl Database. Data for Curry County, Oregon was based on Oregon State Spotted Owl Database. Habitat data for Mendocino, Humboldt, and Del Norte counties was based on the Resources Agency of California (1993). Habitat data for Curry County, Oregon was only provided for two ownerships: Siskiyou National Forest (D. Lyke, pers. comm., January 22, 1999); and Coos Bay District of the BLM (J. Flora, pers. comm., January 11, 1999). As a result, the amount of suitable habitat in Curry County is underestimated. The estimate for the two ownerships, however, was overestimated because all canopy cover classes and size classes of predominately smaller diameter trees (generally not considered suitable habitat) were included in the total. The overestimate is greatest on the Siskiyou National Forest. The error in the estimate could not be determined for the purpose of this consultation.
[4] The recovery unit is defined as the California Coast Province (USDI Fish and Wildlife 1992a). Numbers of owls were based on the same source.
[5] "-" indicates data are not available.
[6] Owl numbers were based on USDA Forest Service and USDI Bureau of Land Management (1994). Habitat data were based on USDI Fish and Wildlife Service (1992a, Volume 1, page 37).

Suitable habitat

Landscape comparison

The PALCO lands encompass approximately 170,404 acres of suitable spotted owl habitat: nesting (94,543 acres); roosting (40,302 acres); and foraging (35,558 acres) (PALCO 1999). Nesting habitat is further described as follows: high quality (58,783 acres); moderate quality (35,223 acres); and low quality (537 acres). Foraging habitat in this context describes timber stands apparently suitable for use as foraging cover, and does not include early seral stages that may produce prey species.

The distribution of suitable spotted owl habitat is further described as follows, relative to key locations in the action area: MMCAs - 7,832 acres; and Headwaters Forest - 6,761 acres. Habitat quality in these area is further described as follows, based on PALCO (1999): MMCAs - high quality nesting (4,761 acres), moderate quality nesting (1,552 acres), low quality nesting (168 acres), roosting (524 acres), and foraging (826 acres); and Headwaters - high quality nesting

(4,606 acres), moderate quality nesting (1,157 acres), low quality nesting (91 acres), roosting (64 acres), and foraging (843 acres).

The amount of suitable habitat on PALCO lands is compared on a landscape level (table 23). Suitable spotted owl habitat on the PALCO lands comprise about 22 percent, 6 percent, and 2 percent of the total amount of suitable habitat in the action area, regional area, and rangewide, respectively.

The listed range of the northern spotted owl encompasses 54,360,500 acres, including all ownerships (USDI Fish and Wildlife Service 1992a). This estimate is based on province totals. PALCO lands occupy less than 0.4 percent of its total listed range.

Dispersal habitat
For the purpose of this consultation, all late-seral habitat (including uncut old-growth, residual old-growth, and late-seral forest) and mid-seral forest stands were assumed to provide adequate structural conditions for dispersal habitat. A total of 145,532 acres of dispersal habitat occurs on the PALCO lands: late-seral (63,170 acres; and mid seral (82,362 acres) (PALCO 1999).

Other protective measures
Spotted owls are covered by protection measures of the CFPRs. These protective measures are summarized as follows:

1. Determine if the proposed action would result in take of the northern spotted owl.

2. Implement the following measures to avoid take:
    a. Prohibit timber harvest within 500 feet of nest or pair activity center during the breeding season.

    b. Retain roosting habitat within 500 to 1,000 feet of nest or pair activity center.

    c. Retain 500 acres of suitable habitat within a 0.7-mile radius of a nest or pair activity center; less than 50 percent of the area may be under operation in any one year.

    d. Retain 1,336 acres of suitable habitat within a 1.3-mile radius of a nest or pair activity center.

    e. Conform retention areas to natural landscape.

<u>Bald eagle</u>
Species
Numbers and distribution

Bald eagle nest sites are not known to occur on the PALCO lands or in the action area (Table 24) (source: CDFG Bald Eagle Database). Although no observations of bald eagles are recorded on lands owned by the Elk River Timber Company, the bald eagle is suspected to occur on these lands. Nesting bald eagles are unlikely to occur in the future on the PALCO lands in large numbers, based on the size of the nesting population in the regional area. Any nesting population on the PALCO lands would represent a very small percentage of the total, compared to totals in the recovery management unit or range-wide.

Table 24. Comparison of number of eagle pairs at different landscape levels, based on 1997 survey data.

Landscape level	Number of pairs
PALCO lands	0
Action area	0
Regional area[1]	10
Recovery mgt. unit 23	12
California	142
Pacific recovery region	1,359
Lower 48 states	5,170

[1] The regional area is defined as Mendocino, Humboldt, and Del Norte Counties, CA, and Curry County, OR. Data for Mendocino, Humboldt, and Del Norte Counties were based on CDFG bald eagle data base, and data for Curry County was based on Oregon State Bald Eagle Database.

Wintering bald eagles (5 to 11 individuals) have been observed from November to March in various watersheds on PALCO lands: Yager Creek watershed (three to seven eagles); Eel watershed (one to two eagles); and Humboldt watershed (one to two eagles).

Reproduction
No information on reproduction of the bald eagle is available for PALCO lands or the action area, since no nests are documented for either area. Reproduction rates for the bald eagle have met or exceeded recovery goals at the recovery unit and range-wide levels.

Suitable habitat
Acreage
Late-seral forests provide suitable habitat for the bald eagle. For the purpose of this consultation, suitable bald eagle habitat is defined as follows: primary nesting and roosting habitat – all residual old-growth and uncut old-growth stands within 0.5 mile of Class 1 streams; secondary nesting and roosting habitat – all residual old-growth and uncut old-growth greater than 0.5 mile from Class 1 streams; wintering habitat – all late-seral forests, residual old-growth, and uncut old-growth.

Suitable habitat for the bald eagle on PALCO lands is quantified as follows: primary nesting and roosting habitat - 19,792 acres; secondary nesting and roosting habitat - 23,839 acres; and wintering habitat - 69,231 acres (table 25).

Table 25. Acres of suitable bald eagle habitat on the PALCO lands, MMCAs and Headwaters Reserve.

	Land Allocation		
Habitat type	PALCO	MMCAs	Headwaters
Primary nesting/roosting	19,792	1,654	3,115
Secondary nesting/roosting	23,839	5,262	3,783
Wintering	69,231	5,788	5,304

Distribution and quality

Primary nesting and roosting habitat (19,792 acres) is currently distributed throughout the PALCO lands. The distribution of this habitat by WAA is summarized as follows: Bear Mattole - 3,683 acres; Eel River - 5,125 acres; Humboldt Bay - 4,525 acres; Van Duzen - 1,492 acres; Yager Creek - 4,880 acres; and Mad River - 88 acres. The distribution of the other habitat types was not compiled for the purpose of this consultation.

Landscape comparison

A meaningful comparison of the amount of suitable habitat at different landscape levels was not possible due to a lack of appropriate information (e.g., locations of Class I streams and vegetation characteristics) for all levels. Estimates of the amount of suitable habitat for the action area, regional area, and range-wide are not available.

Suitable habitat on the PALCO lands is assumed to occupy less than 1 percent of the total listed range, based on the size (most of the lower 48 states) of the eagle's listed range. Acres within the listed range of the bald eagle were not calculated for the purpose of this consultation.

Factors affecting species and suitable habitat in the action area

Other protective measures

Bald eagles are covered by the CFPRs. These protective measures are further summarized as follows:

1. Retain a buffer of at least 10 acres around active nests. Prohibit clear-cutting but allow commercial thinning, salvage, selection, and shelterwood (except seed tree removal step)

timber harvest prescriptions within the buffer. Retain all designated perch, screening, or replacement trees.

2. Prohibit timber operations within the buffer zone during the breeding season (January 15 to August 15 or four weeks after young leave the nest). Exceptions for hauling on existing roads can be made.

3. Prohibit helicopter yarding within 0.25-mile radius of the nest tree; allow gradual approach of helicopters within 0.5-mile radius of nest tree.

Marbled murrelet

The action area for the analysis of effects on the marbled murrelet is defined as all PALCO lands, including the Headwaters acquisition area. It is important to note that this definition is different from that used for some of the other species addressed in this biological opinion.

Species

Numbers

The Final EIS/EIR provides information on the marbled murrelet population at the following scales: the Bioregion, Recovery Zone 4 (USDI Fish and Wildlife Service 1997), and California. The Bioregion extends from the Mad River south to Shelter Cove and inland 35 miles including the action area. The Bioregion includes public lands in the King Range National Conservation Area, HRSP, and GCSP. Population estimates for California range from approximately 5,000 to 6,000 murrelets (Swartzman et al. 1997, Ralph et al. 1995). The Bioregion population is estimated to be 1,479 murrelets (Swartzman et al. 1997).

The precise number of murrelets occupying the action area is unknown but can be crudely estimated in two simple ways based on available data:

1. First estimate the amount of likely occupied habitat in the action area and in California. Using at-sea survey results for California (Nelson 1997), then estimate the proportional number of murrelets expected in occupied habitat in the action area. Using this method, the FWS estimates there are approximately 1000 murrelets on PALCO lands, including the Headwaters acquisition area.

2. Swartzman et al. (1997, page 12 and Appendix 1) divided the northern California subpopulation into two distinct groups and used local at-sea surveys to estimate the number of murrelets in Bioregion. They estimated 1,479 murrelets occur in the Bioregion. To further apportion murrelets to the action area within the bioregion, the FWS used this figure to estimate that approximately 926 murrelets occur on PALCO lands, including the Headwaters acquisition area.

These two figures likely overestimate of the number of murrelets residing on PALCO lands because the FWS probably underestimates the amount of occupied habitat in HRSP; this issue is discussed later in the section describing the amount of occupied habitat in the Bioregion.

In the SYP/HCP, Ralph et al. conclude that the northern California marbled murrelet population appears stable. In contrast, a recent analysis of this data on population trend found stable populations offshore the Redwood National Park region and declining populations offshore of the northern Del Norte region (6.6 percent per year) and the Bioregion (13.3 percent per year) (Stanley 1998). This report shows yearly declines of 7.9 percent for the northern California population with a cumulative decline from 1989-1997 of 48 percent. A rate this high seems unlikely to have gone unnoticed by field researchers (USDI Fish and Wildlife Service 1997, page B-18), but most at-sea survey designs currently in use have a low power to detect declines of these magnitudes because of low statistical power (Becker et al. 1997). Murrelet movements north and south within the northern California remain unknown and further confound interpretation of the data. The Stanley (1998) analysis is a draft currently being peer reviewed for publication and the Ralph et al. analysis (SYP/HCP) has not been adequately reviewed. Until these analyses receive acceptable peer review and their conflicting conclusions are addressed, the FWS will continue to rely on the demographic modeling conducted by the Recovery Team (USDI Fish and Wildlife Service 1997, Appendix B) as the best available information concerning murrelet population trends. These authors concluded that the murrelet is most likely declining at rates of between 4 and 7 percent per year, with the possibility that sharper declines may be occurring in some localized areas.

Distribution

For the purposes of calculation at the landscape level, both of these population estimation methods assume that murrelets occur homogeneously within all occupied habitat within the action area, Bioregion, Zone, and listed range. When evaluating distribution at the scale of the forest stand, it is more reasonable to assume that murrelets occur differentially in occupied habitats in amounts that reflect habitat quality, occurring in higher densities and/or achieving greater reproductive success in good habitat and in lower densities with lower success in poorer habitats (Ralph et al. 1995, Swartzman et al. 1997, pages 13-14, 18-19). For example, it is logical to assume that murrelets occur in the action area in greater densities in high quality habitat such as the Allen Creek stand and in lower densities in lower quality residual redwood stands such as "Turkey Foot," even though both stands are categorically classified as "occupied" (Swartzman et al. 1997, page 13). It is important to note that residual old-growth redwood stands "exhibit a wide range of potential suitability for murrelets, with some resembling old-growth, some resembling clear cuts with a few large trees left standing, and some in between" (Swartzman et al. 1997, pgs. 13, 18-19).

However, we have no reliable information with which to apply a meaningful measure of these habitat differences, relate this measure to murrelet densities and distribution, and calculate precise estimates of murrelet numbers on a site specific basis. This issue of differential habitat quality is discussed later in this opinion.

Most of the known occupied stands are located in the northern part of the action area. However, smaller stands of relatively isolated old-growth habitat containing murrelets are scattered across PALCO lands, with several occupied stands located in the southern part of the SYP/HCP area adjacent to HRSP and GCSP.

Reproduction
There is no quantitative data available on marbled murrelet reproductive success in the action area. As discussed above, it is likely that reproductive success is higher in high quality habitat and low in lower quality habitat. The specific habitat features that affect reproductive success, such as canopy cover and stand size, are discussed in the Suitable Habitat section below.

Suitable Habitat
In development of this Environmental Baseline, the FWS has observed some inconsistencies with the habitat acreage estimates in the various publications describing the SYP/HCP and in recent revisions or new information updates. All of these observed inconsistencies are small (on the order of 1-3 percent), and are unlikely to negatively affect the FWS's ability to describe the impacts of the SYP/HCP. Small discrepancies in acreage totals between different tables are most likely due to variation in GIS estimates and calculations or to small errors in some source data; also, there were revisions to the SYP/HCP made in December, 1998, which placed more habitat into reserve areas. The FWS resolved most of these discrepancies in the course of developing this biological opinion.

Most of these revisions occur in the following areas: PALCO has completed review of data from 1998 field work and has provided more information to the agencies concerning (1) the amount of known or likely occupied habitat in HRSP, (2) the amount of potentially suitable residual old-growth redwood habitat that has been field verified to actually be suitable or unsuitable, and (3) some additional suitable residual old-growth redwood that has been surveyed to PSG protocol (Ralph et al. 1994) and determined to be either occupied or unoccupied by marbled murrelets.

To estimate the total amount of potentially suitable murrelet habitat on PALCO lands (including Headwaters acquisition area), the Service updated the analysis (T. Reid, pers. comm., January 11, 1999, Appendix 1) and incorporated the December, 1998, additions to conservation areas; we conclude there are 26,105 acres of suitable murrelet habitat on PALCO's ownership. The FWS has received recent information from PALCO further updating this analysis with results from 1998 field surveys (S. Chinnici, January 19 and January 25, 1999). Ground surveys revealed that 1,837 acres of residual redwood was not suitable murrelet habitat; this number was subtracted from the 12,447 acres of this type in Appendix 1. This information was reviewed and confirmed by the agencies. Applying these updated figures, approximately 24,268 acres of potentially suitable murrelet nesting habitat occurs on the PALCO lands (including the Headwaters acquisition area), which is about 11 percent of the total ownership. The remainder of the forest on PALCO lands, such as late-seral forests that lack a residual old-growth component, is not considered potentially suitable murrelet habitat (although impacts to some of this acreage, if contiguous with suitable habitat, could affect the marbled murrelet if not adequately buffered).

Estimate of Different Types of Suitable Habitat

Marbled murrelet suitable habitat in the SYP/HCP area can be divided into three general habitat types: unentered old-growth redwood (UOG), residual old-growth redwood (ROG), and old-growth Douglas-fir (DFOG) (Table 26). Old-growth redwood or Douglas-fir stands that are determined by the company and the agencies to not be suitable murrelet habitat, such as the 1837 acres described above, are not included in this discussion.

Table 26. Acreage estimates of potentially suitable marbled murrelet habitat on PALCO ownership and the Headwaters acquisition area in three habitat types: unentered old-growth redwood (UOG), residual old-growth redwood (ROG), and old-growth Douglas-fir (DFOG). Data from Appendix A.

	UOG	ROG	DF	Total
Acres	5,139	10,610[1]	8,519	24,268

[1] Appendix 1: 12477 - 1837 (S. Chinnici, January 25, 1999) = 10,610

Unentered Old-Growth Redwood: The FWS defines UOG as those stands of old-growth redwood from which commercial timber has not been removed. Of the 5,139 acres of UOG, the largest stands are primarily found in the northern third of the PALCO property (see Final EIS/EIR map at figure 3.9-2). The largest contiguous block of UOG is the Headwaters Forest (including the Elkhead Springs stand), which contains about 3,117 acres of UOG (61 percent of the UOG on the property). The remaining UOG stands often contain over 30 old-growth trees per acre and, although small openings do occur, often exhibit 80 to 100 percent canopy closure.

Residual Old-Growth Redwood: The FWS defines ROG as those stands of old-growth redwood from which commercial timber has been selectively removed at some point in the past. Stands of potentially suitable ROG, in which varying numbers of old-growth trees remain after selective harvest, occupy approximately 10,610 acres. These residual stands are widely scattered across PALCO lands (see Final EIS/EIR map at Figure 3.9-2), and many have been internally fragmented by recent clear-cutting. About 96 percent of the residual stands contain fewer than 15 old-growth trees per acre.

Old-Growth Douglas-fir: The FWS defines DFOG as those stands dominated by old-growth Douglas-fir and from which commercial timber has or has not been removed. There are approximately 8,519 acres of potentially suitable DFOG stands on the ownership. This habitat is relatively drier and has more of a hardwood tree component than the UOG and ROG redwood stands. Although much of this habitat appears to be suitable for marbled murrelet nesting, murrelet surveys of this habitat (46 percent of the 8,519 acres has been surveyed) revealed low occupancy rates (approximately 5 percent). This is discussed below in the section that addresses the amounts of occupied acreage on PALCO lands.

Estimate of Occupied Habitat on PALCO Ownership (including Headwaters)
PALCO forest stands have been surveyed for marbled murrelets to varying degrees. Some areas are known to be occupied, some are known to be unoccupied, others are partially surveyed, and still other areas have not been surveyed and may not even be suitable nesting habitat when field inspected. The Service used the following steps to estimate the total amount of PALCO acreage that is likely to be occupied by nesting murrelets:

1. Tabulate the acreage known to occupied, known to be unoccupied, and incompletely surveyed or unsurveyed (Table 27).

2. Segregate by general habitat type (i.e., UOG, ROG, DFOG)

3. Use an occupancy index, calculated from stands within each habitat type with completed surveys, and apply this index to the unsurveyed acreage; this figure is the "likely occupied."

4. Add the known occupied and likely occupied to get an estimated total occupied for each habitat type.

Prior to conducting marbled murrelet surveys in a timber stand, an assessment is conducted regarding the suitability of the habitat and a final determination is made by company biologists, consultants, and agency biologists. If the habitat is determined to be suitable (i.e., it contains the requisite habitat features to allow murrelet nesting), surveys are conducted. If the habitat is deemed unsuitable, surveys are not conducted. Appendix A describes the respective amounts of UOG, ROG, and DFOG habitat types that have been surveyed. Although survey effort was not applied in a totally consistent manner across all areas due to logistical concerns, the FWS believes these data are statistically adequate to arrive at general conclusions concerning the respective rates at which unsurveyed DF, ROG, and UOG are likely to be occupied (Marbled Murrelet Recovery Team, November 30, 1998; S. Chinnici, PALCO, pers. comm., January 19, 1999).

As described in table 27, there is a significant amount of potentially suitable murrelet habitat in the ROG and DF types that, through field examination, has not yet been determined to be occupied or unoccupied by murrelets. Nevertheless, harvest of some of this habitat is part of the proposed action. Likewise, there is a large area of potentially occupied habitat in the Bioregion but not on PALCO ownership (e.g., in HRSP) that has not been adequately surveyed to determine whether it is occupied by murrelets.

Because removal of suitable habitat could adversely affect the murrelet and removal of occupied habitat could result in take of murrelets, the Service believes it is reasonable to use rates of suitability and occupancy derived from surveyed habitat to estimate the amounts of unsurveyed habitat that are likely unoccupied and occupied (Ralph et al. 1995, page 18). The Service discussed with biologists from PALCO and CDFG the appropriateness of applying occupancy rates to unsurveyed areas, and it was agreed by field biologists that such an approach was reasonable.

This approach, which has been applied in other murrelet HCPs (e.g., Elliott State Forest HCP), is justified provided two related conditions are met:

> The survey effort expended in the habitat types with known outcome was sufficient to constitute representative samples of those habitat types, so that the resulting rates incorporate and reflect within-type variation;
>
> The unsurveyed stands to which these rates will be applied are from the same "population" or habitat stratum from which the respective rates were derived.

Although the PALCO survey effort was not originally designed to address this statistical need, the Service believes that both of these conditions are adequately met (Marbled Murrelet Recovery Team, November 30, 1998). Since the murrelet was listed, PALCO has surveyed approximately 46 percent of the DFOG type and over 87 percent of the ROG type. This level of survey effort is very likely to capture the within-type variation that exists on the ownership, assuming all or a great majority of the survey effort was not concentrated in a particular geographic area or some unique subset of the habitat type. PALCO has informed the FWS that the survey effort should be considered as representative samples of the respective habitat types; if a bias does exist, according to PALCO it is biased towards overestimating murrelet use of all residual stands (S. Chinnici, pers. comm., January 19 and January 25, 1999).

Table 27. Acreage estimates of occupied, unoccupied and potential but unsurveyed murrelet suitable habitat on PALCO lands (including the Headwaters acquisition area) proposed for harvest or protection, respectively. Data from Final EIS/EIR, Appendix N2, Tables 3A and 5A, and Appendix A (as updated by P. Detrich, USFWS, pers. comm., January 2, 1999, T. Reid, pers. comm., January 11, 1999, and S. Chinnici, PALCO, pers. comm., January 19 and January 25, 1999). Adjustments of 1-2 percent were made to some figures to reconcile slightly different estimates from the various tables.

Habitat Type	Occupancy Status	Acres
Unentered Old-Growth Redwood (UOG)	Occupied	4,230
	Unsurveyed	909
	Unoccupied	0
	Subtotal	5,139
Residual Old-Growth Redwood (ROG)	Occupied	5,517[1]
	Unsurveyed	4,717[2]
	Unoccupied	376[3]
	Subtotal	10,610[4]
Old-Growth Douglas-fir (DFOG)[5]	Occupied	190
	Unsurveyed	4,563
	Unoccupied	3,766
	Subtotal	8,519
TOTAL ACRES		24,268

[1] Table 5A

[2] Table 5A: 10610 - 5517[1]= 4717

[3] 376 (unoccupied per S.Chinnici, pers. comm., January 25, 1999)

[4] Table 7A (1/11/99): 12,447 - 1,837 (unsuitable per S.Chinnici, pers. comm., January 25, 1999) = 10,610

[5] Table 5A

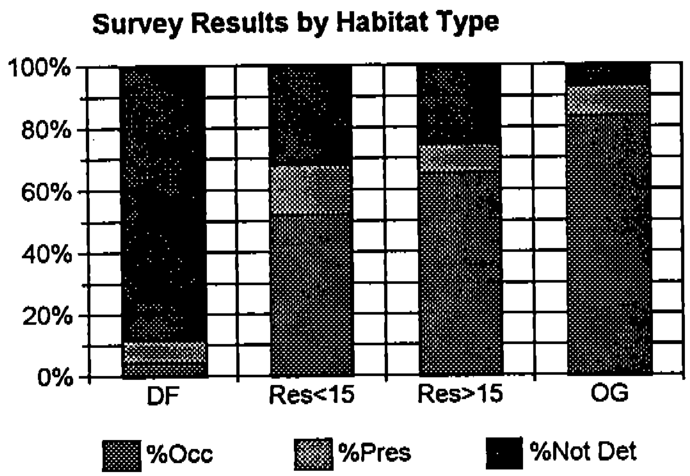

Figure 1. Percentage area determined to be occupied, present, or not detected for DF, ROG (<15 old-growth trees/acre), ROG (>15 old-growth trees/acre), and UOG habitats that have been surveyed to accepted PSG standards (Ralph et al. 1994).

Applying likely occupancy rates for the three habitat types, table 28 describes the amounts of the unsurveyed habitat that are likely occupied and unoccupied by applying the respective habitat type occupancy indices. Combining these results with the known occupied acreage, table 29 describes the total amounts of known or likely occupied habitat on PALCO lands (including the Headwaters acquisition area).

The following acres of habitat on PALCO lands (including the Headwaters acquisition area) are known to be occupied: 4,230 acres of old-growth redwood, 5,517 acres of residual redwood, and 190 acres of Douglas-fir (Final EIS/EIR, Appendix N2, table 5A). Using occupancy rates derived from this surveyed habitat, the Service estimates there are an additional 910 acres of occupied old-growth redwood, 2,343 acres of occupied residual redwood, and 228 acres of occupied Douglas-fir.

Table 28. Estimates of unsurveyed habitat that is likely occupied and unoccupied by applying occupancy indices derived from surveyed area results on PALCO (including the Headwaters acquisition area).

	Unentered Old-Growth Redwood	Residual Old-Growth Redwood > 15 OG trees/acres	Residual Old-Growth Redwood < 15 OG trees/acre	All Old-Growth Douglas-Fir Dominant
Unsurveyed Acres	910	212*	4505*	4563
Occupancy Index	1.0^	0.66	0.52	0.05
Estimated Occupied Acres	910	140	2343	228
Estimated Unoccupied Acres	0	72	2162	4335

*Of the total 4717 acres of ROG, it was unknown exactly how much was <15 trees/ac and how much was >15 trees/ac. We used the overall estimate of 4.5 percent ROG is >15 trees/ac from Appendix 1.

^Occupancy index of 1.0 was applied here because remaining unsurveyed UOG is continuos or proximal to occupied habitat and almost certain to be occupied.

Quality

Distinguishing high quality habitat from low quality habitat is difficult for this cryptic and secretive species. The best measures of habitat quality would be those that describe actual life history parameters important to the species, such as reproductive success or nesting attempts per unit area (Grenier and Nelson 1995, page 201; Hamer and Nelson 1995, page 80). Unfortunately, these types of data are lacking for PALCO lands and for most of the species' range (Ralph et al. 1995, page 8), a situation especially common on private lands (Hamer 1995, page 173). Because of the logistical difficulty and expense in collecting these data, researchers are beginning to collect other measures of habitat quality specific to the murrelet, such as density and availability of nesting platforms. However, these data are also not currently available.

Table 29. Total acres of likely occupied murrelet habitat in UOG, ROG, and DF habitat types on PALCO ownership (including the Headwaters acquisition area).

	Unentered Old-growth Redwood	Residual Old-Growth Redwood		All Old-growth Douglas-fir Dominant	Total Occupied Acres
		> 15 OG trees/acres	< 15 OG trees/acre		
Known Occupied Acres	4,230	248	5,269	190	9,937
Estimated Additional Occupied Acres	910	140	2,343	228	3621
Total Likely Occupied Acres	5,140	388	7,612	418	13,558

Therefore, the FWS used available information to assess the relative quality within and between the UOG, ROG, and DFOG habitat types on PALCO lands (including the Headwaters acquisition area), including data on murrelet occupancy surveys, timber volume, a combined measure of canopy closure and subcanopy (height of second growth trees), and stand size or configuration. The Service acknowledges that use of these indirect measures has some limitations. But as described below, cautious inferences concerning habitat value can be drawn from these measures, and the FWS believes these data are the best available information to address this issue (Ralph et al. 1995, page 18; Swartzman et al. 1997, pages 13-14).

Occupancy survey data as a measure of habitat quality: The FWS believes that PSG (Ralph et al. 1994) survey data in the different habitat types can give insight into the relative value of various habitat, but such inferences should be made conservatively (Burger 1995, pages 158-161). The observation of occupied behaviors indicates that a timber stand is likely used by marbled murrelets for nesting (Ralph et al. 1995). Occupancy determinations may be made at different rates for different habitat types, suggesting that these habitats are preferred or utilized by murrelets at different rates.

Some consultants hired by PALCO believe that gross numbers of murrelet presence or occupancy detections from PSG surveys give reasonable insight into the relative value of different stands with differing rates of murrelet detections (Ralph et al. in SYP/HCP, Volume IV, Part B, Section 9). These consultants used a "relative bird value" (RBV) calculation and concluded that most of the murrelets in the Bioregion occur in the Headwaters stand and HRSP, and relatively few birds occur in potential harvest areas.

As the FWS expressed previously to PALCO and its consultants (USDI Fish and Wildlife Service, pers. comm., February 28, 1997), we do not agree that absolute or relative numbers of detections can be used at this time to accurately assign quantitative relative value to individual stands. Due to the difficulty in detecting murrelets and the possibility that multiple observations of the same bird could give misleading estimates (Cooper and Blaha 1998, Cooper et al. 1998), other researchers reject this approach as unjustified (Paton 1995, page 116, S.K. Nelson, pers. comm., October 31, 1997). The FWS believes that PSG survey results can be used to assess relative habitat quality by ascribing *categorical* designations to various stands (e.g., "occupied" or "unoccupied"), which in turn can be organized by stand type to derive relative rates of occupancy. This approach does not allow the quantitative use of detections to further discriminate between the different habitat types, as well as between stands within the same habitat type. We believe the "RBV" approach may have merit for future research and monitoring efforts if certain statistical and logistical problems can be reduced.

Although there may be some overlap in quality between the types, figure 1 illustrates that UOG is on average occupied by murrelets at a higher rate than all other habitat types, and both types of ROG redwood are occupied at greater rates than the DFOG. All other stand characteristics being equal (e.g., stand size, shape, and degree of fragmentation), and assuming that murrelets are preferentially selecting certain stands to nest in (and exhibit occupied behaviors) and are avoiding less desirable habitats, it is reasonable to conclude that UOG is likely the more preferred habitat and is of relatively greater value to the species. This conclusion is consistent with the general hypothesis and supporting research suggesting that stands with more old-growth trees provide more nesting opportunities and better cover from predators and adverse weather (Ralph et al. 1995, page 7; Swartzman et al. 1997).

Due to the low occupancy rates (about 5 percent) for the DFOG type described above, the data suggest that this habitat type is used by murrelets at very low levels. This observation is consistent with observations of Douglas-fir suitable habitat elsewhere in portions of California (Hunter et al. 1998). Known nest sites in California have a higher percentage of redwood trees than Douglas-fir even though some nests in these stands were in Douglas-fir trees (Hamer and Nelson 1995, page 75; Swartzman et al. 1997). Therefore, the FWS concludes that the DF habitat type has limited value to the murrelet on PALCO lands, and the following discussion of other habitat quality indicators focuses on UOG and ROG redwood types only. (However, we did include estimates of occupied DFOG habitat in the section describing Effects of the Action.)

Volume and stem density as an indicator of habitat quality: Absent any quantitative information on the PALCO ownership regarding specific murrelet habitat attributes such as nest platform density, the FWS analyzed timber volume density as a surrogate indicator. Although this type of measure is indirect and may be relatively imprecise (Hamer and Nelson 1995, page 80), it makes use of the best available information and will give useful insight (Hamer 1995, page 173). In proceeding with this analysis, the FWS generally assumed that the greatest volume density occurs in stands with the largest number of the largest old-growth trees, and that these stands in turn are likely to have the greatest number of large limbs suitable for murrelet nesting. Thus, as a general hypothesis, murrelet nesting opportunities should be higher in old-growth stands with greater volume and proportionately lower in stands with less volume. Although the FWS is unaware of any empirical studies that demonstrate a positive linear relationship between volume density and nest platform density, this approach is consistent with conclusions from the murrelet scientific literature. For example, Burger (1995, page 158) found that occupied detections were positively correlated with mean tree diameter and basal area, and Hamer (1995, page 174) suggested that stem density may be associated with higher rates of successful murrelet nesting.

Timber volume density varies markedly between the two redwood habitat types (Final EIS/EIR, Appendix N2, table 1.B). About 28 percent of the acres of ROG stands contain less than 25 mbf/ac, about 68 percent contain between 25 and 50 mbf per acre, and about 4 percent contain more than 50 mbf/ac. In contrast, about 90 percent of UOG stands exceed 100 mbf per acre, and 50 percent exceed 150 mbf per acre.

Canopy closure and second growth subcanopy as a measure of habitat quality in residual stands: Canopy closure and the height of second growth subcanopy is another potential measure of current and future murrelet habitat quality (Swartzman et al. 1997, page 14). In general, the agencies assume that the best habitat in ROG stands would be provided where the highest timber volume and high canopy closure among the residual overstory (which would result from higher density of large residual trees and/or large limb structure) are combined with maximum height of the second-growth stand beneath the residual overstory. Miller and Ralph (1995, page 212) found that occupied stands had higher percentages of old-growth cover than stands with presence only or no detections. Areas with higher canopy closure provide cover from predators and adverse weather conditions for nesting murrelets (Nelson and Hamer 1995a, page 66). Vertical cover, such as that provided by second growth, may also provide cover from predators or elements (Grenier and Nelson 1995, page 199). Although recent research is continuing to investigate the relationship between canopy and murrelet nesting success (e.g., there may some value to small openings in the canopy to allow murrelets access to nest limbs (Grenier and Nelson 1995, page 199)), researchers suggest that higher rates of canopy closure and vertical stem density may be associated with higher rates of successful murrelet nesting (Swartzman et al. 1997, page 14; Hamer 1995, page 174; Hamer and Nelson 1995b, page 80; Marbled Murrelet Recovery Team, 1998).

Most of the residual stands have relatively low canopy closure because a relatively small number of large trees remain. About 59 percent of the residual acres on PALCO lands (including the Headwaters acquisition area) have a canopy closure of less than 25 percent, and less than 2 percent of the residual acres have canopy closure over 50 percent (Appendix N1, Final EIS/EIR). Most known murrelet nests in redwood stands are over 120 feet above the ground (n=10, mean= 154 feet, SD=36 feet, range 108-223 feet) (Hamer and Nelson 1995b), so surrounding second growth should exceed that height to provide protective cover. Where the overstory residual trees are sparse, or where the understory second-growth does not reach above 120 feet in height, habitat for murrelets is assumed to be of lower quality. Under very good conditions, some young dominant redwoods may exceed 120 feet at 40 years of age, but most stands would be expected to grow somewhat slower than this rate (Lindquist and Palley 1963 cited in Appendix N1, Final EIS/EIR).

Although conditions vary, on the PALCO ownership it is reasonable to expect that most second-growth redwood stands on the ownership would not exceed 120 feet in height until they are over 60 years of age (T. Robards, pers. comm.). Because the partial harvest in many of the residual stands occurred in recent decades, there are few remaining residual stands where the second-growth exceeds 100 feet in height; about 695 acres of such stands (less than 6 percent of total ROG) exist on PALCO lands (including the Headwaters acquisition area). In other stands totaling about 4,036 acres (32 percent of the residual stands), the second growth beneath the residual trees is now between 60 feet and 100 feet in height.

Relative stand size as a measure of habitat quality: The FWS evaluated the significance of stand size as another possible indicator of habitat quality. The potential relationship between forest fragmentation, edge, stand size, and adverse effects on forest nesting birds has received increased attention during the last few decades. In a comprehensive review of the many studies on this topic, Paton (1994) concluded that "strong evidence exists that avian nest success declines near edges."

Small patches of habitat have a greater proportion of edge than do large patches of the same shape (Schieck et al. 1995). Although murrelets can nest successfully in small stands (USDI Fish and Wildlife Service 1997), murrelet occupancy rates are generally higher in larger stands. It is believed that larger stands with less edge are likely to have greater rates of murrelet nest success due to reduced predation (Burger 1995, page 158; Nelson and Hamer 1995b, page 96; Swartzman et al. 1997, page 18). In the only direct measure of marbled murrelet reproductive success, Nelson and Hamer (1995b) found that successful murrelet nests were further from edge than unsuccessful nests. They also found that successful murrelets tended to nest in larger stands than did unsuccessful murrelets, but these results were not statistically significant. Miller and Ralph (1995) compared murrelet survey detection rates among four stand size classes in California. Recording a relatively consistent trend, they observed that a higher percentage of large stands (33.3 percent) had occupied detections when compared to smaller stands (19.8 percent), while a greater percentage of the smallest stands (63.9 percent) had no presence or occupancy detections when compared to the largest stands (52.4 percent) (Miller and Ralph 1995). However, these results were not statistically significant, and the authors did not conclude that murrelets preferentially select or use larger stands. Schieck et al. (1995) found that murrelet presence and abundance were positively correlated with old-growth stand size in British Columbia, but their data were not statistically significant.

Table 30 shows the number and size of old-growth and residual redwood stands, while Figure 5B (Appendix N2, Final EIS/EIR) displays the location of these stands on the ownership. The Effects of the Action section will discuss the difference in size between the harvested and protected stands.

Table 30. Number of discrete unentered and residual old-growth redwood stands in different acreage size classes on PALCO lands (including the Headwaters acquisition area). Douglas-fir habitat type included where contiguous to redwood stands.

Stand Size (ac.)	No. Stands
<5	208
5-9	52
10-49	117
50-99	16
100-199	12
200-300	9
>300	13
Total No. Stands	427

Summary of relative habitat quality: In general, unentered old-growth redwood (UOG) stands are higher quality nesting habitat than stands of residual old-growth redwood (ROG), which in turn are of high quality relative to stands of old-growth Douglas-fir (DFOG). However, without data on productivity within the three habitat types, it is impossible at this time to quantify the relative magnitude of these differences. There is likely some overlap between the high and low ends of these respective habitat types (e.g., depending on the specific habitat measure, some lower quality UOG may be similar in value to the murrelet as some high quality ROG), but overall there are probably significant differences in value between these respective habitat types (Swartzman et al. 1997, Marbled Murrelet Recovery Team 1998). The Effects of the Action section will discuss differences in quality between those areas proposed for harvest and those proposed for conservation.

Marbled murrelet critical habitat

Number and acreage of units

Most of the analyses in this biological opinion are based on the action area(see the description of the proposed action for discussion of the action area. Other analyses of effects on the marbled murrelet in the Final EIS/EIR and this biological opinion are based on the so-called southern Humboldt bioregion. Boundaries of CHUs are bisected by the boundaries of both of these scales of analysis; so, to avoid confusion, the following discussion does not precisely conform to the defined action area or the southern Humboldt bioregion, but instead directly applies to those six CHUs or discrete portions of CHUs that are within the vicinity of the action area. These local CHUs were described in Table 15 above.

The area encompassed within the six CHUs in proximity to the action area constitutes about 14 percent of the total acreage within CHUs in Conservation Zone 4, and about 3.5 percent of the acreage within the three-state range. Habitat with primary constituent elements in the CHUs near the action area is estimated to constitute about 14.9 percent of the habitat within CHUs in Conservation Zone 4, and about 3.5 percent of the suitable habitat within CHUs within the three-state range.

Forest stands designated as critical habitat in the action area include three types: uncut old-growth, residual old-growth, and young forest where the average height exceeds ½ the site potential tree height and that is within ½ mile of uncut or residual old-growth. On most of the PALCO property, which is Site Class 2, the site potential tree height is estimated to be 218 feet. Because available forest inventory data for the PALCO ownership that includes tree height is available only in small polygons that are not easily aggregated for analysis, growth equations were used to predict an average stem diameter equivalent to ½ the site potential tree height. (For details on determination of site potential tree height and associated stem diameters, see Appendix B.) The average stem diameter of stands with an average height of ½ the site potential tree (i.e., 109 feet) is about 24 inches. Coincidentally, that diameter represents the division point between two CWHR classes, late-seral and mid-seral, which are classified in the PALCO data base and analyzed in the Final EIS/EIR and elsewhere in this opinion. Therefore, where stands classed as CWHR late-seral occur within ½ mile of old-growth or residual stands, they are counted as critical habitat for this analysis.

Approximately 2,786 acres of this late-seral critical habitat exists in the project area within CHU-CA-03-a. This constitutes about 23 percent of the actual critical habitat acres in the CHU. Of this late-seral total, 1,745 acres are on Eel River Timber Company lands, mostly adjacent to the Headwaters old-growth stand, and 1,041 acres are on PALCO lands. Because these forests are too young for the trees to produce large limbs, this habitat does not provide nesting substrate for marbled murrelets, but it is believed to provide protection from effects of predation and weather on nesting habitat in neighboring old-growth stands.

Factors affecting primary constituent elements

Other protective measures

Currently, critical habitat in the action area is subject to varying degrees of protection. On HRSP and GCSP, no timber harvest or other habitat removal occurs, although facilities such as campgrounds and trails may affect habitat quality. On BLM lands, all CHUs are allocated as LSRs, where timber harvest may only occur to enhance attainment of late successional characteristics. On private lands, if habitat is occupied by murrelets, it is protected under the CFPRs, CESA, and ESA. However, if critical habitat on private lands is not occupied by murrelets, there are no specific murrelet-related protections for habitat under state or federal law, unless a federal action is involved that must be evaluated under section 7 of the Act. Thus, under existing conditions, unoccupied critical habitat in old-growth, residual, or young forest on private lands may be harvested, with the exception of 300-foot protective buffers applied around occupied habitat to avoid take of murrelets. As a result, there probably has been some ongoing decline in lower quality, unoccupied critical habitat on private lands in the action area. The degree of this decline is unknown.

Western snowy plover

Species

Numbers and distribution

Within the action area, snowy plovers recently were found to nest on gravel bars along the lower Eel River in Humboldt County, California, the first documented nesting of snowy plovers on river gravel bars in the western U. S. (Tuttle et al. 1997). These locations are about several miles down river from PALCO property. Intensive surveys, mostly associated with ongoing commercial gravel extraction operations on the lower Eel River, have been implemented to ascertain the seasonal and spatial use of the lower Eel River. These surveys cover ten large gravel bars representing several hundred acres on approximately 8 river miles between the mouth of the Van Duzen river to the downstream end of Singley Bar near the end of Fulmor Lane in Ferndale, California. The primary purpose of these surveys is to monitor plover use of gravel bars, relative to existing gravel mining operations, and to quantify the current distribution of the species on the Eel River. Survey data indicate plovers occur on nearly all large gravel bars in the study area and nest on several of the largest gravel bars. Reconnaissance-level surveys conducted on the Eel River upstream from the mouth of the Van Duzen River have not detected any plovers. Several agencies under the coordination of CDFG have conducted surveys on 12 nesting areas on ocean beaches or sand spits of coastal bays and lagoons. Currently there are no documented occurrences of western snowy plovers on PALCO's ownership.

Reproduction

Based upon data accumulated from surveys, the Eel River population represents the largest concentration of snowy plovers between Point Reyes, California and the Oregon border. Approximately 12 to 15 plovers were seen during the 1996 study, 20 birds were found during 1997, and as many as 28 were detected in 1998. At least 16 nesting pairs were located in 1997 along river bars; in 1998, a total of nine nests were located. Ten of the 16 nests found during 1997 were monitored; seven hatched at least one chick. Of nine nests reported from Eel River gravel bars in 1998, two were documented as hatching. Additional breeding pairs may occur on the Eel River, given available suitable nesting habitat and observations of young not associated with known nests. In contrast, only two coastal breeding sites were known to have nesting plovers during 1998; these two sites produced one nest each, both of which failed to hatch.

Suitable habitat

Within Humboldt and Del Norte Counties, 13 areas with historic nesting and wintering use have been identified, for a total of 6,341 acres on 60.5 miles of coastal beach, which represents 14.6 percent of all acres and 13.3 percent of the miles of potential suitable habitat within the three-state listed range area. The largest gap of potential suitable habitat for the western snowy plover exists along the California coast from south central Humboldt County to central Sonoma County. Within this approximately 200-mile coastline, only two known areas of suitable habitat are identified: McKerricker Beach and Manchester Beach. Although snowy plovers were reported to move several hundred miles between breeding and wintering areas, plovers tend to be relatively faithful to sites used as breeding grounds between years. However, at least one record exists of a female plover moving more than one hundred miles between nest sites in one nesting season. This degree of fidelity suggests some plovers in Humboldt and Del Norte Counties may be reproductively isolated from those in central and southern California.

The amount of suitable habitat on the action area (i.e., suitable gravel bars of the lower Eel River) is not precisely known but is estimated to be several hundred acres. Suitable habitat is associated with the most open gravel bars along the banks of the Eel River from the mouth of the Van Duzen downstream to at least the lower end of the Singley bar below Fernbridge. The amount of the gravel that is suitable substrate is unknown. Currently no gravel bars on PALCO lands within the action area that have characteristics of suitable habitat are known to be occupied by snowy plovers.

Landscape comparison
The baseline to be used for the analysis of western snowy plover effects is the gravel bars of the lower Eel River. The gravel bars of the lower Eel River (i.e., all suitable habitat within the action area) contain only a small portion (less than 2 percent) of the total suitable habitat for the western snowy plover within the species range, and approximately 15 percent of the suitable habitat within Humboldt and Del Norte Counties. However, based on recent surveys, gravel bars in the action area provide a very high percentage of the nesting effort within the two-county area. In addition, gravel bars on the lower Eel River produced the only known successful nests of plovers in the two counties during the 1998 nesting season.

Within the species range on the Pacific coast, the lower Eel River is the only known location where snowy plovers commonly nest on river gravel bars. This is thought to be, in part, due to the large size, very flat topography, and sparse vegetation on these gravel bars when compared to nearly all other river systems within the species range.

Factors affecting the species and suitable habitat in the action area
Other completed or contemporaneous actions
Currently, several major commercial and one governmental (Humboldt County Department of Public Works) gravel extraction operations are being implemented on the lower Eel River downstream from the mouth of the Van Duzen River. In total, approximately 400,000 cubic yards of gravel and sand are extracted from the these bars annually, with up to 1.6 million cubic yards permitted under existing regulatory authority. As a condition of the permits under which these activities are conducted, all gravel bars must include a pre-operations topographic survey, and all operational areas must be graded to pre-operations contours at the end of each annual extraction period.

Other protective measures
Snowy plover protection measures that are currently in place on these gravel extraction areas call for annual operations to begin after September 15 (considered to be the last day of the local nesting season). Operations may begin as early as August 16 only if intensive protocol surveys indicate that no plovers are nesting or rearing broods on bars on which proposed gravel extraction

activities occur. If plovers are detected, no activities may occur within 1,000 feet of plover nests or broods.

Southern Oregon/Northern California Coast ESU coho salmon

Within the action area, coho salmon have been documented during this decade in Freshwater Creek, Elk River, Mattole River, and the Eel River (including Van Duzen River and Yager Creek). The Final EIS/EIR estimates there are approximately 66 miles of habitat suitable for coho salmon within the Plan area. Based on historical observations, the Final EIS/EIR provides general information on estimates of coho abundance within the action area. For example, the South Fork Eel River is reported as probably supporting the largest remaining natural spawning population in California (CDFG 1994). In the 1989 to 1990 spawning season, less than 300 adult coho salmon spawners were counted in the South Fork, which is believed to represent a maximum population estimate of about 1,320 adults (CDFG 1994). Similarly, adult coho salmon in the Mattole River number less than 800 fish annually, a number much reduced from historic levels (CDFG 1964). Recent observations in tributaries of the Van Duzen found only a few (less than four) adults in any one year. Brown et al. (1994) estimated that Elk River supports a run of about 400 native salmon and recent reports indicate that Freshwater Creek and Elk River currently support viable populations. Overall, the general trend is for fewer coho salmon in most streams in the action area, with some streams that may be maintaining or increasing populations (e.g., Freshwater Creek or Elk River).

In Freshwater Creek, the Humboldt Fish Action Council (HFAC) downstream migrant traps in 1996 captured 922 0+ coho salmon on the mainstem. Traps set up in various Freshwater Creek tributaries also caught coho salmon in 1996 (IFR 1998). Downstream migrant traps provide information about community structure, but are not statistically robust and therefore cannot be used to determine population trends. According to the Final EIS/EIR, carcass surveys conducted by CDFG found 925 adult coho salmon in the North Fork of the Elk River and 14 adult coho in the Yager Creek watershed (CDFG 1995). The same surveys by CDFG found coho salmon carcasses in the Van Duzen River watershed and the Eel River watershed. Electrofishing surveys completed by CDFG in 1991-1993 found a few coho salmon in Stevens Creek, a tributary to the Van Duzen River, and in tributaries to the lower Eel River, but did not find any coho salmon in Yager Creek, in the lower mainstem of the Eel River, in other tributaries to the Van Duzen River, or in tributaries to the Mattole River (IFR 1998). Community structure surveys, such as these electrofishing surveys completed by CDFG, provide an indication of what species may be present in a given area, but are not rigorous enough to definitively establish absence. The Mattole Salmon Support Group (MSG) estimated for 1997 an annual coho salmon adult return of 300 fish to the Mattole River (MSG 1997).

PALCO has released coho salmon from their hatchery program into the Eel River and Humboldt WAAs. According to the Final EIS/EIR, PALCO planted 10,655 coho salmon in the Eel WAA in 1983. The Final EIS/EIR also reports that 174,462 coho salmon have been planted in the Freshwater and Elk River drainages since 1965.

PROPOSED SPECIES/CRITICAL HABITAT:

Southern Oregon and California Coastal ESU chinook salmon

Within the action area, chinook salmon have been documented in the Freshwater Creek, Elk River, Yager Creek, Van Duzen River, Eel River, and Mattole River drainages. The Final EIS/EIR estimates that there are approximately 82 miles of suitable habitat for chinook salmon within the action area.

In Freshwater Creek, HFAC downstream migrant traps captured 1,270 0-plus age chinook salmon from the mainstem in 1989. In 1996, 5 0+ chinook salmon were trapped from the mainstem (IFR 1998). According to the Final EIS/EIR, CDFG (1995) reported carcass survey results for the Elk River and Yager Creek The survey found 130 chinook salmon carcasses in the North Fork Elk River and 116 carcasses in the South Fork Elk River. Within the Yager Creek watershed, a total of 927 chinook salmon carcasses were found between 1987 and 1995. The same survey recorded a total of 909 chinook salmon carcasses in the Van Duzen River watershed. Electrofishing surveys completed by CDFG in 1991 did not find any chinook salmon in these watersheds (IFR 1998). In the Eel River, CDFG (1995) reported finding chinook salmon carcasses in Bear, Carson, Jordan, Chadd, and Larabee Creeks. Electrofishing surveys from 1990 to 1994 did not document the presence of chinook salmon within the Eel River watershed (IFR 1998, Final EIS/EIR). MSG (1997) provided data on chinook salmon redds and carcasses from the Mattole River from 1981 to1997 (cited in IFR 1998). Estimated chinook salmon escapement range from 3000 adults in 1981 to 100 adults in 1990. The 1997 estimates were 800 adult chinook salmon.

According to the Final EIS/EIR, PALCO has released hatchery-raised chinook into the Yager Creek watershed and streams in the Humboldt WAA. Releases range from 2,636 to 85,500 fish per year in Yager Creek. Since 1964, a total 86,855 chinook salmon have been released into the Humboldt WAA.

Proposed coho salmon critical habitat

Critical habitat for the SONCC ESU coho has been proposed for all accessible river reaches within the action area. The only identified barriers within these drainages, Matthews Dam (Mad River) and Scott Dam (Eel River), are upstream of the action area. Currently, all rivers identified as critical habitat are considered vital to the survival and recovery of coho salmon in the SONCC ESU. Factors within the action area that may affect critical habitat include land management activities such as timber harvesting, agriculture, residential development, gravel mining, recreational activities, and livestock grazing, that may impact or alter the riparian functions (shade, sediment control, nutrient and chemical regulation, streambank stability, and input of woody debris and organic material). Other threats to critical habitat within the action area include road construction, gravel mining, stream enhancement, bank stabilization, and water diversions. These activities have the potential to alter essential habitat features and degrade properly functioning conditions.

Proposed chinook salmon critical habitat

Critical habitat for the SOCC ESU has been proposed for all accessible river reaches within the action area. Similar to the proposed designation for SONCC coho salmon ESU, the only identified barriers within these drainages, Matthews Dam (Mad River) and Scott Dam (Eel River), are upstream of the action area. Currently, all rivers identified as critical habitat are considered vital to the recovery and survival of chinook salmon in the SOCC ESU. Factors within the action area that may affect critical habitat include land management activities such as timber harvesting, agriculture, residential development, gravel mining, recreational activities, and livestock grazing, that may impact or alter the riparian functions (shade, sediment control, nutrient and chemical regulation, streambank stability, and input of woody debris and organic material). Other threats to critical habitat within the action area include road construction, gravel mining, stream enhancement, bank stabilization, and water diversions. These activities have the potential to alter essential habitat features and degrade properly functioning conditions.

UNLISTED SPECIES:

Bank swallow

Species

Numbers

No surveys for this species have been conducted within the action area. No records of this species are known in the action area, although it probably occurs as a very rare migrant or summer visitor, especially along lower portions of the Eel River. An estimated 100 to 150 breeding adults occur within the regional area (Harris 1996).

Landscape Comparison

None of the estimated breeding adults in the regional area are known to breed in the action area.

Distribution

No information is available on the species' distribution.

Reproduction

No colonies are known in the action area, and no trend data exist for the regional area. Within the regional area the only currently known nesting colonies are in Del Norte County along the lower Smith River and at the Crescent City landfill (Harris 1996). However, Talmadge (1947) reported five scattered single-pair nest sites in Humboldt County; the site closest to the action area was one at an unspecified location somewhere along the Van Duzen River. No additional information on the sites is discussed by Talmadge (1947).

Suitable habitat

Landscape comparison

The amount of suitable habitat existing along Class I streams in the action area and the proportion of the range-wide or regional habitat contained in the action area are unknown. The action area constitutes less than 0.01 percent of the total breeding range (USDA Forest Service 1994).

Factors affecting species and suitable habitat in the action area

Other completed or contemporaneous actions
Road or bridge construction, or gravel mining may have affected some potential habitat in the action area.

Other protective measures
While no specific State of California protective measures exist for this State threatened species, measures are implemented to avoid take when State biologists conduct consultations for projects under their jurisdiction (CDFG 1995).

<u>Pacific fisher</u>
Species
Numbers
No estimates on the number of fishers exist for the action or regional areas.

Fisher have been detected in the action area but are thought to be rare. For example, during 2,000 camera nights in 1995 and 1996 on PALCO lands four fishers were detected. Fishers may be more abundant in northwestern California than anywhere else in the United States (Powell and Zielinski 1994). Fisher numbers decrease in the southern Coast Ranges in northwestern California (R. Kluge, pers. comm., January 15,1999).

Distribution
All known fisher detections on PALCO lands have been within the Yager and Humboldt WAAs. Although surveys were conducted in all five of the major WAAs on the ownership, the survey methodology was not sufficient to determine if areas without detections were unoccupied. Based on survey results in the coastal redwood region, forests with an abundance of hardwood and Douglas-fir are more likely to provide suitable habitat for fishers. Douglas-fir makes up at least 20 percent of many stands classified as redwood on PALCO lands (S. Chinnici, pers.comm., January 14, 1998).

Reproduction
Reliable data on fisher population trends do not exist in the action or regional areas. Although they had limited information and provided no quantitative analysis, Schempf and White (1977) thought fishers were "common and increasing in numbers", Yocom and McCollum (1973) thought they were "increasing" in interior northwestern California. Recent research in northwestern California does not provide information to estimate population trends.

Suitable habitat
Landscape comparison
On PALCO lands there are an estimated 69,231 acres of LSH. This constitutes approximately 32 percent of the current ownership outside of the Headwaters acquisition area, and Grizzly Creek Complex. Of these acres, approximately 59,983 acres are in patches at least 80 acres in size. This may be a conservative estimate of suitable resting and denning habitat on PALCO lands, since this figure does not include CWHR 4D stands, which may be suitable for this subspecies when legacy

components such as down logs, large snags, and large green trees are present. Table 31 provides information on the amount of potentially suitable resting and denning habitat present at different landscape levels.

Table 31. Comparison of acres of potentially suitable resting and denning habitat for Pacific fishers present within the subspecies range at different landscape levels.

Landscape level	Acres of LSH or equivalent	Acres of CWHR 4D or equivalent
PALCO lands[1]	69,231	55,380
Action area (outside of PALCO lands)[2]	62,491	122,908
Regional area (outside of PALCO lands)[2,3]	791,214	1,407,076
Range-wide	N/A	N/A

[1] Habitat information derived from PALCO 1999. Vegetation inventory. Unpublished technical information.

[2] Habitat information for California derived from The Resource Agency of California (1993). The Report of the California Timberland Task Force. Revised May 1996.

[3] The regional area is defined as Mendocino, Humboldt, and Del Norte Counties, California, and Curry County, Oregon. Habitat information provided for Curry County is only for the Siskiyou National Forest and Coos Bay and Medford Districts of the BLM. There is an additional undetermined amount of potentially suitable Pacific fisher habitat on private lands within Curry County, OR.

Habitat classified as CWHR 3M and larger (CWHR 3D, 4M, 4D, 5M, 5D, and 6) is considered potentially suitable foraging habitat for fishers. There are approximately 153,798 acres of habitat classified as CWHR 3M or larger of conifer and montane hardwood conifer habitat types on PALCO lands outside of the Headwaters acquisition area and the Grizzly Creek Complex. This constitutes approximately 72 percent of the current PALCO ownership. There is an additional 6,665 acres of potential foraging habitat in the Headwaters acquisition area, and 1,243 acres within the Grizzly Creek Complex.

Factors affecting species and suitable habitat in the action area

Other completed or contemporaneous actions
Refer to **Baseline common to all species** section above.

Other protective measures
California closed the trapping season for the harvest of fishers in 1945, although fishers are still caught incidentally in traps set for other fur-bearing mammals.

There are no Federal regulatory measures that specifically protect the Pacific fisher or its habitat. Consideration of significant impacts to listed and non-listed species is provided for in the CEQA Regulations (14 CCR §15380) and the CFPRs (14 CCR § 919.4) respectively. These State regulatory measures may provide some level of protection for the Pacific fisher.

Red tree vole

Species

Numbers

There are approximately 90 recorded observations of red tree voles or red tree vole nests on PALCO lands. No additional information is available on the population size on PALCO lands.

Distribution

Red tree voles were opportunistically observed throughout all of the WAAs on the ownership. Multi-species surveys conducted in mid-1990s documented red tree voles in the Humboldt, Yager, and Bear-Mattole WAAs. As found elsewhere in the species range, red tree vole nests were found to be patchily distributed (i.e., several nests were found in close proximity to one another, but clumps of nests were not necessarily evenly distributed within or between stands).

Reproduction

Red tree vole nests have been located on PALCO lands. No information is available on reproduction trends of red tree voles on PALCO lands. Currently, patches of LSH ranging from 80 to over 1,000 acres in size exist within the five major WAAs on the ownership. It is likely that red tree voles are successfully reproducing within these stands.

Suitable habitat

Although red tree vole nests have been found in young (20 to 60 year-old) stands, it is unclear how sustainable these populations are through time. Since red tree voles have been found to be more abundant in mature and old-growth stands, PALCO lands classified as LSH (including residual old-growth and uncut old-growth) are assumed to have the highest likelihood of providing habitat capable of sustaining red tree vole populations through the life of the permit and beyond. Other seral stages such as CWHR 4D are likely to provide some level of suitable habitat. Since younger trees do not commonly have large limb structures capable of supporting large red tree vole nests, these habitat are considered lower in quality than LSH.

Under the Final SYP/HCP, habitat typed as redwood can include up to 50 percent of the conifer cover in Douglas-fir trees (Volume III, Part B, page 32 of the SYP/HCP). A majority of the project area outside of the Bear-Mattole WAA is classified as redwood, and according to PALCO (Sal Chinnici, pers. comm., November 23, 1998), Douglas-fir makes up at least 20 percent of many redwood dominated stands across the PALCO lands. Sample plot data can be found in Volume II, Part K, of the SYP/HCP. Additional information on tree species composition within these stands is not available at this time. Of the 90 records of red tree voles or red tree vole nests on PALCO lands, approximately 82 percent of these localities are within habitat typed as redwood (Sal Chinnici, pers. comm., January 14, 1999). Based on this information, for the purpose of this analysis, it is assumed that habitat classified as Douglas-fir or redwood on PALCO lands can support populations of red tree voles.

Approximately 69,231 acres of LSH (redwood, Douglas-fir, and montane hardwood/conifer habitat types combined) occur on PALCO lands. Of these acres, there are 12,746 acres of LSH within patches 80 to 475 acres in size and 8,830 acres of LSH within patches 475 to 1,000 acres in size and 38,407 acres of LSH within patches > 1,000 acres in size. Other forest seral stages, such as CWHR 4D, may provide suitable habitat of a lower quality for red tree voles. Table 32 provides information on the amount of potentially suitable red tree vole habitat present at different landscape levels.

Table 32. Comparison of acres of potentially suitable red tree vole habitat present within the species range at different landscape levels.

Landscape level	Acres of LSH	Acres of CWHR 4D or equivalent
PALCO lands[1]	69,231	55,380
Action area (outside of PALCO lands)[2]	62,491	122,908
Regional area (outside of PALCO lands)[2,3]	641,114	1,276,264
Range-wide (outside of PALCO lands)[2]	685,994	1,332,196

[1] Habitat information derived from PALCO 1999. Vegetation inventory. Unpublished technical information.

[2] Habitat information for California derived from The Resource Agency of California (1993). The Report of the California Timberland Task Force. Revised May, 1996.

[3] The regional area is defined as Mendocino, Humboldt, and Del Norte Counties, California, and Curry County, Oregon. Since the California red tree vole does not occur in OR, acres of potentially suitable habitat in Curry County are not included in these figures.

Factors affecting species and suitable habitat in the action area

Other completed or contemporaneous actions

Refer to **Baseline common to all species** section above.

Other protective measures

A majority of this species range is on private timber lands in northern California. No State or Federal regulatory measures exist to specifically protect the California red tree vole or its habitat. Consideration of significant impacts to listed and non-listed species is provided in the CEQA Regulations (14 CCR §15380) and the CFPRs (14 CCR § 919.4) respectively. These State regulatory measures may provide some level of protection for the red tree vole.

Northern red-legged frog
Baseline information on northern red-legged frog populations outside the PALCO ownership is not available. Due to limitations of existing data, the following baseline discussion will pertain to the PALCO ownership, with limited general assumptions of lands within the action area outside of PALCO ownership.

Species
Numbers and distribution
Based on incidental observations, the northern red-legged frog is assumed to be locally abundant in suitable habitat within PALCO lands (PALCO 1998). However, without statistically valid survey data, the assumption of local abundance can be questioned. Specific information on numbers and distribution within the ownership is unavailable. The subspecies has been described as being associated with old-growth, late-successional and mature habitats, but has also been found in lower abundance in other seral stages (Bury and Corn 1988, Aubry and Hall 1991). Because of past management activities affecting terrestrial habitat, it is likely populations of the northern red-legged frog on PALCO lands and the larger action area are disjunct and isolated due to habitat fragmentation.

Reproduction
Information on reproductive trends is not available for the subspecies.

Suitable habitat
Landscape comparison
Northern red-legged frog microhabitats are expected to be found in cold, slow-moving reaches and pools in Class I and II streams and wetlands. Suitable habitat for the subspecies is difficult to estimate given the lack of information pertaining to vegetative and aquatic associations on the landscape. Table 3.8-1 in the Final EIS/EIR summarizes stream miles on PALCO lands, including Elk River lands, as follows: 264 miles of Class I streams; 752 miles of Class II streams (total class I and II= 1,016 miles). Additionally, table 3.7-3 in the Final EIS/EIR lists 486 acres of wetlands. The proposed Headwaters Reserve includes the following miles of stream: 17 miles of Class I and 27 miles of Class II. All miles of stream are described as suitable due to absence of stream morphology descriptors in this ownership. Due to the subspecies' affinity for pools and slow-moving reaches, this is likely a substantial overestimation of suitable aquatic habitat. For comparison, Welsh and Ollivier (1998) found the percentage of pools in channels (step pools and main channel or backwater pools) for ten non-fish bearing streams on comparable lands (tributaries of Prairie Creek) ranged from 3 to 26 percent. Though this study excluded Class I systems, it does indicate that only some proportion of streams in this area may contain mesohabitat types more likely to be suitable for the subspecies.

The Final EIS/EIR summarizes current stream habitat conditions for PALCO lands in section 3.8.2. Overall, these aquatic systems are not in good condition. All five WAAs are generally characterized as having high incidences of sedimentation, low percent pools, shallow mean pool depth and/or high temperatures. For purposes of this consultation, we assume that many of the existing step pools would not provide the depth required by the species. Similarly, many of the main channel pools are susceptible to stagnation and warming unless they have a nearby source of cold water, such as a spring or seep.

The estimate of suitable habitat provided in the Final EIS/EIR excludes acres of terrestrial habitat which could be used for foraging and overwintering. For the purposes of describing terrestrial habitat, we assume a distance of 530 feet would include potential upland use areas along Class I and II streams, as proposed by Welsh et al. (1998). Higher quality suitable forested habitat within that zone is assumed to consist of mid-mature, late-successional and old-growth stands because of the higher amount of protective canopy and herbaceous cover used by the subspecies. However, an estimate of these acres is not available for this analysis. Based on a 530 foot zone of use along 1,016 miles of Class I and II streams, a total of 134,047 acres of potentially suitable habitat for the subspecies occurs on PALCO lands. This is likely an overestimate because probably not all acres within the 530 foot zone of use are suitable or accessible.

Limited comparative information is available for the action area and north coast region outside of PALCO lands. Approximately 1,377 miles of Class I streams occur in the Action Area outside of PALCO lands (Appendix D). The GIS layer available for this analysis did not provide complete coverage of Class II and wetlands within this zone, therefore data for these areas are unavailable. PALCO lands cannot be accurately compared to the action area due to a lack of information on Class II streams in the action area.

Although data outside the action area is not analyzed here, some generalizations can be made. A significant proportion of the north coast is under private ownership, much of which is industrial timberland. These lands have been under heavy management over the past century, so it is likely a large proportion of terrestrial habitat within the subspecies range has been fragmented, and aquatic habitat has been impacted.

As discussed under the range-wide baseline account, a total of 5.6 million acres occur within Riparian Reserves on Federal lands within the subspecies' range. PALCO lands contain an estimated 134,047 acres of potentially suitable habitat: approximately 2 percent of the total acreage on Federal and PALCO lands combined. These figures provide gross estimates and should be considered with caution for the following reasons: 1) private lands data outside of the ownership within the subspecies range is unavailable; 2) the acres within Riparian Reserves on Federal lands do not consider terrestrial habitat which may be used beyond those distances established by Riparian Reserves, i.e. beyond the one or two potential tree height distances; and, 3) portions of the riparian reserves on Federal lands may be unsuitable or inaccessible.

In summary, we assume natural conditions are highly variable within the northern red-legged frog's range. Additionally, current habitat conditions and management practices between federal and private ownerships will result in variable habitat conditions now and in the long-term. PALCO lands represent a relatively small percent of potential habitat in the subspecies' range.

Factors affecting species and suitable habitat in the action area

Other protective measures

Existing land allocations and State environmental regulations may provide some protection for the northern red-legged frog. Some suitable habitat is partly to fully protected in waters such as park lands or rivers designated as Wild and Scenic under Federal law.

CEQA Regulations (14 CCR Sec. 15380) and the CFPR (14 CCR Sec. 919.4) provide for the assessment of significant impacts on listed and non-listed species. These regulations may provide some level of protection for the northern red-legged frog. Habitat features are considered adequately protected by the state if identified and classified in the THP development process. Northern red-legged frogs generally occur in habitats protected as Class I and II watercourses under CFPRs (Article 12, Parts 916.5, 936.5 and 956.5). Those rules require maintenance of 50 percent canopy cover in a buffer zone of 50 to150 feet (depending on stream class and slope).

CFPR Sections 914.7, 934.7, and 954.7 describe limitations of winter timber operations. While tractor yarding shall only be conducted in the winter period with a winter operations plan, cable, helicopter, or balloon yarding methods are allowed. These actions may occur only if the wet weather road use restrictions and other disturbance avoidance measures described can be met. The intent of the CFPR provisions is to minimize soil erosion and compaction during harvest operations. A reduction or prevention of activities within terrestrial habitat during rainy periods is expected to reduce impacts to the subspecies both on land and in the water.

Foothill yellow-legged frog and northwestern pond turtle

Baseline information on northwestern pond turtle and foothill yellow-legged frog populations outside the PALCO ownership is not available. Due to limitations of existing data, the following baseline discussion will pertain to the PALCO ownership, with limited general assumptions of lands within the action area outside of PALCO ownership.

Species

Numbers and distribution

Population numbers and trends for the northwestern pond turtle and the foothill yellow-legged frog within PALCO lands or the action area are not known. Additionally, surveys specific to the pond turtle or yellow-legged frog have not been conducted on the PALCO ownership.

The northwestern pond turtle has been observed in the Yager and Eel WAAs (PALCO 1998). The northern California region is considered a "stronghold" for the range of the northwestern pond turtle (Holland 1998). Large populations are known to occur, particularly in the Klamath and Hayfork drainages, and compared with other areas in the range, at least some populations on the California portion of the Klamath for example, show little evidence of recruitment declines (Holland 1991).

It is not known what percentage of the rangewide population occurs on the PALCO ownership, whether this subspecies historically occurred in high densities, or what role this ownership plays in the overall conservation of this subspecies. It can be surmised that given the topographic landscape, this area historically would have had populations in some areas, but may not have supported a large population. PALCO streams make up small proportion of the overall range, so contributions of this area to the subspecies as a whole are not likely significant.

The SYP/HCP indicates that the foothill yellow-legged frog is locally abundant and widely distributed throughout suitable habitat, with incidental sighting records along major water courses such as the Eel and Van Duzen Rivers, and within Yager, and Bear-Mattole WAAs. Anecdotal observations of the foothill yellow-legged frog have been recorded in areas along smaller Class II streams with low canopy cover on PALCO lands (P. Detrich, pers. comm., July 28, 1998, in Final EIS/EIR). Although this species has not been documented to occur on Elk River Timber Company lands (PALCO 1998), it may occur there based on the availability of habitat.

Reproduction
Information on reproduction of the northwestern pond turtle or foothill yellow-legged frog is not available for PALCO lands or the action area.

Suitable habitat
Landscape comparison
Suitable habitat for the northwestern pond turtle and the foothill yellow-legged frog is difficult to estimate for PALCO lands or the action area given the lack of specific information pertaining to vegetative and aquatic associations on the landscape. Therefore, the following discussions will refer to PALCO lands only as described in the Final EIS/EIR.

Northwestern pond turtle
The estimation of suitable aquatic habitat is likely an overestimate, because not all miles of Class I and II streams contain the microhabitat characteristics suitable for pond turtles. Tables 3.7-3 and 3.8-1 in the Final EIS/EIR summarize wetlands and stream miles on PALCO lands, including Elk River lands, as follows: 264 miles of Class I streams, 752 miles of Class II streams, and 486 acres of wetlands. The proposed Headwaters Reserve includes the following: 17 miles of Class I and 27 miles of Class II. A maximum estimation of 1,060 miles of Class I and II streams and 486 acres of wetlands occur on PALCO lands, Elk River lands, and Headwaters Reserve.

Without specific suitable habitat attributes to quantify the adjacent terrestrial habitat, a maximum estimate of 199,000 acres of potential northwestern pond turtle terrestrial habitat occur on PALCO lands (along Class I - 264 miles; along Class II - 752 miles). Additional habitat may occur adjacent to mapped wetlands, but this figure is unknown. This estimate considers terrestrial habitat 1,640 feet from water's edge, and likely represents a substantial overestimation for the following reasons. Lacking information on microsite conditions (i.e., soil conditions or previous management) all land with slopes $\leq$50 percent is considered suitable. Though some terrestrial overwintering sites have been found on hillsides with slopes of 55 percent, most occur on slopes less steep than this. As described in Holland (1991), pond turtles in the north coast region are most abundant in medium-sized, shallow, warm streams. Most likely, a minority of the streams included in this analysis meet these conditions.

A stream habitat assessment is summarized in table 8 of Volume I, SYP/HCP which presents average values for stream habitat variables. A variable important for the northwestern pond turtle are pools. Streams sampled in WAAs on the ownership averaged 14 to 45 percent pools. These percentages were compared with the miles of streams in the given WAA (table 3.8.1, Final EIS/EIR) to estimate a minimum estimate of suitable stream miles. Most of the wetlands occur in lower landscape positions and are associated with riparian areas (Final EIS/EIR, page 3.721).

Table 33. Northwestern Pond Turtle Minimum Habitat Estimation:

WAA	Miles of Class I and II	% Pools	Estimated Suitable Stream Miles
Humboldt	153.4	45	69
Yager	178.8	22	39
Van Duzen	113.8	14	16
Eel	360.1	23	83
Bear/Mattole	160.1	15	24
Total	966*		231

*Total stream miles do not add up correctly in Table 3.8-1 of Final EIS/EIR

Assuming turtles will use terrestrial habitats adjacent to stream miles containing suitable attributes, a gross estimate was made using 1,640 feet from the water's edge. Therefore, an estimated minimum of 91,840 acres of terrestrial habitat may occur along 231 miles of stream within PALCO ownership.

Limited comparative information is available for the action area and north coast region outside of PALCO ownership. Approximately 1,377 miles of Class I streams occur in the action area outside of PALCO ownership. The GIS layer available for this analysis did not provide complete coverage of Class II and wetlands within this zone, therefore data for these areas are unavailable. Data outside this area is not analyzed here, however some generalizations can be made. A significant proportion of the northern coastal area is under private ownership, much of which is industrial timberland. These lands have been under heavy management over the past century, so it is likely a large proportion of terrestrial habitat within the subspecies range in this area is fragmented, and aquatic habitat has been impacted.

Data for a range-wide landscape comparison for the subspecies was not available.

Foothill yellow-legged frog
The Final EIS/EIR describes suitable habitat for the foothill yellow-legged frog to include miles of Class I and II streams only. However, terrestrial habitats are essential for this species (Welsh et al. 1998). Few data are available to support estimation of the width of streamside use zones for this species. Based on Reid and Hilton's (1998) recommendation that riparian buffer widths should be about 1.1 site potential tree height, and on modeling of buffer zones based on projected LWD input, the FWS determined the distance of 230 feet distance from water's edge to estimate the terrestrial habitat most likely to be utilized by the foothill yellow-legged frog. The literature contains some documented locations of the yellow-legged frogs species occurring in terrestrial habitat more than 230 feet from waters (Welsh et al. 1998), but no information were available on vegetation, season, or other microhabitat specificity. Some small proportion of individuals may occur at distances further than 230 feet from the waters edge, but the majority of individuals will likely occur within this distance. Based on this distance, foothill yellow-legged frog terrestrial habitat on PALCO lands is estimated to include 16,362 acres along Class I, and 41,741 acres along Class II streams (total = 58,103 acres). Additional habitat may occur adjacent to 486 acres of mapped wetlands, but this figure is not available.

Limited comparative information is available for the action area and north coast region outside of PALCO ownership. Approximately 1,377 miles of Class I streams occur in the action area outside of PALCO ownership. The GIS layer available for this analysis did not provide complete coverage of Class II and wetlands within this zone, therefore data for these areas are unavailable. Data outside this area is not analyzed here, however some generalizations can be made. A significant proportion of the northern coastal area is under private ownership, much of which is industrial timberland. These lands have been under heavy management over the past century, so it is likely a large proportion of terrestrial habitat within the species range in this area is fragmented, and aquatic habitat has been impacted.

As discussed under the range-wide baseline account, a total of 11.5 million acres occur within Riparian Reserves on Federal lands within the species' range. Not all the acres within Riparian Reserves may be suitable because of the microhabitat conditions selected by this species. PALCO lands contain an estimated 58,103 acres of potentially suitable habitat, less than 1 percent of the total acreage on Federal lands. These figures provide gross estimates and should be considered with caution because private lands data outside of the ownership within the species range is unavailable.

In summary, we assume natural conditions are highly variable within the foothill yellow-legged frog's range. Additionally, current habitat conditions and management practices between federal and private ownerships will result in variable habitat conditions now and in the long-term. PALCO lands represent a relatively small percent of potential habitat in the species' range.

Distribution/Quality
Suitable habitat in the action area for the northwestern pond turtle and the yellow-legged frog is assumed to occur at elevations ranging from sea level to 6,000 feet. Suitable habitat within this

area is climatically, topographically, and hydrographically similar, regardless of location on the ownership, due to proximity to the coast. Most wetlands are found at lower elevation (Final EIS/EIR). The greatest amount (186 acres) of wetlands are found in the Eel River WAA; 80 percent and 70 percent of which are located in forested areas and WLPZs (Final EIS/EIR page 3.10-25), respectively. On PALCO lands, the amount of suitable habitat for these species has likely declined over the past 150 years, due to current and historic land use practices (e.g., grazing, timber harvest, road construction, and mining). This ownership likely contains a relatively small percent of potential habitat for the northwestern pond turtle and yellow-legged frog when compared to the species'ranges. Also, landscapes in the action area outside of the ownership have been intensively managed during the past 150 years. These land uses have altered water temperature, channel morphology, and the suitability of upland habitats. A more refined and accurate assessment of suitable habitat may become available as the amphibian and reptile assessment modules of the watershed analysis process are developed. See additional information in **Aquatics Baseline**.

Factors affecting species and suitable habitat in the action area

Other protective measures

See this discussion for northern red-legged frog above.

<u>**Tailed frog**</u>

Species

Numbers

No census data are available for the action area.

Landscape Comparison

No data are available to enable landscape comparisons, but see the comparison below for suitable habitat and occupancy.

Reproduction

No reproductive data are available for the action area.

Suitable habitat

Acreage and distribution

Amounts of suitable habitat on PALCO lands are uncertain. As stated in the Final EIS/EIR, the majority of habitat is found along Class II stream reaches. However, given the specificity of their habitat associations (Welsh et al. 1993), it is improbable that the entire 386 miles of Class II streams with late successional forest habitat are suitable. In addition, other studies document significant habitat and population losses in disturbed landscapes (Welsh and Ollivier 1998, Welsh et al., 1993, Welsh et al.1998); this factor would reasonably be expected to have habitat on the PALCO ownership.

Landscape comparison

The PALCO ownership (approximately 211,000 acres) make up 0.063 percent of the documented range (33.46 million acres) of the species. The action area (815,063 acres), including PALCO lands plus adjacent lands subject to influence, makes up about 2.4 percent of the species range.

Several recent studies in northwestern California enable comparisons in habitat quality and occupancy between managed and unmanaged redwood timberlands. The discussion below applies those studies to PALCO lands. All of the studies are based on presence/absence data, so the results lend insight into the comparative availability of suitable habitats and population responses to those habitats. Because of the way the studies were structured, the issue of habitat availability cannot be separated from that of population responses. Consequently, this discussion should also shed light on the landscape comparison (above) for animal numbers. One of the studies took place on PALCO lands (Wroble and Waters 1989) and the remainder took place on comparable industrial timberlands, reserved parklands and managed National Forest lands. All the studies, except one, were contained within Del Norte, Humboldt, Trinity and Mendocino Counties. Three inferences can be drawn from the studies outlined in the three numbered sections below. First, suitable habitats appear to be declining in abundance; second, populations appear to be declining; and third, the known capability of the tailed frog to disperse and colonize suitable habitat is diminished. Taken together, these inferences are consistent with the features of a decline in a metapopulation, in which the loss of habitat patches increases the effective distance between the remaining suitable patches to a point where it exceeds the dispersal capability of the species (e.g., see Wiens, 1996).

(1) *Evidence of losses of suitable habitat.* Wroble and Waters (1989) surveyed portions of 17 streams on PALCO lands for tailed frog and southern torrent salamander. They subdivided their sample into disturbed and undisturbed stream reaches based on the proximity of earlier harvests. By their definition, a disturbed reach would either marginally meet or fail to meet the canopy closure requirement for this species found in Welsh, et al. (1993) (see the discussion of canopy closure in **Life History**, above). Wroble and Waters (1989) found tailed frogs on 11 of 16 (69 percent) undisturbed reaches, and 7 of 17 (41 percent) disturbed reaches (not a statistically significant difference), but speculated that the difference may be attributable to unstable parent geology and higher sediment influx. However, Welsh et al. (1998) surveyed ten streams at Prairie Creek Redwoods State Park, with explicit experimental controls for parent geology, and found no correlation with frog abundance or presence. With this additional information, Welsh et al. (1998) offered the alternative explanation that consolidated streamside parent materials are more resistant to erosion and soil loss, so if the species is found predominantly on these sites, then it is an indication that suitable habitat is being lost on the more vulnerable unstable stream reaches. The FWS believes that the more rigorous experimental controls in Welsh et al. (1998) lends greater weight to their interpretation.

(2) *Evidence of reduced abundance.* No data are available showing census trends on intensively managed lands versus protected lands. However, Welsh et al. (1998) compared two studies of frog sightings per unit of effort that demonstrate statistically significant differences in relative abundance. Wroble and Waters (1989) reported an average of 0.108 sightings per hour of search

time from 17 drainages on PALCO lands. In contrast, Welsh and Ollivier (unpublished data) found 2.40 frogs per hour of search time on 10 streams at Prairie Creek Redwoods State Park. This is a twenty-two-fold difference and is statistically significant (Mann-Whitney test; $Z = 4.30$, $p = 0.0001$). However, with existing information it is difficult to evaluate the comparability of these studies, which could be influenced by differences in methodology and observer skill. (Also see the discussion in (1) above on stream channel parent geology.) In addition, landscape-level studies in the Pacific northwest have revealed statistically significant negative correlations between tailed frog presence (and abundance) and the extent of harvesting in the surrounding watershed (e.g., Bull and Carter 1996, Corn and Bury 1989). Similarly, Hawkins et al. (1988) report significant positive correlations between tailed frog larval abundance and the amount of surviving remnant forest in areas impacted by the Mount St. Helens eruption.

(3) *Evidence of reduced dispersal capability.* The tailed frog has a highly subdivided population and low dispersal capability. One generalization about this set of attributes is that the species is highly susceptible to further fragmentation of its habitat and population. Welsh et al. (1998) consider this species to be the "... most sensitive to ecosystem perturbations of all the stream amphibians in the redwood region." As habitat patches are lost and remaining habitat patches become isolated, it becomes increasingly difficult for a sedentary species to recolonize unoccupied patches of suitable habitat (Hanski 1977).

Welsh et al. (1993) provided a test of this prediction by subdividing a large presence/absence data set (collected throughout the species range in northwestern California) into four subsets: clearcuts, young forest, mature forest and old-growth forest. The results are shown as the percentage of suitable sites that are occupied, and are as follows: clearcuts (36 percent), young forest (50 percent), mature forest (64 percent), and old-growth forest (66 percent). The results are generally consistent with the test prediction. When the results were pooled and compared (clearcuts plus young versus mature plus old-growth) the pooled results were statistically significant.

Other protective measures
Tailed frogs generally occur in habitats protected as Class II Watercourses under CFPRs (Article 12, Parts 916.5, 936.5 and 956.5). Those rules require maintenance of 50 percent canopy cover in a buffer zone of 50 to 100 feet (depending on slope). However, in Welsh et al.'s (1993) habitat model, threshold (minimum) canopy cover for the presence of tailed frogs is approximately 86 percent. In light of this information, and in light of current habitat and population trends, including those on privately managed lands, the past effectiveness of the CFPR protection measures is open to question.

<u>Southern torrent salamander</u>
Species
Numbers
No census data are available for the action area.

Landscape Comparison

No data are available to enable landscape level comparisons, but see the comparison, below, for suitable habitats and occupancy.

Reproduction
No reproductive data are available for the action area.

Suitable Habitat
Acreage and distribution
Amounts of suitable habitat on PALCO lands are uncertain. As stated in the Final EIS/EIR, the majority of habitat is found along Class II stream reaches, with lesser amounts where cold water seeps join Class I reaches. However, given the specificity of their habitat associations, it is improbable that the entire 386 miles of Class II streams with late-successional forest habitat are suitable. Ollivier (pers. comm., 1998 and 1999) advises, based on survey experience in similar areas, that (a) mapped Class III reaches probably contain some perennially wetted seepage areas that are suitable habitat, and (b) occupied habitat is frequently found around upland springs and seeps in Class III drainages. Welsh and Lind (1992) report 0.18 suitable habitat sites per stream mile and 0.11 occupied suitable habitat sites per stream mile in northwestern California, based on a study area which included coastal and interior areas under private and public ownership. For Class II reaches, this yields a gross estimate of 70 total sites within suitable habitat, of which approximately 50 are occupied (386 miles multiplied by 0.18 suitable sites per mile; and 386 miles multiplied by 0.11 occupied sites per mile). There is not enough information available to make a quantitative estimate for Class I and III reaches, nor for upland springs and seeps.

Landscape Comparison
The PALCO lands (approximately 211,000 acres) make up 2.03 percent of the documented range (10.45 million acres) of the species. The action area (815,063 acres), including PALCO lands, make up 7.8 percent of the species range.

Several recent studies in northwestern California enable comparisons in habitat quality and occupancy between managed and unmanaged redwood timberlands. Several of the studies named above in the corresponding discussion on the tailed frog also included field observations of southern torrent salamanders; all of the inferences proposed in that discussion are applicable here.

(1) *Evidence of losses of suitable habitat.* Wroble and Waters (1989) survey, described above under the tailed frog discussion, also included field observations of the southern torrent salamander. Again, by their definition, a disturbed reach would either marginally meet or fail to meet the canopy closure requirement for this species found in Welsh and Lind (1996) (see the discussion of canopy closure in **Life History**, above). Similarly they found salamanders on 8 of 27 undisturbed reaches (29.6 percent), and 17 of 28 disturbed reaches (3.6 percent). In this instance the difference was statistically significant at a high degree of confidence. The authors' proposal that the difference may be attributable to unstable parent geology was also applied to this species.

(2) *Evidence of reduced abundance.* No data are available showing population trends on intensively managed lands versus protected lands. However, Welsh et al. (1998) compared two previous studies of salamander sightings per unit of effort to show that there are significant differences in relative abundance. Wroble and Waters (1989) reported an average of 0.052 sightings per hour of search time from 17 drainages on PALCO lands. In contrast, Welsh and Ollivier (unpublished data) found 0.724 salamanders per hour of search time on ten streams at Prairie Creek Redwoods State Park. The difference is fourteen-fold and is highly significant (Mann-Whitney test; $Z = 2.93$, $p = 0.003$). Welsh et al. (1998) report that Wroble and Waters (1989) attributed their low success rate to local parent geology. Welsh et al. (1998) tested this claim by evaluating a much larger data set (83 localities throughout the species range in northern California) and found no correlation between salamander presence and parent geology. Again, the studies were conducted in coastal forest and redwood ecosystems, with one on PALCO lands, and we believe that the general inferences are reasonably and specifically applicable to the action area.

Other protective measures

Southern torrent salamanders generally occur in habitats protected as Class II Watercourses under CFPRs (Article 12, Parts 916.5, 936.5 and 956.5). Those rules require maintenance of 50 percent canopy cover in a buffer zone of 50 to100 feet (depending on slope). However, in Welsh and Lind's (1996) habitat model, threshold (minimum) canopy cover for the presence of southern torrent salamanders is approximately 80 percent. In light of this information, and in light of current habitat and population trends, including those on privately managed forestlands, the effectiveness of the CFPR protection measures is open to question.

<u>Northern California ESU steelhead</u>

Steelhead are the most widely distributed salmonid species within the action area. They have been documented in Freshwater Creek, Elk River, Yager Creek, several tributaries to the Eel River, the Van Duzen River watershed, and the Bear and Mattole Rivers. According to the Final EIS/EIR, there is approximately 152 miles of suitable steelhead habitat within the action area.

In the mainstem of Freshwater Creek, HFAC trapped 288 0+ age steelhead in 1996. HFAC also trapped fish in various Freshwater Creek tributaries (IFR 1998). According to the Final EIS/EIR, CDFG (1995) observed 56 adult steelhead in the North Fork Elk River. CDFG electrofishing surveys in 1991-1993 found variable populations of steelhead in several Yager Creek tributaries (IFR 1998). The Final EIS/EIR noted that CDFG (1995) reported 32 steelhead adults from the Yager Creek watershed. The survey method was not reported. In the Van Duzen River drainage, steelhead juveniles and adults were found in Cummings, Grizzly, Hely, Root, and Stevens creeks by CDFG (1995; cited in SYP/HCP). CDFG (1995) also reported adult and juvenile steelhead in several Eel River tributaries. CDFG electrofishing surveys of several Eel River tributaries also found small numbers of steelhead in 1990 to 1992 (IFR 1998). The Final EIS/EIR states that steelhead are present in Rattlesnake Creek and the mainstem Mattole River (CDFG 1995) and the Bear River.

According to the Final EIS/EIR, PALCO has released hatchery-raised steelhead into the Yager Creek watershed from their facility on Cooper Mill Creek. Release numbers have ranged from 3,427 to 30,000 fish/year over the past 15 years. PALCO has also released steelhead into the Eel River drainage.

Southern Oregon/California Coasts ESU coastal cutthroat trout

There are very limited data available to determine the distribution and abundance of coastal cutthroat trout within the action area. The lower Eel River marks the southern boundary of the species' range. The Final EIS/EIR states that there are approximately 31 miles of suitable habitat within the action area.

On the mainstem Freshwater Creek, Humboldt Fish Action Council downstream migrant traps captured two 1+ age coastal cutthroat trout in 1989 and 12 1+ age coastal cutthroat trout in 1996 (IFR 1998). CDFG electrofishing surveys in 1994 found two coastal cutthroat trout in the Elk River drainage (IFR 1998). A 1998 downstream migrant trap operated by CDFG on the North Fork Elk River captured three 1+ age coastal cutthroat trout (IFR 1998). According to the Final EIS/EIR, coastal cutthroat trout have also been collected from Strongs Creek, a tributary to the lower Eel River.

EFFECTS OF THE ACTION

Effects Common to All Species

Interrelated and interdependent actions

An "interrelated activity" is an activity that is part of the proposed action and depends on the proposed action for its justification. An "interdependent activity" is an activity that has no independent utility apart from the proposed action. Regulations implementing section 7(a)(2) of the Act require the Services to consider the effects of activities that are interrelated or interdependent with the proposed Federal action (50 CFR §402.02).

There are no known interrelated or interdependent activities that have effects common to all of the species proposed for coverage under the ITPs. Those interrelated and interdependent activities with effects common to specific groups of species, i.e., salmonids and amphibians and aquatic reptiles, are discussed in the specific sections relating to those species.

Effects Common to Species Associated with Late-Seral Habitat

Direct effects

Species

Injury or disturbance

Late-seral associated species may be disturbed by covered activities around nest or den sites. The use of motorized equipment, helicopters, or blasting during the breeding season in or near late-seral habitat has the potential to disrupt essential foraging or breeding behaviors by: 1) causing abandonment of the breeding effort by failure to initiate courtship or nesting and denning, or complete incubation, 2) disrupting nesting/denning activity such as feeding young, and 3) causing premature fledging or dispersal of juveniles. A lack of breeding effort or breeding activity would negatively affect annual reproduction. Premature fledging or dispersal of juveniles may result in the increased likelihood of death or injury due to predation, lack of sheltering, or injury. Disturbance avoidance measures contained in the HCP will minimize these effects for most of the covered species.

Suitable habitat

Habitat protection

Over the life of the SYP/HCP, certain areas (MMCAs and RMZs) which contain LSH will be subject to little or no timber management activity. These areas are likely to provide the highest density of structural components important to late-seral associated species, thus providing the highest quality habitat over the permit period for these species. The acres protected within no harvest buffers of RMZs can vary post-watershed analysis. The post-watershed analysis width of the protection buffers can vary from 170 to 30 feet for Class I, from 170 to 10 feet for Class II, and from 30 to 0 feet for Class III RMZs. The no harvest buffer on Class II RMZs could only be reduced to 10 feet if the wildlife agencies determine that such reduced buffers would benefit aquatic species. Table 34 provides acres of LSH on PALCO lands in areas restricted from timber harvest activity by decade, using a "worst case" estimate for protection within RMZs. The Services believe that reduction of Class II RMZ no harvest buffers below 30 feet is unlikely. Therefore, our "worst case" analysis will analyze Class II RMZ no harvest buffers of 30 feet.

Table 34. A "worst case" estimate on the amount of LSH protected from timber harvest in RMZs applying the minimum no harvest buffer widths that could result post-watershed analysis (30 feet on Class I and Class II RMZs), as well as other areas protected from harvest on PALCO lands.

Decade	[1]MMCAs	[2]Grizzly Creek Complex	[3]Class I and II RMZs	Total Acres
Present	4,815	973	2,602	8,390
Decade 1	4,815	0	2,676	7,491
Decade 2	4,815	0	3,029	7,844
Decade 3	4,815	0	3,098	7,913
Decade 4	4,815	0	3,560	8,375
Decade 5	4,815	0	3,695	8,510

[1] For the purpose of this analysis we assumed that the acres of LSH would remain constant over the permit term, although acres of LSH are likely to increase as the mid-seral forests within the MMCAs grow. Data was not available to estimate the amount of ingrowth of LSH over the period.

[2] For the purpose of analyzing impacts to terrestrial covered species, other than the marbled murrelet, it is assumed that the Grizzly Creek Complex will only be protected from harvest for 5 years.

[3] The minimum no harvest buffer for Class III RMZs is 0 feet, therefore Class III RMZs are not included in these figures.

Since acres protected within RMZs can vary post-watershed analysis, we have also included an estimate of the maximum amount of LSH that would be protected from timber harvest post watershed analysis. Table 35 provides a "best case" estimate of acres of LSH on PALCO lands restricted from timber harvest within Class I and II RMZs.

Table 35. The "best case" estimate, using LTSY projections, of the amount of LSH protected from timber harvest in Class I and II RMZs on PALCO lands applying the maximum no harvest buffer widths (170 feet) that could result post-watershed analysis.

RMZ	Present	Decade 1	Decade 2	Decade 3	Decade 4	Decade 5
Class I	4,265	4,011	4,440	4,466	4,918	5,409
Class II	11,649	10,387	11,314	11,285	13,153	15,895
Total	15,914	14,398	15,754	15,751	18,071	21,304

The initial watershed analyses must be completed within five years of ITP issuance. The post-watershed analysis harvest prescriptions for RMZs will vary across the ownership by hydrologic unit, and prescriptions will be revisited every five years, or sooner due to changed circumstances. Thus, we cannot predict the acres of LSH protected within RMZs over the permit period. The acres protected will fall between the "best case" and "worst case" estimates described above.

In addition to PALCO lands, the Headwaters acquisition area is within the action area and contains 5,304 acres of LSH. These acres are expected to be present throughout the permit period and beyond.

Habitat modification
Under the SYP/HCP, LSH outside of MMCAs and no harvest buffers in RMZs will be available for harvest during the permit period. In areas subject to timber harvest, the effects of harvest on LSH are dependent upon the silvicultural prescriptions used, and to a lesser degree, the condition of the habitat prior to harvest. As described in the SYP/HCP, the late-seral selection and the selection harvest regimes are designed to maintain late-seral forest conditions. During the permit period, the late-seral selection harvest regime will be applied to approximately 30,786 acres (20 percent) and the selection regime to approximately 2,958 acres (2 percent) (Appendix Q, Final EIS/EIR) of the 154,868 harvested acres. Not all of these acres are currently LSH. The MMCAs, RMZs, and areas managed to address mass wasting and sedimentation concerns will be treated with these prescriptions.

Habitat removal
At a minimum, conservation measures for habitat diversity will retain at least 10 percent of the PALCO ownership in each WAA in LSH throughout the permit period. Using LTSY modeling information, Table 36 projects the amount of late-seral habitat that will be present on PALCO lands by decade. At the end of the first decade, the current amount of LSH will be reduced by 38 percent. By the end of the second decade, the amount of LSH will be reduced by 54 percent. The smallest amount of LSH (42 percent of the baseline acres) will be present by the end of the third decade. LSH is projected to increase in the fourth and fifth decades of the permit period to 47 percent and 58 percent of the baseline acres, respectively, due to ingrowth of habitat.

Table 36. Projected acres of uncut old-growth, residual old-growth, and other LSH on PALCO lands by decade using LTSY model information.

Seral Type	Present	Decade 1	Decade 2	Decade 3	Decade 4	Decade 5
Uncut Old-Growth	6,569	3,940	3,324	3,203	2,467	1,806
Residual Old-growth	18,205	7,875	7,301	6,727	6,605	6,491
Other LSH	44,457	30,042	20,392	19,370	23,033	31,643
Total	69,231	41,857	31,017	29,300	32,105	39,940

Forested areas outside of the MMCAs, RMZs, and areas managed to address mass wasting and sedimentation concerns are not expected to be managed to support late-seral associated species unless additional measures are identified through the adaptive management process outlined in the SYP/HCP. The loss of late-seral habitat will result when the even-aged and shelterwood/seed tree harvest regimes are applied. During the permit period, these harvest regimes will be applied to approximately 106,220 acres (69 percent) of the 154,868 harvested acres.

The use of mechanical equipment in management of forests increases the risk of wildfire. The SYP/HCP identifies responses to changed circumstances including wildfires. If a fire greater than 20 percent of a planning watershed occurs that is less than 5,000 acres in size, an expedited watershed analysis would be completed on the hydrologic unit impacted by the fire. As identified in the watershed analysis process, potential impacts to LSH associated species would be taken into consideration during post-watershed analysis synthesis and prescription development.

Distribution and fragmentation

Fragmentation of LSH will increase over PALCO lands throughout the life of the permit. The number of patches of LSH 475 to 1,000 acres in size, and greater than 1,000 acres in size, will decrease from 13 patches to 9 patches, and from 20 patches to 1 patch, respectively. The number of patches of LSH less than 80 acres in size and 80 to 475 acres in size will increase from 669 patches to 4,588 patches and from 73 patches to 86 patches respectively over the permit period as portions of the larger patches are systematically harvested, creating smaller and smaller intact blocks of LSH. The degree of fragmentation will vary by WAA. PALCO has developed LTSY projections for its ownership. The modeling used for this analysis was conducted on a WAA by WAA basis, therefore habitat patches which overlap between WAAs, are considered two separate patches, dividing at the WAA boundary. Although these projections are not spatially accurate, they do provide general trend information on the degree of fragmentation expected throughout the life of the permit.

Humboldt Bay WAA: The Humboldt Bay WAA totals approximately 128,448 acres, of which PALCO currently owns 38,985 acres (30 percent). At the end of the permit period, the Lower North Fork Elk and Elk Head Residual MMCAs, and other miscellaneous patches, will provide blocks of LSH greater than 80 acres in size. There are currently 18,383 acres of LSH within this WAA. Approximately 6,849 acres of LSH will persist at the end of the permit period, of which, 4,143 acres (60 percent) will be in blocks at least 80 acres in size. Table 37 provides future projections of LSH based on LTSY modeling information.

Table 37. Projected number of patches of LSH and acres of LSH by patch size on PALCO lands in the Humboldt Bay WAA by decade, based on LTSY model information.

Decade	Patch size								Total acres	Percent of PALCO lands in WAA
	0 - 80		80 - 475		475 - 1000		>1,000			
	acres	no. of patches	acres	no. of patches	acres	no. of patches	acres	no. of patches		
Present	872	88	1,436	5	679	1	15,415	5	18,402	47
1	1,835	337	1,864	11	2,366	4	2,798	2	8,863	23
2	2,043	479	2,350	14	1,514	2	1,303	1	7,210	18
3	2,139	587	2,180	12	2,129	3	0	0	6,448	17
4	2,209	600	2,436	13	2,064	4	0	0	6,709	17
5	2,706	727	3,042	16	1,101	3	0	0	6,849	18

In addition to PALCO lands, the Headwaters forest acquisition area is within the action area in the Humboldt Bay WAA and is expected to provide LSH throughout the permit period. The Headwaters acquisition area is 7,502 acres in size. It contains approximately 5,304 acres of LSH, of which, 3,783 acres are uncut and residual old-growth habitat. For the purposes of this analysis, the amount of LSH currently existing in the Headwaters acquisition area is assumed to be present throughout the life of the permit.

Yager Creek WAA: The Yager Creek WAA totals approximately 84,541 acres, of which PALCO currently owns 33,730 acres (40 percent). At the end of the permit period, Bell Lawrence, Booth's Run, Road 7 & 9 North, Right Road 9, Shaw Gift, Cooper Mill, Allen Creek and Extension, Road 3, and Owl Creek MMCAs, and other miscellaneous patches will provide blocks of LSH greater than 80 acres in size. There are currently 6,671 acres of LSH within this WAA. Approximately 7,661 acres of LSH will persist at the end of the permit period, of which, 6,347 acres (83 percent) will be in blocks at least 80 acres in size. Table 38 provides future projections of LSH based on LTSY modeling information.

Table 38. Projected number of patches of LSH and acres of LSH by patch size on PALCO lands in the Yager Creek WAA by decade, based on LTSY model information.

Decade	Patch size								Total acres	Percent of PALCO lands in WAA
	0 - 80		80 - 475		475 - 1,000		>1,000			
	acres	no. of patches	acres	no. of patches	acres	no. of patches	acres	no. of patches		
Present	1,064	98	2,065	12	2,198	4	2,102	2	7,429	22
1	802	180	1,056	6	2,679	4	1,118	1	5,655	17
2	764	205	1,024	5	2,620	4	1,267	1	5,675	17
3	786	219	1,029	5	2,622	4	1,159	1	5,596	17
4	1,205	439	727	3	3,650	5	1,241	1	6,823	20
5	1,315	435	782	6	4,291	6	1,273	1	7,661	23

Mad River WAA: The Mad River WAA totals 332,077 acres in size, of which PALCO currently owns 3,904 acres (1 percent). There are currently 158 acres of LSH within this WAA. Approximately 804 acres of LSH will persist at the end of the permit period, of which, 95 acres (0.1 percent) will be in blocks at least 80 acres in size. PALCO's minimal ownership within the Mad River WAA limits the importance PALCO lands play in supporting LSH associated species in the WAA.

Van Duzen River WAA: The Van Duzen River WAA totals 55,361 acres in size, of which PALCO currently owns 24,934 acres (45 percent). At the end of the permit period, a limited amount of LSH would occur in patches greater than 80 acres in size on PALCO lands. There are currently 6,189 acres of LSH within this WAA. Approximately 3,993 acres of LSH will persist at the end of the permit period, of which, 2,228 acres (56 percent) will be in blocks at least 80 acres in size. Table 39 provides future projections of LSH on PALCO lands based on LTSY modeling information.

Table 39. Projected number of patches of LSH and acres of LSH by patch size on PALCO lands in the Van Duzen River WAA by decade, based on LTSY model information.

Decade	Patch size								Total acres	Percent of PALCO lands in WAA
	0 - 80		80 - 475		475 - 1,000		>1,000			
	acres	no. of patches	acres	no. of patches	acres	no. of patches	acres	no. of patches		
Present	1,226	74	2,116	13	1,490	2	1,362	1	6,194	25
1	1,049	149	1,366	8	1,166	2	1,574	1	5,155	21
2	1,320	263	1,406	10	0	0	0	0	2,726	11
3	1,233	278	1,458	9	0	0	0	0	2,691	11
4	1,687	445	2,117	15	0	0	0	0	3,804	15
5	1,765	508	2,228	15	0	0	0	0	3,993	16

The Grizzly Creek Complex is within this WAA on PALCO lands. The Grizzly Creek Complex is required to be protected from timber harvest and other management activities for the first 5 years of the permit. The fate of the Grizzly Creek Complex will not be determined by issuance of the ITP. The SYP/HCP and IA include a process by which the Grizzly Creek Complex, or that portion of the Grizzly Creek Complex that has not been acquired by the state or other entities at the end of the 5 years will be re-evaluated under section 7 of the Act and under CESA. This evaluation will consider the potential impacts to the marbled murrelet of harvesting the Grizzly Creek Complex, and will require protection of the complex as an MMCA for the life of the permit, if necessary, to avoid jeopardy to the murrelet. For the purposes of analyzing impacts on other covered LSH associated species, this analysis assumes that the Grizzly Creek Complex will be harvested during the life of the permit.

In addition to PALCO lands, Grizzly Creek State Park is within the action area in the Van Duzen River WAA. This park is expected to provide LSH throughout the plan period. Grizzly Creek State Park is approximately 268 acres in size, most of which is considered to be LSH.

Eel River WAA: The Eel River WAA totals approximately 427,468 acres, of which PALCO currently owns 73,862 acres (17 percent). At the end of the permit period, only miscellaneous patches will provide a limited amount of LSH in blocks greater than 80 acres in size on PALCO lands. There are currently 30,384 acres of LSH within this WAA. Approximately 12,885 acres of LSH will persist at the end of the permit period, of which, 6,224 (48 percent) will be in blocks at least 80 acres in size. Table 40 provides future projections of LSH on PALCO lands based on LTSY modeling information.

Table 40. Projected number of patches of LSH and acres of LSH by patch size on PALCO lands in the Eel River WAA by decade, based on LTSY model information.

Decade	Patch size								Total acres	Percent of PALCO lands in WAA
	0 - 80		80 - 475		475 - 1,000		>1,000			
	acres	no. of patches	acres	no. of patches	acres	no. of patches	acres	no. of patches		
Present	3,078	236	4,387	26	5,220	7	17,712	8	30,397	41
1	4,201	714	5,081	27	2,859	6	5,295	2	17,436	24
2	5,268	1,165	5,288	28	1,086	2	0	0	11,642	16
3	4,780	1,256	4,791	28	1,270	2	0	0	10,841	15
4	5,571	1,336	5,401	31	1,023	2	0	0	11,995	16
5	6,767	1,671	5,682	30	542	1	0	0	12,991	18

In addition to PALCO lands, HRSP is within the action areas in the Eel River WAA. This park is expected to contribute substantial amounts of LSH throughout the permit period. The park is approximately 51,800 acres in size, of which 21,534 acres are LSH.

Bear/Mattole WAA: The Bear/Mattole WAA totals approximately 159,054 acres, of which PALCO currently owns 30,580 acres (19 percent). At the end of the permit period, only miscellaneous patches will provide a limited amount of LSH blocks greater than 80 acres in size on PALCO lands. There are currently 7,382 acres of LSH within this WAA. Approximately 8,413 acres of LSH will persist at the end of the permit period, of which, 2,578 (30 percent) will be in blocks at least 80 acres in size. Table 41 provides future projections of LSH on PALCO lands based on LTSY modeling information.

Table 41. Projected number of patches of LSH and acres of LSH by patch size on PALCO lands in the Bear/Mattole WAA by decade, based on LTSY model information.

Decade	Patch size								Total acres	Percent of PALCO lands in WAA
	0 - 80		80 - 475		475 - 1,000		>1,000			
	acres	no. of patches	acres	no. of patches	acres	no. of patches	acres	no. of patches		
Present	2,829	161	2,741	17	0	0	1,815	1	7,385	24
1	2,823	384	1,165	8	663	1	0	0	4,651	15
2	2,759	562	832	6	0	0	0	0	3,591	12
3	2,596	422	1,188	9	665	1	0	0	4,449	15
4	2,282	452	1,219	9	0	0	0	0	3,501	11
5	5,835	1,108	2,578	18	0	0	0	0	8,413	28

Removal of special habitat components
Timber harvest may reduce the quantity and quality of special habitat components such as large green trees, snags, hardwood trees, and down logs. These components are used either directly by LSH associated species or by their prey for breeding, feeding, or cover. This effect could be substantial due to a potential loss of suitable nesting and denning substrate and reductions in prey populations; however, the retention requirements for these components (see **Description of the proposed action**) would minimize the impact of timber harvest, and provide levels of special components adequate for the needs of covered species. The effect, in terms of numbers of trees, snags, or logs, was not quantified for the purpose of this consultation.

Prescribed fire is often used as a management tool to remove unwanted vegetation and logging slash after harvest. Prescribed fire can consume habitat structural elements such as snags and downed logs that are important to LSH associated species. Monitoring for structural components described in the SYP/HCP will evaluate the effectiveness of management actions in retaining these habitat elements after prescribed burning. Additional measures are expected to be taken if necessary to ensure retention of these elements through subsequent harvest rotations.

Dispersal habitat condition
RMZs are expected to provide dispersal corridors throughout the permit period for certain late-seral associated species (Pacific fisher and California red tree vole). Prescribed fire is often used as a management tool to remove unwanted vegetation and logging slash after harvest, and can threaten the integrity of the LSH within the RMZs. The aquatic conservation plan proposes additional measures associated with RMZs to maintain adequate buffers between upslope burning activities and the stream channels. The measures are designed to keep prescribed fires out of

RMZs by limiting prescribed burns to only those times when optimal conditions exist and by requiring fire-setting techniques that will encourage the fire to burn away from RMZs. Numerous variables such as vegetative moisture content, wind, and humidity can influence the ability to control a prescribed fire once it is set. Although management of controlled burns may never be 100 percent effective, these measures described in the aquatic conservation plan are expected to minimize the possibility of fire from prescribed burning compromising the integrity of the shade-providing canopy in the RMZs.

Indirect effects

Predation

The overall mix of seral stages within PALCO lands will shift to a predominance of younger-aged stands throughout the permit period. This shift has the potential to negatively affect species associated with LSH in the following ways:

1. Increased fragmentation of LSH has the potential to increase the time late-seral associated species spend traveling and foraging away from protective cover, thereby exposing them to greater risk of predation.

2. The foraging efficiency of certain predators which prey on late-seral associated species may increase as a result in WAA-wide changes in vegetation seral stage composition.

3. Certain predators which prey on late-seral associated species may increase in density as a result of WAA-wide changes in vegetation seral stage composition. The resultant increased predation is likely to result in an increase in the loss of individuals from the population.

All three of the factors listed above are likely to adversely affect reproduction. The magnitude of this effect could not be quantified for this consultation.

Injury or disturbance

Indirect effects are similar to the direct effects listed above, but are likely to happen later in time. An example would be vehicle traffic expected to occur over the term of the permit on roads constructed early in the permit period. Vehicle traffic that occurs during the breeding season in or near late-seral habitat has the potential to disrupt essential foraging or breeding behaviors by: 1) causing abandonment of the breeding effort by failure to initiate courtship or nesting and denning, or complete incubation, 2) disrupting nesting/denning activity such as feeding young, and 3) causing premature fledging or dispersal of juveniles. A lack of breeding effort or breeding activity would negatively affect annual reproduction. Premature fledging or dispersal of juveniles may result in the increased likelihood of death or injury due to predation, lack of sheltering, or injury.

Habitat loss or modification

Timber management activities may result in the indirect loss or modification of LSH. Openings in forest stands created by several types of silvicultural prescriptions (e.g., clearcutting, selection harvest, shelterwood, seed tree, or commercial thinning) may increase the likelihood of all or portions of the stands being treated or the stands directly adjacent to treated areas being lost due to windthrow. Local topography affects the pattern and severity of windthrow. On PALCO lands wind-fallen trees are a common, but localized, occurrence. The exact magnitude of this effect could not be quantified for this analysis. However, the effects of such indirect habitat loss or modification on late-seral associated species would likely be minor.

Effects Common to Pacific Salmonids

The objective of this analysis is to determine if the direct, indirect, or cumulative effects of the proposed ITP for PALCO in Humboldt County, California, are likely to jeopardize the continued existence of threatened or endangered anadromous salmonids or destroy or adversely modify proposed critical habitat. Specifically, this analysis focuses on the direct, indirect, and cumulative effects of the proposed action on the threatened SONCC coho salmon; the SOCC chinook salmon, which has been proposed for federal listing as a threatened species; the northern California steelhead, which is a candidate for federal listing as a threatened species; and the SOCC coastal cutthroat trout, which is currently being reviewed for possible federal listing under the Act. The analysis also focuses on proposed critical habitat for both the SONCC coho salmon and the SOCC chinook salmon within the action area.

This analysis of effects is intended to determine if the actions covered by the proposed ITP and accompanying SYP/HCP could reasonably be expected to appreciably reduce the likelihood of both the survival and recovery of any of these species in the wild or appreciably diminish the value of critical habitat to listed salmonids. Because PALCO has applied for an ITP that would be effective for 50 years, this assessment considers the effects of actions that would occur between March 1, 1999, and March 1, 2049.

Assessment Approach

In recent years, the decline and extinction of Pacific salmon populations most commonly results from habitat loss and degradation in their spawning and rearing streams (Nehlsen et al. 1991). As a result this assessment of the effects of action associated with the proposed ITP for PALCO on four salmonids and proposed critical habitat is habitat-based. To conduct our assessment, we used the best scientific and commercial data available to estimate changes to water quality conditions, channel condition and dynamics, flow, hydrology, physical barriers to migration, and the general condition of watersheds that support the biological and ecological requirements of populations of these salmonids. An underlying assumption of this analytical approach is that these species will experience demographic changes (that is, changes in vital rates, population size, and distribution) commensurate with the changes in these habitat-related variables. As a result, these habitat-related variables are used as surrogates or indices of population trends for the purposes of this assessment. This approach is consistent with the approach used in the EIS.

The relationship between changes in habitat quantity, quality, and connectivity and the status and trends of fish and wildlife populations has been the subject of extensive scientific research and publication, and the assumptions underlying our assessment are consistent with this extensive scientific base of knowledge. For more extensive discussion of and data supporting the relationship between changes in habitat variables and the status and trends of fish and wildlife populations, readers should refer to the work of Fiedler and Jain (1992), Gentry (1986), Gilpin and Soule (1986), Nicholson (1954), Odum (1971, 1989), and Soule (1986, 1987). For detailed discussions of the relationship between habitat variables and the status and trends of salmon populations, readers should refer to the work of FEMAT (USDA Forest Service et al.1993), Gregory and Bisson (1997), Hicks et al. (1991), Murphy (1995), National Research Council (1996), Nehlsen et al. (1991), Spence et al. (1996), Thomas et al. (1993), The Wilderness Society (1993), and any of the numerous references contained in this rich body of literature.

The relationship between habitat and populations is embodied in the concept of carrying capacity. The concept of carrying capacity recognizes that a specific area of land or water can support a finite population of a particular species because food and other resources in that area are finite (Odum 1971). By extension, increasing the carrying capacity of an area (that is, increasing the quality or quantity of resources available to a population within that area) increases the number of individuals the area can sustain over time. By the same reasoning, decreasing the carrying capacity of an area (that is, decreasing the quality or quantity of resources available to a population) decreases the number of individuals the area can support over time. Restoring habitat that had been previously destroyed or degraded can increase the size of a population the habitat can support; conversely, habitat destruction and alteration can reduce the size of a population the habitat can support. In either case, there is a corresponding, but non-linear relationship between changes in the quality and quantity of resources available to a species in an area and the number of individuals that area can support.

The approach used in this assessment is intended to determine if the proposed action is likely to destroy or degrade the quantity and quality of natural resources necessary to support populations of the four salmonid species in the action area. Finally, the assessment approach is intended to determine if any changes are likely to decrease the size, number, dynamics, or distribution of listed salmonid populations in the action area in ways that appreciably reduce the likelihood of both the survival and recovery of listed species in the wild.

To make this determination, this assessment examines characteristics of watersheds and aquatic ecosystems within the action area that are essential to support populations of coho salmon, chinook salmon, steelhead, or coastal cutthroat trout. These variables, which are derived from a synthesis of most published reviews on the status and trends of Pacific salmon, must be present to ensure that watersheds function properly for listed salmon populations, include water quality, water quantity, channel conditions and dynamics, riparian vegetation, watershed conditions, physical barriers to fish migration within the watershed, and specific habitat variables such as food supply, substrate, large woody debris, pool frequency, pool quality, off-channel habitat, and remnant aquatic areas and refugia (USDA Forest Service et al. 1993, Gregory and Bisson 1997, Hicks et al. 1991, Murphy 1995, Nehlsen et al. 1991, Thomas et al. 1993). The variables are primarily developed from information on the habitat needs of salmon, including coho salmon, but will be treated as equally relevant to the other salmonid species considered in this Opinion. Although the presence of these variables does not assure the presence of salmon, salmon populations are not likely to survive in a stream if these variables are absent or highly degraded.

This assessment also analyzes whether the proposed action will adversely modify or destroy proposed critical habitat for the SONCC coho salmon and SOCC chinook salmon. It is necessary to analyze the effects of the action on the constituent elements of critical habitat proposed as essential to the survival and recovery of the listed species. If an action affects critical habitat, but does not appreciably diminish the value of constituent elements essential to the species' conservation, the adverse modification or destruction threshold is not exceeded. Many activities can be expected to take place within proposed critical habitat without appreciably diminishing the value of constituent elements essential to the species' conservation. On the other hand, the adverse modification threshold is exceeded when the proposed action will adversely affect the proposed critical habitat's constituent elements or their management in a manner likely to appreciably diminish or preclude the role of that habitat in both the survival and recovery of the species.

Constituent elements are not specifically defined in the proposed critical habitat designations for either coho (62 FR 62741, November 1997) or chinook salmon (63 FR 11482, March 1998). Therefore, in order to analyze whether the proposed actions will adversely modify or destroy proposed critical habitat, NMFS analyzed the effects of the action on the essential habitat features. That is, using the best scientific and commercial data available, we estimated the changes to substrate and sediment levels, water quality conditions, flow, stream temperatures, physical habitat elements, channel condition, chemicals and nutrients, riparian vegetation, habitat accessability, and the general condition of watersheds that support the biological and ecological requirements of coho and chinook salmon. In this, the analysis of effects of the action on proposed critical habitat was identical to the analysis of effect on the species.

To facilitate an understanding of the elements of the proposed action, a summary of the baseline environmental conditions is presented, followed by a summary of the proposed ITP, which includes a brief description of the covered activities and the proposed aquatic conservation plan. Following these summaries, the effects of the proposed covered activities are described, which is followed by an effects analysis of the aquatic conservation plan. Interrelated and interdependent effects are also discussed and cumulative effects are described last.

Background Summary of Baseline Conditions

As discussed previously, the action area for this biological opinion encompasses five watershed areas. These areas will be affected differently by the proposed action because of difference in the geology, topography, the types of timber management and road construction they will experience, and their significance to Pacific salmon. The following discussion provides a general overview of different features of these watershed areas as background summary for this analysis of effects of the proposed action.

The action area for this biological opinion encompasses approximately 815,063 acres of forest and associated grasslands in Humboldt County, California. It includes approximately 211,700 acres of lands owned by PALCO and a 1.3-mile buffer around those lands; these areas include the Mad River (Butler Valley hydrologic unit), Jacoby Creek, Freshwater Creek, Elk River, Salmon Creek, Humboldt Bay, Eel River, Van Duzen River, Yager Creek, Bear River, Salt River, and Mattole River watersheds.

Where data were available, the Baseline and following narrative discusses the known distribution of the four species of salmon within each watershed (data on the distribution and abundance of salmonids in the action area and within specific watersheds is derived from the Final EIS/EIR). However, it is important to note the limitations in the data on these species within these watersheds. The number and extent of surveys for these species in the action area is limited, so we cannot conclusively determine their actual distribution. Most importantly, a species may occur within these watersheds even though existing data do not show them as present. In the EIS and the Environmental Baseline section of this biological opinion, salmon were assumed present in a stream if suitable habitat existed; that protocol continues in this assessment of effects.

Bear/Mattole River Watershed. This watershed area includes the Bear River, Mattole River Delta, North Fork of the Mattole River, and Upper North Fork of the Mattole River hydrounits. This watershed area encompasses approximately 163,000 acres and includes approximately 30,495 acres of palustrine forested wetlands, 7,472 acres of riparian habitat, and 255 miles of streams (see Table 42 below). Twenty-five percent of the Bear River hydrounit and 9 percent of the Mattole River hydrounit are owned by PALCO.

Table 42: Stream Miles on PALCO Lands within the Bear/Mattole River Watershed Area (from EIS/EIR 1999).

Hydrologic Unit	Class I	Class II	Class III	Total
Bear River	22.6	58.8	45.6	127.0
Mattole Delta	5.0	10.2	9.9	25.1
North Fork Mattole River	5.0	17.7	15.0	37.7
Upper North Fork Mattole River	9.6	31.2	25.0	65.8
Totals	**42.2**	**117.9**	**95.5**	**255.6**

Based on the data presented in the Final EIS/EIR, chinook salmon and steelhead are recorded from the Bear/Mattole watershed area. Chinook salmon are known to occur within about 0.1 stream miles of the Upper North Fork Mattole hydrounit. Steelhead are known to be occur within about 9.0 stream miles of the Bear River hydrounit, 3.2 stream miles of the Mattole Delta hydrounit, 0.8 miles of the North Fork Mattole River hydrounit, and 6.3 miles of the Upper North Fork hydrounit. Existing surveys of this hydrounit have not conclusively determined the presence or absence of coho salmon and coastal cutthroat trout in streams. This WAA is outside of the known range of coastal cutthroat trout.

Functioning aquatic habitat in the Bear/Mattole WAA is limited by high embeddedness, excess fines, high water temperatures, low percent canopy cover, low percent pools, low levels of LWD instream and for recruitment, and low percent instream cover (PALCO 1998). The Mattole River is also listed under section 303(d) of the Clean Water Act for sediment and water temperatures problems.

Eel River Watershed. This watershed area includes the Eel Delta, Giants Avenue, Larabee Creek, Lower Eel River, and Sequoia hydrounits. About 0.3 miles of the Eel Delta are included in the Headwaters Reserve.

Table 43: Stream Miles on PALCO Lands within the Eel River Watershed Area (from EIS/EIR 1999).

Hydrologic Unit	Class I	Class II	Class III	Total
Eel Delta	12.6	39.7	27.4	78.7
Giants Avenue	1.2	4.9	4.3	10.4
Larabee Creek	21.5	62.7	43.9	128.1
Lower Eel River	30.9	130.8	91.5	253.2
Sequoia	13.7	42.1	30.8	86.6
Totals	**79.9**	**280.2**	**197.9**	**558.0**

Based on the data presented in the Final EIS/EIR, coho and chinook salmon, coastal cutthroat trout, and steelhead are recorded from the Eel River watershed area. Coho salmon are known to occur within 0.1 miles of the Eel Delta hydrounit, 3.9 miles of the Larabee Creek hydrounit, 2.9 miles of the Lower Eel River hydrounit, and 3.6 miles of the Sequoia hydrounit. Chinook salmon are known to occur within about 0.2 miles of the Eel Delta hydrounit, 0.2 miles of the Giants Avenue hydrounit, 6.0 miles of the Larabee Creek hydrounit, 6.7 miles of the Lower Eel River hydrounit, and 4.4 miles of the Sequoia hydrounit. Steelhead are known to occur within about 6.3 miles of the Eel Delta hydrounit, 0.7 miles of the Giants Avenue hydrounit, 12.3 miles of the Larabee Creek hydrounit, 15.6 miles of the Lower Eel River hydrounit, and 10.5 miles of the Sequoia hydrounit. Coastal cutthroat trout are known to occur within about 2.5 miles of the Eel Delta hydrounit.

Functioning aquatic habitat in the Eel WAA is limited by high water temperatures, low LWD abundance instream and for recruitment, low instream cover levels (PALCO 1998) and excessive sediment. The Eel River is also listed under Section 303(d) of the Clean Water Act for sediment and water temperature problems. Bear Creek, Jordan Creek and Stitz Creek have also been listed by CDF (1998) as being cumulatively affected by sediment problems due to land management activities.

Humboldt Bay Watershed. The Humboldt Bay watershed area includes the Elk River, Freshwater Creek, and Salmon Creek hydrounits. Approximately 66 percent of the Elk River hydrounit, 56 percent of the Freshwater Creek hydrounit, and less than 5 percent of the Salmon Creek hydrounit are owned by PALCO.

Table 44: Stream Miles on PALCO Lands within the Humboldt Bay Watershed Area (from EIS/EIR 1999).

Hydrologic Unit	Class I	Class II	Class III	Total
Elk River	21.5	49.2	49.4	120.1
Freshwater Creek	21.8	56.7	38.7	117.2
Jacoby Creek	0.0	1.6	0.9	2.5
Other	0.0	0.1	0.2	0.3
Salmon Creek	0.7	1.8	1.5	4.0
Totals	42.2	117.9	95.5	255.6

Based on the data presented in the Final EIS, coho salmon are known to occur within about 15.8 miles of the Elk River hydrounit, 11.1 miles of the Freshwater Creek hydrounit, 4.7 miles of the Salmon Creek hydrounit. Chinook salmon are known to occur within about 15.5 miles of the Elk River hydrounit, 9.9 miles of the Freshwater Creek hydrounit, 7.2 miles of the Salmon Creek hydrounit. Steelhead are known to occur within about 13.9 miles of the Elk River hydrounit, 11.2 miles of the Freshwater Creek hydrounit, 7.2 miles of the Salmon Creek hydrounit. Coastal cutthroat trout are known to occur within about 17.1 miles of the Elk River hydrounit, 7.3 miles of the Freshwater Creek hydrounit, 7.2 miles of the Salmon Creek hydrounit.

Under the proposed action, approximately 7,503 acres of land containing 3,117 acres of uncut, old-growth redwood forest would be placed in the Headwaters Forest Reserve. About 18.8 miles of the Elk River hydrounit within the Humboldt Bay watershed are within the Headwaters Reserve. Another 19.2 stream miles of the Elk River of the hydrounit currently owned by the Elk River Timber Company would be transferred to the Headwaters Reserve while another 44.3 stream miles of the Elk River would be transferred from the Elk River Timber Company to PALCO.

Functioning aquatic habitat in the Humboldt WAA is limited by shallow mean pool depths, low instream cover levels, and high levels of fine sediment (PALCO 1998). Freshwater Creek and Elk

River have been listed under section 303(d) of the Clean Water Act due to sediment problems. Freshwater Creek and Elk River have also been listed by CDF (1998) as being cumulatively affected by sediment due to management activities.

Mad River Watershed. The Mad River watershed area includes the Butler Valley and Iaqua Buttes hydrounits.

Table 45: Stream Miles on PALCO Lands within the Mad River Watershed Area (from EIS/EIR 1999).

Hydrologic Unit	Class I	Class II	Class III	Total
Butler Valley	0.6	6.1	3.9	10.6
Iaqua Buttes	2.9	9.5	5.7	18.1
Totals	3.5	15.6	9.6	28.7

The Mad River is listed under Section 303(d) of the Clean Water Act for sediment and turbidity problems.

Van Duzen River Watershed. The Van Duzen River watershed area includes the Van Duzen River hydrounit.

Table 46: Stream Miles on PALCO Lands within the Van Duzen River Watershed Area (from EIS/EIR 1999).

Hydrologic Unit	Class I	Class II	Class III	Total
Van Duzen River	30.4	83.3	65.7	179.4

Functioning aquatic habitat is limited in the Van Duzen WAA due to low percent pools, low abundance of LWD instream and for recruitment, low instream cover levels, and high levels of fine sediment (PALCO 1998). The Van Duzen River is also listed under Section 303(d) of the Clean Water Act for sediment problems.

Yager Creek Watershed. The Yager Creek watershed area includes the Lawrence Creek, Lower Yager River, Middle Yager River, and North Yager River hydrounits. This watershed area encompasses approximately 84,541 acres and has topography that ranges from 400 to 3,300 feet in elevation.

Table 47: Stream Miles on PALCO Lands within the Yager Creek Watershed Area (from EIS/EIR 1999).

Hydrologic Unit	Class I	Class II	Class III	Total
Lawrence Creek	25.6	55.9	41.7	123.2
Lower Yager River	19.6	51.6	46.7	117.9
Middle Yager River	7.2	6.2	6.3	19.7
North Yager River	3.5	9.2	7.5	20.2
Totals	55.9	122.9	102.2	281.0

Functioning aquatic habitat in the Yager WAA is limited by low percent canopy cover (PALCO 1998). The Yager River is also listed under section 303(d) of the Clean Water Act for sediment problems.

Summary of the Proposed Incidental Take Permit

The Action Area for this Opinion encompasses approximately 815,063 acres of forest and associated grasslands in Humboldt County, California. It includes approximately 211,700 acres of lands owned by PALCO and a 1.3-mile buffer around those lands; these areas include the Mad River (Butler Valley hydrologic unit), Jacoby Creek, Freshwater Creek, Elk River, Salmon Creek, Humboldt Bay, Eel River, Van Duzen River, Yager Creek, Bear River, Salt River, and Mattole River watersheds.

Covered Activities

The proposed ITP would cover timber management activities on approximately 203,000 acres of the action area (see table 48, below). These timber management activities include timber harvest and regeneration, site preparation (including burning), planting, vegetation management, thinning, and fire suppression. As part of the proposed action, approximately 174,386 of those 203,000 acres (86 percent), including lands transferred to PALCO from the Elk River Timber Company, would be managed intensively for timber production. Based on PALCO's timber harvest projections for the next 10 years, the largest proportion of the harvests would occur in the Lower Eel, Freshwater Creek, Elk River, Larabee Creek, and Van Duzen Creek hydrounits. These hydrounits would be most affected by timber harvests within this period.

Table 48. Approximate acres of timber harvest, by silvicultural prescription. Compiled from data in unnumbered table "Area Assigned by Silvicultural Prescription Code, Alternative 164g" in SYP/HCP, Volume III, Part C.

Plan Decade	Clearcut Acres	Active THPs [1]	Late-Seral Selection	Single Tree Selection	Restock	Total Acres Harvested
1	36,005	14,479	3,265	637	497	54,883
2	49,612	0	3,275	115	0	53,002
3	39,242	0	6,600	327	0	46,169
4	17,025	0	7,059	6	1,690	25,780
5	5,887	0	4,235	0	0	10,122
Totals	147,771	14,479	24,434	1,085	2,187	189,956

[1] Most existing THPs result in commercial thinning in decade 1, followed by clearcut in decades 2 or 3. For the purposes of this analysis, we assume that all active THPs will be implemented and these acres have been considered as harvested in the environmental baseline.

Proposed covered road activities include road maintenance, upgrading, construction, reconstruction, storm-proofing, closure, decommissioning and road use. Approximately 400 miles of new road would be built, adding to the existing 1500 miles, during the permit period: 150 miles in the first decade, 100 miles in the second decade, 75 miles in the third decade, 50 miles in the fourth decade, and 25 miles in the fifth decade. An unknown, unlimited number of roads will be reconstructed during the permit period. At least 750 miles of existing roads will be storm-proofed per decade with all the roads on the property have been brought up to that standard within the first 20 years. The road program also generally entails clearing vegetation from road rights-of-way, removing trees, grubbing (removing stumps and surface organics), grading, and compaction; extraction of rock, sand, and gravel from small borrow pits for use in road construction and maintenance, drainage facility repair, and erosion control; construction of stream crossings (bridges, fills with culverts, fords, and a variety of temporary crossings); maintenance of surfaced roads, seasonal roads, culverts, bridges, fords, cuts and fill slopes; and closure of roads, temporarily or permanently (i.e., closed or decommissioned).

The proposed ITP will also cover PALCO's operations of two commercial hard rock quarries in the action area. The two quarries are identified as Rock Quarry 1/Road 24 and Rock Quarry 2/Road 9. Rock Quarry 1 is located on a 3.5-acre site located in the Yager Creek drainage, which produces approximately 125,000 cubic yards of aggregate material. Rock Quarry 2 is located in the Lawrence Creek drainage of the Yager Creek watershed and is mined for commercial purposes. Approximately 450,000 cubic yards of material are available for production at Quarry 2. Operations at these two quarries would be covered under the proposed ITP for two years. After two years, any additional coverage for these quarry operations will require amendments to the ITP and associated conservation plan.

Quarry operations include excavations, drilling, blasting, screening, loading and hauling, road relocation, and erosion control. Extraction activities in borrow pits are similar to but less intensive than in quarries. Material is hauled off-site and transported by truck or rail to the areas they will be used to stabilize slopes, as bedding, and road base. Mining operations are seasonal, with most operations occurring from April through November.

PALCO uses many small sand or rock sources (borrow pits) in the action area for road maintenance, drainage facility repair, and erosion control. Activities associated with these borrow pits are part of PALCO's road and sediment control program and are covered by the ITPs for five years after the effective date of the permit. Coverage for borrow pits beyond that five-year period will require an amendment to the permits.

Aquatic Conservation Plan

As part of the proposed action, the SYP/HCP contains several strategies to conserve species covered by the ITP. The aquatic conservation plan defines the principle strategies that will be taken to minimize, mitigate and monitor effects of the proposed action on the four salmonid species being considered in this biological opinion. The aquatic conservation plan establishes interim prescriptions and requires that prescriptions be generated by watershed analysis. Interim prescriptions will be implemented as part of the proposed action unless they are modified by the results of a watershed analysis. Watershed analysis would be required for all of the lands covered by the ITP, with initial watershed analyses completed within the first 5 years of permit issuance.

The proposed aquatic conservation plan consists of six main interrelated elements to minimize, mitigate and monitor the effects of timber harvesting activities on aquatic ecosystems: riparian management strategy, hillslope management, road management, watershed analysis, a disturbance index, and monitoring. The aquatic conservation plan also includes measures for other covered activities: burning, rock quarries, borrow pits, and water drafting. Monitoring would be conducted to determine compliance, effectiveness, and trends for all covered activities. The effectiveness of the aquatic conservation plan requires full implementation of all six elements; if any of these elements are not fully implemented, the strategy may appreciably reduce the likelihood of the survival and recovery of the threatened and endangered aquatic species in the action area and may adversely modify or destroy proposed critical habitat. Through watershed analysis, new scientific studies, and monitoring, the prescriptions for any covered activity could be modified such that the SYP/HCP continues to meet the objective of maintaining or achieving, over time, a properly functioning aquatic habitat condition. Thus, the level of protection, after watershed analysis or other adaptive management, would be equal to or greater than the interim prescriptions. Mitigation for changed circumstances per the "no surprises" policy would also be implemented with the same objective to maintain or achieve, over time, a properly functioning aquatic habitat condition.

Headwaters Reserve
As part of the proposed action, the Federal government and State would complete acquisition of a portion of PALCO's property to establish a reserve (the Headwaters Reserve) upon issuance of ITPs. The acquired land would include 5,625 acres from PALCO and 9,468 acres from the neighboring Elk River Timber Company. The PALCO land and approximately 1,764 acres of Elk River Timber Company land would be placed into the Headwaters Reserve; the remaining Elk River Timber Company land would be transferred to PALCO. The Headwaters Reserve would be jointly owned by the Federal and State governments. The State would own the Owl Creek and Grizzly Creek acquisitions, if completed. Prior to the completion of the latter acquisitions, the Owl Creek area would be protected for the term of the ITPs, and the Grizzly Creek area would protected for 5 years. Management of the Headwaters Forest, following acquisition, is not part of the proposed action and will not be evaluated as part of this Biological/Conference Opinion.

Effects of the Proposed Incidental Take Permit
As summarized in the preceding section and discussed in more detail in the *Description of the Proposed Action*, the proposed action would allow timber management activities on approximately 203,000 acres of the action area. These timber management activities include timber harvest and regeneration, site preparation (including burning), planting, vegetation management, thinning, and fire suppression. Approximately 174,386 of these acres (86 percent) would be intensively managed for timber production. Based on PALCO's timber harvest projections for the next 10 years, the largest proportion of timber harvests would occur in the Lower Eel, Freshwater Creek, Elk River, Larabee Creek, and Van Duzen Creek hydrounits. The proposed action covers PALCO's entire road management program, including road assessments, road storm-proofing, road construction, reconstruction, and upgrading, road inspections, maintenance, use, closure, decommissioning, operation and construction of borrow pits and water drafting for dust abatement and fire suppression. In addition, the proposed action includes two quarry operations that involve excavation, drilling, blasting, screening, loading and hauling, road relocation, and erosion control activities. Material extracted from the quarries will be hauled off-site and transported by truck or rail beyond the action area.

In the following discussion, the general effects of the proposed timber and road management activities will be considered separately from the effects of the borrow pits and two quarries. After considering the direct and indirect effects of the proposed timber and road management activities, and the borrow pits and quarries, we will consider the direct and indirect effects of the conservation measures proposed in the SYP/HCP to minimize and mitigate the potential adverse effects of the covered activities on threatened and endangered salmon in the action area.

As proposed, approximately 11,290 acres of PALCO land would not be initially harvested, including 3,769 acres of RMZs and 7,521 acres included in MMCAs. Approximately 26,123 acres of land would be selectively-harvested in RMZs to protect riparian habitat within the action area. At least 10 percent of PALCO's lands in each WAA would be maintained as late seral forest, but approximately 69 percent of residual old growth would be harvested within the first 10 years of the ITP. At the end of 50 years, the area outside of RMZs and MMCAs on PALCO lands would be dominated by early- and mid-seral forests.

Since the 1950s numerous authors and groups have studied the effects of logging activities on salmon and their habitat. Comprehensive reviews of these studies have been conducted by Gibbons and Salo (1973), Salo and Cundy (1987), Meehan (1991), Thomas et al. (1993), FEMAT (USDA Forest Service et al. 1993), Murphy (1995), and Spence et al. (1996). Most studies of the effects of timber harvests on salmon have focused on the relationship between specific habitat components and specific phases of salmon life cycles. Fewer studies have examined the collective effects of logging on the entire life cycle of salmon; as a result, our understanding of the relationship between habitat effects at the ecosystem level and the response of salmon populations is still being developed (Hicks et al. 1991). Although the information available on the effects of timber management on salmon and their habitats does not facilitate quantitative predictions of the effects of proposed timber management activities on the habitat of threatened and endangered salmon, those studies make it possible for us to project the probable direction and magnitude of habitat changes and their effects on salmon and their habitats.

Timber and Road Management

The broad category called "timber management" encompasses a large range of activities that includes the actual timber harvest, use of fertilizers, pesticides, fire retardants, and replanting activity. Road management encompasses the generalized categories of road existence, use, construction, maintenance, and closure.

Based on PALCO's timber harvest projections for the next 10 years, the largest proportion of the harvests would occurs in the Lower Eel, Freshwater Creek, Elk River, Larabee Creek, and Van Duzen Creek hydrounits. As a result, these hydrounits are most likely to experience adverse effects caused by timber harvests within this period. Within the first ten years of the proposed permit, PALCO expects to harvest timber on 5,543 acres of land within the Bear/Mattole River watershed; 26,234 acres within the Eel River watershed; 12,772 acres within the Humboldt Bay watershed; 186 acres within the Mad River watershed; 4,286 acres within the Van Duzen River watershed; and 5,883 acres within the Yager Creek watersheds.

PALCO proposes to construct 400 miles of new roads and a reconstruct an unspecified amount of roads. During the first decade, 150 miles of new roads are planned to be built. An unspecified and unlimited amount of roads may be reconstructed.

The following effect discussion address the different variables associated with properly functioning aquatic habitat.

Stream Temperature

Increased water temperatures in streams is often associated with the removal of shade-producing vegetation (Thomas et al. 1993). The principal source of energy for heating streams results from solar radiation directly striking the surface of water (Beschta et al. 1987). Water temperatures in forest streams increase as a result of reductions in canopy cover, which can increase stream temperatures by as much as 50° F (Beschta et al. 1987). Increases in stream temperatures up to 50° F were observed when clear-cutting was followed by burning (Brown and Krygier 1970 cited in Spence et al. 1996). The temperature increase in a stream is directly proportional to the area exposed to sunlight and inversely proportional to the volume of water in the stream. As a result, the effect of canopy removal on stream temperatures is greatest for small streams and diminishes as streams get wider.

Changes in stream temperature are considered harmful to salmon because these species are adapted to the specific, natural temperature ranges of their natal streams. Laboratory studies concluded that changes in stream temperature ranges can alter salmon development, growth, survival, and the timing of life history phenomena (Beschta et al. 1987). Based on the conclusions of these laboratory studies, increased temperatures beyond the preferred or optimal ranges of salmon are expected to cause juvenile salmon to leave their rearing areas or decrease their rates of growth. Berman and Quinn (1991) reported that fecundity and the variability of spring chinook salmon eggs were adversely affected by elevated water temperatures. High temperatures can inhibit the upstream migration of adult salmon and increase the incidence of disease throughout a salmon population. As stream temperatures increase, competition between salmon and warmwater fish species, which can cause salmon populations to become extirpated as a result of the competitive pressure (Reeves et al. 1987).

The percent canopy closure along streams within the action area is highly variable and ranges from 3 percent (Beer Bottle in the Bear/Mattole River watershed) to 96 or 97 percent (portions of Freshwater Creek in the Humboldt Bay watershed; Root Creek in the Van Duzen watershed; portion of the Lower Eel and Giants Avenue hydrounits in the Eel River watershed). Given the amount of acreage that would be subjected to timber harvests within the Eel River watershed within the first decade of the proposed action, and the significance of that watershed to one or more of the four salmonids being considered in this biological opinion, the greatest risk to these species caused by increases in stream temperatures associated with the loss or reduction of canopy closures are associated with the Eel River watershed.

Sediment

The soil in virgin forests generally resist surface erosion because their coarse texture and thick layer of organic material and moss prevent overland flow (Murphy 1995). All of the activities associated with proposed timber management on PALCO lands has previously been known to destroy the ability of forest soils to resist erosion and contributes to the production of non-point sources of stream pollution by fine sediment. Road construction, use, and maintenance; tree-felling, log hauling, slash disposal, site preparation for replanting, and soil compaction by logging equipment are all potential sources of fine sediment that could ultimately pollute streams in the action area (Hicks et al. 1991, Murphy 1995). The potential for delivering sediment to streams increases as hillslope gradients increase (Murphy 1995).

Timber harvests can substantially increase the delivery of sediment to streams through surface erosion and mass wasting events. The loss of protective vegetative cover can increase splash erosion (erosion caused by raindrops detaching soil particles) and reduce slope stability. Yarding activities that cause extensive soil disturbance and compaction can increase splash erosion and channelize overland flow. Site preparation and other actions which result in the loss of the protective humic layer can increase the potential for surface erosion (Hicks et al. 1991). Controlled fires can also consume downed wood that had been acting as sediment dams on hillslopes. After harvesting, root strength declines, often leading to slumps, landslides, and surface erosion (USDA Forest Service et al. 1993, Thomas et al. 1993). Riparian tree roots provide bank stability; streambank sloughing and erosion often increases if these trees are removed, leading to increases in sediment and loss of overhanging banks, which are important habitat for rearing Pacific salmonids (Murphy 1995). Increases in sediment delivery can destabilize channel morphology, outpacing the ability of the stream to transport sediment through the system.

Roads are considered the main cause of accelerated surface erosion in forests across the western United States (Harr and Nichols 1993). Processes initiated or affected by roads include landslides, road surface erosion, secondary surface erosion (landslide scars exposed to rainsplash), and gullying. In many locations, poorly-designed roads have been shown to have a larger effect on sedimentation than hillslope landslides or surface erosion (Kelsey 1980, Best et al. 1995, Wu and Swanston 1980, Swanson et al. 1987, Ziemer et al. 1996). Hagans and Weaver (1987) found that fluvial hillslope erosion associated with roads in the lower portions of the Redwood Creek watershed produced about as much sediment as landslide erosion between 1954 and 1980. In the Mattole River watershed, which is partially included in the action area, surveys found that roads, including logging haul roads and skid trails, were the source of 76 percent of all erosion problems mapped in the watershed (MRC 1987).

Road surface erosion is particularly affected by traffic, which increases sediment yields substantially (Reid and Dunne 1984). Other important factors that affect road surface erosion include condition of the road surface, timing of when the roads are used in relation to rainfall, road prism moisture content, location of the road relative to watercourses, methods used to construct the road, and steepness on which the road is located. In the proposed action area, the number of road and stream crossings is highest in the Lower Eel River hydrounit.

Historically, roads have adversely affected salmonid habitat by increasing sediment loads in streams, altering the morphology of stream channels, destabilizing streambanks, modifying drainage networks, creating barriers to movement, and increasing the potential for chemical pollution of the aquatic ecosystem (Furniss et al. 1991). Construction of road networks can also greatly accelerate erosion rates within a watershed (Beschta 1978, Best et al. 1995, Gardner 1979, Hagans and Weaver 1987, Haupt 1959, Kelsey et al. 1981, Reid and Dunne 1984, Swanson and Dyrness 1975, Swanston and Swanson 1976). Cederholm et al. (1981) reported that the percentage of fine sediments in spawning gravels increased above natural levels when more than 2.5 percent of a basin area was covered by roads.

Roads are also a chronic source of sediment to streams (Swanston 1991). Roads and related ditch networks are often connected to streams via surface flowpaths, providing a direct conduit for the sediment. Where roads and ditches are maintained by periodic "blading," the amount of sediment delivered continuously to streams may temporarily increase as bare soil is exposed and ditch-roughness features which store and route sediment are removed. In steeper terrain, road construction may trigger landslide processes that deliver large amounts of sediment directly into streams (Furniss et al. 1991). Improperly maintained roads may still fail, years after construction (Furniss et al. 1991). Roads built near watercourses can deliver sediment to streams, destabilize streambanks, and constrain the natural geomorphological migration of the stream channel. Road networks can affect hillside drainage; intercepting, diverting, and concentrating surface and subsurface flow, and increasing the drainage network of watersheds (Hauge et al. 1979, Wemple et al. 1996). This can lead to changes in peak and base flows in streams. Stream crossings can restrict channel geometry and prevent or interfere with migration of adult and juvenile salmonids (Furniss et al. 1991). Crossings can also be a source of sedimentation, especially if they fail or become plugged with debris, causing debris torrents and significant cumulative impacts downstream (Furniss et al. 1991, Murphy 1995).

Culverts and bridges associated with forest roads pose the greatest risk to streams that support salmon in the action area. When a culvert is plugged by debris or is overtopped by high flows, streams associated with these structures can be diverted, can contribute to road failure, and can cause severe sedimentation (Murphy 1995). Although proper design and location of these structures can minimize the risk of structural failure, any crossing structure is almost certain to fail if it is not maintained or removed when a road is abandoned (USDA Forest Service et al. 1993, Murphy 1995). Nevertheless, even proper culvert design and location is not proof against failure: for culverts designed for a 25-year flood, there is an 80 percent probability of failure over a 50-year period; for culverts designed for a 100-year flood, there is a 40 percent probability of failure over that same 50-year interval (USDA Forest Service et al. 1993). Given the 50-year duration of the proposed action, and the number of streams within the action area, the probability that one or more culverts associated with the 400-miles of road will fail is almost certain. The effects of such a failure on salmon habitat will depend on when it occurs, the stream the failure is associated with, antecedent weather conditions, the number of salmon using the stream system that is affected, and PALCO's response to the failure.

Mass wasting associated with roads can be more than 300 times more frequent than an undisturbed forest in comparable terrain (Furniss et al. 1991). Furthermore, because mass wasting associated with roads are relatively large, the amount of sediment pollution from roads greatly exceeds the amount from forests and clearcuts (Furniss et al. 1991).

As part of the proposed action, approximately 400 miles of road will be built during the permit period: 150 miles in the first decade, 100 miles in the second decade, 75 miles in the third decade, 50 miles in the fourth decade, and 25 miles in the fifth decade. At the end of the 50-year period of the proposed permit, there would be approximately 1,520 miles of road on PALCO lands. The

Eel River watershed would have the largest number of road miles, followed closely by the Humboldt Bay and Yager River watersheds.

The greatest potential risk of these roads to threatened and endangered salmon in the action area is in the Eel River watershed because it has the most stream miles of Class I and II streams (more than 360 streams). The Eel River watershed is scheduled to have the greatest number of new road miles within the first decade of the proposed action and the largest proportion of timber harvests. The Eel River watershed has the highest number of road crossings per mile of any stream in the action area (17.7 crossings per mile; Final EIS) which heightens our concern about the potential risk of sedimentation to salmon within this watershed. All four of the species being considered in this Opinion - coho and chinook salmon, coastal cutthroat trout, and steelhead are known to occur in the Eel River watershed - which heightens the likelihood that sedimentation associated with road construction, operation, and maintenance in this watershed will adversely affect threatened salmon within the watershed.

The Humboldt Bay watershed, which is scheduled to have the second greatest number of new road miles constructed in the first decade, has the second largest number of Class I and Class II streams within the action area. Coho and chinook salmon, steelhead and coastal cutthroat trout are known to occur within several hydrounits of this watershed, particularly the Elk River and Freshwater Creek hydrounits.

Table 49: Existing Road and stream crossings on PALCO lands by watershed (from table 3.6-3 of EIS/EIR).

	Watershed Areas					
Road Type	Bear/Mattole	Eel	Humboldt Bay	Van Duzen	Yager	Total
Stormproofing	31.11	16.83	10.15	0.0	26.29	84.38
Rock	5.78	151.54	99.66	48.91	146.29	452.18
Proposed for construction	11.75	58.27	51.32	11.44	17.29	150.07
Proposed for abandonment	0.0	0.0	0.58	0.0	0.0	0.58
Reconstructed	2.74	15.74	8.39	3.33	0.53	30.73
Other	96.02	328.67	146.14	113.73	117.65	802.21
Total Road Miles	147.40	571.05	315.24	177.41	308.05	1,520.15
Miles per square mile of PALCO lands	3.1	54.9	5.2	4.5	5.8	4.8

In addition to the relatively large amount of mass wasting associated with roads, lesser amounts of mass wasting is associated with clearcuts as roots of cut trees die and the soil they retain is lost.

Although the amount of soil erosion associated with these clearcuts is much smaller than that associated with roads, the greater area of clearcut makes this form of erosion a substantial source of sediment in salmon streams (Swanston 1991). The risk of this type of erosion increases 2 to 10 years after trees are cut (Burroughs and Thomas 1977, Ziemer and Swanston 1977); consequently, the proposed action poses substantial risk of increasing sedimentation within streams within the action area given the long-term duration of the proposed action and the spatial scale of the proposed timber harvests.

Past forest practices have changed the sediment equilibrium and storage in streams by increasing hillslope erosion and causing a loss of structural channel features (Everest et al. 1987). The loss of structure features of the stream reduces material storage and accelerates the routing of bedload sediment downstream. As a result, aggraded downstream reaches become wider, shallower, and more prone to lateral migration and bank erosion (MRC 1987, Sullivan et al. 1987).

As part of the proposed action, PALCO will operate two commercial hard rock quarries in the action area for two years in the Yager Creek watershed. The effects of rock mining on aquatic resources depend on the type of mining and distance from waters. Rock mining can cause increased sedimentation, accelerated erosion, increased streambank and streambed instability, and changes to substrate. Surface mining may result in soil compaction and loss of the vegetative cover and humic layer, increasing surface runoff. Mining may also cause the loss of riparian vegetation.

There are no data on the direct effects of sedimentation on salmon populations in the action area. However, a general picture of the effects of sedimentation on salmon populations can be constructed from investigations elsewhere in the Pacific Northwest. Fine sediment can directly reduce egg-to-fry survival, food production, summer rearing area, and winter survival; it can also change the morphology and stability of stream channels, causing long-term reductions in the carrying capacity of the stream and the survival of salmon in the stream (Murphy 1995). Holtby and Scrivener (1989) concluded that increased sedimentation following timber harvest reduced escapement by chum salmon (*0. keta*) by 25 percent in a stream in British Columbia. Scrivener (1991) concluded that sedimentation associated with logging over a 40-year period contributed to the decline of the chum salmon population on western Vancouver Island. Cederholm and Reid (1987; cited in Murphy 1995) concluded that sediment from a debris torrent and a streamside salvage operation caused a stream in Washington to aggrade to the point at which the stream dried up during the summer; the yield of coho salmon smolt in that stream declined by 60 to more than 80 percent.

Streamflow

Timber harvesting activities can have significant effects on hydrologic processes that determine streamflow. Timber harvests and road construction alter a watershed's water balance and accelerate surface flows from hillsides to stream channels (Chamberlin et al. 1991). These accelerated flows can change summer base (low) flows and peak flows during rainstorms and snowmelt. Harvesting and associated site preparation practices can alter total water yield, the timing and volume of peak runoff, and the volume of summer low flows. Removal of vegetation reduces evapotranspiration, which can increase the amount of water that infiltrates the soil and ultimately reaches the stream. Conversely, soil compaction caused by heavy equipment can decrease infiltration capabilities, increasing surface runoff. Forest management activities that substantially disturb the soil, such as yarding, burning, or road and skid trail construction, may alter both surface and subsurface pathways that transport water to streams (Murphy 1995, Thomas et al. 1993). This can increase or decrease total volume of streamflows. Logging can also alter the internal soil structure. As tree roots die, soil "macropores" collapse or are filled in with sediment. These subsurface pathways are important for water transmission. When they become blocked, water is forced to the surface, increasing surface runoff and accelerating erosion.

Peak flows increase after timber harvests because water is routed more quickly to stream channels once a forest has been cleared (McIntosh et al. 1994). During timber harvests, any activities that disturb and compact the soil increase surface run-off and allows surface run-off to reach streams faster than subsurface flows. Ditches associated with roads collect run-off and intercept subsurface flows and route them to streams more quickly. Roads acts as first order streams and channel more water directly into larger streams (Wemple 1994). Increased peak flow is detrimental to salmon because the resulting bedload overturn can scour stream channels, kill incubating eggs, and displace juvenile salmon from winter cover (McNeil 1964, Tschaplinski and Hartman 1983).

Large Woody Debris

Large woody debris is an integral part of streams in forested watersheds, providing structure to stream ecosystems and important habitat for salmon (Bisson et al. 1987). Large woody debris is a major habitat-forming structure in streams and can control stream morphology, regulating storage of sediment and particulate organic matter, and creating and maintaining fish habitat. Removal of large woody debris results in immediate loss of important habitat features and decline in salmon population sizes (Hicks et al. 1991). Debris removal generally reduces the quality and quantity of pools in a stream and destabilizes stream channels and cover that are essential to adult and juvenile salmon (House and Boehne 1987). The increases in riffles that accompany the loss of large woody debris may favor underyearling steelhead and cutthroat trout while harming coho salmon and older steelhead and cutthroat trout (Bisson and Sedell 1984, Murphy et al. 1986).

Logging activities can reduce large woody debris in several ways (Bisson et al. 1987). Tree-felling and yarding can destabilize existing large woody debris and later export that debris downstream or onto the floodplain or riparian zone. Salvage of merchantable logs from stream channels and floodplains removes large woody debris and destabilizes what is left. After logging, the amount of large woody debris in streams declines over time if riparian trees are cut because second-growth trees provide insufficient new debris to replace key pieces of debris as they decay or wash downstream (Andrus et al. 1988, Murphy and Koski 1989).

Woody debris in streams is naturally-depleted by decay, fragmentation, and transport to downstream stream reaches and floodplains (Bisson et al. 1987). The depletion rate depends mostly on the size of the debris, the species of wood, and the type of stream. Species like redwood and western red cedar (*Thuja plicata*) persist as wood debris for longer periods of time than other woody species found in the forests of the action area.

The effects of timber harvests in riparian areas can last hundreds of years because they eliminate new sources of large woody debris (Murphy 1995). If all sources of new, large woody debris are removed from riparian areas by clearcutting, the key pieces of LWD in a stream will disappear over a period of about 250 years (Murphy and Koski 1989). Because second growth forests do not contribute key pieces of large woody debris for 60 to 80 years after logging, clearcuts in riparian areas can cause large woody debris in adjacent streams to decline for 100 years after the cut with recovery requiring more than 250 years after a cut (Murphy 1995, Murphy and Koski 1989). Timber rotations of less than 100 years in riparian areas will permanently eliminate large woody debris from adjacent streams unless streams are protected by adequate buffer areas.

Habitat Access

Changes in stream channels afer timber harvests and road construction can interfere with salmon migration by blocking their passage through culverts, causing logjams, decreasing cover from predators, decreasing the frequency of large pools that are used for resting during migration, and adversely affecting water chemistry (temperatures and dissolved oxygen). Decreases in the number of pools in a stream caused by the loss of large woody debris can expose migrating adult salmon to predation and deprive them of resting habitat. Suitable pools are usually limited in number in any stream reach, making each of them important.

If they are not properly-installed, culverts can block the migrations of both outmigrating juvenile salmon and adults who are returning to spawn. If it is not properly installed, a single culvert can eliminate an entire salmon run by preventing adult salmon from reaching spawning areas.

Rock Quarries and Borrow Pits

The effects of quarrying on aquatic resources depend on the type of mining, the degree of disturbance, and the distance from waters. Various surface mines, including quarries, can cause increased erosion, increased streambank and streambed instability, and changes to substrate (Spence et al. 1996). Surface mining may result in soil compaction and loss of the vegetative cover and humic layer, leading to increased surface runoff. If quarries are located in riparian areas, loss of riparian vegetation will result. Surface mining can also affect water quality. Some chemicals used to clean or treat rock are toxic to aquatic species. Some types of rock, when exposed during mining, react to create acids. Run-off from mining areas may transport these acids to streams, leading to significant drops in pH levels (reviewed in Nelson et al. 1991). Acidification of surface waters by mining operations is generally considered to be the most serious consequence of mining (Spence et al. 1996). Borrow pits are constructed on a much smaller scale than rock quarries, but we expect that many of the erosion and sedimentation effects would be similar, especially for borrow pits located near streams.

Effects of the Proposed Conservation Measures

The proposed action includes an Aquatic Conservation Plan, which consists of six main interconnected elements to minimize, mitigate, and monitor the effects timber harvesting activities on aquatic ecosystems: the riparian management strategy, hillslope management, road management, watershed analysis, a disturbance index, and monitoring. The aquatic conservation plan also includes measures for other activities: burning, rock quarries, borrow pits, and water drafting. Monitoring would be conducted to determine compliance, effectiveness, and trends for all covered activities. The effectiveness of the aquatic conservation plan requires implementation of all six elements; if any of these elements are not fully implemented, the strategy may appreciably reduce the likelihood of the survival and recovery of the threatened and endangered aquatic species in the action area. NMFS assumes that PALCO will fully implement all the strategies. Through watershed analysis, new scientific studies, and monitoring, prescriptions for any covered activity could be modified such that the Plan continues to meet the objective of maintaining or achieving, over time, a properly functioning aquatic habitat condition. Mitigation for changed circumstances per the "no surprises" policy would also be implemented consistent with the goal to maintain or achieve, over time, a properly functioning aquatic habitat condition.

Measures Affecting Timber Management

The proposed action prescribes several strategies to minimize the impacts from harvesting on threatened and endangered species. To ensure that PALCO is managing its lands to promote sustained yields of timber, the proposed actions includes: (1) retention of at least five percent of its forested lands in each watershed analysis area in mid-seral vegetative stages; (2) a limit on increases in maximum harvest levels between the first and second decade by more than 15 percent, between the second and third decade by more than 12.5 percent, and by more than 10 percent thereafter; (3) management to ensure that harvests in any decade are less than long-term sustained yield volumes (2,335,200 mbf per decade).

Conservation measures proposed to minimize and mitigate the effects of timber harvesting activities on aquatic ecosystems include riparian management, hillslope management, road management, burning prescriptions, and a DI. The riparian, hillslope, and road strategies include prescriptions that all interlink to minimize and mitigate effects from specific elements of road management to protect the aquatic environment.

Riparian Management

The proposed aquatic conservation plan includes measures to minimize the impacts of timber harvesting on waters and riparian areas within the action area by establishing RMZs. Riparian buffer areas are a management tool designed to protect the canopy cover over streams, provide recruitments for large woody debris, add small organic matter to streams, stabilize streambanks, regulate nutrient and pollutant inputs to streams, and reduce potential adverse effects from sediment that is not captured through other management measures (Spence et al. 1996). Although riparian buffers alone are insufficient to ensure healthy aquatic habitat, they have been generally accepted as a way to minimize, mitigate, and, in some areas, avoid the adverse effects of timber management on aquatic communities (USDA Forest Service et al. 1993, Murphy 1995, Thomas et al. 1993, Spence et al. 1996, and others).

In summary, in Class I RMZs no harvesting is allowed immediately adjacent to streams (between 0 and 100 feet from the water), and the outer buffer has conifer retention standards designed to mimic attributes of a late-seral forest condition. Prescriptions for Class II RMZs are similar, except that the No Harvest Band is from 0 to 30 feet from the water. The total width of riparian forest with limited or no harvesting would actually be wider where there are channel migration zones, slopes greater than 50 percent, or mass wasting areas of concern. The total miles of stream where these additional prescriptions increase the overall buffer widths is unknown. Impacts would be further minimized by restricting harvest to one entry every 20 years, limiting the amount of basal area that can be removed in a single entry to 40 percent, requiring that trees left after harvesting conform to a specified tree size distribution, and the minimum pre- and post-harvest basal area standards. Loss of canopy caused by the presence of roads within the first 30 feet of a Class I or Class II RMZ would be mitigated by increasing the width of the No Harvest Band the equivalent width of the road prism on the opposite side of the stream.

Approximately 3,769 acres of RMZs would not be harvested under the proposed action. Approximately 26,123 acres of PALCO land would be harvested in a way that protects the function of the RMZs. Where harvest is allowed, the RMZs maintain the objective of developing or retaining a multi-layer tree canopy with large trees, down wood, and snags.

Temperature

One of the purposes of riparian buffers is to provide adequate overstory canopy to shade aquatic habitat. The removal of overhead canopy cover results in increased solar radiation reaching the stream, which result in increased water temperatures (Spence et al. 1996). Spence et al. (1996) reported that old-growth stands provided between 80 and 90 percent canopy cover from studies in western Oregon and Washington. Flossi et al. (1998) and CDFG (1996) recommend a 85 percent riparian canopy to properly shade streams that might be used by salmonids. A high canopy percentage within the action area is also necessary because current average summertime temperatures within the action area often exceed the 53.2 to 58.2°F range specified for juvenile coho salmon. On average, only riparian corridors in the Humboldt WAA, which includes portions of the Headwaters Forest, currently come close to this 80 to 90 percent canopy standard. According to the Final EIS/EIR, sampling locations on PALCO's ownership where temperature criteria for coho salmon were exceeded were located in reaches with less than 30 percent canopy cover, indicating that stream shading is an important factor influencing stream temperatures in the action area.

Based on review of numerous investigations, Johnson and Ryba (1992) concluded that buffers widths greater than 100 feet generally provide the same level of shading as that of an old-growth forest stand. Other authors (e.g., Beschta et al. 1987, Murphy 1995) have also concluded that buffers greater than 100 feet provide adequate shade to stream systems. The curves presented in FEMAT (USDA Forest Service et al. 1993) suggest that 100 percent effectiveness for shading is approached at a distance of approximately 0.75 tree heights from the stream channel. Assuming a tree height of 170 feet (100-year old redwood, site class 2; Lindquist and Palley 1963), this buffer width should be 127 feet wide to provide 100 percent shading effectiveness.

Based on calculations using various timber models (Peters 1998), in the aquatic conservation plan, the Outer Band (Class I) or Selected Harvest Band (Class II) would have an approximately 80 percent canopy cover immediately post-harvest. The Class I and II No Harvest Bands should also approach the 80 to 90 percent conifer canopy cover within the life of the ITP, if they are not currently already at this high canopy cover. Additional information to predict future canopy cover in RMZs can be found from the February, 1999 LTSY projections. These projections are that the total amount of late seral and old growth forests within Class I and II RMZs will increase over the life of the ITS from a current 12,600 acres to 18,267 acres in decade five. Based on the No Harvest Bands, the width of the total RMZs, and the harvest limitations in the outer portions of the RMZs, NMFS expects the Class I and II RMZs to provide 80 to 90 percent conifer canopy cover over time, thus providing the shade needed to maintain suitable water temperatures for Pacific salmonids.

Riparian buffers also function to minimize the impacts of upslope site preparation activities on streams temperatures. Burning is a common method used by PALCO to clear away debris from logging after a clear cut. Stream temperatures can be impacted by burning due to loss of overstory canopy and increases in sedimentation. Increases in stream temperatures up to 50°F were observed when clear-cutting was followed by burning (Brown and Krygier 1970).

The aquatic conservation plan proposes additional measures associated with RMZs to maintain adequate buffers between upslope burning activities and the stream channels. The measures are designed to keep prescribed fires out of RMZs by limiting prescribed burns to only those times when optimal conditions exist and by requiring fire-setting techniques that will encourage the fire to burn away from RMZs. Numerous variables such as vegetative moisture content, wind, and humidity can influence the ability to control a prescribed fire once it is set. The condition of the RMZs should also create a microclimate differential which may aide in limiting fire entry into a RMZ. Although management of controlled burns may never be 100 percent effective, these measures described in the aquatic conservation plan are expected to minimize the possibility of fire from prescribed burning compromising the integrity of the shade-providing canopy in the RMZs.

Sediment

Timber harvesting can substantially increase delivery of sediments to streams through surface erosion and mass wasting. Harvesting, especially with heavy equipment, removes the humic layer, increasing surface erosion. Yarding and heavy equipment use compacts soil, channelizing surface runoff (Spence et al. 1996). Root strength is lost as stumps decompose after logging, leading to slumps, landslides, and surface erosion (Everest et al. 1987). Removing trees from the banks of streams cause these banks to destabilize, increasing sediment delivery into streams.

Past natural and human-caused events have greatly impacted the sediment levels within watersheds in the action area. The current conditions of streams within the action area are described in detail in the Environmental Baseline section of this Opinion. In general, levels of fine sediment (<0.034 inches) and sand (<0.25 inches) are above levels considered to be functioning habitat. Several rivers within the action area have been listed under section 303(d) of the Clean Water Act as "water quality impaired" due to sediment problems. These rivers are the Mad River, Freshwater Creek, Elk River, Yager River, Van Duzen River, Eel River, and the Mattole River. The CDF has also listed Bear, Jordon, Stitz and Freshwater Creeks and Elk River as being cumulatively impaired due to sediment resulting from past forestry activities.

Riparian buffers can reduce the amount of sediment delivered from riparian and upland areas by providing physical barriers to trap sediments moving overland during rainfall events and by providing root stability to reduce the likelihood of mass failures along the stream channel (Spence et al. 1996). Various studies have suggested different buffer widths necessary to control overland sediment flow and minimize streambank mass wasting events. The FEMAT (USDA Forest Service et al. 1993) review of literature suggested riparian zones greater than one site-potential tree height from the edge of the floodplain as adequate to remove most sediment from overland flow. The review prepared by Johnson and Ryba (1992) noted that the available literature reported buffer widths ranging from 50 to 151 feet to control sediment, but that three of the five references they reviewed suggested 100 feet for this function. These buffer widths focused on minimizing overland flow, but O'Laughlin and Belt (1994 cited in Spence et al. 1996) suggested that sediment control from timber harvest activities cannot be achieved through riparian zones alone, because channel erosion and mass wasting are significant sources of sedimentation in forested streams. Therefore, additional buffers around areas susceptible to mass wasting would be necessary to provide full protection from upland and riparian sediment sources caused by timber harvesting.

Under the aquatic conservation plan, prescriptions within the RMZs are designed to minimize the delivery of sediment from riparian and upland sources. These measures include limiting the amount of ground disturbance within RMZs so that the physical barriers (e.g., humic layer, downed wood) that trap overland flow of sediment are retained; treating most sites within the RMZs that are disturbed due to harvest activity such that they will continue to trap overland sediment flow; prohibitions on removing downed wood that also provide physical barriers to overland flow; the No Harvest Band on Class I, II, and III waters to provide bank stability; and a high tree retention level in the Outer Band (Class I) and Selected Harvest Band (Class II) to provide slope stability. The width of RMZs, combined with the steep slope provisions on Class I and II waters, the sediment retention band (for Class II RMZs), and the mass wasting prescriptions for any mass wasting areas of concern within and upslope of RMZs were designed to minimize delivery of sediment from sources outside of the riparian buffer.

As noted above, the literature does not provide a single riparian buffer width that would buffer streams from unchannelized surface flow originating from upslope sources. The ability of riparian buffers to control sediment inputs is a factor of soil type, slope, and ground cover (Spence et al. 1996). The RMZs for Class I, II, and III waters established in the aquatic conservation plan are different widths, but all are within the range of buffer widths proposed in the literature.

Based on the buffer width recommendations from these literature sources, we expect that the Class I RMZs in the aquatic conservation plan will be of adequate width to trap suspended sediment, while the Class II RMZ width will be slightly less effective at sediment filtration. The effectiveness of the Class II RMZ at trapping sediment is improved by the additional sediment filtration bands on slopes less than 50 percent and the steep slope provision on slopes greater than 50 percent, thereby increasing the overall width of the sediment filtration buffer. The sediment filtration band requires retention of downed wood and other features that act as physical barriers to overland flow. The steep slope provision increases the total width of the Selected Harvest Band up to the break in slope or 400 feet. Because these provisions require the retention of natural features that act as physical barriers to overland flow, these additional measures are expected to provide some buffering from upslope sediment sources. With the additional buffer width provided by the sediment filtration band and steep slope provision, the riparian buffer width on Class II waters is within the range of widths recommended in the literature. In addition, the presence of mass wasting areas of concern activate the mass wasting strategy, increasing the degree of protection, but the amount and extent of this additional protection could not be determined for this biological opinion.

In Class III RMZs, the 30-foot No Harvest Band (or 10-foot No Harvest Band plus 20-foot minimum harvest in the 2,175 acres identified in the SYP) is smaller than the buffer widths recommended in the literature reviews, but the additional measures in the outer 30- or 70-foot bands are expected to provide some additional protection from overland sediment flow. As with the sediment filtration band on Class II RMZs, natural features that act as physical barriers to overland flow will be retained in the outer band of Class III RMZs, although no standing trees are expected to be left within the bands, post harvest. With these additional measures in the outer band of Class III RMZs, the total 50- or 100-foot width proposed in the aquatic conservation plan for Class III RMZs falls within the range of buffer widths recommended in the literature to control sediment, albeit at the lower end of the range. Therefore, the Class III RMZ prescriptions should be moderately effective at trapping all overland flow and have the potential to be highly effective at trapping overland flow from covered activities, although clearly not at the same level provided by the Class I or II RMZs. In addition, within Class III RMZs, the presence of mass wasting areas of concern may increase the degree of protection, but the amount and extent of this additional protection could not be determined for this biological opinion. We expect that a moderate amount of sediment from surface erosion will continue to be delivered into Pacific salmonid habitat from Class III waters due to past and current management. The impact from sediment inputs on aquatic resources will also be compounded by the high density of Class III waters within the action area.

Riparian buffers also function to minimize the impacts of upslope site preparation activities on streams containing salmonids. Burning is a common method used to clear away debris from logging after a clear cut. Prescribed burning destroys vegetative groundcover and the humic layer, creating large areas of bare soil and causing surface erosion and slope instability to increase (Spence et al. 1996). Even when burning does not expose bare soils, a water-repellent layer can form and reduce the ability to infiltrate into the soil, increasing the runoff available for surface erosion (Krammes and DeBano 1965, Bockheim et al. 1973 cited in Chamberlin et al. 1991). These negative effects from prescribed burning can be minimized or avoided by retaining adequate riparian buffers.

The aquatic conservation plan proposes additional measures associated with RMZs to maintain riparian buffer integrity. Our analysis of these measures was presented earlier in this biological opinion in terms of protecting riparian overstory canopy. We anticipate that these measures will minimize the possibility of prescribed burning compromising the integrity of the riparian zone. If the RMZs are not burned, we expect that they will function at various levels of effectiveness, commensurate with their width, to buffer waters within these zones from upslope sediment sources during site preparation burning activities. Class I and II RMZs are wider than Class III RMZs, and therefore are expected to provide more filtration capacity.

The probability of bank instability, landslides, and slumping due to loss of root strength would be minimized under the proposed management. No harvesting would be allowed within 100 feet of Class I waters, within 30 feet of Class II waters, or within 30 feet of Class III waters, except for the 2,175 acres where the No Harvest Band would be 10 feet. Within the outer bands of the Class I and II RMZs, the limited harvest prescriptions would assure a high number of trees in a wide range of sizes would be retained to provide root strength. These harvest prescriptions would also be extended upslope to the break in slope or 400 ft, whichever is less, for slopes steeper than 50 percent. In Class III streams, outside of the No Harvest Bands there are no standing tree retention standards, except those defined in the mass wasting strategy. The mass wasting strategy would provide additional protections against landslides or slumping caused by forestry practices within and outside of all RMZs. Under the mass wasting strategy, no harvesting would be allowed within areas identified as mass wasting areas of concern. These areas are defined to include areas identified as having extreme, very high, or high mass wasting hazard, inner gorges, headwall swales, and unstable areas, including those within Class I, II, and III RMZs. Combined with other measures to control mass wasting from other activities, we believe that these measures will minimize harvest-induced landsliding and slumping by retaining adequate root strength in the soil within and above RMZs. These prescriptions are not expected to be 100 percent effective, so some harvest-induced landsliding is expected to occur. Small to moderate amounts of sediment will continue to be transported into waters containing Pacific salmonids and proposed critical habitat depending on the condition of the individual RMZs.

According to the best scientific and commercial information, at least 95 percent of the vegetative cover within riparian buffers should be retained to properly filter overland sediment flow and minimize surface erosion from exposed soils. Although the exact amount of vegetative cover that will remain within the RMZs after harvest entry cannot be calculated, we expect that the prescriptions in the aquatic conservation plan will retain a high degree of vegetative cover and that most areas that are exposed would be treated such that the 95 percent vegetative cover recommendation will be achieved. This conclusion is based on the following: first, the equipment exclusion zones would minimize soil disturbance within RMZs. Second, most areas that are disturbed due to management activities would be treated. "Treatment" is not specifically defined in the aquatic conservation plan, but along the California north coast, it usually involves mulching and seeding bare soil areas such that surface erosion is minimized. Typical treatments include mulching with grass straw up to 2 inches depth over 90 percent of the exposed area. Areas left untreated would be less than 100 square feet each and would not be likely to deliver sediment to waters. We anticipate that these measures will combine to provide a high percentage of vegetative cover or other form of cover that will act as a physical barrier to overland flow and minimize surface erosion within riparian areas. With these prescriptions, sediment may continue to be delivered to Pacific salmonid habitat, but the amount from harvest-related surface erosion in RMZs should be minor.

With the combined measures discussed above, NMFS expects that moderate to substantial decreases in sediment delivery from timber management activities will occur within and above the Class I and II RMZs. The prescriptions identified for Class III RMZs, while not providing the same level of protection as Class I and II RMZs, would still result in minor to moderate decreases in sediment delivery over current levels. As proposed, the RMZs equal or exceed the published recommendations available in the literature. Consequently, based on the best scientific and commercial data available, we believe the proposed RMZs are likely to prevent an appreciable reduction in the value of stream habitat from sediment for the four salmonids proposed to be covered under the ITP, when used in concert with other conservation measures. This conclusion also applies to proposed critical habitat values.

Large Woody Debris

Timber management modifies the physical stream characteristics by removing LWD from streams and logging trees from adjacent riparian stands, decreasing the recruitment of LWD into waters (Bisson et al. 1987). Most wood likely enters the stream from toppling or windthrown trees from adjacent riparian stands (Spence et al. 1996), but wood is also provided to stream systems from hillslope processes such as debris torrents (McGarry 1994) and from the undercutting of streambanks and redistribution of wood from upstream sources. As a tool for forestry management, riparian buffers are designed to provide a supply of trees for potential recruitment into adjacent streams. Cederholm (1994) observed that in the available literature, the recommendations of buffer widths for maintaining recruitment of LWD to streams ranged from 100 to 197 feet. Based on a review of the available literature, FEMAT (USDA Forest Service et al. 1993) concluded that the greatest contribution of large wood to streams comes from trees within one tree height of the channel. Spence et al. (1996) also summarized the most recent studies, noting that buffers composed of late seral forest approaching one site-potential tree height are needed to maintain natural levels of LWD recruitment.

An additional consideration relative to providing LWD to streams from riparian zones is the potential size distribution of the large wood. Murphy (1995) notes that in streams, larger pieces of wood form key structural elements, serving to retain smaller debris that would otherwise be transported downstream. Studies by Bilby and Ward (1989) and Fox (1994) show that while the number of LWD pieces decreased with the increasing width of a stream, the average diameter, length, and volume of the LWD increased. Therefore, riparian buffers need to ensure not only an adequate supply of wood, but pieces of sufficient size to serve as "key pieces" (Murphy 1995).

There are limited data on current levels of LWD in streams within the action area. R2 (1997) summarized data collected by CDFG during stream habitat surveys. Values in those studies ranged from less than one piece of LWD per 100 feet of stream in the Eel River WAA to over 15 pieces per 100 feet in the South Fork of Freshwater Creek. Information is available in the Final EIS/EIR on the seral stage of RMZs by HU for Class I, II and III waters within PALCO lands (see Final EIS/EIR, figures 3.8-2a, 3.8-2b, and 3.8-2c). In general, most riparian stands within PALCO lands are currently in mid-to-late seral stages. There is very little old-growth or late-seral forest present on any PALCO lands within riparian areas except along the North Fork Mattole River and in the Headwaters Forest Preserve. Within PALCO lands, there are a total of 57,852 acres within Class I, II and III RMZs (using the highest estimated number of 3,200 miles of Class III waters). According to the 1999 LTSY calculations, of the 10,880 total acres in the 170 foot Class I RMZ (including the channel migration zone), there are currently 2,666 acres of late-seral forest, 456 acres of old-growth (including both Douglas-fir and redwood), and 1,429 acres of residual old-growth forest (including Douglas-fir and redwood). Thus, 42 percent of the current Class I RMZ has the potential to recruit LWD to the forest floor or stream. Based on the February 1999 LTSY projections, the 130 feet Class II RMZ, totaling 23,700 acres, includes 4,865 acres of late-seral forest, 789 acres of old-growth (including both Douglas-fir and redwood), and 2,395 acres of residual old-growth forest (including Douglas-fir and redwood). Thus, 34 percent of the current Class II RMZ has the potential to recruit LWD to the forest floor and stream. The remainder of the Class I and II RMZ stands are in earlier seral stages. No late-seral, old-growth or residual old-growth is accounted for in Class III RMZs. Over the 50 year life of the ITP, late-seral acres increase steadily, but acres of old-growth and residual old-growth drop steadily in the Class I and II RMZs, according to the February 1999 LTSY projections. By the fifth decade of the ITP, Class I RMZs are projected to contain 53 percent of forest types that have the potential to recruit LWD to the forest floor and streams, including 4,323 acres of late-seral forest, 327 acres of old-growth, and 1,166 acres of residual old-growth forest. Based on the 1999 LTSY projections, Class II RMZs are predicted to also contain 53 percent of forest types that have the potential to recruit LWD to the forest floor and streams, including 10,317 acres of late-seral forest, 333 acres of old-growth, and 1,801 acres of residual old-growth forest. For decade specific LTSY projections, refer to table 50.

Table 50. Projected acres of late-seral and old-growth timber types in RMZs (Source: LTSY projections, February 1999)

Anadromous Fish Analysis 1 [1/]						
Present						
WLPZ_CODE [2/]	L	OD	OR	RD	RR	Grand Total
1,100.00	1,508.97	155.80	120.76	135.99	692.73	2,614.25
1,170.00	956.92	105.96	70.03	104.94	412.54	1,650.39
1,999.00	200.32	3.50	0.00	0.00	83.12	286.94
2,030.00	1,198.02	138.03	55.62	196.57	413.98	2,002.22
2,130.00	3,666.68	432.32	162.66	606.31	1,178.42	6,046.39
Grand Total	7,530.91	835.61	409.07	1,043.81	2,780.79	**12,600.19**
Decade 1						
WLPZ_CODE	L	OD	OR	RD	RR	Grand Total
1,100.00	1,508.52	136.51	115.08	120.11	622.07	2,502.29
1,170.00	917.35	93.57	62.08	87.87	348.22	1,509.09
1,999.00	208.00	3.50	0.00	0.00	82.16	293.66
2,030.00	1,221.19	129.00	54.70	175.14	378.55	1,958.58
2,130.00	3,748.11	407.25	127.14	532.08	1,029.81	5,844.39
Grand Total	7,603.17	769.83	359.00	915.20	2,460.81	**12,108.01**
Decade 2						
WLPZ_CODE	L	OD	OR	RD	RR	Grand Total
1,100.00	1,774.44	136.51	115.08	120.11	622.07	2,768.21
1,170.00	1,161.77	40.04	62.08	87.87	320.94	1,672.70
1,999.00	216.42	3.50	0.00	0.00	82.16	302.08
2,030.00	1,498.06	129.00	54.70	175.14	378.55	2,235.45
2,130.00	4,782.99	199.69	127.14	532.08	972.32	6,614.22
Grand Total	9,433.68	508.74	359.00	915.20	2,376.04	**13,592.66**
Decade 3						
WLPZ_CODE	L	OD	OR	RD	RR	Grand Total
1,100.00	1,831.90	136.51	115.08	120.11	622.07	2,825.67
1,170.00	1,191.97	27.81	62.08	87.87	270.79	1,640.52
1,999.00	217.44	3.50	0.00	0.00	82.16	303.10
2,030.00	1,557.29	129.00	54.70	175.14	378.55	2,294.68
2,130.00	4,953.29	183.81	127.14	532.08	800.76	6,597.08
Grand Total	9,751.89	480.63	359.00	915.20	2,154.33	**13,661.05**
Decade 4						
WLPZ_CODE	L	OD	OR	RD	RR	Grand Total
1,100.00	2,110.39	136.51	115.08	120.11	622.07	3,104.16
1,170.00	1,376.10	26.65	62.08	87.41	260.83	1,813.07
1,999.00	312.12	3.50	0.00	0.00	82.16	397.78
2,030.00	1,934.27	129.00	54.70	175.14	378.55	2,671.66
2,130.00	6,123.61	183.81	127.14	532.08	751.48	7,718.12
Grand Total	11,856.49	479.47	359.00	914.74	2,095.09	**15,704.79**
Decade 5						
WLPZ_CODE	L	OD	OR	RD	RR	Grand Total

1100	2,138.45	136.51	115.08	120.11	622.07	3,132.22
1170	1,863.38	10.01	62.08	85.77	256.05	2,277.29
1999	320.86	3.50	0.00	0.00	82.16	406.52
2030	2,061.16	129.00	54.70	175.14	378.55	2,798.55
2130	8,255.71	21.74	127.14	515.63	731.94	9,652.16
Grand Total	14,639.56	300.76	359.00	896.65	2,070.77	**18,266.74**

1/ This analysis summarizes the acres of late-seral, uncut old-growth Douglas-fir, uncut old-growth redwood, residual old- growth Douglas-fir,
and residual old-growth redwood in Class I and II RMZs and CMZs in the Project Area.
2/ 1100 = Class I RMZs within 100 feet of streams; 1170 = Class I RMZ between 100 and 170 feet from stream;1999 = channel migration zones;
2030 = Class II RMZs within 30 feet of stream; 2130 = Class II RMZs between 30 and 130 feet from stream.

Source: Foster Wheeler, 1999

For recruitment into streams and LWD, old-growth and residual trees provide larger, more complex wood pieces that function better in the stream system than smaller, less mature trees. Murphy (1995) notes that in streams, larger pieces of wood form key structural elements, serving to retain smaller debris that would otherwise be transported downstream.

We do not fully agree with the definition of seral stages used in the February 1999 projections discussed above and believe that the definition results in an overestimate of late-seral acres that have the potential to recruit large wood of adequate size. As defined for the LTSY modeling process, late-seral forest is made up of stands with overstory trees that average larger than 24 inches dbh, and are typically between 50 and 60 years old. Depending on the stream width, debris pieces that average 24 inches dbh are not large enough to function as "key pieces" within the stream system. The late-seral trees under this definition also have not had the time (50 to 60 years) to develop the structural components of mature or old-growth trees that provide structural complexity. Based on a review of literature summarizing the ability of riparian forests to fully provide habitat functions for salmonids, NMFS (1998) defines a late-seral stand as a multi-story stand between 80 and 120 years old. Using this definition of late-seral forest, the February, 1999 LTSY projections may not accurately depict the amount of late-seral habitat that will be available by the fifth decade. It is expected that the actual total amount of forest types with the potential to recruit LWD will be less than the predicted 53 percent for Class I and II RMZs, but the actual amount is unknown.

The aquatic conservation plan prohibits the salvage of downed wood from within Class I, II, or III waters or adjacent RMZs, except for defined emergencies. Although there is currently a deficiency of LWD within stream channels in the action area, this prescription is expected to protect the existing supply of LWD. Because the prescription applies to Class II and III RMZs as well as Class I RMZs, we expect that LWD currently present in these channels will be available for redistribution downstream into salmonid habitat during high flow events.

The best scientific information available indicates that, in order to provide a high number of recruitable trees of sufficient size to function as "key pieces" in waters, riparian zones within the action area should include approximately 24 redwood trees greater than 32 inches dbh, with approximately 18 of those redwood trees greater than 40 inches dbh per acre (Eyre 1980, Bingham, in litt. 1991, California Board of Forestry, in litt. 1992) to provide for adequate recruitment of LWD. We anticipate, based on the literature, that over half of recruitment of both 32 inch and 40 inch trees, and larger, into salmonid streams would come from the channel migration zone and the 100 foot Class I No Harvest Band. The February 1999 LTSY projections predict that the total amount of old-growth and residual old-growth forest within the Class I No Harvest Band remains relatively static during the life of the ITP, but that late-seral forest acres will increase (table 50). Recruitment potential from these areas will improve over the life of the ITP as the trees get older, provided the areas remain no-harvest zones. After watershed analysis, if entry into the channel migration zone and a portion of the Class I No Harvest Band (30 feet to 100 feet) is permitted, the aquatic conservation plan still requires that the 18 largest trees be retained in the RMZ after each harvest entry. Although the opportunity may exist for harvest entry, the goal of achieving properly functioning levels of instream LWD will determine the extent of harvest.

For the Class I Outer Band, management standards in the aquatic conservation plan would require retained trees to be distributed over several size classes. Under this distribution, 12 trees larger than 32 inches would be retained per acre. If the stated size classes are not present, larger tree size classes can be substituted, but smaller tree size classes can not be used for replacement. According to the February 1999 LTSY projections, the amount of late-seral forest within the Outer Band will increase from 957 acres to 1,863 acres in decade five, although old-growth and residual old-growth will decline from totals of 694 acres to 414 acres in decade 5. The restriction on harvest entries to once every 20 years will allow some older or more vulnerable trees within this band to be recruited into the stream or provide downed wood in the RMZ during the interim. The requirement to fell cable corridor trees towards waters, where possible, would also provide some short-term increases of LWD. The NMFS expects that Class I RMZ prescriptions, both pre- and post- watershed analysis, will provide for RMZs that will, over time, develop into stands with a high number of trees of sufficient size to recruit to the streams to function as "key pieces".

Class II RMZs will provide less LWD to salmonid streams, but an estimate of how much less is unknown. The Class II RMZ 30-foot no harvest buffer would provide some recruitment into the Class II waters. The LWD recruitment potential primarily comes from 802 current acres of old growth and residual old growth and 732 acres in decade 5. The outer 100-foot Selected Harvest Band would be managed with similar standards as the Outer Band in Class I RMZs, requiring that 12 trees larger than 32 inches be retained per acre. According to the February 1999 LTSY projections, the amount of late-seral forest within the Selected Harvest Band will increase from 3,667 acres to 8,256 acres in decade five, but the old-growth and residual old-growth will decline from 2,380 acres to 1,396 acres in decade five.

A minor amount of LWD would be expected to be recruited from the Class III No Harvest Band, with less coming from within the 2,175 acres identified in the SYP/HCP. The current acreage of trees of sufficient size to function as LWD are unknown, but is expected to be minimal based on previous harvest projections by PALCO. A more important role for Class III RMZs in the recruitment of LWD to fish-bearing streams may be from natural debris torrents triggered by severe storm events. Such mass wasting events are a part of a watershed's natural disturbance regime and can be beneficial to salmonids, providing coarse sediment and LWD into stream systems (Reeves et al. 1995). Because of the presence of the No-Harvest Band on Class III waters, we anticipate in the future, in the event of a landslide triggered in a Class III water, some larger trees will be delivered downstream. Combined with the recruitment potential from Class I and II RMZs, NMFS believes that the riparian management prescriptions, in the future, should provide for adequate levels of LWD for salmonid habitat, including proposed critical habitat. The effect of the RMZ prescriptions on LWD levels will not be immediate, therefore the lack of LWD instream will continue for some time, likely well beyond the life of the ITP.

Windthrow
PALCO's proposed management outside of RMZs and MMCA's includes clearcutting and other forestry techniques that, ecologically, have similar effects as clearcutting (e.g. shelterwood). Trees within riparian buffers that are immediately adjacent to clearcuts have a greater tendency to topple during windstorms than trees in undisturbed forests. Extensive blowdown of riparian stands can benefit Pacific salmonids and proposed critical habitat through the immediate increase in LWD. However, over the long-term, extensive blowdown of riparian stands results in the loss of the riparian functions vital to Pacific salmonids such as shading, bank stabilization, and the long term recruitment of LWD. Local site conditions dictate the vulnerability of stands to windthrow, but Rhodes et al. (1994) recommended that buffers need to be two site-potential tree heights wide in order to protect riparian buffers from windthrow.

The aquatic conservation plan does not directly address the issue of windthrow events except through changed circumstances and watershed analysis. The widest buffers are 170 feet, on Class I waters, and are approximately one tree height. Class II and III RMZs are smaller. The vulnerability of Class I and II RMZs to windthrow will be offset somewhat by the buffer widths in combination with steep slope provisions. On slopes greater than 50 percent, the aquatic conservation plan requires the outer band prescriptions to be extended to the break in slope or 400 feet from the stream. Where the steep slope provision applies, we anticipate that the resultant vegetated area will be wide enough to protect the core RMZ from the effects of windthrow. In these areas we expect the effects of a blowdown event on salmonid habitat will be minor. The total number of stream miles where the steep slope provision will increase habitat protections is currently unknown.

Class I and II RMZs that are on slopes less then 50 percent and which are not subject to the steep slope provision, will be more vulnerable to the effects of windthrow. Class III RMZs are highly vulnerable to extensive blowdown due to the small vegetated buffer width of 30 feet on either side of the channel. Prior to watershed analysis, there is no provision for identifying the vulnerability of stands to windthrow and protecting them accordingly. Through the watershed analysis process, the areas near streams that have shown past vulnerability to windthrow would be identified and appropriate prescriptions would be applied to protect the function of the RMZs.

Although we cannot currently predict how often windthrow events will occur, or how severe the blowdown will be in the event of a severe wind storm, we expect that the aquatic conservation plan will provide minimal to moderate protection to the integrity of the RMZ from windthrow events. Because such severe storms are uncommon events, NMFS anticipates that the effects from such blowdowns will be localized but the effects due to the loss of critical riparian functions along these reaches would be sustained for a long time.

Stream flow
Timber harvest and associated road construction can alter the hydrologic processes that determine stream flow. Generally, the removal of vegetation increases the amount of water that infiltrates the soil, and ultimately reaches the stream, by reducing water losses from evapotranspiration (Spence et al. 1996). In forested systems where fog drip contributes significantly to the total precipitation, such as the Humboldt Bay watershed, harvesting of trees may have little effect. Harr (1982 cited in Spence et al. 1996) found that in a study in the Cascade Range of Oregon, the total water yield decreased slightly after vegetation removal. Logging can change the total annual water yield, increase the magnitude of peak flows, alter the timing of peak flows, and increase or decrease the magnitude of summer low flows. Further information on the effects of logging on hydrologic processes can be found in Chamberlin et al. (1991) and Beschta et al. (1995).

Alterations to watershed hydrologic processes can be prevented by establishing a process for identifying and minimizing cumulative watershed effects. Although the probability of hydrologic changes resulting from timber harvesting and associated road building generally increases with the percentage of watershed that has been disturbed, there is no widely accepted threshold value for minimizing cumulative hydrologic effects. Within individual hydrological units, the aquatic conservation plan's DI threshold prescription is expected to limit the overall watershed disturbance from timber harvest and road construction. It is unknown whether the 20 percent DI threshold is an appropriate level for minimizing cumulative watershed hydrological effects, but it does provide some level of protection. Therefore, prior to watershed analysis, impacts to hydrologic processes are expected to continue from timber harvesting. The effect of these changes to Pacific salmonids and proposed critical habitat are varied depending on the type of hydrological changes that occur, but could include increased vulnerability of redds to scouring during high flow events and decreased summer rearing habitat. Watershed analysis, which must be completed within the first five years, would include an analysis of cumulative watershed effects. This analysis is expected to determine how a watershed responds to multiple management impacts. After watershed analysis, this site specific information would be used to tailor new prescriptions to minimize cumulative watershed effects and potentially modify the DI threshold. The DI threshold is discussed and analyzed further below.

Channel dynamics
The condition and dynamics of the stream channel in which Pacific salmonids live affects the suitability of the aquatic habitat. Timber management can alter the condition and dynamics of stream channels by removing riparian vegetation, which leads to a loss of root strength and ultimately, bank instability. Increases in sediment inputs from forestry activities destabilizes

channels, fills pools, and causes stream widening and shallowing. Adjacent floodplains provide off-channel habitat for juvenile and adult salmonids and dissipates the energy of water during high flow events. Timber harvesting, including salvaging LWD from channels and riparian areas, reduces the amount and complexity of off-channel habitats. Sedell and Froggatt (1994 cited in Chamberlin et al. 1991), observed that the loss of debris jams and related multiple floodplain channels vastly reduced channel and shoreline areas used by juvenile and adult salmonids.

Mitigation identified in aquatic conservation plan to protect channel condition includes the identification and protection of channel migration zones. Within identified CMZs, harvesting, including salvage operations, is not allowed. With this prescription, it is expected that timber harvesting will have a minimal impact on off-channel habitats. Other measures described above, including the No Harvest Band and erosion control measures within and above RMZs, are also expected to provide some protection to channel condition.

Riparian Management After Watershed Analysis
The prescriptions analyzed above will be applied to PALCO's ownership on an interim basis until watershed analysis can be completed for each watershed. Initial watershed analyses must be completed within five years of ITP issuance and then revisited every five years or sooner due to changed circumstances. Except for specified minimum and maximum No-Harvest Bands on Class I and II waters (30 feet and 170 feet, respectively) and the 18 largest tree retention standard within Class I RMZs, all prescriptions described and analyzed above may be altered due to watershed analysis. Although new prescriptions may be applied post-watershed analysis, the aquatic conservation plan requires that post-watershed analysis prescriptions must maintain or achieve, over time, properly functioning aquatic habitat conditions for salmonids. Therefore, NMFS expects that any post-watershed analysis prescriptions for riparian management, albeit potentially different from the interim prescriptions, will provide equal or greater protection for Pacific salmonids and will maintain or decrease the time required to achieve properly functioning aquatic habitat conditions on PALCOs ownership.

Hillslope Management
The proposed aquatic conservation plan includes measures to minimize the impacts of landslides caused by timber harvesting and road construction on streams and aquatic habitat within PALCO's ownership by implementing a mass wasting strategy. Types of mass wasting events in northern California identified by Bedrossian (1983) include translational/rotational slides, earthflows, debris slides, debris flows, inner gorge slides, and the debris slide slope/amphitheater. Deep seated slides such as earthflows and translational/rotational slides can be triggered by roads or streams cutting across the base of the slide, but the loss of root strength after timber harvesting probably does not affect deep-seated landslide movement. Both timber harvesting and road construction can trigger shallow rapid mass wasting events, such as inner gorge slides, debris slideslope/ amphitheaters, debris slides, and debris flows. These features are susceptible due to the loss of tree root strength after logging and when roads are constructed through them. Debris slides can also be triggered by road failures. The Final EIS/EIR extrapolated the extent of geomorphic features susceptible to mass wasting based on geology and slope. Based on this

extrapolation, an estimated 60,388 acres of land within PALCO lands may be covered by the proposed mass wasting strategy. PALCO's July 1998 Draft HCP estimates that approximately 40,000 acres may be covered by the mass wasting strategy.

Under the proposed mass wasting strategy, we anticipate that there is a low risk of sediment delivery to waters from timber harvest due to the prohibition, and a low to moderate risk of sediment delivery to waters due to limited road construction from deep-seated landslides. Timber harvest activities are not likely to trigger movement within these features due to the prohibitions on timber harvesting on identified mass wasting areas of concern prior to watershed analysis. This assumes that the mapping process correctly identified the areas of concern. There is a higher risk that road construction and reconstruction will trigger movement within these features. This conclusion is based on the increased sensitivity of deep-seated landslide features to impacts caused by road construction and reconstruction and the potential for limited new road construction and reconstruction established in the mass wasting strategy across identified mass wasting areas of concern (i.e., road construction or reconstruction can proceed after approval by the wildlife agencies).

There is a slightly higher risk of sediment delivery from rapid mass wasting events triggered by road construction, but the risk from timber harvest due to the prohibition will be low. The geomorphic features where these rapid mass wasting events can be triggered are more common than deep-seated features within the action area. Under the proposed mass wasting strategy, timber management would be prohibited on mass wasting areas of concern prior to watershed analysis. The definition of this term specifically includes those features most likely to be the source of rapid mass wasting events such as inner gorges and headwall swales. There is a slightly higher risk that road construction and reconstruction will trigger rapid mass wasting from these features. This conclusion is based on the potential for new road construction and reconstruction across identified mass wasting areas of concern prior to watershed analysis. (i.e., road construction or reconstruction can proceed after approval by the wildlife agencies).

Although it is expected that the hillslope strategy will generally result in a low risk of sediment delivery to waters caused by covered activities on or across identified mass wasting areas of concern, there is a degree of uncertainty involved due to the mapping process. There is a possibility that geomorphic features prone to mass wasting may not be currently identified and properly protected from timber harvesting or road construction. According to PALCO (1998), the approach used to develop the mass wasting features map allowed for the delineation of steep terrain as well as unstable and extremely unstable lands at a broad scale. PALCO (1998) acknowledges that smaller features were probably missed by the process due to scale limitations. Ground-truthing and redefinition of area boundaries by the CDMG or a qualified professional geologist on a site-specific basis is permitted under the hillslope strategy, but this process will not necessarily identify new features that were not captured during the initial mapping process. We expect that the ground-truthing process will be effective at determining false-positives (i.e., mapped mass wasting areas of concern that do not exist on the ground), but the process is not likely to identify false-negatives (i.e., mass wasting areas of concern that are not mapped but exist on the ground) if they exist outside of mapped areas. PALCO (1998) identified approximately 38,000 acres that have yet to be characterized and mapped, these areas must be treated as mass wasting areas of concern until which time they are mapped. Watershed analysis requires a more thorough examination and mapping of mass wasting areas of concern. Through the watershed analysis process, we expect that these false-negatives and false-positives will be identified. Until watershed analysis is completed, the uncertainty will remain.

Hillslope Management After Watershed Analysis

The prescriptions analyzed above will be applied to PALCO's ownership on an interim basis until watershed analysis can be completed for each watershed. The prohibition on timber harvest and limited road construction/reconstruction described and analyzed above may be altered due to watershed analysis. Although we cannot predict what, if any, new prescriptions may be applied post-watershed analysis, the aquatic conservation plan does require that post-watershed analysis prescriptions must maintain or achieve, over time, properly functioning aquatic habitat conditions for salmonids. Also, as noted above, the watershed analysis process should result in improved mapping of mass wasting areas of concern, decreasing the possibility of false-negatives. Therefore, NMFS expects that any post-watershed analysis prescriptions for mass wasting areas of concern, albeit potentially different from the interim prescriptions, will provide equal or greater protection for Pacific salmonids and will maintain or decrease the time required to achieve properly functioning aquatic habitat conditions on PALCOs ownership.

Road Management

The proposed action prescribes several strategies to minimize the impacts from road construction, reconstruction, upgrading, maintenance, closure, decommissioning and use on threatened and endangered species. Road management activities can impact salmonid habitat by increasing the delivery of sediment to streams through surface erosion and mass wasting events, blocking or hindering migration of juvenile and adult salmonids, inhibiting recruitment of LWD from riparian stands, altering and constraining channel morphology, modifying the drainage network, and increasing the potential for chemical contamination (Furniss et al. 1991). Road management activities, particularly construction and maintenance activities that require heavy equipment in streams, can also directly impact Pacific salmonids by destroying redds, smothering or crushing eggs and alevins, increasing turbidity, blocking migration, and disturbing overwintering juvenile and adult salmonids. Water drafting for summertime dust abatement and fire suppression can entrain or impinge juvenile salmonids. Management prescriptions are proposed in the aquatic conservation plan to minimize the effects of these activities on listed salmon and their critical habitat in the action area.

The management measures for roads proposed in the aquatic conservation plan are divided into six categories: sediment assessment; road storm-proofing; road construction, reconstruction and upgrading; road maintenance; road inspections; and wet weather use.

Sediment assessment

This is a survey process and, in and of itself, has no direct or indirect effects on salmonids or proposed critical habitat. How quickly PALCO is required to complete the sediment assessment may indirectly affect salmonids in terms of the identification of high priority sites for storm-proofing or upgrading. A long assessment process could increase the probability of sediment delivery if the failure to identify high priority sites results in the generation of sediment into salmonid habitat or continued barriers to movement. Given the extensiveness of the existing road network, we believe the time limits established in the aquatic conservation plan are realistic and appropriate.

Storm-proofing
This process is designed to stabilize road features identified as having a moderate or high likelihood of delivering sediment to waters. Effects of storm-proofing on salmonids and proposed critical habitat include both short-term and long-term effects.

In the short-term, direct impacts to salmonids may occur during corrective work on water crossings. The use of equipment in streams during corrective activities on water crossings disturbs habitat, increases turbidity, and could crush eggs and alevins. Instream equipment use may degrade water quality through localized increases in suspended sediments. We expect that degraded water quality events caused by the use of equipment in streams will be short in duration and localized, but they could affect the ability of the fish to feed and block or delay the migration of juvenile or adult salmonids. Under the aquatic conservation plan, storm-proofing involving instream equipment will be conducted primarily between May 2 and October 14 of any year, thereby avoiding instream activity during winter or spring months when eggs and alevins may be present in the substrate. Some salmonid fry, particularly steelhead and coastal cutthroat trout, may not emerge from gravels until June. Storm-proofing after May 1 that involves instream equipment use could crush steelhead and coastal cutthroat trout eggs and alevins. Turbidity generated by instream equipment could settle on downstream redds, smothering or impairing the ability of fry to emerge from gravels. The majority of salmonids emerge prior to May 2, therefore we expect incidences of instream equipment crushing or smothering redds to be rare. During the summer months, the possibility of a juvenile or adult salmonid being crushed by instream equipment use is considered remote, due to their flight response. Juvenile wild salmonids tend to move to deeper water when disturbed (Knudsen 1992). This behavior may benefit the fish by moving them out of the way of possible harm from instream activities but could force them to relocate to inferior habitats.

Emergency work (e.g. unblocking culverts, stabilizing fill) may be completed during the winter and spring (October 15 thru May 1) if necessary in order to prevent water diversions and fill failure. Heavy equipment might be used in the stream for these emergency activities. If equipment is used in the water, there could be short term direct adverse impacts to Pacific salmonids and proposed critical habitat from these activities during the winter period, including destroyed redds, smothered or crushed eggs and alevins, increased turbidity, blocked migration, and a disruption or disturbance of overwintering juvenile and adult salmonids. Pacific salmonids are particularly vulnerable during the winter, when adult salmonids are migrating and spawning, and the spring, when eggs and fry are still present in the substrate. The activities could scare juveniles out of overwintering habitats such as side channels and deep pools, into inferior habitats or high velocity waters. We believe that impacts incurred due to emergency activities during the winter will be localized and short-term, but may be locally intense, especially if redds are destroyed. With the assessment and storm-proofing schedules established under the aquatic conservation plan, we expect that the frequency of occurrence for such extensive emergency stabilization treatments will be low. Also, over time, as roads and stream crossings are upgraded to the storm-proofing specifications required in the aquatic conservation plan, the necessity for winter and spring emergency stabilization work should decline. The short-term impacts would be further off set by the immediate and long-term benefits incurred from stabilizing fill, preventing culvert blow outs, and minimizing erosion problems.

According to Weaver and Hagans (1994), road-related activities should be performed during the dry season. The aquatic conservation plan prescriptions are expected to minimize sediment production during storm-proofing activities by limiting the timing of permitted activities, primarily to the dryer months (May 2 - October 14). As an additional minimization measure, during this time, storm-proofing would cease during periods of rainfall, and could not resume until soil was no wetter than is found during normal watering treatments. With these prescriptions in place, only minimal amounts of sediment inputs are expected to occur from storm-proofing activities not associated with water crossings during the dry season. Temporary and localized increases in turbidity could result from storm-proofing activities at stream crossings, which could affect the ability of fish to feed, and block or delay the migration of juvenile or adult salmonids.

In the long-term, we anticipate storm-proofing to reduce sediment generated from the existing road network. Storm-proofing actions include removing unstable fill, altering the road bed to reduce the potential for diversion of flows onto the road surface, installation of rolling dips and water bars to route overland flow, replacing inadequate and failing water crossings, and installing drainage structures. These actions are known to reduce the possibility of debris slides from road or water crossing failures and minimize the generation of sediment from surface erosion (Weaver and Hagans 1994).

The ability of PALCO to successfully minimize sediment delivery from their road network depends on the accurate and timely identification of unstable road features that may deliver sediment to waters and, once identified, the prompt stabilization of those features. The aquatic conservation plan requires that all roads will be storm-proofed within the first 20 years at a minimum rate of 750 miles per decade and 75 miles per year. Under this schedule, certain unstable road features will not be storm-proofed for 20 years, and impacts to salmonids or proposed critical habitat could occur during the interim if these features fail and deliver sediment into waters. The possibility of these unstable features failing before appropriate stabilization work is performed is minimized by the requirements to storm-proof the worst sites within 10 years, and the sites at risk of imminent failure within the first 3 years. Despite these actions, sediment generation cannot be completely eliminated and the road density per square mile of land will remain high, therefore NMFS anticipates a low to moderate amount of road-related sediment will continue to be delivered into salmonid waters and proposed critical habitat from road within the action area.

Road construction, reconstruction, and upgrades

Many of the impacts from road construction, reconstruction, and upgrades on salmonids and proposed critical habitat are similar to those described previously in this biological opinion for storm-proofing. Impacts include direct impacts from the use of equipment in streams and indirect impacts from the delivery of sediment through surface erosion or road-generated mass wasting events. Direct impacts from the use of equipment in streams will minimized during road construction and reconstruction because the winter period, during which these activities are prohibited, is longer than described for storm-proofing (October 15 through June 1). In addition to the effects described previously, additional impacts are expected due to the addition of 400 miles of new roads and an unspecified, unlimited number of miles of reconstructed roads to the road network during the life of the ITP.

New and reconstructed roads will be built to the storm-proofing specifications analyzed previously. We expect that the prescriptions on the amount of cut and fill, road width, road gradients, road surface drainage specifications, stream crossings design, and other construction, reconstruction, and upgrading standards will reduce the possibility of debris slides from road or water crossing failures and minimize the generation of sediment from surface erosion from new, reconstructed, and upgraded roads. Sediment from these sources can not be completely eliminated, and with an additional 400 miles of new roads, and an unspecified, and unlimited amount of reconstructed roads to be built during the next 50 years, we anticipate that a low to moderate amount of sediment will continue to be generated from these sources. This anticipated impact will be offset to an unknown extent by the requirement in the aquatic conservation plan that sediment generated from THP-related roads must be compensated for by sediment reduction through upgrading or road closure within a planning watershed. An unknown percentage of the proposed 400 miles of new roads and the reconstructed roads will be THP-related roads, therefore it is anticipated that sediment generated from these roads will be low.

The construction of new water crossings, while minimized, would not be capped or restricted in any quantitative manner under the aquatic conservation plan. Given that 400 miles of new roads and unspecified miles of reconstructed roads are to be constructed under the proposed action, the number of stream crossings is expected to increase across the Plan area. Culverted stream crossings are naturally susceptible to failure (Weaver and Hagans 1994), potentially generating large amounts of sediment directly into waters. Based on information provided in Weaver and Hagans (1994), the design specifications identified in the management plan are expected to increase the probability that culverted stream crossings can withstand a high flow event. In addition, we anticipate that the annual inspections and wet weather inspections with associated routine maintenance of these culverted stream crossings will aide in minimizing the potential for culvert blockages to cause catastrophic failures.

The building of new roads and the reconstruction of roads are not permitted in the RMZ. NMFS expects that this measure will also minimize the effects of roads on salmonid habitat by reducing the potential for additional road related sediment from reaching waters.

Road maintenance
Road maintenance operates in conjunction with road inspections, and is designed to prevent or minimize potential impacts from surface erosion or fill and culvert failures before they occur. The success of a road maintenance program depends, in part, on the successful identification of unstable areas in time to complete corrective work before the next wet season.

Road maintenance prescriptions include treating all permanent roads and water crossings within RMZs with rock, chip seal, or pavement, maintaining the proper surface drainage, and routine corrective work such as repairing cross drains, water bars, road surfaces, and unblocking culverts. These activities are expected to decrease surface runoff from roads, especially roads within RMZs, and minimize the possibility of catastrophic failures of culverts and unstable fill. The Aquatic Conservation Plan restricts non-routine maintenance activities to the summer months, between June 2 and October 14, of any year. This is expected to minimize the amount of sediment generated from such maintenance activities. Maintenance activities may require the use of equipment within waters. As described in the storm-proofing section, maintenance activities during summer months may degrade water quality through localized increases in suspended sediments. We expect that degraded water quality events caused by the use of equipment in streams will be short in duration and localized, but they could affect the ability of the fish to feed and block or delay the migration of juvenile or adult salmonids. Instream equipment use could also disturb juvenile and adult salmonids and force them to move away from preferred habitats. The impact from such disturbance is expected to be short in duration. Overall, we expect that the road maintenance program will decrease the amount of sediment entering streams and other waters from roads.

Road inspections
Inspections are a process and, in and of themselves, will not have any direct or indirect affects on salmonids or proposed critical habitat. In that the maintenance program, described and analyzed above, depends on the identification of maintenance needs through inspections, road inspections may affect salmonids and proposed critical habitat. If roads are not inspected on a regular basis, the probability of sediment delivery from a road or culvert failure increases.

Under the aquatic conservation plan, roads are required to be inspected annually to ensure that drainage facilities are in proper condition. Roads must also be inspected at least once during January or February, after a major storm event, and multiple inspections during the winter months are encouraged. Roads that cannot be inspected must be closed or decommissioned. Even closed and decommissioned roads must be inspected after the first five-year storm event to ensure that the treatments are functioning as intended. The combination of annual inspections and "storm-patrol" inspections in January and February, along with required schedules for correcting identified maintenance needs, is expected to reduce sediment production from roads and associated drainage structures. Because the current road network is extensive, the workload associated with the inspection program is anticipated to be heavy. Due to this, we anticipate that PALCO will begin decommissioning or closing roads unnecessary to PALCO's operations, further reducing sediment generated from the road network within the action area.

Wet weather road use
The aquatic conservation plan limits the use of the road network any time during the year when the road surface is not dry. When roads are wet, traffic impacts brings fine sediments to the surface of roads, in part by the "pumping" of fine-grained subgrade materials up through the surfacing gravels (L. Reid, in litt., 1998). Mud on the surface of the road is then washed of during the next storm event, increasing turbidity in salmonid habitat. Under the aquatic conservation plan, road use is limited with the most heavy road use prohibited during defined periods of precipitation, regardless of the time of year, and afterwards until the road is dry. The prescription focuses on preventing any visible increase in turbidity in a drainage facility or road surface which drain directly to a Class I, II, or III water. This prescription is expected to result in a significant reduction of incidences of turbidity in these waters generated from the pumping of fines.

Road use is allowed on wet roads for emergencies (both human safety and road related). Sediment will be generated by these events, but the occurrence of use is expected to be rare, and, in the case of road related emergencies, will be expected to decline over time as the road network is upgraded and storm-proofed. Limited light vehicle road use during periods of wet weather would be allowed on both rocked and non-rocked roads. Because of the specified vehicle weight (three-quarter ton trucks or less) limitation, in combination with the requirement to repair damage to the road surface or drainage facility within 24 hours, and the requirement that the damage should only be to an extent that repair can be made with hand tools, the impact of these vehicles is expected to result in low levels of sediment input into waters. NMFS also expects that any potential impact from light vehicle use on wet roads will be furthered minimized by limiting types of use on non-rocked roads prior to 48 hours after the termination of precipitation.

Other road related effects
Roads can also affect Pacific salmonids by blocking or hindering the migration of juvenile and adult salmonids, usually through the presence of stream crossings. Crossings can be barriers to migration, usually because of outfall barriers, excessive water velocity, insufficient water depth in culverts, turbulence disorienting fish, lack of resting pools below culverts, or a combination of these (Furniss et al. 1991). Under the aquatic conservation plan, stream crossings are to be minimized, but how this will be measured is not described. There are currently 3,728 water crossings on PALCO's ownership (Final EIS/EIR 1999). Given that the proposed action includes the construction of an additional 400 miles of new road on PALCO's ownership, the number of stream crossings is expected to increase across the Plan area, increasing the potential for barriers to migration. The aquatic conservation plan management prescriptions for stream crossing construction indicate that new and reconstructed roads across fish-bearing and restorable fish-bearing streams must provide for unimpeded fish passage. In the long-term, it is anticipated that

unimpeded fish passage will be achieved by following culvert installation standards currently in development by NMFS. While these standards are being developed, an unknown number of new and reconstructed water crossings may be installed on PALCO's ownership. New stream crossings must be permitted under California Fish and Game Code section 1603. Current culvert installation standards used by CDFG are believed to provide for unimpeded passage of adult salmonids, but whether they are as successful in providing for the movement of juveniles during low water conditions is currently unknown. Therefore, it is anticipated that some unknown portion of the culverts installed under the ITP will impede the passage of juveniles.

Water crossings on Class I waters are also to be sized to permit passage of a 100-year recurrence interval flood without overtopping the culvert. This culvert sizing should be large enough such that the bankfull width is not constrained and flow of water is not constricted, which could increase water velocity and cause streambed and streambank instability downstream. Therefore, we anticipate the effect of new stream crossings on channel morphology will be minimal. Current water crossings are sized to permit passage of a 50-year recurrence interval flood. Many of these existing culverts are probably constraining channel morphology. The effect of these culverts is expected to decline over time as these culverts are replaced under the storm-proofing program.

Drafting water from fish-bearing streams may also impact Pacific salmonids. Weaver and Hagans (1994) recommend dust control and watering to minimize the amount of dust and loose soil created by summer road use. PALCO usually drafts water for dust abatement purposes from local water sources, often directly from streams. Drafting that diverts a substantial portion of the flow can draw down water levels in pools, decreasing space availability and increasing the vulnerability of salmonids to predators. Water drafting in fish bearing streams can divert juvenile salmonids into the water tanks unless a screening device is placed over the intake hose. Screening devices can substantially reduce the direct impact of water withdrawals, but in order to provide for full protection, the appropriate size of the mesh or holes in the screen and the corresponding approach velocity to the screen must be designed properly (Smith and Carpenter 1987).

The aquatic conservation plan's drafting specifications require screening of hose intakes and limited diversion rates. According to the aquatic conservation plan, the diversion rate while drafting cannot exceed the rate of inflow. PALCO would be required to utilize the most recent NMFS water drafting screening specifications. The current NMFS standards were established based on laboratory tests (Smith and Carpenter 1987) to protect 100 percent of the smallest life stage and weakest swimming fish from entrapment and impingement due to screened diversions (R. Wantuck, NMFS, pers. comm., Jan. 1999). The specifications also require that screens must be kept in good repair and always used when drafting water. While in use, screens must be cleaned frequently to prevent the approach velocity from exceeding the standards established by NMFS. Impacts to juvenile Pacific salmonids from drafting are expected to be minimal.

The presence of roads within riparian zones can inhibit recruitment of LWD from riparian stands. Wood that falls across roads must be removed from the road to maintain accessability. In these situations, the road acts as an barrier, preventing recruitment of large wood from upslope sources into waters. Within Class I and II RMZs, mitigation for this impact increases the width of the No Harvest Band on the opposite side of the water an equivalent distance of that portion of the existing road prism. Although this will not fully compensate for the lost recruitment from the portion of the RMZ upslope from the road, some additional trees will be recruited from the expanded No Harvest Band. It is expected that the presence of roads within RMZs will continue to restrict the full recruitment of potential LWD into waters. Because of the current poor supply of LWD in waters within the action area, NMFS expects that, with the described mitigation, the effect of RMZ roads on the recruitment of LWD to be a moderate effect on the ability of a watershed to attain properly functioning levels of woody debris, within those watersheds with high densities of RMZ roads.

Bridges and other structures can be damaged or destroyed by the downstream movement of LWD during large storm events. Although the salvage of LWD is, generally, not permitted under the Aquatic Conservation Plan, exceptions are allowed where LWD is threatening life or property, including bridges and other road structures. Therefore, we anticipate that some pieces of LWD will be removed from waters due to such emergencies. Because of the current poor supply of LWD in waters within the action area, NMFS expects the effect of emergency removal of LWD to be a moderate to significant impact on the ability of a watershed to attain properly functioning levels of woody debris within those watersheds with high densities of roads and hence, a high density of water crossings.

Roads and stream crossings can alter and constrain channel morphology. The aquatic conservation plan prohibits new road construction within RMZs; this will prevent impacts from future road construction, but does not affect existing riparian roads. It is unknown how many riparian roads are currently constraining channel morphology. The impact from existing riparian roads on channel morphology is expected to continue across PALCO's ownership. Such impacts will persist as long as the road is present and, depending on how severely channel morphology is constrained, may alter stream conditions downstream.

Road networks can have significant impacts on hydrologic processes that determine streamflow (Spence et al. 1996). King and Tennyson (1984 cited in Spence et al. 1996) observed altered hydrology when roads constituted four percent or more of a catchment area. The Aquatic Conservation Strategy does not place density limitations on the number of miles of roads PALCO may construct during the life of the ITP. Within individual hydrological units, the DI threshold prescription is expected to limit new construction of roads, but the 20 percent threshold is higher than the percent roaded area observed to alter hydrology. Therefore, impacts to hydrologic processes are expected to continue from the road network, in the form of changes to the timing and volume of peak and base flows. The effect of these changes to Pacific salmonids and proposed critical habitat are varied depending on the type of hydrological changes that occur, but could include increased vulnerability of redds to scouring during high flow events and decreased summer rearing habitat.

When roads cross over waters, there is an increased risk of contamination from spills or petrochemicals dripping or washing off of equipment. There are currently 3,728 water crossings on PALCO's ownership. This number is expected to increase during the life of the ITP, therefore the possibility of chemical contamination is also expected to increase. Contamination of waters at amounts toxic to Pacific salmonids depends on both the likelihood of exposure and the toxicity of the chemicals (Norris et al. 1991). Contamination of waters from leaking vehicles is "somewhat of a concern" when equipment is used in streams (M. Yancheff, Caltrans, pers. comm., Jan.1999). Petroleum products are toxic to eggs and juvenile fish at certain concentrations (polycyclic aromatic hydrocarbons are toxic at concentrations between 500 and 1,000 ppb in estuarine sediments; J. Haas, USFWS, pers. comm Jan.1999), but small amounts of oil, gas, or diesel fuel dripping or washing off of vehicles or heavy equipment is normally not concentrated enough to affect salmonids (J. Haas, pers. comm, Jan. 1999). To prevent an accidental spill of any hazardous material, PALCO's spill contingency plan (Draft SYP/HCP, Vol. II, Part P) would be implemented. Based on discussions with contaminant specialists (J. Haas, USFWS), we expect the likelihood of a spill occurring to be low. If a spill were to occur at concentrations high enough to be toxic to fish, it is expected that the impact to Pacific salmonids and proposed critical habitat would be severe but localized and of short duration.

Disturbance Index

The aquatic conservation plan establishes an assessment of watershed disturbance at the hydrologic unit scale for purposes of minimizing cumulative sediment production, based on a measure of ground disturbance. This DI would be used to guide management in directions that will minimize cumulative sediment impacts. Although the DI is designed to assess sediment-related impacts, management actions taken to lower the DI below the set threshold of 20 percent could also minimize cumulative hydrologic impacts.

Data on watershed conditions indicate that many watersheds within the action area currently exhibit cumulative sediment impacts. The CDF has identified the following watersheds within the action area as cumulatively affected by sediment: Freshwater Creek, Elk River, and Bear Creek, Jordan Creek, and Stitz Creek (tributaries to the lower Eel River). Freshwater Creek and the Elk, Yager, Van Duzen, Eel, and Mattole Rivers have also been listed under section 303(d) of the Clean Water Act for sediment problems.

The DI is an evaluation process and, in and of itself, has no direct or indirect affect on Pacific salmonids or proposed critical habitat, but the establishment of an impact threshold beyond which management must be altered in order to decrease cumulative impacts below the threshold will have an effect. By limiting the total amount of impact from management activities that can occur in a watershed, we anticipate that this prescription will be moderately effective at limiting cumulative sediment impacts within these watersheds. This conclusion is based on the following factors: (1) The DI will be calculated at the hydrologic unit scale. Although this scale is not the smallest hydrological unit used in analyses, it should be adequately sensitive to discern localized but concentrated impacts. Management activities such as timber harvesting or road construction can not be concentrated in small sub-watersheds that may be locally important to salmonids. (2)

Roads that are used at any time during the 10-year interval and any improperly abandoned roads remain in the baseline calculation of DI. This means that the long-term sediment-generating potential from roads will be factored into any DI calculation. Given the current high density of roads in many watersheds on PALCO's ownership, a high number of sub-watersheds are believed to currently exceed the 20 percent threshold. This prescription will substantially minimize future management within these watersheds, until the DI calculation drops below the 20 percent threshold. (3) Prior to watershed analysis, the aquatic conservation plan places restrictions on management actions in any Class I sub-basin containing a salmonid population where the DI is calculated to be at or above 20 percent. Management restrictions include a ban on clearcutting, new road construction, skid trail construction, or broadcast burning within the identified sub-watershed. The management restrictions in these watersheds will substantially reduce sediment production from future activities in these watersheds. Given the baseline conditions within the action area, we also expect that this prescription will be applied to a large, but currently unknown, portion of Class I sub-watersheds containing a salmonid population.

We have some concern with the DI threshold value of 20 percent. It is difficult to establish a set threshold for all areas because the response of watersheds to management activities depend on many geological and morphological variables unique to each area. Because of this uncertainty, we anticipate that cumulative effects may continue in certain sub-watersheds where the 20 percent threshold is too high. These cumulative sediment effects will impact Pacific salmonids and proposed critical habitat.

Disturbance Index After Watershed Analysis

Watershed analysis would include an analysis of cumulative watershed effects. This analysis is expected to determine how a watershed responds to multiple management impacts. After watershed analysis, this site specific information would be used to tailor new prescriptions to minimize cumulative watershed effects and potentially modify the DI threshold. Although we cannot predict what, if any, new prescriptions may be applied post-watershed analysis, the aquatic conservation plan does require that post-watershed analysis prescriptions must maintain or achieve over time properly functioning aquatic habitat conditions for salmonids. Therefore, NMFS expects that any post-watershed analysis DI thresholds or management prescriptions addressing cumulative effects, will provide equal or greater protection for Pacific salmonids compared to the interim DI and will maintain or reduce the time required to achieve properly functioning aquatic habitat conditions on PALCOs ownership.

Rock Quarries and Borrow Pits

The proposed action includes a few strategies to minimize the impacts from rock quarries and borrow pits on threatened and endangered species. Operations associated with the two rock quarries that will be carried out under the proposed action include excavations, drilling, blasting, screening, loading and hauling, road relocation, and erosion control. Sand and rock removed from small borrow pits are part of PALCO's road and sediment control program and are used for road maintenance, drainage facility repair, and erosion control.

Under the proposed action, operations at two quarries in the Yager WAA would be covered under the ITP for two years. Rock Quarry 1 is located on a 3.5 acre site in the Yager Creek drainage. Approximately 125,000 cubic yards of material are approved for removal from this quarry. PALCO is permitted to remove approximately 450,000 cubic yards of material from Rock Quarry 2. To minimize potential sediment and contaminant impacts, detention ponds and erosion control would continue to be used to reduce runoff to streams. Mitigation would be implemented so that operations would not result in a visible increase in turbidity in any drainage facility, work site, quarry area, etc., any of which drain to a Class I, II, or III water. Impacts from the operation of these two rock quarries may include increases in sediment and turbidity and acidification of waters from runoff. Due to the measures to control runoff, we anticipate that impacts from operations of these two quarries will be minimal.

Under the proposed action, an undisclosed number of small sand and rock borrow pits will be used by PALCO to provide material for road maintenance, drainage facility repair, and erosion control. Activities associated with these borrow pits would be covered under the ITP for five years. Measures to minimize impacts from borrow pits include all pertinent mitigation measures required for roads, including a prohibition on new borrow pits in RMZs, a prohibition on new borrow pits on mass wasting areas of concern prior to watershed analysis, the road construction/reconstruction standards, and wet weather operation restrictions. As part of watershed analysis, all borrow pits will be mapped and analyzed for site-specific and hydrologic unit scale impacts. Additional mitigation and minimization measures could be required as a result, including sediment control structures, limitations on overburden placement and distribution, removal of spoil material, revegetation, and abandonment.

The impact from these borrow pits on Pacific salmonids and proposed critical habitat is unknown. There is no information available to us that indicates the number, size, and location of these pits in relation to waters. We expect that the road management measures that will be applied to borrow pit operations will provide some level of protection to salmonids from borrow pit operations. Additional protective measures may be applied after watershed analysis. Due to the prohibitions on new borrow pits within RMZs and within mass wasting areas of concern (prior to watershed analysis), we expect that the total number of sites within these sensitive areas will decline, over time, with a corresponding decline in impacts to salmonids.

Adaptive Management

The aquatic conservation plan allows for changes to be made to management prescriptions in response to watershed analysis, new scientific studies, and monitoring. Although we cannot predict what, if any, new prescriptions may be applied based on this new information, the aquatic conservation plan requires that these prescriptions must maintain or achieve, over time, properly functioning aquatic habitat conditions for salmonids. Therefore, it is expected that any adaptive management prescriptions will provide equal or greater protection for Pacific salmonids and proposed critical habitat than the interim prescriptions described and analyzed above. We anticipate that, although adaptive management prescriptions may be different from the interim prescriptions, these prescriptions, as a whole, will maintain or increase the trajectory of essential habitat features toward achieving properly functioning condition.

Monitoring

The aquatic conservation plan requires compliance, effectiveness, and trend monitoring to assure that over time, the prescriptions maintain or achieve properly functioning aquatic habitat conditions for salmonids. Monitoring will mostly take the form of passive observation, therefore direct impacts to salmonids and proposed critical habitat are expected to be minor. The application of monitoring findings may result in modifications in PALCO's management. As noted above, any changes to management prescriptions must maintain or achieve over time properly functioning aquatic habitat conditions for salmonids. Therefore, the impact from any changes to management prescriptions are expected to provide equal or greater protection for Pacific salmonids and proposed critical habitat than the interim prescriptions.

Changed Circumstances

Changed circumstances identified in the SYP/HCP include fire, windthrow, landslides, floods, and earthquakes. If any of these circumstances were to occur, an expedited watershed analysis would be completed on the hydrologic unit impacted by the changed circumstance. Site-specific prescriptions would be implemented upon the completion of the watershed analysis. The effect of post-watershed analysis prescriptions on Pacific salmonids and proposed critical habitat was discussed previously in this biological opinion.

Interrelated and Interdependent Effects

The use of forest chemicals (herbicides and fertilizers) during management activities is an interrelated action that may affect Pacific salmonids and proposed critical habitat. The application of these chemicals on PALCO's ownership would not be covered under the ITP. Both direct effects from exposure and indirect effects from the alteration of habitat or changes in primary and secondary production may occur within the action area.

Herbicides that currently can be used on PALCO's ownership include glyphosate (Roundup, Accord, and Rodeo), tryclopyr (Garlon), 2,4-D, atrazine (Aatrex), sulfometuron methyl (Oust), hexazinone (Velpar), and Imazapyr (Arsenal, Chopper). Adjuvants and diluents are often added to the above chemicals and may affect salmonids or proposed critical habitat separately from the herbicide.

The contamination of surface waters by herbicides, and the resultant risk of toxic effects on salmonids, depends on the form and application rate of the chemical, the application method, soil type, weather conditions during and after application, and the retention of riparian buffers. The persistence of these chemicals in the environment varies due to differences in water solubility, absorption rates into organic and inorganic matter, and sensitivity to photodecomposition or microbial activity. No-spray riparian buffers substantially reduce the risk of contamination (Norris et al. 1991), but toxic levels of chemicals may still reach streams from runoff and wind drift. If contamination of surface waters occurs, impacts to salmonids and proposed critical habitat include acute and chronic toxicity, leading to injury or death, behavior modifications, reduced growth, decreased reproductive success, and increased vulnerability to diseases and pathogens (reviewed in Beschta et al. 1995). Norris et al. (1991) reviews the behavior and toxicity of many of the commonly used herbicides, but this review is now nine years old and newer chemicals are not discussed. Although there is substantial literature on the toxicity of various herbicides on salmonids, most of the information comes from laboratory studies focusing on acute lethal doses and not on chronic toxicity (Spence et al. 1996).

Indirect impacts from the application of herbicides on PALCO's ownership include changes to the vegetative structure of riparian and upland stands, which may restrict the ability of the riparian vegetation to provide shade, organic debris, and other inputs into salmonid habitat. Salmonids may also be affected by the application of herbicides through changes in the primary and secondary production of the aquatic system. Herbicides that alter habitat for terrestrial and aquatic insect species may reduce the population of these species, affecting salmonids' food base. There is very little information in the literature about the effects of herbicides on aquatic invertebrates.

Fertilizers may also be used on PALCO's ownership to accelerate conifer growth. The application of fertilizers typically results in increased concentrations of nutrients, particularly nitrogen, in streams. High levels of nitrogens has the potential to promote nutrient enrichment of surface waters, leading to the growth in benthic algae and phytoplankton. High production of these organisms produces algal blooms, which can cause respiration problems, poor visibility, and deplete oxygen levels in water.

Due to the paucity of information concerning the chronic toxicity of forest chemicals and long term changes to salmonid habitat, we are unable to determine the effect chemical application will have on Pacific salmonids and proposed critical habitat. It is expected that impacts will occur from the application of chemicals within watersheds containing Pacific salmonids, but the impacts are unknown. The application of chemicals within these watersheds is subject to the requirements of all applicable Federal and State laws, including the requirements of section 9 of the Act.

In association with the SYP/HCP, PALCO is proposing to enter into a 5-year Streambed Alteration Agreement with CDFG pursuant to California Fish and Game Code section 1603 for certain covered activities that may substantially divert or obstruct the natural flow of or substantially change the bed, channel, or bank of any stream within the Plan area. Activities that would be covered under the 5-year Streambed Alteration Agreement include permanent road crossings over fish bearing or restorable fish bearing streams, permanent culvert road crossings on Class II and III waters, temporary crossings over fish bearing and restorable fish bearing streams, other temporary crossings, fords, water drafting, and road construction, reconstruction, and storm-proofing involving permanent and temporary crossings and fords. Covered activities that are not appropriately covered under the 5-year agreement would be addressed under separate agreements pursuant to Fish and Game Code section 1603.

Mitigation proposed under the 5-year Streambed Alteration Agreement avoids or minimizes many of the impacts of these covered activities on Pacific salmonids. Crossings on fish bearing or restorable fish bearing streams would not be installed before June 15 or after October 15, thereby restricting instream activities to the summer months, when salmonid eggs and alevins are not in the gravel. Temporary crossings must be installed after June 15 and removed before October 15. This also avoids impacts to salmonid eggs and alevins, and minimizes the possibility of blocking or hindering adult fish passage. Permanent crossings of fish bearing or restorable fish bearing streams must provide for fish passage, although the specific prescriptions are designed to provide for adult salmonid migration. There are no specific prescriptions for summertime movement of juveniles and adults, therefore some constraints to summertime movement are anticipated. Crossing designs that alter water velocity or significantly alter the channel profile are not permitted. Bare mineral soils exposed by any permitted operations must be treated. The prescription requires 100 percent of bare soil, except for within the streambed, to be treated immediately upon completion of work with a minimum of 4 inches of straw mulch and 100 pounds/acre equivalent barley seed. With this prescription, only minimal surface erosion is anticipated. Increases in turbidity are expected from any instream equipment use, but this turbidity should be localized and of short duration but they could affect the ability of fish to feed and block or delay movement of salmonids. Adults and juvenile salmonids may be disturbed and harassed by instream equipment use. Injury to these salmonids is not anticipated due to their flight reflex, but the disturbance may force them out of preferred habitats into inferior locations, where they would be more susceptible to predation and temperature-related stress. This effect is expected to localized and would last only as long as the equipment is in the water.

Impacts on salmonids could include temporary increases of turbidity, degraded or destroyed habitat, harassment of juvenile and adult salmonids, temporary or permanent blocking or hindering of salmonid movement, changes to water velocity and channel profile, and crushing or smothering of eggs and alevins. These effects are discussed in detail in the road management section of the Aquatic Effects section, above. The effects will be localized. The overall impact to the species in the action area will be minor.

LISTED SPECIES/CRITICAL HABITAT

American peregrine falcon

Direct effects

Species

Numbers and reproduction

Properly implemented conservation measures should ensure that the risk of direct adverse impacts to peregrine falcons resulting from PALCO timber operations and other covered activities is insignificant. Conservation measures are intended to detect nest sites prior to implementation of covered activities that could adversely affect these sites due to disturbance, or due to habitat modification in the immediate proximity (within 500 feet) of the eyrie. For all present and future occupied nest sites, no timber operations may occur closer than 0.5 mile during the breeding season, or within 1 mile for activities capable of introducing loud noise. Based on these considerations, the proposed action is not likely to affect the number or reproduction of peregrine falcons.

Distribution

The proposed project is not anticipated to result in significant changes to the distribution of peregrine falcons at any landscape scale. The risk of direct adverse effects to any of the known or potential nest sites is anticipated to be insignificant, as none of the covered activities are likely to result in structural changes to any of the known or potential nest sites. Surveys implemented as part of the conservation measures should identify any active nest sites prior to implementation of timber operations. Maintenance of nest sites should ensure that no significant changes to the distribution of peregrine falcons occurs at the action area or any larger scale. Based on these considerations, the proposed action is not likely to affect the distribution of peregrine falcons.

Injury or disturbance

Activities such as rock climbing; use of chain saws, explosives or aircraft; construction activities; vehicular access; and timber harvest during the nesting season can disturb nesting peregrines, resulting in the abandonment of nesting attempts or nesting sites. Activities during the non-nesting season would not result in significant adverse effects of peregrine falcons. The objective of the conservation measures for the peregrine falcon is to provide for a high probability of successful nesting of peregrine falcons. Given full implementation of these measures, activities directly associated with timber operations are likely to result in a low likelihood of significant disturbance to occupied nests. If these conservation measures are implemented during all timber operations, disturbance to occupied nest sites from these activities is likely to be an insignificant risk to the species. Therefore, based on these considerations, the proposed action is not likely to affect the peregrine falcon through injury or disturbance.

Suitable habitat

Habitat loss or modification

The foraging area for the known nest site is unknown. Based on its location near the edge of the property, it is reasonable to expect that only a portion of the foraging area is on the property. The proposed action will likely result in the harvest of forest stands within the foraging zone around existing and future peregrine falcon nest sites, although no timber harvest would be allowed within 500 feet of active nest sites to protect the integrity of those nest sites. Since peregrine falcons normally forage on prey species in flight over a variety of wetland, forest, shrubland and riparian habitats, they would not be directly affected by forest stand structure or seral stage. However, peregrines are likely to be adversely affected due to changes in prey abundance and availability immediately following timber harvest within foraging range of occupied nest sites. Prey species abundance and composition is likely to be substantially changed as late-successional forests are clearcut, resulting in landscape patches with sparse vegetation prior to reestablishment of forest stands and associated early seral vegetation. As early seral vegetation is reestablished, and plant abundance and species diversity increases, corresponding abundance and diversity of prey species is likely to once again increase to levels similar to those of late-successional stands, albeit with a new prey species composition (see also indirect effects, below). Thus, to the extent that the foraging area includes the property, the peregrine falcon is likely to suffer adverse effects associated with changes to prey species abundance and availability as a direct result of timber operations within foraging range of present and future nest sites.

Indirect effects

Although peregrine falcons are not dependent upon prey species directly associated with late-successional and/or old-growth forest habitat, and, in this location, may be deriving prey from other habitat types off the property, the overall prey base (and their relative availability) may change with changes to the seral stage distribution of forests within foraging range of eyries. Both early seral forest habitats and late-seral/old-growth forest habitats are generally acknowledged to provide higher numbers of vertebrate fauna, including avian prey species, than do mid-seral forest stands. As forest seral stage changes from early seral (through regrowth of young stands) and late-seral (through timber harvest and other means, and subsequent regrowth) to mid-seral conditions, prey biomass and prey species diversity are likely to decrease. Prey availability may also change. As a result, to the extent that the foraging area includes the property, peregrines may suffer adverse effects due to changes in prey abundance and availability as intensively managed forest stands change from relatively more diverse late-seral and early seral stages to more uniform and biologically simpler mid-seral conditions.

The HCP/SYP does not provide for future road access management or other restrictions on human intrusion into the 0.5 mile zone around occupied nest sites that may be expected to occur as a result of other activities during the 50 year life of this plan, including but not limited to vehicular access. These types of activities, especially early in the nesting period, have the potential to adversely affect nesting peregrines through disturbance at the nest site. The likelihood of nesting peregrines abandoning the nesting attempt, or even the nest site altogether, increases with the number and intensity of disturbance events. However, the known site is not directly exposed to forest roads and the terrain is not favorable for road construction. Even so, it is possible that the proposed action may adversely affect peregrine falcons due to future disturbance from noise above ambient levels and human presence associated with a variety of activities.

Northern spotted owl
Direct effects
Species
Numbers
The proposed action could affect the numbers of spotted owls both on PALCO lands and the action area outside of the PALCO lands through two primary mechanisms: modification of habitat within owl home ranges by timber harvest and related activities, and disturbance of reproductive efforts by such activities within proximity to activity centers. The most immediate effect of either of these mechanisms would be expected to occur as a lowered reproductive rate, and later, as a reduced rate of juvenile and adult survival, or increased emigration. The net result would be a lower population size on the property and the action area. As described in more detail below, at least 108 activity centers would be maintained at all times throughout the permit period (50 years); this would allow a reduction of approximately 31 percent from the existing population level of 156 activity centers. The proposed action would result in changes in the number of activity centers found in the action area outside of the PALCO lands only if there are substantial effects on portions of home ranges that extend onto PALCO lands. The degree of this effect is unknown. Even at the minimum level provided by the HCP, the remaining owl population on PALCO's property would exceed the goal of 60 pairs established for the entire southern Humboldt - northern Mendocino area by the northern spotted owl Recovery Team in the draft Recovery Plan (USDI 1992).

The FWS believes that the goals established by the draft Recovery Plan for non-Federal lands are still valid, although the Northwest Forest Plan now guides management of Federal forest lands. The Northwest Forest Plan provides for more protected owl sites on Federal lands than were contemplated under the draft Recovery Plan. The Northwest Forest Plan did not make recommendations for non-federal lands, but because the level of protection is now higher on Federal lands, and densities are high on non-Federal lands in the Coast Province, the FWS believes that the Recovery Plan standard is still adequately protective for this region.

At a wider perspective, the FWS recognizes that the impacts of actions approved elsewhere in the range should be evaluated to determine whether they might alter the Service's conclusions about the recovery needs for the NSO in the Coast Province stated in the draft Recovery Plan. All federal actions covered by the Northwest Forest Plan have been subject to consultation under Section 7 of the Act, and the FWS has not discovered impacts on NSO populations that were not contemplated under the Northwest Forest Plan. The so-called "318 sales", which removed habitat in areas not planned for harvest under the Northwest Forest Plan, did not occur in California and had relatively insignificant impacts on northern spotted habitat (USDI Fish and Wildlife Service et al. 1997). In addition, ten HCPs affecting the northern spotted owl have been completed since 1992. Two HCPs in California cover 380,500 acres of nonfederal lands and allow incidental take of 52 spotted owl sites. Three Oregon HCPs cover 302,106 acres and allow incidental take of 36 spotted owl pairs and spotted owls associated with 22,000 acres of nesting, roosting and foraging habitat. In Washington, five HCPs covering about 1.83 million acres allow incidental take of 251 owl pairs, juveniles, and/or territorial singles. All of these plans have been completed with a view toward meeting the local needs of the species within the context of management on Federal lands, and have also been subject to consultation under the Act. Their effects have been incorporated into the range-wide baseline for the species that is considered in this biological opinion. The consideration of the status of the baseline does not alter our conclusion regarding the continuing validity of the Recovery Team's assessment. Therefore, the FWS believes that the recommendations of the Recovery Team contained in the draft recovery plan for non-Federal lands in coastal California are still valid.

Distribution

Northern spotted owl activity centers would remain generally distributed throughout PALCO lands. Some current gaps would continue to exist in the distribution of northern spotted owl activity centers on a watershed basis. Future gaps in the distribution of activity centers would not be considered significant because dispersal conditions and total numbers of activity centers on PALCO lands would still allow movements and interaction between occupied sites. The retention of an adequate distribution of activity centers would benefit the northern spotted owl by enhancing interaction with owls on PALCO lands and in the action area.

Reproduction

An objective of the SYP/HCP's spotted owl conservation plan is to maintain an average reproductive rate of at least 0.61 fledged young per pair. The target rate represents the average observed on PALCO lands during the period 1994 to 1998, under complete no-take protections. Therefore, the reproduction rate is not expected to differ from that previously observed. This rate is slightly lower than that observed on neighboring lands (Franklin 1998a, Simpson Timber Company 1998). The total number of young produced on the property is expected to decline in proportion to the decline in the overall population level discussed below. Spotted owl reproduction (i.e., number of young per nesting pair) will be monitored and a Scientific Review Panel, in conjunction with the FWS and CDFG, will review potential reasons for failure to achieve the objective, then develop and implement corrective measures. Additional demographic data would be needed to determine the influence of the proposed action on the intrinsic rate of population growth or decline (i.e., lambda); however, maintenance of a sufficient population size and reproductive rate may indicate adequate performance of the population.

Injury or disturbance

In previous consultations conducted by the FWS, human presence and activity within 0.25 mile (1,320 feet) of known or suspected activity centers was assumed to adversely affect behavioral patterns of the northern spotted owl during the breeding season (February 1 to July 31, as defined by the FWS). Noise exceeding ambient levels was assumed to adversely impair essential behavioral patterns, including breeding, feeding, or sheltering (i.e., disturbance). Timber felling within 0.25 mile of activity centers has been assumed as having the likelihood of injuring or killing individuals. However, field experience has indicated that in many cases, breeding has been successful under conditions that do not comply with these assumptions, especially where the potentially disturbing effect is relatively minor, or where owls are acclimated to activity.

The SYP/HCP's spotted owl conservation plan addresses the potential for injury or disturbance by requiring completion of three-visit surveys of all timber harvest operations to determine the presence and status of spotted owls within 1,000 feet of all timber harvest units; and precluding timber harvesting between March 1 and August 31 within 1,000 feet of all activity centers where breeding activities are underway. The FWS believes that these measures are likely to effectively minimize disturbance in most cases. Disturbance could still result if surveys fail to detect owls that are actually breeding in proximity to activities, or if the 1,000 foot distance is not sufficiently protective for certain individual owls, or if owls initiate breeding prior to March 1 (which is unlikely based on local experience). Thus, an undeterminable number of spotted owls may be subject to disturbance, injury, or death as a result of the proposed action, but the overall effect on breeding owls is expected to be reduced.

At activity centers that are not subject to Level One or Level Two protection, and where breeding activities are not underway, timber harvest could occur. This would be expected to disturb and displace the adult owls inhabiting the site, but not result in direct injury, since the adults are capable of leaving the site. Based on experience under the Simpson HCP, some of these displaced owls may establish nearby breeding territories in subsequent years, while others may become reproductively inactive (Simpson Timber Company 1997).

Suitable habitat

Habitat protection

Effects on habitat are evaluated at the landscape scale and at the scale of individual activity centers. Habitat important for northern spotted owls in the action area consists of both early seral forests that produce quantities of dusky-footed woodrats (the owls' primary prey), and old-growth, late-seral, and mid-seral forests that provide the owls cover for breeding, roosting and foraging. With the exception of old-growth, most owl habitat stages will be provided on a rotation basis as young stands develop from the forage-production stage to older stages providing cover requirements, and are eventually harvested and returned to early stages. Protected old-growth stands and RMZ stands will provide foraging habitat on a permanent basis. Although the RMZs may be too narrow to provide good nesting habitat during periods when they are bordered by new clearcuts and young forest stages, they should provide nesting habitat while they are bordered by mid- and late-seral stages.

At the landscape level, the proposed timber harvest will continually create the early seral stages that provide owl prey. The amount of early seral forest on the property is expected to vary from 43,021 acres at year 0 to 58,066 acres at year 50 (USDI Fish and Wildlife Service and California Department of Forestry and Fire Protection 1999, table 3.9-1, page 3.9-2). Insufficient information is available to evaluate the occurrence of this habitat element around individual activity centers, but it is assumed that the dispersion of young stands will be adequate to provide a source of prey species for owl activity centers throughout the ownership.

Because older timber stands that provide the best quality nesting habitat are also the focus of harvest activity, their protection, regeneration and maintenance are of elevated concern. At the landscape scale, several conclusions may be derived. About 9,000 acres of high quality uncut old-growth and residual old-growth owl breeding habitat will be provided in the Headwaters acquisition and in the MMCAs. The proposed action would provide for a total of 177,173 acres of suitable habitat on PALCO lands at the end of 50 years, an increase of 6,769 acres compared to current levels (table 51).

Table 51. Projected acres of suitable northern spotted owl habitat on PALCO lands over 50 years (data from PALCO 1999).

	Decade						Net
Habitat type	0	1	2	3	4	5	change
High quality nesting	58,783	37,688	25,129	23,737	28,850	37,098	-21,685
Medium quality nesting	35,223	29,249	50,732	62,283	64,427	73,716	38,493
Low quality nesting	537	1,114	117	19	19	28	-509
Roosting	40,302	45,721	36,540	28,238	31,740	19,365	-20,937
Foraging	35,558	53,540	53,728	60,836	47,471	46,966	11,408
Total:	170,404	167,313	166,247	175,112	172,506	177,173	6,769

Depending on the outcome of watershed analysis and establishment of RMZ prescriptions, between 3,695 acres and 21,304 acres (refer to tables 34 and 35 in the **Effects Common to Species Associated with Late-Seral Habitat**) of potential breeding habitat will exist in RMZs. This estimate assumes all stands in RMZs will become suitable within 50 years. The quality of this habitat may be limited by the lack of interior forest and high amount of edge while surrounding stands are in lower seral stages. RMZs located next to substantial blocks of suitable habitat may better contribute to the habitat needs of the spotted owl, especially breeding.

At the level of activity centers, a substantial amount of suitable habitat would be provided around the 80 activity centers, based on Level One protection measures. Estimates of habitat protected in the vicinity of activity centers are imprecise because of an unknown degree of overlap in home ranges of neighboring owls and overlap between locations of activity with various land allocations such as MMCAs and RMZs. (For example, if activity centers share overlapping habitat at a factor of 50 percent, the amount of habitat provided under Level One would be about 53,000 acres). Projections of the amount of high quality and medium quality owl nesting habitat that will be available during various decades are presented in table 51.

Habitat removal and modification

In past consultations on proposed activities that might affect the northern spotted owl, the Service has assumed that the behavioral patterns of the species may be significantly affected when the amount of "suitable" habitat is reduced below 1,336 acres within 1.3 miles and below 500 acres within 0.7 mile of the activity center. Suitable habitat is generally defined as including mature and old-growth forests. These thresholds were based on studies conducted on US Forest Service lands in the interior of northern California (e.g., Solis 1983, Sisco 1990, Paton et al. 1990). Based on home-range sizes reported in these studies, past consultations have assumed that activity centers with less than the above threshold amounts of mature and old-growth habitat are not capable of maintaining northern spotted owls over the long-term.

This biological opinion for the SYP/HCP will also use these thresholds as an indicator of possible effects. However, in the light of the observed high densities of northern spotted owls on the PALCO ownership and neighboring ownerships, and because abundant prey are produced in lower seral stage stands in the coastal region, it is likely that home ranges in the coastal region are substantially smaller than those measured further inland. Therefore, the anticipation that adverse effects would occur if habitat levels are reduced below the above-stated threshold is regarded as a worst case. Although no specific data are available to determine a more realistic threshold for the coastal region, it is likely that a substantial portion of the population would persist on the property with a lower amount of forested habitat than that expressed by the above habitat threshold.

Habitat removal and modification may affect activity centers, both on the PALCO ownership and in the surrounding action area. On PALCO lands, a minimum of 80 activity centers will be retained under Level One protection, which would provide habitat in amounts equal to or greater than the above-stated habitat quantities of 1,336 acres within a 1.3 mile radius and 500 acres within a 0.7 mile radius. At all times, at least 28 more activity centers will be provided Level Two protection, which will leave at least 18 acres of nesting-quality habitat around activity centers. Monitoring and adaptive management would ensure that at least 108 activity centers are maintained on the property, with a reproductive rate equivalent to that in existence prior to the SYP/HCP. Since the existing population consists of approximately 156 activity centers, the number of activity centers on the PALCO property, and the associated owl population, could be reduced by approximately 31 percent. The decline would be greatest during the first 20 years, the peak period of timber harvest. The potential loss of these sites would have an adverse effect on the local spotted owl population, due to a decrease in the size (i.e., number of individuals) and reproductive output (i.e., total number of young produced) of the population. The remaining spotted owl population on PALCO lands, however, would still far exceed the population goal of 60 pairs for the southern Humboldt - northern Mendocino area recommended by the Northern Spotted Owl Recovery Team (USDI 1992a).

In the action area outside of the PALCO lands, an undetermined portion of the approximately 259 spotted owl activity centers in that area may be affected by modification of habitat on PALCO lands if their home range extends onto PALCO property. The potential loss of these sites would have an adverse effect on the local spotted owl population, due to a decrease in the size (i.e., number of individuals) and reproductive output (i.e., total number of young produced) of the population.

The SYP/HCP's spotted owl conservation plan addresses the retention of habitat in the vicinity of spotted owl activity centers. Habitat modification around 80 activity centers will be limited by Level One Protection measures that conform with the above threshold criteria and are assumed to be adequate to assure retention of activity centers. The remaining specified habitat retention requirements (i.e., Level Two Protection measures - 18 acres of nesting habitat around the activity center; sites other than Level One or Two Protection measures - no acres specified) will not conform with the above threshold levels. However, the requirement to maintain at least 108 activity centers with an average of 0.61 young per pair would be expected to act as a constraint to harvesting habitat down to minimum levels around activity centers, especially if monitoring results indicate that sites with low habitat levels are not performing adequately. In the worst case, habitat removal and modification could occur to a degree sufficient to reduce the population to 108 activity centers and 82 pairs -- about 69 percent of its existing level.

The proposed action, however, would result in a net gain (a benefit to the owl) of 6,769 acres of suitable habitat at the end of 50 years, an increase of 3.9 percent from the total of 170,404 acres. Habitat quality, however, would shift as follows: high quality nesting, a reduction of 37 percent; moderate quality nesting, a gain of 109 percent; low quality nesting, a loss of 95 percent; roosting, a loss of 52 percent; and foraging, a gain of 32 percent (table 51). Overall, high and moderate quality nesting habitat increases slightly (16,798 acres), compared to current levels (94,006 acres). Although the quality of nesting habitat is generally reduced from high to moderate, the net increase in nesting habitat is a benefit to the owl.

The proposed action would remove or modify the following acres of mid- and late-seral forests (including old-growth and residual Douglas-fir or redwood), by prescription category: clearcut - 18,474 acres; commercial thin - 3,232 acres; selection - 20,032 acres; shelterwood restock - 400 acres; and shelterwood seed step - 105 acres. All canopy cover classes are included in this estimate, therefore, these data may overestimate the effect. Both mid- and late-seral forests are suitable habitat for the spotted owl.

Habitat fragmentation

Fragmentation (e.g., changes in the number, size, configuration, and distance between forest stands) of suitable spotted owl habitat was not quantified for the purpose of this consultation. However, the trend in fragmentation of suitable owl habitat is likely to be similar to that of LSH, since LSH is a subset of suitable owl habitat (refer to the distribution and fragmentation discussion under **Effects common to species associated with late-seral habitat).** The fragmentation of suitable habitat is often considered an adverse effect due to the potentially increased energy required to move from one patch of suitable habitat to another and the increased edge effects (e.g., reduced interior forest conditions, increased predation, decreased microclimate). However, Franklin (1998b) found that the amount of edge between cover habitat and forage-producing early seral stages was a positive factor in owl performance.

Habitat distribution

Although the quality of suitable habitat is expected to change over time (table 51), suitable habitat would remain distributed throughout PALCO lands as a result of continuing timber harvest and growth. Throughout the 50-year permit period, forested lands in each WAA will include at least 10 percent late-seral, 5 percent mid-successional, and 5 percent young forest. Measures to maintain habitat diversity would provide for retention of snags and logs that would provide potential nesting structures and habitat for prey species distributed across the landscape.

Suitable spotted owl breeding habitat on the PALCO lands at a minimum is comprised of mid- and late-seral stages. At least 15 percent of the forested area in each watershed would occur as suitable breeding habitat throughout the permit period. The area of PALCO lands by WAA is summarized as follows (Final EIS/EIR, table 3.4-2): Humboldt Bay - 38, 985 acres; Mad River - 3,904 acres; Yager - 33,730 acres; Van Duzen - 29,934 acres; Eel - 73,862 acres; and Bear-Mattole - 30,580 acres.

Removal of special habitat components.
Refer to the discussion under **Effects common to species associated with late-seral habitat**.

Dispersal habitat condition
The spotted owl conservation plan does not directly address the retention of dispersal habitat. Measures described to conserve habitat diversity (e.g., seral stage distribution), in combination with habitats found on lands where intensive timber management would be constrained (e.g., RMZs, MMCAs, etc.), would be expected to provide dispersal habitat conditions. The proposed action would reduce the amount of dispersal habitat from 145,532 acres to 121,392 acres (based on Final EIS/EIR, table 2.6-1) at the end of 50 years, a reduction of about 17 percent. At the end of 50 years, dispersal habitat would comprise about 57 percent of the PALCO lands. The reduction in dispersal habitat would be considered an insignificant effect because more than 50 percent of the ownership would provide adequate dispersal conditions.

Indirect effects

Predation, habitat loss or modification, and injury or disturbance

Although the species is not strictly associated with LSH in coastal California, the reduction in LSH under the proposed action could indirectly affect the northern spotted owl, through increased predation, habitat loss or modification, and injury or disturbance. These effects are similar to those described for late-seral associated species. Refer to **Effects Common to Species Associated with Late-Seral Habitat** section above for further discussion on potential indirect effects on spotted owls.

In particular, concern exists regarding the presence of barred owl (*Strix varia*) populations in the action area, and the possibility that timber harvest may favor this competitor of the northern spotted owl. Barred owl populations are expanding throughout northern California (Dark et al. 1998), and the species has been located at 12 sites on the PALCO ownership (Draft SYP/HCP, Section IV, Part C, page 2). At this time, the factors that may favor this expansion are not well understood.

Bald eagle

Direct Effects

Species

Numbers, distribution, and reproduction,

The objectives of the bald eagle conservation plan are to implement nest site identification and protection measures which have a high probability of providing for successful nesting of bald eagles and to minimize disturbance of foraging bald eagles. The conservation plan addresses the following as a means for achieving the objectives: surveys to determine the presence and nesting status of bald eagles; measures to protect habitat and to limit disturbance in the vicinity of active nest trees; measures to avoid disturbance of wintering eagles; and monitoring of nest sites.

Active bald eagle nest sites are not known to occur on PALCO lands or in the action area, therefore, the proposed action would not directly affect any known active nest sites. Few nests are likely to occur on the PALCO lands in the future, based on the size of the nesting population in the action and regional areas. Proposed survey measures focus on the detection of bald eagles in THPs within 0.5 mile of Class I waters that provide potential foraging habitat (i.e., primary nesting and roosting habitat) and provides for evaluation of potential habitat in all THPs and localized searches for nests and eagles if appropriate. The bald eagle conservation plan has a high likelihood of reducing disturbance and maintaining the integrity of the nest tree and immediate area in primary nesting habitat if nest sites are detected. A small likelihood remains that nests might go undetected in timber harvesting, planning, in which case disturbance of an unknown nest could result. The rationale and significance of the these effects are discussed in the following sections.

Injury or disturbance

In past consultations, we have determined that the following activities may disrupt essential behavioral patterns of nesting eagles when within the specified distances of eagle nests: blasting within 1.0 mile; use of helicopters within 0.5 mile; and use of motorized equipment within 0.25 mile, unless the activity is line-of-sight, and then the distance is 0.5 mile. The bald eagle conservation plan contains measures that would reduce the likelihood of disturbance by helicopters either in nest surveys or in timber yarding.

In addition, the FWS has determined that the use of motorized equipment, helicopters, or aircraft within 0.25 mile of wintering areas may disrupt wintering behavior. The bald eagle conservation plan addresses measures to reduce disturbance to winter foraging eagles. These measures are likely to reduce the disturbance of eagles found perched or foraging or night roosting near Class I streams, thus meeting the conservation objective. The plan, however, does not address disturbance of wintering roosting eagles that could occur elsewhere on the PALCO lands, due to the use of motorized equipment, helicopters, or aircraft. The plan does not require surveys to detect wintering roost sites.

In summary, while the proposed action could directly affect either the number, distribution, or reproduction of nesting bald eagles, or result in disturbance of nesting or wintering eagles, the likelihood of such effects is expected to be low. The general effects of disturbance are discussed in the **Effects Common to Species Associated With Late-Seral Habitat**. An undetermined number of nesting eagles and at least 11 wintering eagles may be affected at a low level of likelihood. Any reduction in the number, distribution, and reproduction of bald eagles would be considered an adverse effect, but because the number of eagles using the property are a very small fraction of the nesting or wintering population of the Pacific Recovery Region, these effects would not be substantial.

Suitable habitat

Habitat protection

Suitable bald eagle habitat on PALCO lands would be protected (i.e., no timber harvest) as follows: MMCAs (primary nesting/roosting - 1,654 acres; secondary nesting/roosting - 5,262 acres; and wintering - 5,788 acres), no harvest buffers of RMZs (between 3,695 acres and 21,304 acres, refer to tables 34 and 35 in the **Effects Common to Species Associated with Late-Seral Habitat**), and the Headwaters Reserve (primary nesting/roosting - 3,115 acres; secondary nesting/roosting - 3,783 acres; and wintering - 5,304 acres). The acreage estimate for RMZs assumes all acres are suitable habitat. Acreage estimates were not added because overlap between areas was not considered. An undetermined amount of suitable eagle habitat (all categories) also would be protected in areas subject to silvicultural restrictions (e.g., adjacent to protected spotted owl activity centers and mass wasting areas). The additional amount of protected habitat could not be determined for the purpose of this analysis. Protection of suitable habitat in these areas would benefit the bald eagle by providing nesting, roosting, and wintering opportunities. For a general discussion on habitat protection in the action area, refer to **Effects Common to Species Associated with Late-Seral Habitat**.

Habitat modification

The bald eagle conservation plan allows for timber management within 500 feet of an active nest, but such harvest would be limited to prescriptions that enhance long-term eagle habitat. Impacts on the loss or changes in habitat quality could not be determined for the purpose of this consultation, due to a lack of site specific information.

Although the bald eagle conservation plan provides habitat for winter foraging use in RMZs, it does not address the protection of winter roosting habitat. If roosting sites are harvested, wintering eagles may be displaced to other suitable sites on or off PALCO lands, and the quality of wintering habitat used by at least 11 eagles may be reduced. The loss of wintering habitat and displacement of wintering eagles would be considered an adverse effect, but the number of eagles using the property is a very minor portion of the Recovery Region's wintering population, so this effect would not be substantial.

Habitat removal and modification

The proposed action would remove or modify the following acres of late-seral forests (including old-growth and residual Douglas-fir or redwood), by prescription category: clearcut - 35,319 acres; commercial thin - 3,935; selection - 27,253 acres; shelterwood restock - 1,730 acres; and shelterwood seed step - 1,010 acres. Potential effects associated with this modification have been discussed in previous sections.

Suitable bald eagle nesting habitat (all habitat categories combined) would decline from 69,231 acres to 39,940 acres over the permit period (Refer to table 36 in the **Effects Common To Species Associated With Late-Seral Habitat**).

Habitat distribution
Suitable bald eagle habitat is generally comprised of late-seral stages. Therefore, at least 10 percent of the forested landscape in each WAA would remain as suitable habitat throughout the permit period. The proposed action would provide for at least 20,598 acres of suitable habitat, distributed as follows by WAA (based on Final EIS/EIR, table 3.4-2): Humboldt Bay – 3,898 acres; Mad River – 390 acres; Yager – 3,373 acres; Van Duzen – 2,493 acres; Eel – 7386 acres; and Bear-Mattole – 3,058 acres.

Habitat fragmentation
Refer to the discussion under **Effects Common to Species Associated with Late-Seral Habitat**.

Removal of special habitat components
Outside riparian management zones and nest protection areas, timber harvest could reduce the quantity and quality of special habitat components such as snags which eagles may use for roosting or perching. The number of these components likely to be removed cannot be quantified. The retention requirements for snags, as previously described in the description of the proposed action, may minimize the impact of the action depending on the height of snags retained. Taller snags would benefit the eagle the most. The significance of the loss of special habitat components depends on their location relative to nesting, roosting, perching, and feeding areas. If these components are used by eagles or are located next to bald eagle nest, roost, perch, or feeding sites, their loss may be an adverse effect, but since such features would be protected in primary use areas, the effects are expected to be minimal.

Indirect effects
<u>Injury, disturbance, habitat loss or modification</u>
Refer to **Effects Common to Species Associated with Late-Seral Habitat** for potential indirect effects on bald eagles.

Implementation of the aquatic species conservation plan may increase the prey base (e.g., fish) of nesting or wintering eagles, due to improved riparian conditions. The extent to which bald eagles will respond to improved aquatic conditions is unknown at this time. Any increase in the number of nesting or wintering eagles detected during future survey and monitoring efforts and attributed to increased prey base on PALCO lands would be considered a beneficial effect.

<u>Marbled murrelet</u>

For the purposes of this analysis, the proposed action is the granting of a section 10 permit to PALCO and the permanent acquisition of the Headwaters and associated stands. Therefore, the following analysis of effects on the murrelet includes consideration of the harvest proposed in the SYP/HCP as well as the permanent set aside of acquired areas and the conservation of other PALCO lands for the SYP/HCP permit period.

The primary adverse impact to the murrelet will be through loss of nesting habitat in the first 10 years of the permit period, and there could be some direct mortality of murrelets if timber harvest occurs in nesting habitat during the nesting season; these impacts are described below. Direct and indirect effects to murrelets and suitable murrelet habitat were measured first, which were then applied to estimating the short term and long term adverse and beneficial impacts on the species' numbers, distribution, and reproduction.

The short-term loss of nesting habitat will likely have the most significant adverse effect on the murrelet, while the long-term development and maintenance of additional high quality habitat in large contiguous reserve areas should provide benefits to the species. The FWS took the following steps to evaluate these various effects:

1. Using information provided in the Environmental Baseline, quantify the respective area of suitable murrelet nesting habitat that will be either removed through harvest or protected in the acquired Headwater stand and SYP/HCP reserves.

2. Divide this harvested or protected suitable murrelet habitat into relevant habitat types: UOG, ROG, and DFOG.

3. Assess the relative value of these three habitat types to the marbled murrelet, and quantify the amount of habitat protected and removed within each habitat type.

4. Enumerate and assess the adverse effects of the proposed harvest on the species.

5. Enumerate and assess the long term beneficial effects of the SYP/HCP and the permanent acquisition of the Headwaters stand.

6. Summarize, quantify, and assess the relative adverse and beneficial impacts of the proposed action on the survival and recovery of the marbled murrelet.

Direct and Indirect effects

Suitable Habitat

Habitat Protected and Removed

Based on the updated data provided to the FWS (appendix A, T. Reid, pers. comm., January11, 1999) and some recent revisions from PALCO (S. Chinnici, pers. comm., January 19 and January 25, 1999) that have been confirmed by the FWS, the proposed action will result in the protection of 9,056 acres of suitable nesting habitat and will release for harvest approximately 15,213 acres (table 52)[1]. The protected habitat will be preserved permanently in the Headwaters acquisition area, or in MMCAs for the life of the permit. These acreage figures include all confirmed or potential suitable murrelet habitat, including 8,519 acres of low quality and mostly unoccupied Douglas-fir habitat. Table 53 presents data on redwood forest types only; of the 15,749 acres of suitable murrelet habitat in redwood forests, 6,909 acres (44 percent) is proposed for harvest and 8,840 acres will not be harvested (66 percent). The majority of this harvested habitat, assuming it is not protected in riparian reserves or otherwise restricted, is expected to be removed within the first 5 to 0 years of the permit period, which would have an immediate adverse effect on the species.

It is important to note that the above estimate of harvest of murrelet habitat, and several similar analyses in following sections, did not deduct the habitat acreage that would be released from harvest restrictions related to murrelets, but would remain encumbered by riparian and other restrictions. These acreages were not available until late in the completion of this biological opinion, and are not accounted for in most data tables in the following sections of this opinion. (They are, however, mentioned in footnotes where appropriate). This general reduction in effect of harvest is summarized here and should be borne in mind in consideration of analyses that follow. Approximately 4,775 acres of old-growth forest (UOG (159 acres), ROG (2,387 acres), and DFOG (2,229 acres)) released from murrelet restrictions (i.e., included within the 15,213 acres included in the total "harvest" estimates for this opinion) will not be harvested or will be only partially harvested, because it is protected under the aquatic conservation strategy. Although some of this reserved habitat may continue to harbor murrelets after adjoining areas are harvested, the FWS considers it adversely affected because of impacts due to stand fragmentation, increases in edge, and stand size reduction. These retained old-growth riparian areas may have future value to the murrelet if adjoining second growth stands are allowed to grow to a size class where they can buffer these older trees and provide some interior forest conditions.

The proposed action will result in the removal of known occupied nesting habitat, unsurveyed potential nesting habitat, and surveyed but unoccupied suitable nesting habitat for the marbled murrelet. Estimates of habitat removed and protected is organized by habitat type and murrelet occupancy status and is presented in table 54.

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[1] This estimate assumes the Grizzly Creek complex is not harvested, per the description in the ITP of this biological opinion.

Table 52. Potentially suitable murrelet habitat proposed for protection (i.e., MMCAs and Headwaters) and potential harvest. Totals include all potentially suitable murrelet habitat in redwood old-growth and Douglas-fir forests: known occupied, known unoccupied, and unsurveyed but potentially suitable murrelet habitat.

Habitat Type	Harvest	Protect	Total Acres
Unentered Old-growth Redwood (UOG)	446	4,693	5,139
Residual Old-growth Redwood (ROG)	6,463	4,147	10,610
Old-growth Douglas-fir (DFOG)	8,304	216	8,520
Total Acres	15,213*	9,056	24,269

* NOTE: This estimate of total harvested acres does not correct for the approximately 4,775 acres of unentered old-growth and residual forest within riparian areas (RMZs) but outside of reserves that will be protected from harvest to varying degrees (O. Rand, pers. comm., GIS biologist, Foster Wheeler, February 4, 1999). Approximately 159 acres of UOG, 2,387 acres of ROG, and 2,229 acres of DFOG are in riparian reserves. Total unencumbered harvest is 10,438 acres of old-growth and residual.

Table 53. Potentially suitable murrelet habitat on Pacific Lumber lands proposed for protection (i.e., MMCAs and Headwaters) and potential harvest. Totals include all potentially suitable murrelet habitat in redwood old-growth forests: known occupied, known unoccupied, and unsurveyed but potentially suitable murrelet habitat. Updated source data from Appendix 1 and S. Chinnici, (pers. comm., January 25, 1999).

Habitat Type	Harvest	Protect	Total Acres
Unentered Old-growth Redwood (UOG)	446	4,693	5,139
Residual Old-growth Redwood (ROG)	6,463	4,147	10,610
Total Acres	6909*	8,840	15,749

* NOTE: This estimate of total harvested acres does not correct for the approximately 159 acres of UOG and 2,387 acres of ROG within riparian areas (RMZs) but outside of reserves (MMCAs) that will be protected from harvest to varying degrees (O. Rand, pers. comm., GIS biologist, Foster Wheeler, February 4, 1999). Total unencumbered harvest in UOG is 287 acres and in ROG is 4,076 acres. Assumes protection of Grizzly complex.

Table 54. Acreage estimates of unoccupied, occupied, and potential but unsurveyed murrelet suitable habitat on Pacific Lumber lands proposed for harvest or protection (i.e., MMCAs and Headwaters), respectively. Data from Final EIS/EIR, Appendix N2, tables 3A, 5A, and Appendix 1 (as updated by S. Chinnici, pers. comm., January 25, 1999). Adjustments of 1 to 2 percent were made to some figures to reconcile slightly different estimates from the various tables.

Habitat Type	MM Occupancy Status	Harvest	No Harvest
Unentered Old-Growth Redwood (UOG; 5,139 ac.)	Occupied[1]	446[2]	4,693[2]
Residual Old-Growth Redwood (ROG; 10,610 ac.)	Occupied	1,767[4]	3,750[3]
	Unsurveyed	4,320[5]	397
	Unoccupied	376[5]	0
	Subtotal	6,463[6]	4,147[7]
Old-Growth Douglas-fir (DFOG; 8,519 ac.)[8]	Occupied	9	181
	Unsurveyed	4,563	0
	Unoccupied	3,731	35
	Subtotal	8,303	216
TOTAL ACRES	24,268	15,212[9]	9,056

[1] All UOG is presumed occupied.

[2] Appendix -1

[3] Table 5A : 5517-2083+316 (December Extension, Appendix -1) = 3,750 occupied

[4] Table 5A: 5517-3750[2]=1767

[5] Table 5A:6533 - 1837 (unsuitable per S. Chinnici, January 25, 1999)- 376 (unoccupied per S. Chinnici, January 25, 1999) = 4334

[6] Appendix -1: 8300 (residual) - 1837 (unsuitable per S. Chinnici, January 25, 1999)

[7] Appendix -1

[8] Table 5A and P. Detrich, January 2, 1999

[9] NOTE: This estimate of total harvested acres does not correct for the approximately 4,775 acres of unentered old-growth and residual forest within riparian management areas (RMZs) but outside of reserves that will be protected from harvest to varying degrees (O. Rand, pers. comm., February 4, 1999). Total unencumbered harvest is about 10,438 acres of old-growth and residual.

Estimate of Confirmed and Likely Occupied Habitat Harvested

Using data from the above tables and the occupancy rates from the Environmental Baseline, the Service calculates that approximately 446 acres of occupied UOG, 4013 acres of occupied ROG, and 228 acres of occupied DFOG habitat will be harvested under the proposed SYP/HCP (table 55). Most of the highest quality occupied habitat will be conserved in a permanent Headwaters reserve or MMCAs: 91 percent of the occupied unentered old-growth redwood, and 50 percent of the known and likely occupied residual redwood.

Table 55. Combined acreage estimate of confirmed and likely occupied murrelet habitat proposed for harvest and no harvest. Acres as a percentage of the total amount within each habitat type are displayed in parentheses. Occupancy rates from Environmental Baseline were used to calculate likely occupied acres in ROG and DFOG.

Habitat Type	Harvest	No Harvest
UOG	446[1] (8.7 %)	4,693[1] (91.3%)
ROG[2]	4,013[3] (50%)	3,956[4] (50%)
DFOG	237[5] (57%)	181 (43%)
Total Occupied Acres	4,696[6] (35%)	8,830 (65%)

[1] No occupancy rate applied. All UOG assumed occupied.

[2] Unknown how much of this ROG is >15 OG trees/ac and where it occurs. Assumed 95-100% unsurveyed residual is <15 OG trees/ac. and used 0.52 occupancy rate for both harvest and no harvest. Therefore, the total estimated here is 31 acres less than the total estimated in table 28, Environmental Baseline.

[3] $1767 + 4320(0.52) = 4013$

[4] $3750 + 397(0.52) = 3956$

[5] $9 + 4563(0.05) = 237$

[6] NOTE: This estimate of total harvested acres does not correct for the 159 acres of likely occupied UOG, 1,241 acres of likely occupied ROG, and 111 acres of likely occupied DFOG within riparian management areas (RMZs) but outside of reserves that will be protected from harvest to varying degrees (O. Rand, pers. comm., February 4, 1999). Therefore, approximately 3,185 acres of potentially occupied murrelet habitat will be released for unencumbered harvest.

Relative Habitat Quality Between Harvested and Protected Areas

The quality of murrelet nesting habitat varies across PALCO lands and within and between the three major habitat types (see discussion in Environmental Baseline). A goal of this SYP/HCP is to direct harvest away from the highest quality murrelet nesting habitat and -- to the greatest possible extent -- harvest the habitat of the lowest value to the species. This approach, which is consistent with other HCPs involving marbled murrelets (see, e.g., the Elliott State Forest HCP in Oregon and the WDNR HCP), is expected to reduce potential take and adverse impacts. To evaluate whether the SYP/HCP is successful in meeting this goal, the Service measured the respective amounts and relative quality of murrelet habitat that would be released from murrelet restrictions or protected within MMCAs and the acquired Headwaters reserve.

The Environmental Baseline section presented background information on various habitat quality measures. The following analysis provides information on how much habitat in the various quality categories would be harvested or protected, respectively.

Occupied Habitat Harvested: The proposed action will allow harvest 35 percent and protect 65 percent of the known or likely occupied murrelet habitat on PALCO lands (including the Headwaters acquisition area). Approximately 91 percent of all occupied UOG, 50 percent of known or likely occupied ROG, and 43 percent of known or likely occupied DFOG on the ownership will be protected. Of the total amount of occupied habitat protected, 53 percent is UOG and is likely to be the highest quality habitat with the greatest density of nesting platforms and the highest rates of reproductive success (Swartzman et al. 1997).

The Environmental Baseline describes using occupancy data to assess relative habitat quality between different habitat types. Occupancy determinations may be made at different rates for different habitat types, suggesting that these habitats are preferred or utilized by murrelets at different rates. UOG is occupied by murrelets at a substantially higher rate than all other habitat types, and both types of ROG redwood are occupied at greater rates than the DFOG. All other stand characteristics being equal (e.g., stand size, shape, and degree of fragmentation), and assuming that murrelets are preferentially selecting certain stands to nest in (and exhibit occupied behaviors) and are avoiding less desirable habitats, it is reasonable to conclude that UOG is likely the more preferred habitat and is of relatively greater value to the species. This conclusion is consistent with the general hypothesis and supporting research suggesting that stands with more old-growth trees provide more nesting opportunities and better cover from predators and adverse weather (Ralph et al. 1995, page 7).

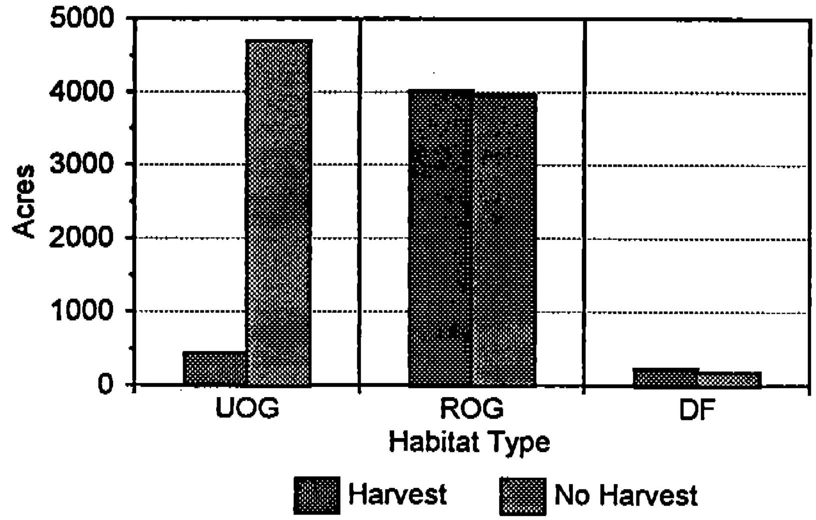

Figure 2. Respective amounts of known or likely occupied habitat acres proposed for harvest or protected within the UOG, ROG, and DF (i.e., DFOG) habitat types.

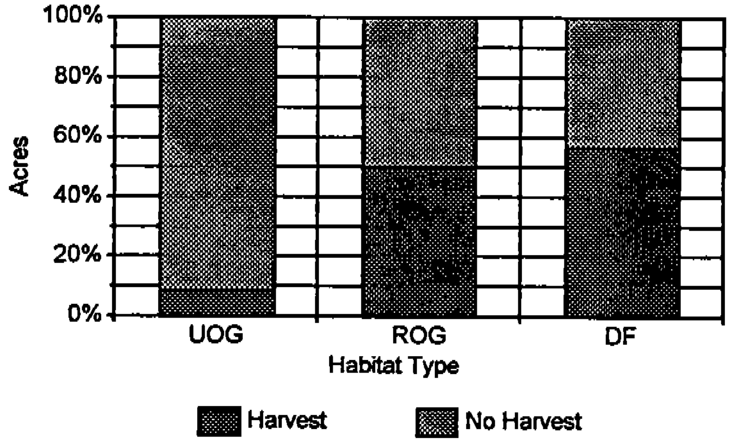

Figure 3. Respective percentages of known or likely occupied habitat acres proposed for harvest or protected within the UOG, ROG, and DF (i.e., DFOG) habitat types.

As figure 2 and figure 3 indicate, the FWS believes that the proposed action does an adequate job protecting known or likely occupied murrelet habitat, and — as measured by occupancy rates — it does a reasonable job of directing the harvest of occupied habitat away from the highest quality UOG and towards the lower quality ROG and DFOG habitat types.

Due to the low occupancy rates for the DFOG type described above, the data suggest that this habitat type is used by murrelets at very low levels. This observation is consistent with observations of Douglas-fir suitable habitat elsewhere in portions of California (Hunter et al. 1998), and known nest sites in California have a higher percentage of redwood trees than Douglas-fir even though some nests in these stands were in Douglas-fir trees (Hamer and Nelson 1995, page 75; Swartzman et al. 1997). Therefore, the FWS concludes that the DFOG habitat type has limited value to the murrelet on PALCO lands, and the following discussion of other habitat quality indicators focuses on UOG and ROG redwood types only.

Other measures of potential habitat quality are described below. Some of these measures may be directly correlated with occupancy rates, such as volume and canopy closure, but they also provide the potential to assess relative habitat quality within a given habitat type and evaluate where harvest and protection will occur.

Volume and stem density as an indicator of habitat quality: Timber volume density on PALCO lands (expressed in thousands of board feet per acre, or mbf per acre) is detailed in the Final EIS/EIR (Appendix N2, table 1.B, as updated by T. Reid). About 90 percent of the UOG stands exceed 100 mbf per acre, and 50 percent exceed 150 mbf per acre. In contrast, about 28 percent of the acres of ROG stands contain less than 25 mbf per acre, about 68 percent contain between 25 and 50 mbf per acre, and about 4 percent contain more than 50 mbf per acre (see figure 6, Appendix N2, Final EIS/EIR). Figure 4 illustrates the number of acres in six volume categories that are proposed for either harvest or protection, while figure 5 represents these data as a percentage of the total within each volume class. Both of these figures show that the majority of the acreage proposed for harvest occurs in the areas with the lowest volume density.

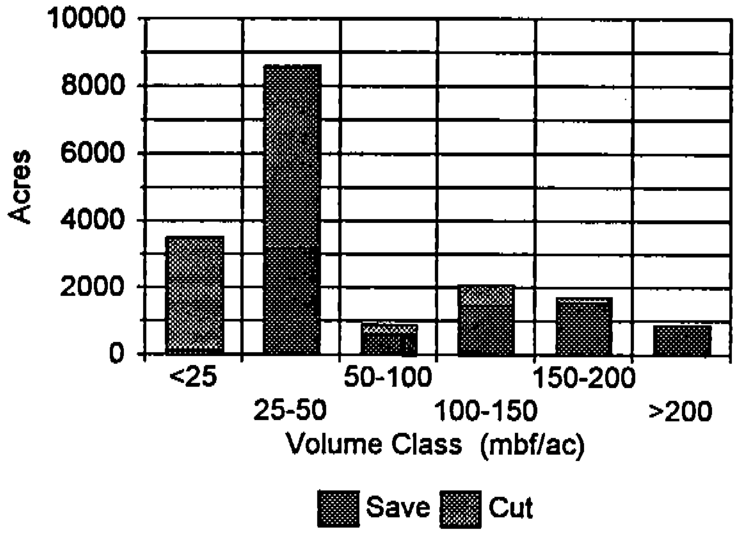

Figure 4. Acres of the suitable redwood old-growth habitat within each volume class (mbf/ac) proposed for harvest or conservation, respectively.

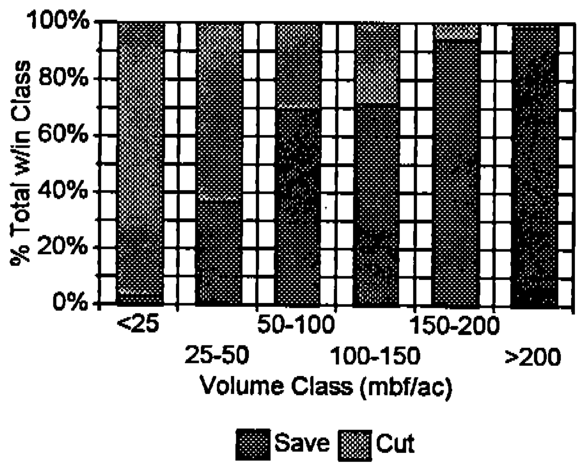

Figure 5. Percentage of the suitable redwood old-growth habitat within each volume class proposed for harvest or conservation, respectively.

The proposed action will preserve acres with large amounts of volume and focuses harvest in acreage that has relatively low volume density. Assuming that per acre volume and large trees per acre are positively correlated with nest platform density, this approach would conserve the areas with the most nesting opportunities for murrelets and the areas likely to have the highest density of breeding murrelets and the highest relative nest success (Swartzman et al. 1997, page13).

According to PALCO, the harvest methods that resulted in today's ROG stands removed the largest trees with the most timber volume, and left smaller trees with more likelihood of future growth. The smaller trees left unharvested (which are often large trees by most standards) sometimes have fewer of the large limbs and deformities that murrelets use for nesting (see notes from SYP/HCP Scientific Panel May 26 and 27, 1998; in Volume IV, Part B, Section 7, in Draft SYP/HCP, although no quantitative data were provided to the FWS on this issue). Thus, with fewer trees per acre and fewer nest structures per tree, ROG stands probably have fewer nesting opportunities than UOG stands (S. K. Nelson, pers. comm., November 12, 1998). There may be some site specific exceptions to this conclusion (i.e., some low volume stands may have some individual trees with many platforms, while some high volume stands may have some large trees with low numbers of nest platforms), but as a general rule the FWS believes that the high volume acres likely contain significantly higher quality murrelet habitat.

Canopy closure and second growth subcanopy in harvested and conserved stands: Using data provided on ROG in table N.1-3 of Appendix N1 of the Final EIS/EIR, as updated by T. Reid (pers. comm., February 5, 1998), figure 6 illustrates how much ROG and UOG habitat will be either harvested or protected in six different categories of canopy closure and height of second-growth. Canopy closure and height of second-growth were each divided into three relative categories of low (L), medium (M), and high (H). These ratings were combined for the two measures and were applied to harvest or protected areas.

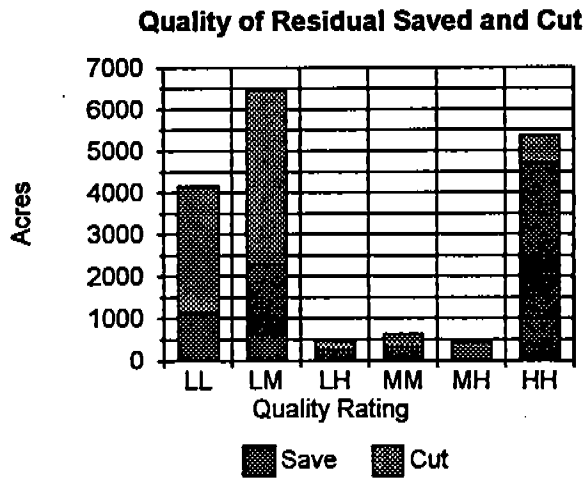

Figure 6. ROG and UOG habitat acres that will be either harvested or protected in six relative categories of canopy closure and height of second-growth, with these two measures combined as done in table N1-3 of the Final EIS/EIR. L = low quality, M = medium quality, H = high quality. (Data from T. Reid, table 7E, February 5, 1999).

The most important conclusion from this figure is that most of the area proposed for harvest is from areas with relatively low or moderate vertical cover (i.e., second-growth height) and canopy closure, while most habitat reserved has high canopy closure and vertical cover. However, the figure indicates that about 1,000 acres of ROG or UOG with moderate or high canopy closure and vertical cover that will be harvested; these areas are good quality murrelet habitat, and their removal will adversely affecting nesting murrelets.

The FWS concludes the proposed action would succeed reasonably well in focusing harvest in the ROG stands with lower canopy closure, while conserving the most UOG and some ROG areas that have the highest canopy closure and some of the tallest understory trees (see also Marbled Murrelet Recovery Team, November 30, 1998). Although the direct relationship between canopy closure and nest success is not yet known, these conserved areas with greater canopy closure are likely to have greater nest success than areas with lower canopy closure due to reduced predation and greater protection from adverse weather (Swartzman et al. 1997, page 14; Hamer 1995, page 174; Hamer and Nelson 1995, page 80; Nelson and Hamer 1995b, pages 91 and 96). It is expected that most of these second-growth trees will grow tall enough during the permit period to enhance the value of remaining old-growth redwoods and increase murrelet nest success within these stands (see Appendix 1). The condition of second-growth within residual stands is important where residual stands are found near occupied old-growth stands because the old-growth stands could provide the source of murrelets for re-occupation of the improving residual habitat (Divoky and Horton 1995, Swartzman et al. 1997, page 52). Residual stands with well-developed second-growth that neighbor old-growth stands offer the highest available potential for habitat improvement within the life of the SYP/HCP (Marbled Murrelet Recovery Team, November 30, 1998). Therefore, in evaluating potential future habitat, the agencies regard residual stands near occupied old-growth as more valuable than residual stands that are isolated from old-growth stands.

Relative stand size between harvested and conserved areas: Landscape analysis conducted by the FWS found there are 427 identifiable old-growth stands on PALCO lands (including the Headwaters acquisition area). Almost 50 percent are less than 5 acres in size, and about 88 percent are less than 50 acres in size. Thirteen stands are greater than 300 acres, with nine proposed for conservation and four proposed for harvest. To adequately assess if the proposed action conserves the larger and potentially higher quality stands, we compared the size and quality of the largest "named" redwood stands in the harvest and conservation categories, respectively (figures 7, 8, 9, and 10).

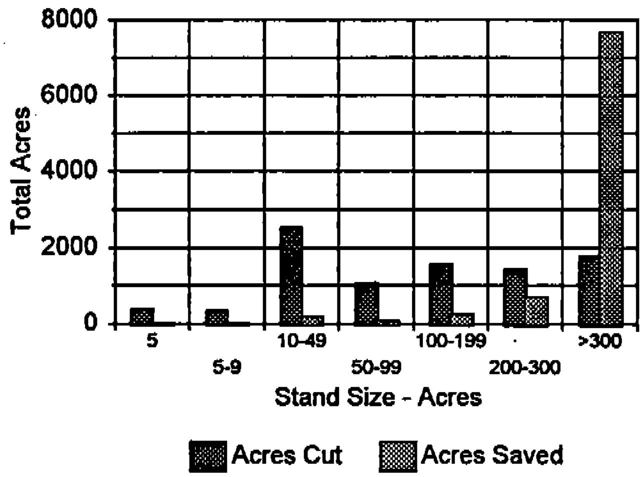

Figure 7. Acres proposed for harvest and acres conserved in stands of various sizes, UOG and ROG combined.

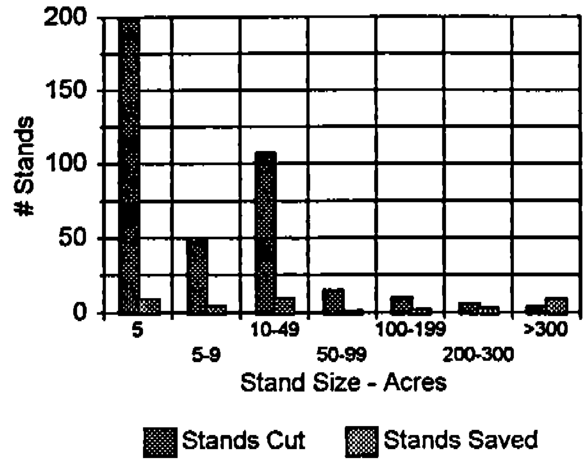

Figure 8. Total number of stands of various stand size proposed for harvest and conservation, UOG and ROG combined.

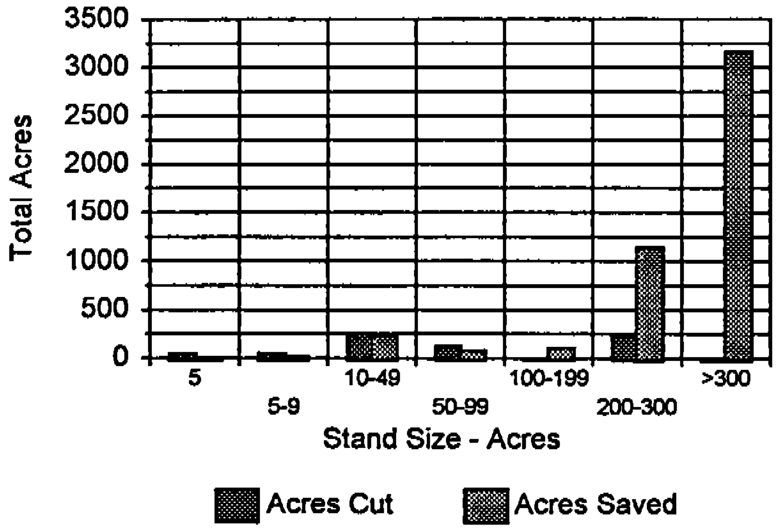

Figure 9. Acres proposed for harvest and acres conserved in stands of various sizes, UOG only.

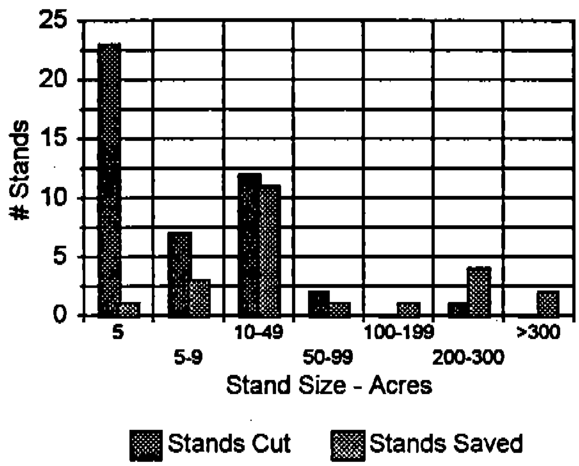

Figure 10. Total number of stands of various stand size proposed for harvest and conserved, UOG stands only.

High degrees of fragmentation and isolation from old-growth are evident in visual examination of the distribution of most of the residual stands that would be harvested (see Final EIS/EIR map at figure 3.9-2). Many of these small stands, especially the 260 stands under 10 acres in size, are likely to have little or no current value for murrelets due to high amounts of edge (assuming most are not currently adequately buffered with older second-growth).

In contrast, a few of these ROG stands are relatively large. Approximately 2,040 acres, or about 25 percent of the ROG available for harvest, are in six stands of over 200 acres each. Observations of murrelet occupied behavior have occurred in three of these stands, although the rates of occupied detections in these stands have been much lower than those observed in typical UOG (Ralph et al. 1998; see Volume IV, Part B, Section 10 in Draft SYP/HCP); these three stands are in the Grizzly Creek area, the lower Jordan Creek area, and the upper portion of the North Fork Elk River watershed (a.k.a. Turkey Foot).

At approximately 566 acres, the Turkey Foot stand is the largest contiguous ROG stand that is proposed for harvest. Aerial photography and GIS analysis indicate this stand is characterized by a fragmented, linear configuration with high amounts of edge and an open forest with low canopy closure. It also has a low volume density (approximately 30 mmbf per acre; T. Reid, pers. comm.), suggesting it has relatively low numbers of nest platforms and canopy closure when compared to UOG stands. It is the only one of the six that is within designated critical habitat.

The remaining three of the largest six ROG stands in the harvest category have not been adequately surveyed for murrelets. One is in the upper portion of the Jordan Creek drainage (412 acres); site visits to this stand have determined that it is not considered suitable murrelet nesting habitat. The second stand (205 acres) is in an isolated parcel up the Eel River over 10 miles from the remainder of the ownership, and the third is in the lower Bear Creek drainage (244 acres).

Other areas of ROG available for harvest that may have some medium or high value for murrelets include two areas of mixed stands that are contiguous with occupied residual in MMCAs. These two areas (one of about 110 acres and one of about 160 acres) are adjacent to the "Below Road 7 and 9" MMCA stands (see Map 4 in Volume IV, Part B, Section 12, in Draft SYP/HCP). In this area, unlike most other MMCAs and the Headwaters, the proposed action will place contiguous habitat outside the reserves. Murrelets have been detected in these areas without observations of occupied behavior, but the stands have not been surveyed adequately to conclude that they are unoccupied. Most of the area in these two stands proposed for harvest have canopy closures of 25 to 50 percent, which is relatively high within the ROG type. Both are within designated critical habitat. Because of their location and relatively good quality, these trees might represent the most valuable residual available for harvest and probably constitute the most significant short-term impact to the species.

The FWS concludes that the proposed action would protect most of the largest discrete stands of UOG and ROG that likely contain the best murrelet habitat, while releasing for harvest the relatively smaller stands of ROG and some small stands of UOG. Although there are a few relatively large stands that would be released for harvest (e.g., Turkey Foot), the proposed action protects the largest stands of the highest quality, especially within the UOG habitat type.

Summary of relative habitat quality between harvested and protected areas: Based on interpretations of murrelet surveys, habitat data for each of these habitat types, and the scientific literature regarding habitat quality, the FWS concludes the proposed action effectively focuses conservation in areas that are likely to have the greatest current value for marbled murrelets, while releasing for harvest a large amount of habitat that is of relatively low to moderate value to murrelets. The proposed action would be reasonably successful at protecting the highest quality habitats and much of the moderate quality habitats (Marbled Murrelet Recovery Team, November 30, 1998; P. Karieva, December 7, 1998), while targeting most (but not all) harvest to the lower quality habitats. However, some of these released ROG stands, while relatively low quality today, represent potentially valuable recovery habitat if their condition was allowed to improve over longer time periods. It is anticipated that this impact will to some extent be offset by the development of improved habitat conditions in the MMCAs and in the Headwaters acquisition area.

To summarize, UOG redwood conserved in MMCAs and in the Headwaters acquisition area likely provides more nesting opportunities and higher rates of reproductive success per acre than does the ROG habitat proposed for harvest for the following reasons:

1. Habitat types with greater occupancy rates are probably more valuable to the species than habitat types with lower occupancy rates (Ralph et al. 1995);

2. Habitat with greater volume densities likely has, on average, more nesting and hiding opportunities and higher reproductive success rates (Swartzman et al. 1997, page 13; Hamer and Nelson 1995, page 80);

3. Modified forests may have higher predator populations or predation rates than unmodified old-growth forests (Ralph et al. 1995, page 7; Nelson and Hamer 1995a, page 67);

4. Microclimate conditions and protection from adverse weather conditions are likely to be better in denser old-growth stands with greater horizontal and vertical canopy closure (Ralph et al. 1995, page 7; Hamer and Nelson 1995, page 80);

5. Larger, contiguous stands with less edge are likely to have lower rates of predation than smaller, open stands with more edge (Ralph et al. 1995, page 15; Hamer and Nelson 1995, page 80; Swartzman et al. 1997, page 18).

Adverse Effects of the Proposed Final SYP/HCP

The preceding analysis enabled (1) the quantification of suitable and occupied habitat that will be removed and conserved, and (2) an evaluation of the relative value of the habitat areas that will be removed or conserved. Using this information, this section will assess the adverse effects of the proposed timber harvest on the species. The goal of this assessment is twofold:

Describe and quantify, to the great possible extent, the actual impact of the proposed action on the murrelets in the action area; and

Analyze and determine whether these impacts would appreciably reduce the likelihood of the listed species' long term survival and recovery.

The anticipated adverse impacts of the proposed action include:

1. An overall reduction in the total amount of suitable and occupied nesting habitat on PALCO lands, with most loss occurring in the first 10 years of the SYP/HCP;

2. Displacement of direct mortality of nesting murrelets due to harvest of occupied habitat, resulting in a reduced number of breeding murrelets on PALCO lands for an indeterminate time period;

3. Indirect adverse effects to nesting murrelets due to nest disturbance, potentially resulting in some small reduction in reproductive success;

4. Indirect adverse effects to nesting murrelets due to forest fragmentation on some portions of PALCO lands, resulting in potential increases in predation and negative microclimate conditions; these impacts should be minimized or eliminated in many areas due to the buffering of reserve stands; and

5. Indirect long-term adverse effects due to the loss of suitable habitat that will not be recruited to occupied status and will not contribute to recovery.

Overview of Adverse Effects Associated with Timber Harvest: The murrelet was listed due mainly to the loss of suitable nesting habitat throughout its range in the Pacific Northwest. The effects of habitat modification activities on murrelet habitat depend upon the silvicultural prescriptions used and the location of the harvest related to suitable habitat. Impacts may include a complete loss of habitat, a degradation of habitat, or harvest of unsuitable habitat adjacent to and contiguous with suitable habitat. Removal of murrelet habitat and other harvest prescriptions that result in even-aged, monotypic forests produce unsuitable murrelet habitat; silvicultural prescriptions that promote multi-aged and multi-storied stands may in some cases retain suitability for murrelets and perhaps increase the quality of habitat over time.

Considerable evidence links the declining numbers of murrelets to the removal and degradation of available suitable nesting habitat (Ralph et al. 1995). The removal of suitable habitat likely to occur during the implementation of a proposed action can potentially adversely affect the murrelet population in several ways. These effects include:

- The immediate displacement of birds from traditional nesting areas;
- The concentration of displaced birds into smaller, fragmented areas of suitable nesting habitat that may already be occupied;
- Increased competition for suitable nest sites;
- Decreased potential for survival of remaining murrelets and offspring due to increased predation;
- Diminished reproductive success for nesting pairs;
- Diminished population due to declines in productivity and recruitment; and
- Reduction of future nesting opportunities.

Murrelets have few defenses from predation, and the ability to remain concealed is essential for successful reproduction. Continued fragmentation of habitat may result in increases in exposed forest edges and the displacement of murrelets to already-occupied habitat. The increased murrelet densities and exposure to edges in remnant nesting habitat may make birds more susceptible to predation. Predation by corvids and raptors is a known cause of murrelet nest failure. From 1974 through 1993, 57 percent of known nest failures were due to predation, with corvids suspected as the major predator (Nelson and Hamer 1995a). Corvids are typically "edge species" that increase with increased forest fragmentation or decreased distance of nests from a forest edge (Gates and Gysel 1978, Andren et al. 1985, Small and Hunter 1988, Yahner and Scott 1988). Nelson and Hamer (1995a) found that successful marbled murrelet nests were significantly further from forest edge than unsuccessful nests, and cover directly around the nest was significantly greater at successful nests. Preliminary results from a study using simulated murrelet nests (Marzluff et al. 1996) indicate that proximity to human activity and landscape contiguity may interact to determine rate of predation. Interior forest nest stands far from human activity appear to experience the least predation. Although the exact relationship between forest fragmentation, predation, and marbled murrelet nesting success has not been specifically demonstrated through an intensive study, the best available information strongly suggests that reproductive success may be adversely affected by forest fragmentation associated with certain land management practices (USDI Fish and Wildlife Service 1997).

It is likely but unknown if individual murrelets return to the same nest sites or forest stands in consecutive years. Most species of alcids exhibit high nest site fidelity (Nettleship and Birkhead 1985, Gaston 1992), as do many other species of birds nesting under a variety of environmental conditions. The prevalence of this trait in so many bird species strongly suggests that the behavior confers distinct survival advantages. Occupation of traditional nesting sites over many generations is common in species that display strong nest site fidelity (Ehrlich et al. 1988), and murrelet nesting sites appear to be traditionally used. Observations of nest sites have shown that individual nest trees are used in consecutive years, but it is unknown if these trees are used by the same individual birds in successive years. The potential for colonization of new nesting sites, assuming adequate suitable habitat is available, is not known. Significant loss of occupied nesting habitat is likely to hamper efforts to stabilize the population and to recover the species (Ralph et al. 1995), and the Recovery Plan (USDI Fish and Wildlife Service 1997) emphasizes preventing the loss of occupied nesting habitat as a means to assist in the recovery of the murrelet.

Harvest of Occupied Nesting Habitat in the Proposed Action: Using the information described above and from the Environmental Baseline, the FWS estimates that the proposed action will result in the harvest of 15,212 acres of potentially suitable murrelet habitat. Of this amount, there are 2,222 acres of known occupied habitat and 2,476 acres of unsurveyed but likely occupied habitat. In total, approximately 4,696 acres of known or potential occupied habitat will be harvested or otherwise impacted, or about 35 percent of the likely occupied habitat on PALCO lands (including the Headwaters acquisition area). This loss of habitat will have direct and indirect adverse effects to the species.

To further refine this impact by habitat type, implementation of the proposed action would result in the harvest and permanent loss of 446 acres of occupied high-quality UOG habitat, 4,013 acres of occupied low to moderate quality ROG habitat, and 237 acres of occupied low quality DFOG habitat. The removal and fragmentation of this habitat would result in the take of an unknown number of murrelets associated with this habitat.

The proposed harvest acreage is approximately 21.7 percent of the likely occupied habitat in the Bioregion, 3.6 percent of the likely occupied habitat in Marbled Murrelet Conservation Zone 4, and 0.67 percent of the likely occupied habitat in the three-state listed range (range) (table 56).

Table 56. Percentage of the total estimated amounts of likely occupied habitat at the PALCO lands, Bioregion, marbled murrelet conservation zone 4, and three-state listed range scales, respectively, that will be lost due the proposed harvest of 4,696 acres of known or likely occupied habitat. Data from table 13, Environmental Baseline section.

	PALCO Lands (inc. Headwaters)	Southern Humboldt Bioregion	Conservation Zone 4	Three-State Listed Range
Estimated Total Acres Likely Occupied	13,526[1]	21,693	130,638	702,335
SYP/HCP Harvest of Occupied Habitat as Percentage	34.6%[2]	21.7%	3.6%	0.67%

[1] Unknown how much of unsurveyed ROG is >15 OG trees/ac and where it occurs. Assumed 95-100% unsurveyed residual is <15 OG trees/ac. and used 0.52 occupancy rate for both harvest and no harvest calculation. Therefore, to be more conservative from the species' perspective, the total estimated here is 32 acres less than the total estimated in Environmental Baseline.

[2] NOTE: This estimate of percentage occupied acres harvested does not correct for the potentially occupied habitat that is protected within riparian management zones (RMZs) but outside of reserves; if likely occupied riparian reserve UOG, ROG, and DFOG acreage are subtracted from the occupied habitat harvest total, the percentage of likely occupied habitat that is released for unencumbered harvest is reduced to 23.5%on the ownership, 14.7% in the Bioregion, 2.4% in conservation zone 4, and 0.45% in the listed range (O. Rand, pers. comm., February 4, 1999).

The FWS believes that the largest impact to the species as a consequence of this harvest will be the physical displacement of the resident birds and the likely loss of subsequent reproductive output from most of these individuals and their offspring. Harvest of UOG and ROG will result in permanent loss of an unknown number of sites used for nesting, which would require affected murrelets to nest elsewhere or abandon nesting behavior. Some percentage of displaced adult and immature birds may be able to find other habitat where they can breed successfully in subsequent years, thereby reducing the effect of harvest (Kress and Nettleship 1988, Divoky and Horton 1995, page 87). The FWS believes that the likelihood of this occurring is low for most displaced murrelets. We therefore assume that most (but not all) of these birds are effectively removed from the breeding population, thereby reducing the total number of murrelets on PALCO lands at least for the early portion and perhaps most of the permit period.

Potential for Direct Mortality: PALCO proposes to harvest some potentially occupied or unsurveyed marbled murrelet habitat during the breeding season but states that if nests are found in stands available for harvest, they would be protected until after the breeding season. The Service believes that lack of pre-project surveys and the difficulty of finding nests renders this proposed mitigation of little conservation value. However, the SYP/HCP will substantially minimize this potential take by precluding harvest in all known occupied stands and in half of the unsurveyed stands. The designation of unsurveyed stands in which to defer harvest during the breeding season will be based on a ranking of habitat features such as canopy closure, stand size, and potential nest platform density. Stands that rank in the upper 50 percent of this group will not be harvested during the nesting season, while those stands that rank in the lower half can be harvested during the nesting season. There are approximately 4,320 acres of unsurveyed suitable ROG proposed for harvest. Under the proposed rating scheme approximately 2,160 acres would be available for harvest during the nesting season. Of this total, approximately 1,123 acres are anticipated to be occupied, using the 0.52 occupancy rate. Harvest during the breeding season in this lower quality habitat would probably result in some mortality of eggs and flightless young, but most adults would probably escape.

Loss of Suitable Unoccupied Habitat: In addition to the loss of occupied habitat and the associated take of murrelets through displacement or a small amount of direct mortality, the proposed action will adversely affect the species by removing a large amount of currently suitable but unoccupied habitat. Although direct take will generally not occur with the harvest of this habitat, its removal could adversely affect the recovery of the species (USDI Fish and Wildlife Service 1997) in two general ways: (1) additional fragmentation of the surrounding landscape, opening up gaps where predators and adverse weather conditions can negatively affect the remaining suitable habitat, and (2) loss of recruitment habitat for future murrelets to colonize and occupy. Some of this habitat, if allowed to remain on the landscape, would likely have been colonized by dispersing murrelets as its quality improved with time and as the population begins to stabilize and recover. It is expected that second growth and residual redwood recruitment habitat that will develop or improve in the MMCAs and in the Headwaters area will to some extent offset this loss and is discussed later in this opinion. Most of the Headwaters acquisition area, the MMCAs, and State Park boundaries are buffered with over 2,100 acres of forested habitat; this buffer habitat consists of existing residual old-growth (14 percent), late-seral (23 percent), mid-seral (50 percent), or early seral (13 percent) forest. These buffers should minimize adverse effects due to potential fragmentation (See discussion in Appendix N2, Final EIS/EIR; Marbled Murrelet Recovery Team, November 30, 1998).

Forests with older residual trees remaining from previous forest stands may develop into nesting habitat more quickly than those without residual trees (USDI Fish and Wildlife Service 1996a). Stands with residual old-growth trees, even if unoccupied, have value to the marbled murrelet as recruitment habitat. Re-growth of the understory in these stands could in a relatively short time provide protective cover to the remaining potential nest trees. This habitat can become high quality murrelet nesting habitat much faster than unsuitable areas that lack potential nest trees. Forests typically require 200 to 250 years to attain characteristics necessary to support nesting marbled murrelets, although these conditions may develop in coastal redwood forests (USDI Fish and Wildlife Service 1996a).

Disturbance Effects: The SYP/HCP outlines a process to minimize to the greatest extent feasible the potential adverse effects to nesting murrelets from noise disturbance. This process includes standard measures for reducing the likelihood of disturbance wherever feasible, but because other management needs may influence the degree of its application, the actual degree of effectiveness cannot be accurately predicted. The FWS believes that the proposed action will result in some disturbance of nesting marbled murrelets, although information is not available to quantify the exact number of murrelets that might be taken.

Noises associated with various activities proposed in the SYP/HCP could disturb nesting murrelets in adjacent, occupied habitat. Murrelets may be relatively sensitive to disturbance due to their secretive nature and their vulnerability to predation, but some birds appear to habituate to regular disturbances along existing roads and near campgrounds. Preliminary research has found that human disturbance caused adult murrelets to abort feeding visits to the nest, while hatchlings appear relatively tolerant of many disturbance stimuli (Nelson et al. 1998). Other than this preliminary work, there is little detailed information concerning the vulnerability of murrelets to disturbance effects, research on a variety of other bird species suggest that such effects are possible (Henson and Grant 1991, Reijnen et al. 1995, Rodgers and Smith 1995). Such studies have shown that disturbance can affect productivity in a number of ways: nest abandonment; egg and hatchling mortality due to exposure and predation; longer periods of incubation; premature fledgling or nest evacuation; depressed feeding rates of adults and offspring; reduced body mass or slower growth of nestlings; and avoidance of otherwise suitable habitat.

Due to the significant lack of disturbance-related information on murrelets, coupled with the studies mentioned above, it can be assumed that disturbance could result in some negative impacts. However, it is expected that these negative impacts are relatively minor compared to the impacts due to the loss of suitable habitat. In sum, activities occurring on or near up to 13,588 acres of potential occupied marbled murrelet habitat could adversely affect nesting murrelets through disturbance effects.

Summary of Adverse Effects: Approximately 15,213 acres of potentially suitable habitat is proposed for harvest[2]. Of this harvest total, 8,303 acres is unoccupied Douglas-fir habitat expected to be of little to no value to the murrelet, and approximately 4,496 acres is known or likely to be occupied habitat that is of low to high quality. In contrast, approximately 9,056 acres of mostly high quality redwood old-growth will receive protection in permanent acquisitions or as

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[2] This estimate of total harvested acres does not correct for the approximately 4,775 acres of unentered old-growth and residual forest within riparian management zones (RMZs) but outside of reserves.

MMCAs for the 50 year permit period. In terms of area, this harvest represents about 35 percent of the total occupied habitat on PALCO lands, 21.7 percent of the Bioregion, 3.6 percent of Zone 4, and 0.67 percent of the listed range.

The removal of this amount of occupied murrelet habitat in the short-term (5 to10 years) is a serious adverse affect to the species, especially if this impact occurs before benefits begin to accrue for murrelets in the protected areas. If one assumes homogeneous distribution of murrelets in all occupied habitats, one might conclude that removal of 21.7 percent of the Bioregional habitat impacts 21.7 percent of the murrelets nesting in the Bioregion. But such an assumption is not justified, and the percentage of murrelets in the Bioregion impacted by the proposed SYP/HCP is likely to be lower than 21.7 percent.

Most of the occupied acres proposed for harvest are moderate to lower quality murrelet habitat relative to the conserved UOG stands. The ROG and DFOG stands probably have lower murrelet nesting densities and lower rates of reproductive success than most of the protected reserves and the high quality habitat in portions of neighboring state parks (Swartzman et al. 1997). The harvest stands are smaller, more fragmented, and have lower canopy closures. Therefore, it is probable that the total number of murrelets actually impacted by the proposed action is smaller than the proportion suggested by the acres that will be removed as a percentage of occupied habitat within the Bioregion.

Also, as discussed in the Environmental Baseline, calculations of occupied habitat in the Bioregion may underestimate the amount of occupied habitat in HRSP, thereby overestimating the relative impact of the proposed harvest of occupied habitat within the Bioregion. This possibility, in conjunction with the likelihood that murrelets are occupying the proposed harvest areas in lower densities compared to the high quality reserve areas, leads to the conclusion that the number of murrelets impacted is probably significantly less than 21.7 percent of the birds within the Bioregion. However, the FWS has no reliable quantitative data or method to calculate such a figure and can only conclude with some confidence that the number is likely smaller than indicated by the occupied area estimates.

A goal of this proposed action was to develop a strategy that conserved enough high quality murrelet nesting habitat -- and in sufficient amounts, configuration, and distribution -- to maintain a viable population on PALCO lands (including the Headwaters acquisition area), in the Bioregion, and in Recovery Zone 4, while allowing harvest in habitat whose loss was not likely to jeopardize the species. Although the total number of murrelets on PALCO lands will likely be reduced as a consequence of this habitat removal, the proposed action protects a significant majority of the most important murrelet habitat on the ownership and, therefore, a majority of murrelets (P. Karieva, December 7, 1998). Over 91 percent of the most valuable unentered old-growth is retained, and approximately 50 percent of the occupied residual old-growth is also retained, much of which is the higher quality habitat within the ROG class as measured by stand size, canopy, and volume density. In addition, the proposed action retains the largest stands and targets harvest to the smaller stands. Successful reproduction in ROG stands is likely to occur at a lower rate than successful reproduction in UOG stands (Swartzman et al. 1997), and reproduction in small UOG redwood stands with high ratios of edge to interior is also likely to be lower than in larger stands of UOG redwood.

Some biologists and scientists involved in the development or review of the SYP/HCP and Headwaters purchase have suggested that low quality habitat could constitute murrelet "sinks" where populations consistently fail to replace themselves, while high quality areas may be "sources" of dispersing individuals to these sinks (See SYP/HCP Scientific Panel notes for June 12 and 13, 1998; Volume IV, Part B, Section 7, in Draft SYP/HCP; D. Murphy, September 10, 1997; P. Karieva, December 7, 1998). Sources are areas where local reproductive success is greater than local mortality, while sinks are areas where local productivity is less than local mortality. In the absence of immigration from source areas, populations in sink habitats decline toward extinction (National Research Council 1995, page 98).

The National Research Council (1995, page 97) recommends that conservation planning for endangered species incorporate this concept of source and sink habitats. However, identifying which habitats are sources and which are sinks can be difficult if basic information on the species of concern is limited (National Research Council1995, page 103), and the FWS believes that there is little reliable information to conclusively determine if some habitats on PALCO lands truly are murrelet "sinks" while others are murrelet "sources." But even if such information is lacking or limited, basic "conservation strategies can be formulated without detailed estimates of needed details of organisms' biology," and "consideration of source-sink dynamics is an important aspect or reserve design and habitat protection" (National Research Council 1995, page 103).

Therefore, the FWS believes the source-sink concept has merit as a general guide in helping design an HCP that protects as much likely source habitat as possible, while focusing the applicant's harvest in areas that are more likely to be sink habitat (National Research Council 1995; Karieva, December 7, 1998; D. Murphy, September 10, 1997). Given the small stand size, low volume density, and lower canopy closure for much of the ROG proposed for harvest, it is likely that most of this ROG habitat contains lower densities of murrelets which are experiencing relatively low rates of reproductive success. It is acknowledged that these ROG stands likely experience greater predation rates that the UOG stands (Swartzman et al. 1997, page 18).

If any stands on PALCO lands are murrelet sinks, it is likely to be some of these ROG stands that are moderate to low quality, especially if predation rates are high for breeding adults and not just eggs or hatchlings. However, the FWS still places an overall premium on all occupied murrelet habitat, as described in the Marbled Murrelet Recovery Plan (USFWS 1997, page 139) and previous murrelet biological opinions, and loss of these sites is an impact to recovery. The MMCA strategy is not an attempt to proactively remove potential sink habitat, although some members of the PALCO scientific panel and other consultants (D. Murphy, pers. comm., September 22, 1997) suggested such an approach was worthy of consideration. Rather, the combination of the MMCAs and Headwaters reserve is an attempt to strategically reduce the impact of harvest on the species in such a way that enough of the highest quality habitat is conserved to ensure the species' short-term and long-term viability.

Beneficial Effects of the Proposed SYP/HCP

The preceding analysis enabled the assessment of the adverse effects of the proposed SYP/HCP on the marbled murrelet. This section evaluates the likely beneficial effects of the proposed SYP/HCP. The anticipated beneficial effects include:

1. A net increase in the total amount of suitable habitat and the overall quality of nesting habitat in the acquired Headwaters reserve complex;

2. A net increase in higher quality nesting habitat and potentially suitable habitat in MMCA reserves by the end of the 50-year term of the SYP/HCP;

3. An increase in murrelet nesting densities and improved reproductive success rates in the Headwaters complex and the MMCA reserves that should fully or partially offset the loss of nesting habitat by the end of the 50-year term of the SYP/HCP; and

4. In addition to the permanent or 50-year protection of 9,056 acres of suitable and mostly occupied habitat, the additional full or partial retention of up to 4,775 acres of old-growth redwood and Douglas-fir in riparian reserves; retention of this riparian old-growth will preserve some future management options for further murrelet conservation if needed.

The total area protected within MMCAs and the Headwaters acquisition is 18,759 acres (O. Rand, pers. comm., February 4, 1999). Of this total, approximately 4,694 acres is unentered redwood old-growth, 4,429 acres is residual redwood old-growth, and 216 acres is Douglas-fir old-growth. The remaining habitat is not old-growth: 2,535 acres of late-seral forest (>24 inches dbh); 3,004 acres of mid-seral forest (12 to 24 inches dbh), 3,473 acres of young seral (<12 inches dbh), and other (table 57).

Over time the Headwaters reserve and MMCAs will improve in several ways that should provide some additional benefits to murrelets:

1. Understory within existing residual old-growth will continue to grow and provide better vertical and horizontal cover for nesting murrelets. This development should increase the density of nesting opportunities and reproductive success within a stand by making more potential platforms usable with better cover.

2. Forest areas that are contiguous with existing nesting habitat but that do not contain large trees with potential nest platforms will continue to grow. The late- and mid-seral forests existing today are currently providing some buffering

function to these adjacent areas. At the stand level, this performance will improve with time, as will recruitment of buffers in what is currently young seral.

3. At the landscape level, as these young, mid-, and late-seral forests continue to grow, many of them will "block up" smaller scattered residual and unentered old-growth patches into a larger contiguous stand that overall will have less total edge habitat and may provide less opportunities for some murrelet predators.

The importance of stand size and canopy and vertical cover to murrelet reproductive success is discussed in the Environmental Baseline and earlier portions of this Effects of the Action section. The following discussion is based on the assumptions and scientific literature cited in those sections.

Although detailed site specific information was not provided to the FWS, it can be assumed that much of the late-seral area in the reserves includes trees greater than 24 inches dbh, and much of the mid-seral area includes trees between 11 and 24 inches dbh. According to data supplied by Vestra and PALCO and analyzed by the FWS (Appendix 2), in general most trees that are greater than 24 inches dbh are already at or very near the height where they should begin providing horizontal and vertical cover to nesting platforms in the lower portions of old-growth trees (approximately 120 feet (Nelson and Hamer 1995b)). As these understory trees grow up in height alongside existing residual old-growth or on the edges of unentered stands, they will continue to "capture" more nest platforms and provide these platforms with cover; Appendix B shows the relationship between tree dbh and height for the SYP/HCP area. This cover should make more nest platforms available to prospecting murrelets (assuming prospecting murrelets use some consideration of cover as a nest site selection criterion), and it should increase the reproductive success of murrelets by decreasing predation and providing cover from adverse weather.

Table 57. Estimates of acreage by habitat type in stands associated with the acquired Headwaters reserve and the MMCA reserves.

Reserve	Uncut DF OG	Residual DF OG	Uncut Red OG	Residual Red OG	Late-seral	Mid-seral	Young Seral	Other Seral	Total
Headwaters	0	0	3117	666	1,521	625	1438	135	7502
Allen Creek	0	0	393	595	150	445	37	109	1729
B Rd 7&9	0	0	21	239	14	98	100	20	492
Bell Lawrence	0	0	339	107	0	23	162	1	633
Booths Run	158	8	0	216	0	78	324	0	784
Cooper Mill	0	0	0	397	16	135	155	0	703
Elkhead Residual	0	0	0	64	0	0	285	0	349
Grizzly Creek	0	0	131	738	104	317	34	82	1406
LNF Elk	0	0	0	237	159	46	9	0	451
Owl Creek	13	6	359	334	45	31	385	22	1195
Road 3	0	0	0	375	38	110	0	40	564
Rt Rd 9	0	0	78	112	0	0	128	0	318
Shaw Gift	31	0	255	55	0	32	130	0	503
Buffers	0	0	0	294	488	1064	285	0	2131
Total	202	13	4693	4429	2535	3003	3473	408	18759

Of the 4,136 acres of residual redwood in the reserves, approximately 1,574 acres (38 percent) have a late-seral or mid-seral understory over 60 feet tall. Some of this late-seral understory is already functioning to provide some cover to nest platforms. This function will increase during the next 50 years as trees grow between another 30 to 90 feet in height (specific growth rates depend on site location). On average, late-seral understory trees should be between 140 and 200 feet at the end of the 50 year permit period. Likewise, with the next 50 years most of the mid-seral age class will have achieved and surpassed, on average, the 120-foot mark where they begin providing cover to nesting platforms in residual old-growth trees (Appendix 2). Approximately 2,562 acres (62 percent) of residuals in reserves have a young to mid-seral understory less than 60 feet in height. Although some of these trees may reach 120 feet in 50 years, most will not provide much improvement for murrelets within the 50-year permit period. These stands will, however, be well positioned to provide future benefits to the murrelet beyond 50 years.

In addition to recruitment of understory cover within the residual old-growth, overall habitat quality should improve due to increases in tree height outside but contiguous to the unentered and residual stands (USDI Fish and Wildlife Service 1997, page 142-144). These improvements will occur at both the stand and the landscape levels. As Figure 3.9.2 in the Final EIS/EIR indicates, much of the old-growth habitat in reserves is scattered and fragmented with high amounts of edge; some of this is due to natural site condition variability, but much of it is a consequence of past timber harvest. Mid-seral and late-seral trees around the old-growth will improve buffering capability. These stands will fill in many of the gaps between residual or old- growth and effectively "block up" some disjunct occupied habitat patches into larger contiguous late-seral stands. Where old-growth borders young seral stands, over the 50 years these hard forest edges should "soften" as they become mid-seral; although these young stands will not provide cover to nest platforms higher in the overstory, they will provide some protection from windthrow and fire (USDI Fish and Wildlife Service 1997, page 143).

The Marbled Murrelet Recovery Plan (USDI Fish and Wildlife Service 1997) describes the importance of using the HCP process to protect murrelet habitat on private lands for long periods of time. Take prohibitions under section 9 of the ESA primarily protect murrelet habitat that is currently occupied. As the murrelet population declines some of this habitat will become unoccupied, eventually resulting in a lapse of restrictions on the harvest of this habitat and allowing a continuing erosion of habitat needed to eventually recover the species (USDI Fish and Wildlife Service 1997, page 133). Therefore, "Habitat Conservation Plans with appropriate measures to minimize and mitigate incidental take in the short-term while providing for maintenance or creation of habitat for the long term probably offer the best means for conservation of the species on non-Federal lands" (USDI Fish and Wildlife Service 1997, page 133).

In sum, at the end of 50 years the murrelet nesting opportunities and reproductive success in the combined 18,759 acres of the Headwaters reserve and the MMCAs are expected to improve in the following ways: (1) more nesting platforms will be positively affected by increased levels of vertical and horizontal cover in the unentered and residual old-growth; (2) buffers around individual old-growth stands will increase in tree height, increasing the size of individual stands and creating more interior forest conditions for existing old-growth trees, in turn making nesting murrelets less vulnerable to predation and adverse weather (USDI Fish and Wildlife Service 1997, page 143; Swartzman et al. 1997, page 18); and (3) at the landscape level, patches of old- growth will be "blocked up" into contiguous, larger stands that have less total amounts of edge and that will be more likely to maintain interior forest conditions. This combination of permanent and long-term habitat protections will benefit the murrelet.

Marbled murrelet critical habitat

The standard for evaluation of effects to critical habitat under section 7 of the Act is whether the proposed action is likely to result in destruction or adverse modification of critical habitat for the species. Destruction or adverse modification of critical habitat is defined at 50 CFR 402 as "direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical." Further, the Final Rule designating critical habitat for the marbled murrelet states " [the basis for an adverse modification opinion would be whether a proposed action appreciably reduces the ability of critical habitat to function in achieving the regional conservation zone goals. In evaluating the effect of a proposed action, the Service will analyze the impacts to individual units in light of their overall contribution to the survival and recovery of murrelets in the conservation zone....and the overall range of the marbled murrelet in Washington, Oregon, and California. Thus an adverse modification finding would be based upon a broader inquiry than mere assessment of adverse effects at the local unit level.]" (USDI Fish and Wildlife Service 1996a).

In the following discussion, effects on critical habitat are evaluated in terms of effects on the primary constituent elements of critical habitat, namely trees with platforms suitable for nesting and young forests with an average height equal to ½ the site potential tree height that are within ½ mile of trees with platforms suitable for nesting. Effects of the proposed action on these primary constituent elements are viewed in both quantitative and qualitative terms. These effects are considered in the context of designated critical habitat at various scales, and in regard to the reasons for designation. The only critical habitat unit that includes lands within the SYP/HCP area is CA-03-a. Harvest within this unit would have no effect on critical habitat in the other five local units. Thus, the following discussion focuses on effects on CHU CA-03-a.

In quantitative terms, forested acres containing primary constituent elements, and thus designated as critical habitat, would be allocated in three ways. Portions would be acquired as part of the Headwaters Reserve, portions would be set aside for the life of the permit in MMCAs, and other portions would be available for harvest, unless protected under other constraints such as riparian protection. These effects are summarized in table 58.

Table 58. Effects on Critical Habitat in Unit 03-a

	Uncut OG DF	Residual OG DF	Uncut OG Redwood	Residual OG Redwood	Late-seral 1/	Total
Headwaters	0	0	3,091	647	795	4,533
Owl Creek MMCA2/	13	6	356	332	45	752
Other MMCAs	189	8	1,083	1,998	163	3,440
Outside Reserves	0	31	92	1,674	1,784	3,581
Total	202	45	4,622	4,651	2,786	12,306

1/ This category only includes late-seral habitat without a residual component that is within 0.5 miles of any uncut or residual old-growth stand.
2/ Owl Creek MMCA listed separately because it may be either acquired permanently or provided MMCA status

In quantitative terms, the amount of critical habitat (3,581 acres) that would be left unprotected by the acquisition of Headwaters and set-aside of the MMCAs comprises about 29 percent of the critical habitat in CHU CA-03-a, about 7.8 percent of the critical habitat in CHUs in proximity to the action area, about 1.1 percent of the critical habitat in Conservation Zone 4, and about 0.3 percent of the critical habitat in the three-state range.

Qualitative factors relating to murrelet habitat, including occupancy status, stem density, canopy closure, stand size, and proximity to high quality habitat, are thoroughly discussed elsewhere in this opinion. In general, the same conclusions as to effects apply to critical habitat as to habitat in more general terms. Harvest under the SYP/HCP would be focused on lower quality habitat in young forest, residual stands, and small old-growth stands; while the highest quality habitat in larger old-growth stands and associated residual stands would be acquired or set aside as MMCAs. Of the 3,581 critical habitat acres in CHU CA-03-a that are not included in the Headwaters acquisition or MMCAs, 48 percent is in residual stands, which have lower availability of nesting substrate than uncut old-growth and likely support a lower level of murrelet reproductive output, and 50 percent is in late-seral stands that contain no known nesting substrate. Only two percent of the critical habitat acreage left un-acquired or outside MMCAs would be within uncut old-growth stands.

Of the 1766 acres of uncut old-growth and residual critical habitat acreage left un-acquired or outside MMCAs by the murrelet conservation plan, an estimated 32 percent will be included in Riparian Management Zones, where it would be protected either completely in no-cut buffers or protected partially in selection cut buffers (O. Rand, pers. comm., February 5, 1999). Habitat in riparian zones probably does not constitute high quality habitat because of lack of interior forest conditions, but it may provide some habitat benefits, especially as the size of second-growth increases within the buffers. Thus, due to qualitative factors and protection under other prescriptions, the degree of effect would be substantially less than that indicated in the simple numeric proportion of quantitative effect.

Of the 1,784 acres of late-seral stands within critical habitat that will not be protected by the murrelet conservation plan, 965 acres are on lands that will be acquired from Elk River Timber Company along the northern boundary of the proposed Headwaters Reserve. Along the edge of the reserve, within these lands, a 300-foot-wide buffer would be applied that would be subject to the late-seral selective harvest prescription, leaving a closed canopy buffer to provide protection from predators and climatic effects. The remainder of the area could be harvested. Thus the overall beneficial buffering effects of late-seral critical habitat will be reduced in this area, but retained along the margin of the reserve.

Critical habitat on private lands was designated in areas where Federal lands are limited or nonexistent, and where private lands are essential for maintaining marbled murrelet nesting populations and nesting habitat. The focus of designation was on protection of large contiguous blocks of nesting habitat, and maintenance of current distribution of the species. The designation of CHU-CA-03-a attempted to meet these criteria by including the largest blocks of nesting habitat in an area with no Federal lands. However, because none of the existing blocks of nesting habitat on the PALCO property (or other private property in the area) exceed 3,200 acres, no truly large blocks of habitat such as exist in Redwood National Park or Federal LSRs are available in CHU-CA-03-a. The primary value within the CHU is contained within the 3,000-plus acres of the Headwaters/Elkhead Springs stands, with secondary value contained in four other stands with several hundred acres of uncut old-growth each, and in numerous scattered stands of residual old-growth. Almost 28,000 acres of the CHU (nearly 70 percent) contains young forest largely devoid of primary constituent elements; by definition these acres do not constitute critical habitat. Because these young stands are not legally protected from harvest, and because public acquisition of these lands is unlikely, there appears to be little possibility that a truly large block of murrelet nesting habitat could be created in this CHU. Thus, practically speaking, most of the recovery value for this unit is contained in the existing occupied habitat. If marbled murrelet populations continue to decline, and currently occupied habitat becomes unoccupied as a result, the legal protections for some of today's occupied habitat could be lost, resulting in further harvest of the existing habitat. Therefore, in absence of an HCP, it is doubtful that the existing condition of this CHU can be maintained, much less improved.

Because the proposed action will result in the harvest of designated critical habitat, some adverse effects will occur. However, for the reasons described above, the FWS believes that the most important effect of the proposed project on the value of critical habitat for the survival and recovery of the murrelet is not the negative effect of harvest of lower quality critical habitat, but rather the positive effect of permanent acquisition of the Headwaters and 50-year set-aside in the MMCAs of the largest blocks of the best remaining habitat in the CHU, together with the assured protection of adjacent areas of improving residual habitat and second-growth buffers. This will ensure that the goals of critical habitat designation are met for the long term, and that if populations stabilize and begin to recover, the best of today's available habitat will remain in place to support that population, irrespective of changes in population structure or protective regulation that may occur in the future.

Also among the effects of the action would be a change in the legal status of designated critical habitat in the area covered by the SYP/HCP. In the Final Rule designating critical habitat (USDI Fish and Wildlife Service 1996a), the FWS defined critical habitat for the marbled murrelet to exclude lands covered by a legally-operative ITP, including permits issued subsequent to the designation. This exclusion is to apply during the period the permit is in effect. Because the lands protected under the SYP/HCP would fill the role of designated critical habitat, this change in legal status would have no biological effect. If for some reason the permit were terminated, those lands that are currently critical habitat would revert to critical habitat status.

Western snowy plover

The analysis area used in this opinion includes all gravel bars on the Eel River that have the potential to be suitable nesting and brood rearing habitat. The SYP/HCP, as currently proposed, does not include the removal of gravel from gravel bars on the Eel River as a covered activity, except as incidental to placement and operation of low-water road crossings. Commercial gravel operations will not be conducted on gravel bars under the authority of the SYP/HCP.

Direct and indirect effects

Currently, no known snowy plover nesting or wintering sites are known to occur on PALCO lands or within any "vested rights" area (those lands where rights to gravel extraction are under the control of PALCO). Western snowy plovers have not been documented on PALCO lands (CDFG 1998a, PALCO 1998). The CDFG has no record of this species occurring on Elk River Timber Company lands of the project area, and it is not expected to occur there based on the known distribution of the species and the lack of sufficiently wide river-gravel bars. Therefore, no acres of currently occupied breeding or wintering habitat are likely to be affected by current activities covered under this SYP/HCP, and no direct adverse effects to the species are likely to occur.

Two circumstances could occur which might lead to SYP/HCP-covered activities potentially affecting the western snowy plover: the future PALCO acquisition of plover habitat or the detection of plovers on current PALCO lands. Should PALCO acquire lands or vested rights that include gravel bars or habitat adjacent to known plover nesting areas at some time during the life of the plan, the potential exists for PALCO activities to affect the species through habitat modification or disturbance.

The relatively recent discovery (during 1996) of plovers nesting on the lower Eel River gravel bars (Tuttle et al. 1997) may indicate that the species has only recently begun to adapt its nest habitat selection. Should this be true, the current distribution of the western snowy plover on the Eel River, as documented through recent intensive surveys, may be gradually expanding upriver to include additional gravel bars if they have the characteristics of suitable habitat. It is not possible to predict the exact upstream limit of breeding habitat for this species, given the amount and location of existing survey data. The condition of the gravel bars on this stretch of the river may provide characteristics that would lead to the eventual use of these bars by snowy plovers. On this portion of the river, the gravel bars are wider and more gradually sloped than are those bars in the faster flowing and generally more constrained stream channel upstream from the bridge at Rio Dell, California. Therefore, some potential remains for future activities conducted under the SYP/HCP and ITP to affect the plover on existing PALCO lands and vested rights gravel bars upstream from the mouth of the Van Duzen River.

To minimize and mitigate for these potential sources of effects to this species, the snowy plover conservation plan establishes two criteria for nest site detection and protection. The SYP/HCP conservation measures for the western snowy plover call for PALCO to conduct reconnaissance-level surveys (as described in COE gravel extraction permits for the area) on gravel bars upstream from the Highway 101 bridge near Rio Dell. If reconnaissance-level surveys locate plovers above the Rio Dell bridge, full protocol surveys will be instituted on all gravel bars within one mile of the sighting. If plovers are detected, the individual(s) shall be observed for evidence of nesting behavior. If a nest site is discovered, a 1,000-foot seasonal operations buffer will be applied until the end of the breeding season, or until it is determined that the nest has failed or nesting has been completed.

If PALCO acquires rights to gravel bars downstream from Rio Dell, those bars shall be surveyed in full compliance with FWS protocol existing at the time, and nest protection measures shall be implemented that are consistent with measures used on the lower Eel River area at the time. If the species' breeding range is determined by any means to extend up the Eel River to the Rio Dell bridge, PALCO shall begin full protocol surveys of gravel bars above the Rio Dell bridge, and if nests are located, PALCO shall implement nest protection measures as above. PALCO shall evaluate proposed gravel extraction levels with respect to potential indirect effects downstream. Within three years of permit issuance, PALCO and the agencies will meet to evaluate indirect effects of extraction on downstream gravel bars and to determine whether practicable mitigation measures would be appropriate.

The conservation plan provides for adequate protection of the western snowy plover should they be found on PALCO lands at any time during the life of this SYP/HCP. We determine that there will be no significant effects to the species for the life of the ITP.

Southern Oregon/Northern California Coast ESU coho salmon
Refer to **Effects common to Pacific salmonids.**

PROPOSED SPECIES/CRITICAL HABITAT:
Southern Oregon and California Coastal ESU chinook salmon
Refer to **Effects common to Pacific salmonids.**

Coho salmon critical habitat
Refer to **Effects common to Pacific salmonids.**

Chinook salmon critical habitat
Refer to **Effects common to Pacific salmonids.**

UNLISTED SPECIES

Bank swallow

Direct effects

The FWS has determined that the proposed action is not likely to adversely affect the bank swallow for the following reasons: this species is not known to occur in the action area; the action area constitutes an exceedingly small and relatively insignificant portion of its range, both within the regional area and range-wide; aquatic conservation measures, principally the CMZ and RMZ measures, will minimize potential impacts to this species should they occur in the future; survey requirements for new road construction which crosses low gradient Class I streams will identify any new colonies that could be impacted; any colonies that are found will be protected and monitored by the conservation measures stated in the SYP/HCP and/or by measures developed during required consultation with the FWS and CDFG; and it is not anticipated that any bank swallows would be injured or killed as a result of the proposed action. While the FWS does not anticipate that any active colonies would be destroyed, if surveys fail to detect bank swallows, nest sites could be destroyed. Because the presence of a nest colony is usually quite obvious, it is unlikely that this will occur.

Indirect effects

Changes in flow regime as a result of timber harvest, road construction, and other covered activities could result in decreases or increases in suitable riverbank nesting habitat in the future. These effects, should they occur, would be more pronounced lower in drainages. The FWS anticipates no other indirect effects on this species.

Pacific fisher

Direct effects

Species

Numbers

Although fisher have been detected on PALCO lands, data are not available on the current number of fisher within the regional or action areas. The lack of information available on the extent of fisher use of redwood-dominated forest types make it difficult to quantify the change in number of fishers expected as a result of implementation of the SYP/HCP. However, due to the limited amount of LSH outside of PALCO lands within the action area, the number of fisher within the action area is expected to decrease, due to substantial reduction in the amount of LSH on PALCO lands. The decrease in numbers would not be directly proportional to reductions in the amount of LSH, due to the following: 1) the irregular distribution of larger patches of LSH on PALCO lands throughout the permit period; and 2) the fact that fishers may use additional habitats not included in the definition of LSH, such as CWHR 4D stands which provide structural components important to fishers.

Distribution

Fisher have only been detected within the Humboldt Bay and Yager Creek WAAs on PALCO lands. Retention of LSH within the Humboldt Bay and Yager Creek WAAs is likely to provide the best distribution of resting and denning habitat on PALCO lands. PALCO owns 30 percent (38,985 acres) of the Humboldt Bay WAA and 40 percent (33,730 acres) of the Yager Creek WAA. These two WAAs combined account for approximately 34 percent of the PALCO ownership. Habitat that appears suitable is also present in other WAAs. Assuming that all potentially suitable LSH is occupied, the distribution of resting and denning habitat on PALCO lands within the Van Duzen River, Eel River, and Bear Mattole WAAs is expected to be substantially reduced by the end of permit period. However, public lands within and directly adjacent to these WAAs are likely to provide resting and denning habitat throughout the permit period and beyond. Refer to the **Effects common to species associated with late-seral habitat and Effects to Pacific Fisher suitable habitat** sections for additional information.

Reproduction

Fishers are sensitive to forest fragmentation (Rosenberg and Raphael 1986). Female fishers are the sole providers for their young, and generally have smaller home range sizes than males. Adult females, because of their increased energy demands while raising young, are likely more sensitive to changes in the composition and structure of forests at a smaller spatial scale than males.

The abundance and distribution of LSHs will be reduced across PALCO lands. This effect is most pronounced in the reduction of patches of LSH greater than 80 acres in size. Fragmentation of LSHs will likely impact the reproductive success of fishers by limiting the ability of females to capture prey and find denning or resting sites, while minimizing energy expenditure. Although conservation measures will retain some structural components, timber harvest operations are likely to destroy potential rest and den sites, since harvest activities typically occur in older stands which are likely to contain the highest density of habitat components used for resting and denning. These factors combined are likely to negatively effect fisher reproduction in the action area.

Coniferous forest seral stages other than LSH have the potential to provide opportunities for suitable den and rest sites through the retention of structural components (e.g., snags, live culls, and down logs) during timber harvest. When young timber stands grow to reach CWHR 4D, the retention of these structural components may provide opportunities for denning.

Injury or disturbance

Timber harvest operations could disturb fisher reproductive activities. Direct injury of adult fishers from timber harvest activities is unlikely, due to the subspecies high agility and human avoidance behavior. However, natal dens occupied by adult females and young kits could be destroyed during timber felling, skidding, and yarding operations.

Vehicle traffic is known to kill Pacific fishers. The abundance of roads within the PALCO ownership make it possible that vehicle traffic associated with covered activities could kill fishers. **Conservation needs** guideline # 8 listed above for this species is to maintain "open-to-public" road densities to no more than 2 miles per square mile. Road densities on PALCO lands vary widely. Within the Humboldt Bay WAA, the Little South Fork of the Elk River watershed has 1.4 miles per square mile, while the Graham Gulch watershed, a tributary to Freshwater Creek, has 7.9 miles per square mile. Within the Yager Creek WAA road densities range from 4.9 miles per square mile to 6 miles per square mile. Within the Van Duzen WAA road densities range from 2.9 miles per square mile in the Cummings Creek watershed to 5.5 miles per square mile in the Root and Grizzly Creek watersheds. Within the Bear/Mattole WAA road densities range from 1.9 miles per square mile in the Rattlesnake Creek watershed to 3.9 miles per square mile in the Green Ridge watershed. Road density will increase on the PALCO ownership throughout the permit period. Although road densities on most of PALCO lands are higher than 2 miles per square mile, few roads on the ownership are open to the public or receive sustained use, and most do not receive high speed traffic. Therefore, minimal impacts from vehicle traffic are expected. In addition, many dirt logging roads are less than 30 feet wide and are likely to maintain a canopy cover of at least 40 percent, and therefore are not expected to be a barrier to fisher movement.

<u>Suitable habitat</u>

Habitat protection and modification

Suitable fisher habitat will be protected and maintained through RMZ measures, the mass wasting avoidance strategy, cumulative effects/disturbance index restrictions, habitat retention around spotted owl activity centers, MMCAs, the retention standard of 10 percent LSH for each WAA, and conservation measures for structural components. For additional information on habitat modification and projected amounts of LSHs, refer to **Effects Common to Species Associated with LSH**.

In addition to LSH, CWHR 4D may provide suitable habitat for resting and denning when it contains structural components used by fishers. The conservation measures in the SYP/HCP include requirements for retention of structural components often used by fishers for rest and den sites. The LTSY projections estimate that at least 49,962 acres of CWHR 4D will be maintained on the ownership during the plan period. See table 59 for projected distribution of CWHR 4D for the five major WAAs on PALCO lands over the permit period by WAA.

Table 59. Projected acres of CWHR 4D by WAA by decade on PALCO lands and percent of PALCO lands of CWHR 4D within each WAA by decade for the permit period, based on LTSY information.

Decade	Humboldt Bay WAA		Yager Creek WAA		Van Duzen River WAA		Eel River WAA		Bear/Mattole WAA	
	acres	per-cent	acres	per-cent	acres	per-cent	acres	per-cent	acres	per-cent
Baseline	7820	20	8629	26	8058	32	15351	21	13966	46
1	6859	18	6381	19	6276	25	13558	18	14505	47
2	10652	27	12605	37	9876	40	20896	28	16920	55
3	11497	29	19361	57	7327	29	26779	36	12114	40
4	14983	38	12881	38	7760	31	27338	37	12256	40
5	16795	43	9293	28	11043	44	35548	48	7145	23

Conservation needs guideline # 9 listed above for this species is to maintain 60 percent of PALCO lands in each WAA throughout the permit period in CWHR 3M or larger. This guideline is expected to be met. See table 60 for projected distribution of CWHR 3M or larger within the 5 major WAAs on PALCO lands over the permit period.

Table 60. Projected acres of CWHR 3M or larger on PALCO lands by WAA by decade and percent of PALCO lands in CWHR 3M or larger within each WAA by decade, based on LTSY information.

Decade	Humboldt Bay WAA		Yager Creek WAA		Van Duzen River WAA		Eel River WAA		Bear/Mattole WAA	
	acres	per-cent	acres	per-cent	acres	per-cent	acres	per-cent	acres	per-cent
Baseline	32523	83	20176	60	21633	87	55702	75	23445	77
1	26526	68	29592	88	20750	83	50440	68	24541	80
2	30358	78	30789	91	17708	71	55554	75	24822	81
3	29485	76	27546	82	16463	66	62116	84	21339	70
4	31510	81	23756	70	20557	82	61890	84	18456	60
5	30635	79	23563	70	21231	85	60491	82	18870	62

In addition to PALCO lands, public lands (State parks) within the Humboldt Bay, Yager Creek, and Eel River WAAs contain approximately 43,330 acres of potentially suitable foraging habitat for fishers. An additional 6,665 acres of CWHR 3M or larger within the Headwaters Reserve are expected to persist as foraging habitat throughout the life of the permit and beyond.

Habitat removal

Using a "worst-case" estimate, LSH could be reduced within the PALCO ownership from 32 percent (69,231 acres) to 10 percent (21,170 acres) of the ownership. This would constitute a 69 percent (47,304 acre) decrease in the amount of LSH. However, using LTSY projections over the permit period, the amount of LSH will likely be higher than10 percent throughout the entire permit period. Refer to **Effects common to species associated with LSH** for LTSY projections.

Habitat classified as CWHR 4D (potential resting and denning habitat) would be reduced from 26 percent (55,380 acres) to 23 percent (49,205 acres) of the ownership in the first decade, then increase to 38 percent (80,580 acres) of the ownership by the end of the permit period.

Habitat classified as CWHR 3M or larger (potential foraging habitat) would is expected to vary little during the permit period. CWHR 3M will increase from 73 percent (155,041 acres) to 76 percent (162,237acres) of the ownership in the second decade, and then decrease to 74 percent (157,394 acres) of the ownership by the end of the permit period.

Habitat distribution and fragmentation
Fragmentation of LSH will increase throughout PALCO lands over the permit period. The total acreage in patches of LSH greater than 80 acres in size will decrease by 65 percent. The degree of fragmentation will vary by WAA. Refer to the **Effects Common to Species Associated with LSH**, section for discussion on LSH.

Conservation needs guideline # 1 listed above for this species is to maintain at least 40 percent of suitable fisher habitat within a subdrainage as mature or older forests in patches of at least 80 acres in size. Habitat classified as CWHR 3M or larger is considered potentially suitable foraging habitat for fisher. The amount of potentially suitable foraging habitat is expected to vary by no more than approximately 5,000 acres over the permit term, and is not expected to go below the current level. Using the current acres of CWHR 3M and larger (155,041 acres) as a yardstick, at the end of the permit period 13 percent of PALCO lands that are considered suitable fisher habitat are projected to be maintained in patches of LSH greater than 80 acres in size.

In addition to LSH, habitat classified as CWHR 4D may also provide resting and denning habitat for fishers when structural components used by fishers are present. Using LTSY projections, at least 18 percent of each WAA is expected to be maintained in CWHR 4D over the permit period. When stands of LSH are combined with lower quality CWHR 4D stands, the number of patches of suitable resting and denning habitat larger than 80 acres in size increases over the ownership. Using the current acres of CWHR 3M and larger (155,041 acres) as a yardstick, at the end of the permit period 112,214 acres (72 percent) of PALCO lands that are considered suitable fisher habitat are projected to be maintained in patches of LSH/CWHR 4D greater than 80 acres in size. This figure is likely to be an overestimate of the acreage of habitat on PALCO lands that is actually suitable for resting and denning of fishers, since not all CWHR 4D stands contain suitable structural components for fishers.

Humboldt Bay WAA: In addition to LSH, approximately 16,795 acres of potentially suitable resting and denning habitat (CWHR 4D) and 30,635 acres of potential foraging habitat (CWHR 3M or larger) will be present at the end of the permit period on PALCO lands within the WAA.

Yager Creek WAA: In addition to LSH, approximately 9,293 acres of potentially suitable resting and denning habitat (CWHR 4D) and 23,563 acres of potential foraging habitat (CWHR 3M or larger) will be present at the end of the permit period on PALCO lands within the WAA.

Van Duzen River WAA: In addition to LSH, approximately 11,043 acres of potentially suitable resting and denning habitat (CWHR 4D) and 21,231 acres of potential foraging habitat (CWHR 3M or larger) will be present at the end of the permit period on PALCO lands within the WAA.

Bear/Mattole WAA: In addition to LSH, approximately 7,145 acres of potentially suitable resting and denning habitat (CWHR 4D) and 18,870 acres of potential foraging habitat (CWHR 3M or larger) will be present at the end of the permit period on PALCO lands within the WAA.

Eel River WAA: In addition to LSH, approximately 35,548 acres of potentially suitable resting and denning habitat (CWHR 4D) and 60,491 acres of potential foraging habitat (CWHR 3M or larger) will be present at the end of the permit period on PALCO lands within the WAA.

The reduction in LSH is not expected to constitute a gap in the distribution of Pacific fisher in the regional area. The RMZs are expected to provide LSH suitable for dispersal of young and movement of adults within and between WAAs and suitable habitat adjacent to PALCO ownership. Fishers may use riparian areas more than upslope areas (Aubry and Houston 1992, Buck et al. 1983).

Removal of special habitat components
Special habitat components for rest and den sites will be removed from the landscape during timber harvest operations. However, measures to conserve habitat diversity and structural components will maintain these special components at levels similar to those recommended in the **Conservation needs** section above for the Pacific fisher.

Conservation needs guideline # 3 listed above for this species is to maintain three to six trees per acre with deformities or cavities that are at least 30 inches dbh. This guideline will be met. At least four live cull trees per acre will be retained outside of Class I and II RMZs throughout the PALCO ownership. While there is no requirement to specifically maintain trees with deformities, cavities, or of a specific dbh, 30-inch dbh trees with these characteristics are given priority for retention.

Within Class I and II RMZs, post-watershed analysis prescriptions are expected to provide at least two live cull trees per acre.

Conservation needs guideline # 4 listed above for this species is to maintain 9 to 18 live trees per acre that are at least 20 inches dbh in suitable Pacific fisher habitat (CWHR 3M and larger). This guideline will be partially met. At least 60 percent of each of the five major WAAs on PALCO lands are expected to be maintained in CWHR 3M or larger. The average dbh of trees in this size class range from 6 to 11 inches, therefore it is unlikely that 9 to 18 of the trees present within these stands will be at least 20 inches dbh. When even-aged stands reach a CWHR size class of 4 they will likely meet this guideline. At least 18 percent of each WAA is expected to be maintained in CWHR 4D over the permit period, with at least 23 percent of each WAA in CWHR 4D by the end of the permit period.

Live green trees are expected to be left after harvest in varying numbers and sizes in areas treated with uneven-aged harvest prescriptions. Silvicultural requirements associated with the aquatic conservation strategy, mass wasting avoidance strategy, cumulative effects/disturbance index restrictions, and retention of 10 percent LSH for each WAA are likely to retain large green trees across the landscape. In addition, under the SYP/HCP, all harvest prescriptions include a requirement to leave green replacement trees if snags are not present on site, and at least four live cull trees per acre will be retained after harvest throughout the PALCO ownership.

Class I, II, and III RMZs (no harvest and select harvest bands combined) make up approximately 25 percent of the PALCO ownership prior to watershed analysis. Post-watershed analysis these RMZs could be reduced. However, requirements to retain the 18 largest trees per acre within 170 feet of Class I waters will remain in place. Basal area requirements within these zones are expected to provide at least 9 trees per acre greater than 20 inches dbh.

Conservation needs guideline # 5 listed above for this species is to maintain one to two snags per acre at least 30 inches dbh. This guideline is included in the HCP.. At least 1.2 snags per acre over 30 inches dbh will be retained. In addition, all snags that do not constitute a safety hazard will be retained.

Conservation needs guideline # 6 listed above for this species is to maintain, in addition to # 5 above, two to four snags per acre at least 20 inches dbh. This guideline will be met. At least 2.4 snag per acre over 20 inches dbh will be retained. In addition, all snags that do not constitute a safety hazard will be retained. Harvest prescriptions developed for Class I and II RMZs are expected to exceed this guideline.

Conservation needs guideline # 7 listed above for this species is to maintain two to three down logs per acre at least 20 inches in diameter and 15 feet long. This guideline is expected to be met. Conservation measures for structural components include retention for down logs in this size category if they currently exist on site. Adaptive management included in the SYP/HCP will evaluate after 5 years the need to take a more active role to recruit down logs.

Conservation needs guideline # 10 listed above for this species is to retain a hardwood component in the larger size category present on the site. This guideline will be met. The SYP/HCP measures under structural components will retain all hardwoods, up to two per acre, greater than 30 inches dbh where they exist.

While not all guidelines suggested by Freel (1991) and Heinemeyer and Jones (1994) are fully met, guidelines # 3 through # 7 were intended to apply to no more than 60 percent of the subdrainage being considered. The measures to conserve structural components specified in the SYP/HCP will apply to all PALCO lands.

Dispersal habitat condition
Conservation needs guideline # 2 listed above for this species is to maintain travel corridors at least 300 feet wide with at least 60 percent canopy cover. This guideline will be partially met. Pre-watershed analysis, all Class I and II RMZs will have greater than 80 percent canopy closure (Peters 1998). Since Class II RMZs are only 260 feet wide, the 300 feet wide corridor will not be fully met. However, Class I RMZs exceed the suggested 300 feet width and the overall canopy closure will exceed the guideline.

The SYP/HCP includes provisions to survey for Pacific fishers and consider impacts of harvest prescriptions on fishers during the post-watershed analysis synthesis process. Furthermore, harvested areas are not expected to constitute barriers to fishers once canopy cover reaches 40 percent. These measures combined are expected to provide adequate dispersal habitat throughout the ownership.

Indirect effects

Predation

Refer to **Effects Common to Species Associated with Late-Seral Habitat** section above.

Injury or disturbance

Use of newly constructed roads to accommodate a variety of non-covered activities may result in disturbance of fishers. The magnitude of this effect could not be quantified for the purpose of this consultation. This effect may be significant due to changes in behavioral patterns of reproducing fishers during the breeding season. Reproduction may be adversely affected. For additional information, refer to **Effects Common to Species Associated with Late-Seral Habitat** section above.

Habitat loss or modification

Refer to **Effects Common to Species Associated with Late-Seral Habitat** section above.

Red tree vole

Direct effects

Species

Numbers

The SYP/HCP does not include conservation measures that specify the maintenance of a particular red tree vole population size. The only data available on numbers of red tree voles are the 90 observation records discussed in the baseline. Currently, data on population estimates are not available for red tree voles on the PALCO lands. Effects of the action are best described in terms of habitat loss and retention (refer to the discussion under **Effects common to species associated with late-seral habitat**). In general, red tree voles are expected to decrease in number as the amount of LSH in patches greater than 80 acres in size decreases over the permit term.

Distribution

The effects of implementation of the SYP/HCP on the distribution of red tree voles within the action area is best estimated as a function of the distribution of LSH. Retention of LSH within the Humboldt Bay and Yager Creek WAAs is likely to provide the best distribution of suitable red tree vole habitat on PALCO lands. PALCO owns 30 percent (38,985 acres) of the Humboldt Bay WAA and 40 percent (33,730 acres) of the Yager Creek WAA. These two WAAs combined account for approximately 34 percent of the PALCO ownership. Assuming that all potentially suitable LSH is occupied, the distribution of red tree vole populations on PALCO lands within the Van Duzen River, Eel River, and Bear Mattole WAAs is expected to be substantially reduced by the end of permit period. However, public lands within and directly adjacent to these WAAs are likely to support red tree vole populations throughout the permit period and beyond. Refer to the

Effects common to species associated with late-seral habitat section for additional information.

The SYP/HCP measures described under effectiveness monitoring for red tree voles are expected to provide additional information on the distribution of red tree voles on PALCO lands.

Reproduction
The abundance and distribution of LSHs will be reduced across the PALCO lands. This is most pronounced in the reduction in acreage of patches of LSH greater than 475 acres in size (47,236 to 6,450 acres). It is likely that fragmentation of LSHs will increase the energy used by red tree voles to locate suitable nest sites within PALCO lands. Conservation measures will retain some structural components (large live culls and green snag replacement trees) important to this species for nesting. Timber harvesting, however, is likely to destroy potential nest sites, since timber harvest would typically occur in older stands which are likely to contain the highest density of habitat components used for nesting. Larger stands of LSH are more likely to contain stable populations, with more consistent reproductive success, than younger-aged stands. These factors combined are likely to negatively affect reproduction of red tree voles in the action area.

Injury or disturbance
Red tree voles occupy their nests year round, using them for shelter and protection from predators. A majority of the LSH within the PALCO lands will be available for harvest. Timber harvest operations (timber felling, skidding, and yarding) are very likely to cause direct injury of red tree voles as well as disrupt breeding, feeding, and sheltering behaviors.

<u>Suitable habitat</u>
Habitat protection and modification
Suitable red tree vole habitat will be protected and maintained through several facets of the operating conservation measures. These facets include the following: RMZ measures; the mass wasting avoidance strategy; cumulative effects/DI restrictions; habitat retention around spotted owl activity centers; MMCAs; the retention standard of 10 percent LSH for each WAA; and conservation measures for structural components. For additional information on habitat modification and protection refer to **Effects Common to Species Associated with LSH**.

In addition to LSH, CWHR 4D may provide suitable habitat of a lower quality. The LTSY projections estimate that at least 49,205 acres of CWHR 4D will be maintained on the ownership during the permit period. See table 59 for the projected distribution of CWHR 4D over the permit period.

The red tree vole conservation plan within the SYP/HCP includes adaptive management. Habitat information gained from effectiveness monitoring will be used to evaluate conservation measures and potential changes necessary to meet the management objective of sustaining viable red tree vole populations within each WAA throughout the life of the permit.

Habitat removal, distribution, and fragmentation
Refer to the **Effects common to species associated with late-seral habitat** section. In addition to LSH, CWHR 4D may provide suitable habitat of a lower quality for red tree voles. Habitat classified as CWHR 4D is also considered potentially suitable habitat for the Pacific fisher. Refer to the discussion under the **Effects on the Pacific Fisher**.

Conservation needs consideration # 1.a identified above for this species is to provide patches of suitable habitat at least 75 acres in size, and preferably 475 acres in size. The MMCAs are expected to provide several blocks of higher quality (LSH) habitat at least 80 acres in size, as well as patches of LSH at least 475 acres in size within the Humboldt Bay and Yager Creek WAAs throughout the permit period.

Within the Van Duzen River WAA, acreage of LSH in patches at least 80 acres in size will decrease from 4,968 to 2,228 acres over the permit period. By the end of the permit period, all of the LSH patches in this WAA are projected to be less than 475 acres in size.

Within the Eel River WAA, acreage of LSH in patches at least 80 acres in size will decrease from 27,318 to 6,224 acres over the permit period. By the end of the permit period, only one of these patches will be greater than 475 acres in size.

Within the Bear Mattole WAA, acreage of LSH in patches at least 80 acres in size will decrease from 4,556 to 2,578 acres over the permit period. By the end of the permit period, all of the LSH patches in this WAA are projected to be less than 475 acres in size.

In addition to LSH, habitat classified as CWHR 4D may also provide nesting habitat for red tree voles when structural components used by red tree voles are present. Using LTSY projections, at least 18 percent of each WAA is expected to be maintained in CWHR 4D over the permit period. When stands of LSH are combined with CWHR 4D stands, the number of patches and acreage of potentially suitable habitat patches larger than 475 acres in size increases over the ownership. Refer to **Effects to the Pacific fisher** section above for additional information on CWHR 4D habitat patches.

In addition to PALCO lands, the Headwaters acquisition area and other public lands within the action area are also expected to provide patches of LSH greater than 475 acres in size throughout the permit period and beyond.

Removal of special habitat components
Although conservation measures will retain some structural components (large live culls and green snag replacement trees) important to this species for sheltering and nesting, timber harvest is likely to destroy potential nest sites, since timber harvest would typically occur in older stands, which are likely to contain the highest density of habitat components used for nesting.

Dispersal habitat condition
The SYP/HCP measures described under effectiveness monitoring for red tree voles are expected to provide additional information on the distribution of red tree voles in the PALCO lands. The SYP/HCP also includes provisions to survey for red tree voles and to consider impacts of harvest prescriptions on red tree voles during the post-watershed analysis synthesis process.

Conservation needs consideration # 1.b identified above for this species is to provide dispersal habitat between patches of LSH of coniferous forests with a canopy cover of at least 60 percent. CMZs and RMZs are expected to provide dispersal corridors throughout PALCO lands that meet this criteria. Furthermore, harvested areas are not expected to constitute barriers to red tree voles once canopy cover reaches 60 percent. As a result, while fragmentation of LSH is expected to increase, connectivity between LSH and adjacent public lands will be maintained across the ownership.

Indirect effects
Predation, Injury or disturbance, Habitat loss and modification
Refer to **Effects Common to Species Associated with Late-Seral Habitat** section above.

Northern red-legged frog, foothill yellow-legged frog and northwestern pond turtle
Direct effects
For these three species, the most important effect of the action will be the improving condition of habitat provided by the RMZs. However, each species may be negatively affected by continued effects of past management, and by timber management activities in habitat that extends beyond the width of RMZs. FWS used different distances from the waters edge to estimate the amount of suitable habitat for each species as described below.

Based on data collected on pond breeding salamanders with similar habitat requirements, Welsh et al. (1998) suggests a buffer distance of approximately 530 feet as recommended by Semlitsch (1998) likely would be sufficient for long-term maintenance of northern red-legged frog populations. Higher quality habitat expected to be used by the subspecies includes mid- and late-seral, old-growth and residual old-growth.

Habitat within 230 feet from the waters edge of Class I and II waters was considered suitable for foothill yellow-legged frog habitat (see **Action Area Baseline** for explanation).

All forested habitat within 1,640 feet from the waters edge of Class I and II's on slopes less than 50 percent could be considered potentially suitable for the northwestern pond turtle (Holland 1994, Reese and Welsh 1997). However, based on field experience on the PALCO ownership, it is likely that much of this acreage is not suitable for or accessible to turtles. It is also likely that only a small portion of the Class I and Class II streams is suitable habitat for turtles, due to high gradient and lack of pools. Lacking data to support a quantitative evaluation of the amount of suitable habitat, we have reported the entire acreage, with the understanding that it represents a substantial overestimate of the actual amount of habitat present for northwestern pond turtles

Species

Numbers and reproduction

Population levels and reproductive rates of the northern red-legged frog, foothill yellow-legged frog, and northwestern pond turtle are not known for PALCO lands or the action area. The proposed action would result in the loss or modification of an unknown proportion of available suitable habitat which would likely result in the loss of an undetermined number of individuals on PALCO lands. Adverse impacts on the numbers and reproductive rate of the subspecies and species are expected as a result of timber harvest proposed for terrestrial habitats used by the subspecies and species, continued impacts from past management, and potential losses of recruitment into the populations. Future impacts may be even more pronounced for the subspecies and species because of the current fragmented condition of forested habitats on the landscape. However, the improving condition of RMZ buffers substantially larger than those in place for the past 100 years should provide for increasing populations.

Distribution

The exact distribution of northern red-legged frogs, foothill yellow-legged frogs, and northwestern pond turtles on PALCO lands and the action area is not known. It is expected the subspecies and species would remain generally distributed throughout PALCO lands because suitable aquatic habitat and adjacent terrestrial habitat will improve through time as provisions in the HCP for these areas are implemented. Localized effects on northern red-legged frog, foothill yellow-legged frog, and northwestern pond turtle distributions to occur may continue where terrestrial habitat is used outside RMZs. Effects will be commensurate with the amount and intensity of timber harvest. Even-aged prescriptions and road construction likely would have a greater impact on the distribution of the subspecies and species compared to selection harvest prescriptions due to a higher proportion of disturbed ground and removal of protective canopy.

Injury or disturbance

The subspecies and species are known to use upslope habitat beyond the distances proposed in the RMZs; therefore, timber harvest, road construction, and other activities could kill, injure or disturb an undetermined number of individuals. However, during the winter season, when amphibians are most likely to be found outside the riparian zone, several factors will reduce the likelihood of direct impact. The HCP's weather road use limitations will limit access by heavy equipment during this period, and the FPRs prohibit tractor logging on saturated soils, confining yarding to cable or aerial methods. These factors, in combination, should reduce the likelihood of injury or disturbance of the individuals found near key habitat areas (i.e., aquatic habitats), but will not fully avoid impacts. Because some northwestern pond turtle nesting probably occurs outside the RMZs during summer months, timber harvest activities may adversely affect nesting individuals. The proportion of the population nesting outside RMZs is unknown, so the importance of this effect cannot be determined.

Suitable habitat

Habitat protection

Suitable habitat in RMZs would most likely be protected in areas restricted from timber harvest, road construction, or other activities which would directly alter suitable habitat. Before watershed analysis, minimum no harvest buffers along Class I and Class II streams include a total of 13, 697acres distributed as follows: 0 to 100 feet on Class I streams (7,121 acres); and 0 to 30 feet on Class II streams (5,576 acres). After watershed analysis, minimum and maximum no harvest buffers along Class I and Class II streams would protect a range of acres distributed as follows: 30 to 170 feet on Class I streams (2,143 to 11,872 acres, respectively); and 30 to 170 feet on Class II streams (5,576 to 29,993 acres, respectively). It is likely that the results of watershed analysis will provide protection for a total number of acres somewhere in between 7,719 and 41,865 acres.

The Headwaters Forest would protect an additional 17 miles of Class I streams, 27 miles of Class II streams, and 77 acres of wetlands. MMCAs are estimated to contain 117 miles of Class I and Class II streams.

The protection of suitable habitat within no harvest buffers in RMZs and in areas identified outside RMZs would benefit the northern red-legged frog, foothill yellow-legged frog, and northwestern pond turtle, and in the long-term is expected to increase suitable habitat for each subspecies and species, given current management practices and the fragmented condition of the landscape.

Northern red-legged frog

Habitat loss and modification

The proposed action may result in the loss or modification of an undetermined amount of suitable habitat.

Including all acreage outside no-cut zones and within 530 of streams as an analysis area, the potential area affected could range between 92,668 and 126.814 acres of potential habitat that could be modified (table 61). However, consideration of amphibian needs during post-WA prescription setting, as required in the HCP, should minimize adverse effects in RMZs, and most effects should be confined to localized upland areas outside those zones. Timber harvest and prescribed fire may reduce the amount of standing or downed wood in some areas, thus reducing the recruitment of coarse wood into the aquatic system, and hence, structure needed to create pools for the northern red-legged frog. Snag and downed log retention requirements, combined with buffer zones in RMZs, should minimize the impact of this habitat modification. Refer to **Effects Section for tailed frog** for further discussion pertaining to coarse woody debris. It is assumed that water temperatures will improve gradually and consistently throughout the plan period as younger forested stands in RMZ's develop greater height and total canopy mass resulting in more favorable conditions for the northern red-legged frog.

Table 61. Amount of potentially suitable northern red-legged frog habitat subject to removal or modification due to implementation of the PALCO SYP and HCP, Humboldt County, CA.

Stream class	Distance (ft.) from water's edge	Total acres within zones
Class I - Pre WA[1]	100-170[2] - select Rx[3] >170-530 -any Rx	4,751 25,799
Class II - Pre WA	30-130[2] - select Rx >130-530 - any Rx	18,315 72,485 Subtotal: 121,350
Class I & II - Post WA minimum Class I & II - Post WA maximum	30[2]-530 - any Rx 170[2]-530 - any Rx	126,328 92,182
Wetlands		486

[1] WA = watershed analysis.
[2] Distance represents outer band of RMZ.
[3] Rx = prescription.

Foothill yellow-legged frog

Habitat loss and modification

The proposed action may result in the loss or modification of an undetermined amount of suitable habitat. Implementation of the aquatic conservation plan will minimize effects to foothill yellow-legged frog habitat, however, some upland habitat will be harvested. It is assumed that water temperatures will improve gradually and consistently throughout the plan period as younger forested stands in RMZ's develop greater height and total canopy mass resulting in more favorable conditions for the foothill yellow-legged frog. A total of approximately 16,724 to 50,870 acres of potentially suitable terrestrial habitat could be removed or modified depending upon the post-watershed analysis buffer implemented (table 62). This amount does not include indirect effects on aquatic habitats.

Timber harvest and prescribed fire may reduce the amount of standing or downed wood in some areas, thus reducing the recruitment of coarse wood into the aquatic system, and hence, structure needed to create pools for the yellow-legged frog. Snag and downed log retention requirements, combined with buffer zones in RMZs, should minimize the impact of this habitat modification. Please refer to **Effects Section for tailed frog** for further discussion pertaining to CWD.

Table 62. Amount of potentially suitable foothill yellow-legged frog habitat subject to removal or modification due to implementation of the PALCO SYP and HCP, Humboldt County, CA.

Stream class	Distance (ft.) from water's edge	Total acres within zones
Class I - Pre WA[1]	100-170[2] - select Rx[3] >170-230 -any Rx	4,751 4,490
Class II - Pre WA	30-130[2] - select Rx >130-230 - any Rx	18,315 17,850 Subtotal: 45,406
Class I & II - Post WA minimum Class I & II - Post WA maximum	30[2]-230 - any Rx 170[2]-230 - any Rx	50,384 16,238
Wetlands		486

[1] WA = watershed analysis.
[2] Distance represents outer band of RMZ.
[3] Rx = prescription.

Northwestern pond turtle

Habitat loss and modification

As stated earlier, analysis of effects of habitat removal is confounded by lack of information on turtle use of local habitat and on suitability of local conditions. Incorporating into analysis all acreage within the maximum distance turtles have been found from water in other studies, an estimate of up to 191,281 acres of PALCO land (about 95 percent of the property) could be turtle habitat subject to effects (Table 63). This is clearly a substantial overestimate, but there are no data available for determination of more reasonable estimates.

Therefore, the FWS concludes that outside RMZs an unknown amount of habitat could be affected by timber harvest and associated activities. Such effects would probably be focused near riparian zones, in localized areas where turtles find favorable conditions for nesting or estivation. Whether impacts of harvest on such habitats are permanent is unknown. Within RMZs, implementation of the WA reptile/amphibian module and consideration of the species' needs in prescription setting should result in considerable improvement in habitat conditions over time.

Timber harvest and prescribed fire may reduce the amount of standing or downed wood in some areas, thus reducing the recruitment of CWD into the aquatic system, and hence, pools for rearing, and basking or resting sites for the turtle. Snag and downed log retention requirements, combined with buffer zones in RMZs, should minimize the impact of this habitat modification.. Refer to **Effects Section for tailed frog** for further discussion pertaining to CWD.

Table 63. Amount of potentially suitable northwestern pond turtle habitat subject to removal or modification due to implementation of the PALCO SYP and HCP, Humboldt County, CA

Stream class	Distance (ft.) from water's edge	Total acres within zones
Class I - Pre WA[1]	100-170[2] - select Rx[3] >170-1,640 -any Rx	4,751 83,277
Class II - Pre WA	30-130[2] - select Rx >130-1,640 - any Rx	18,315 79,959 Subtotal: 186,302
Class I & II - Post WA minimum Class I & II - Post WA maximum	30[1]-1,640 - any Rx 170[1]-1,640 - any Rx	191,281 157,135
Wetlands		486

[1] WA = watershed analysis.
[2] Distance represents outer band of RMZ.
[3] Rx = prescription.

Indirect effects on northern red-legged frog, foothill yellow-legged frog, and northwestern pond turtle

Habitat loss or modification

The proposed action may indirectly affect the northern red-legged frog, foothill yellow-legged frog, and northwestern pond turtle as a result of a reduction in the quantity or quality of both terrestrial and aquatic suitable habitat. Over the permit period, a substantial number of acres of potentially suitable habitat would be subject to timber management.

The SYP estimates a total harvest of approximately 54,400 acres (26 percent of total ownership) with in the first decade. Of this projected harvest, the majority (about half) is projected to occur within the Eel WAA (FEIS, table 3.4-7). The next highest proportion of harvesting is expected to occur in the Humboldt Bay WAA, where 12,772 acres (23 percent) of the first decade's harvest is proposed. Therefore, impacts to the northern red-legged and foothill yellow-legged frogs and the pond turtle might be highest in these watersheds. However, it should be noted that other factors can influence the degree of impacts resulting from similar actions in different locales. These may include, but are not limited to the following: soil types; existing vegetative conditions; surface erosion potential; and weather systems.

Timber harvesting activities can influence vegetation composition, hydrologic processes, sediment transport, stream temperatures, water quality, nutrients, habitat structure, and numbers and composition of aquatic biota. Influences on aquatic habitats are summarized in detail in the **Effects Common to Aquatic Species** section. Indirect effects on the northern red-legged frog, foothill yellow-legged frog, and northwestern pond turtle in both the terrestrial and aquatic environments could include decreased upland foraging habitat, decreased prey base, decreased water quality for egg masses or foraging, decreased basking sites, and refugia or escape cover.

However, compared to current management practices, implementation of riparian prescriptions within RMZs and other additional protective measures outside RMZs, such as steep slope and mass wasting provisions, will result in long-term increases in coarse wood recruitment and long-term decreases in sedimentation yields. Implementation of these prescriptions will minimize impacts of timber harvest within RMZs, but may not allow maximum attainment of these elements if maximum buffer widths are not utilized. Even if the no-cut band widths were enlarged through the watershed analysis process, it is expected that, due to past management practices, the current levels of sedimentation will continue on the order of decades, before an improving trend will emerge. Refer to **tailed frog Effects Section** for further discussion on importance of CWD components and sedimentation factors in the aquatic system.

Tailed frog and southern torrent salamander

These two species are probably more sensitive to effects of timber harvest than the other covered amphibian and reptile species, because they have narrower tolerances to temperature and sediment. In particular, populations of the tailed frog are already suspected to be experiencing the adverse direct, indirect and cumulative effects of intensive forest management. Based on the site-specific results in Wroble and Waters (1989), and on comparative studies with other similar landbases under differing management regimes (Welsh et al. 1998), the FWS believes that ongoing habitat losses and population declines are occurring on the PALCO ownership. Information from nearby industrial forest ownerships (Welsh et al. 1993; Welsh, et al., 1998) - and on nearby public lands subjected to episodic disturbances originating on adjacent lands (Welsh and Ollivier 1998) - also provide evidence of the causal mechanisms for habitat loss and population declines.

Direct and indirect effects

Each of the five effects on physical habitat that are outlined below may occur directly (at the same time and place as the initiating action), or indirectly (delayed effect following present or past actions). The effects of these habitat changes on expected population trends are discussed in the following section, titled "summary of species responses to the proposed action". The FWS is especially concerned about two persistent and adverse habitat effects resulting from past management of PALCO lands; recruitment of LWD and sedimentation (1 and 3 below). In both instances, conditions may continue to deteriorate for several decades. At that time, the recruitment of late seral acreage in Class II RMZ's will take a sharp upturn, beginning a sustained improving trend (based on the seral stage time series tables in Volume III of the draft HCP). The relationships are discussed in more detail in parts (1)(b1) and (3), below. The FWS considers this timeframe to be unavoidable due to the current low levels of streamside late seral and old-growth acreage in Class II and III RMZ's, and to the time required for younger stands to grow into, at least, a late seral condition.

(1) Recruitment of Instream CWD - This is one of the two factors (the other being (3), below that the Service considers most critical to southern torrent salamander and tailed frog conservation. Pending watershed analysis, the RMZ prescriptions call for 100 foot no-cut buffers along Class I streams, and 30 foot no-cut buffers along Class II and III streams. If selection prescriptions are implemented-cutting bands adjacent to the no-cut bands of Class I and II streams, the selection zones may provide little or no additional LWD recruitment (Reid 1998) because the harvest would remove much of the potential stand mortality before it occurs. However, the selection-cut bands are expected to buffer the no-cut bands from windthrow and to filter sediments (Reid and Hilton 1998), and provide canopy closure.

The expected effects of the RMZ implementation on populations and habitats of both species are as follows: (a) Class I RMZ guidelines will have little or no beneficial effect because both species are largely excluded from those lower reaches by fish predation and warm-water conditions arising from greater stream width and surface exposure. (b) Long term LWD recruitment in Class II and III reaches is problematic for three reasons. First, the forest seral types adjacent Class II reaches are currently skewed to younger age classes. Approximately 33 percent in Class II stream frontage is in late-seral or old-growth condition (SYP/HCP, table 13). Younger stands experience less stand mortality on a volume per-unit-of-time basis, and because down trees are small they are more susceptible to flushing-out during peak flow events. As a result, much of the beneficial effect of the no-cut buffer zones will not materialize immediately, but will accumulate over the decades required for those stands to increase biomass. In the near term, as habitat patches are lost to sedimentation, fewer new suitable patches are being created through channel morphological processes because of the current diminished state of LWD recruitment.

Second, according to Reid's (1998) estimate for Site Class II lands, the 30 foot no-cut band would produce, at most, about 34 percent of the LWD recruitment that would be expected for band-widths equal to the site potential tree height of 230 feet (plus an additional 5 percent originating from the selection-cut band in Class II's). The actual recruitment would be even lower because of the current low amounts (33 percent) of late-seral and old-growth stands adjacent to Class II streams. Even if the no-cut band widths were enlarged through the watershed analysis process, it is expected that, due to past management practices, the current trend of net loss of tailed frog and southern torrent salamander habitat patches will continue for several decades, before an improving trend will emerge.

Third, due to the narrow width of the no-cut bands in Class II and III RMZ's, there is some question about the resilience of the no-cut bands. Class I and II no-cut bands are further "buffered" by selective-cutting zones, which should reduce the incidence of catastrophic windthrows (Reid and Hilton 1998). In contrast, Class III's no-cut bands are "unbuffered" and are found in the upper reaches of drainages with greater exposure to high winds.

(2) Obliteration of Suitable Habitats Through Mass-Wasting Events - Mass-wasting prevention measures in the SYP/HCP should reduce the incidence of direct habitat losses through debris slides. The current prevention measures include prohibitions on harvest around headwalls, inner gorges and unstable areas, and limitations where mass wasting hazard is high-to-extreme. However, in the near term, debris slides may still originate from recent (pre-SYP/HCP) harvests in high-risk areas. There is also cause for concern over continued sediment infusions into streams from recent slides that have not yet stabilized. Since many of the headwall and high-risk areas are in Class III drainages, we expect the mass-wasting provisions will reinforce the Class III RMZ protections. Direct losses of suitable habitat patches due to debris slides are expected to decline in the near and long terms.

(3) Sediment Delivery and Sediment Storage Capability - This is the second of the two factors (the other being (1), above) that the FWS considers most critical to southern torrent salamander and tailed frog conservation. Much of the total sediment yield in a watershed originates from intermittent and ephemeral headwater reaches (mostly Class III's) during peak flow periods. This is attributable to several factors: (a) A significant proportion of land drains into Class III's; (b) headwaters drainages have been disproportionately impacted by harvesting in recent decades (from inspection of Map 5, Vol. V of the Draft SYP/HCP and comparison of published and unpublished (PALCO, 1998) seral stage distribution tables for Class I and II; (c) headwater reaches are mostly intermittent and ephemeral channels and have historically received lower levels of protection through State FPR, so, taken with (b), both the magnitude and intensity of streamside impacts tends to be greater; and (d) stream gradient and sideslopes in low-order streams (e.g., Class III's) tends to be greater than middle and higher order streams (e.g., Class I's and II's) (Sedell, et al., 1988).

Sediment storage capability is constrained by LWD recruitment rates. Based on the seral stage condition of Class III drainages (see (1), above), the FWS concludes that sediment storage capabilities will not recover to desirable levels in the near term, even if RMZ protection measures are maximally effective. As with LWD recruitment (above), the recovery process should unfold over several decades, with interim net losses of suitable habitat in Class II stream reaches due to continuing sediment infusion. The FWS expects that this issue will be examined in depth through the watershed analysis and monitoring review processes. The FWS also foresees that the proposed hillslope protection and road management measures in the Final SYP/HCP (regarding construction, use limits, road repair, road upgrades and limits on harvest in high erosion hazard areas) should produce positive near term results, as they will immediately remedy (or minimize) poor drainage conditions originating from road surfaces. However, the hillslope and road protection measures may not completely offset the larger and continuous influx of sediments from surface erosion on recently harvested upslope areas, especially in the short term.

(4) Forest Canopy Closure and Microclimate in Streamside Areas - Based on preliminary estimates (Peters, 1998) for Class I and II RMZ's, the FWS believes that the selection cutting regimes should provide adequate canopy closure (approximately 80 percent) to maintain favorable microclimate conditions for both species; but the preliminary model estimates should be verified through monitoring.

(5) Stream Temperature Regimes - Both species are associated with cold water streams and are highly sensitive to warm water infusions (see the discussions on habitat specificity for both species under Life History). Considering the current high percentage of forest openings, young forest and mid-successional stands along Class II and III streams, the Service concludes that water temperatures will improve gradually and consistently throughout the plan period as the younger stands in RMZ's develop gréater height and shading capability.

Effects common to amphibians and aquatic reptiles: - interrelated and interdependent effects:

Forest chemicals (i.e., herbicides, pesticides and fertilizers) may be used in connection with PALCO's timber management activities. Herbicides and pesticides may be used to enhance reforestation. Herbicides may be applied aerially or manually to control competing and undesirable plant species. Direct effects to covered species may include exposure to chemicals. Indirect effects may occur due to habitat modification. Fertilizers may be applied aerially or on the ground to increase growth of plantations. Applications of fertilizers have the potential to result in disturbance during the breeding season of species or to affect habitat quality.

Use of forest chemicals may have effects on aquatic amphibians and reptiles, but few specific data are available regarding potential effects on these species. The anticipated likelihood of effects is highly variable depending upon the characteristics of the different compounds and variations in application methodology. A discussion of forest chemical use on the PALCO property is found in Chapter 3.14 of the Final EIS/EIR. In general, the conclusions regarding potential impacts to salmonids are applicable to aquatic amphibians and reptiles.

Use of forest chemicals is not covered under the ITP and this activity remains subject to applicable Federal and State laws including the prohibition on take under Section 9 of the Act. Use of some forest chemicals may be included as a covered activity in the future through an amendment to the ITP. An application to amend the permits would require full compliance with NEPA, ESA and other applicable federal laws and would be subject to public review and comment.

The issuance of a 5-year streambed alteration agreement with the CDFG is also discussed above. Most of the impacts discussed for salmonids would also be expected to apply to covered amphibians and reptiles. Because these impacts occur at localized levels and are subject to the other restrictions of the HCP, the degree of impact to covered amphibians and reptiles would not be expected to be substantial.

<u>**Northern California ESU steelhead**</u>
Refer to Effects common to salmonids.

<u>**Southern Oregon/California Coasts ESU coastal cutthroat trout**</u>
Refer to Effects common to salmonids.

<u>Summary of species response to proposed action</u>

LISTED SPECIES/CRITICAL HABITAT:
<u>**American peregrine falcon**</u>
Only one peregrine falcon nest site is currently known to exist on PALCO lands, at Scotia Bluffs. Two additional nest sites occur within the action area, but not on PALCO ownership. Future surveys may discover an undetermined number of additional nest sites but suitable habitat is limited. Conservation measures identified in the American Peregrine Falcon Conservation Plan are to be implemented for all present and future nest sites within the action area. If these conservation measures are successfully implemented, adverse effects due to disturbance from timber operations and other covered activities will be minimized. No pesticide-associated adverse effects are expected to occur as part of this action. No active nest sites or potential nest sites are likely to be destroyed as part of this action. Habitat modification may have some adverse effects on the species depending on the resulting habitats likely to be created during the 50 year implementation of the SYP/HCP. However, habitat loss has not been considered as a major threat to the peregrine in significant portions of its range, and has not precluded recovery of the species. In summary, conservation measures are likely to minimize disturbance, injury, and habitat loss for this species to the maximum extent practicable.

<u>**Northern spotted owl**</u>
The proposed action may affect and is likely to adversely affect the northern spotted owl. The response of the northern spotted owl to the proposed action over the 50-year period is described in relation to habitat conditions (e.g., removal, protection, distribution) and disturbance.

Habitat protection, in combination with the adaptive management strategy, would maintain at least 108 activity centers distributed throughout the PALCO lands. The population level may decline from a total of 156 to 108 activity centers, a potential reduction of 48 activity centers, due to adverse effects associated with the loss, localized distribution, or fragmentation of suitable habitat. In addition, an undetermined number of activity centers may be removed from the population of owls in the action area outside of the action area. The amount (177,173 acres) of suitable habitat at the end of 50 years may moderate these adverse effects and represents a gain of 6,769 acres, compared to current levels.

other restrictions of the HCP, the degree of impact to covered amphibians and reptiles would not be expected to be substantial.

Northern California ESU steelhead

Refer to **Effects common to salmonids.**

Southern Oregon/California Coasts ESU coastal cutthroat trout

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Northern spotted owls would remain distributed throughout the PALCO lands. Habitat conditions would allow for movement and interchange between occupied sites.

Reproduction would be monitored and corrective measures taken to ensure habitat conditions provide for an average reproduction level of 0.61 fledged young per pair over a 5-year period. The target rate represents the average observed on the PALCO lands from 1994 to 1998. Reproduction at individual sites may be affected. Site-specific factors such as location of activity center relative to proposed project areas, timing and intensity of actions may influence the degree of effect.

An undetermined number of individuals are subject to disturbance, injury, or death. Survey efforts and limited operating periods are expected to reduce the effect if owls are detected during survey efforts. Surveys may fail to detect some owls.

Although suitable habitat would be removed or modified throughout the permit period, the proposed action would result in a net gain of 6,769 acres of suitable habitat at a landscape level, compared to existing levels of 170,404 acres. The proportion of nesting habitat would shift from high to moderate quality. Suitable habitat would be protected in areas such as MMCAs, RMZs, and the Headwaters Reserve. A substantial amount of suitable habitat would be provided in the vicinity of 80 activity centers.

Most conservation needs of the species would be met. Suitable nesting, roosting, foraging, and dispersal habitat would be maintained in an adequate quantity, quality, and distribution to allow a reduced population to persist on the ownership. The population level on the PALCO lands would exceed a desired cluster size of 60 activity centers, contributing to the recovery of the species in the southern part of the regional area. The extent of territory overlap, however, cannot be predicted, but home ranges of owls at most activity centers may overlap, based on the distribution of suitable habitat. Habitat conditions would be stable for a limited number of activity centers, principally within MMCAs and those afforded Level One protection measures.

Bald eagle

The proposed action may affect and is likely to adversely affect the bald eagle. The response of the bald eagle to the proposed action over the 50-year period is described in relation to habitat conditions (e.g., removal, protection, distribution) and disturbance.

There are no known bald eagle nests on the PALCO lands and in the action area; thus, none would be affected unless new territories are formed. Few nests are likely to be discovered in the action area, based on the size of the regional nesting population. Survey efforts have a somewhat reduced likelihood of detecting nesting eagles in suitable habitat greater than 0.5 mile from Class I streams. An undetermined number of individuals or nest, roost, or perch sites may be affected in the vicinity of nest sites that have not been located prior to management activities. At least 11 wintering individuals may be adversely affected.

Conservation measures have a higher probability of reducing impacts on the reproduction of nesting eagles found within 0.5 mile of Class I streams.

Suitable habitat would be protected in large blocks, such as the Headwaters Reserve and in smaller blocks such as MMCA, adjacent to owl activity centers, RMZs, and other areas. These habitats would maintain options for nesting, roosting, and wintering eagles. A total of 39,940 acres of suitable habitat would exist on the PALCO lands at the end of 50 years, down from 69,231 acres. Suitable habitat would remain distributed throughout the PALCO lands. Habitat quality would be reduced, due to a loss of special habitat components.

The conservation needs of the species may be partially met if surveys fail to detect nesting or wintering eagles, due to the effect of disturbance on reproduction and the survival of individuals. PALCO lands, however, play a minor role in the recovery of the species, given the broad range of the species and limited nesting and wintering populations in the area. Suitable habitat would be maintained in an adequate quantity, quality, and distribution to allow a population to persist on the ownership if nesting or wintering areas are detected.

Marbled murrelet

Summary of the Adverse and Beneficial Effects of the Proposed SYP/HCP on the Marbled Murrelet

The following discussion provides a summary and conclusion regarding the Service's analysis of the combined adverse and beneficial effects of the proposed action on the marbled murrelet. The information presented earlier will be reviewed in the context of the potential effects to the species' numbers, reproduction, and distribution. These effects will be evaluated for both short and long term impacts, and they will also be discussed, where relevant, at the appropriate landscape and population scale.

Effect of the Action on Murrelet Numbers: The proposed action will adversely affect the murrelet and will result in the take of murrelets associated with 4,696 acres of known or likely occupied habitat. Most of these adverse effects will occur in the first five to ten years of the permit. Approximately 446 of these harvested acres are high quality UOG, while most of the remaining 4,250 acres are moderate to lower quality residual redwood stands or Douglas fir. In contrast, the action conserves 4,693 acres (91 percent) of the highest quality UOG and 4,137 acres (50 percent) of the likely occupied DFOG and ROG; much but not all of this ROG is higher quality than the ROG that is proposed for harvest. Similar to the approach adopted in other HCPs, the proposed action will conserve a large percentage of the highest quality habitat, which in turn is likely to harbor the largest percentage of successfully reproducing murrelets (Marbled Murrelet Recovery Team, November 30, 1998; P. Karieva, December 7, 1998).

In the short term, the total number of murrelets nesting on the ownership will likely be reduced from current levels for some indeterminable time period. It is expected that murrelet nesting densities and reproductive success will eventually increase within the reserve areas due to improving habitat conditions within the permit period.

Some analyses prepared by consultants to PALCO used the RBV calculation to conclude that 95 percent of the murrelets in the bioregion would be protected in the Headwaters reserve, SYP/HCP MMCAs, and state parks (Ralph et al. (1997 and 1998) in Draft SYP/HCP, Vol. IV, Part B, Sec. 9 and 10). In contrast, other murrelet scientists have suggested in public comments that the number of murrelets impacted by the proposed action will be significantly higher than the figures represented in the final EIS/EIR (H. Carter, pers. comm., Nov. 11, 1998; S. K. Nelson, pers. comm., November 12, 1998). The final EIS/EIR provides a number of best and worst case scenarios to consider the numbers of murrelets impacted (e.g., final EIS/EIR, appendix N2, table 6.D).

The FWS rejects the optimistic RBV estimates of Ralph et al. in the Draft SYP/HCP as well as the more pessimistic appraisals of Carter and Nelson, respectively. Instead, we conclude the total number of murrelets actually impacted will be smaller than the proportion suggested by the acres of known or likely occupied habitat that will be removed within the Bioregion. Even though about 35 percent of the estimated occupied habitat on the ownership is proposed for harvest, the proposed action should protect substantially more than 65 percent of the murrelets on the ownership (including Headwaters acquisition area) because of anticipated higher murrelet densities in the higher quality reserve areas (P. Karieva, pers. comm., December 7, 1998). Likewise, less than 22 percent of the murrelets in the Bioregion will probably be adversely affected by the proposed action.

Murrelet densities in California's redwood zone probably differ from densities in the habitat types in Oregon and Washington and may be higher if gross detection levels are a reliable indicator. Approximately 3.6 percent of the likely occupied habitat in Recovery Zone 4, and 0.67 percent of the likely occupied habitat in the listed range will probably be adversely affected by the proposed action, but the FWS has no quantitative data or method to further estimate the percentage of murrelets impacted at the level of the Recovery Zone or listed range.

After careful consideration of the best available information, including recent materials provided by PALCO and by interested members of the public, the FWS expects that the proposed action will adversely affect the species but will nevertheless protect an adequate number of murrelets to help maintain a viable subpopulation in Recovery Zone 4. The great majority of the remaining occupied habitat throughout the Zone and listed range is protected on Federal lands or through other HCPs and is therefore not likely to decrease from future timber harvest to any significant degree. The take of murrelets associated with the harvest of the proposed amount of mostly low to moderate quality habitat will not appreciably reduce the likelihood of the species' survival and recovery when viewed in conjunction with the long term preservation of the high quality habitat in the acquired Headwaters reserve, the MMCAs, on nearby public lands, and throughout the listed range,

Effect of the Action on Murrelet Reproduction: The proposed action uses the best available science to identify for preservation the highest quality habitat that likely has the highest rates of reproductive success, while identifying areas that have lower rates of productivity for potential harvest (Marbled Murrelet Recovery Team, pers. comm., November 30, 1998, P. Karieva, pers. comm., December 1 and 7, 1998). Similar to the effect on murrelet numbers described above, the proposed harvest will have an adverse effect on reproduction for some number of murrelets likely to be less than 35 percent of the total numbers on the PALCO ownership. Most of these adversely affected murrelets will not be directly killed, but their reproductive opportunities will be eliminated or significantly reduced due to removal of their nesting habitat. Some percentage of displaced murrelets may successfully settle in other uncut habitat, but due to issues of site fidelity, predation, and intraspecific competition for nest sites, this percentage is likely to be small.

An impact to reproduction of murrelets associated with the harvest of this amount of mostly low to moderate quality habitat will not impact the reproductive capacity of murrelets to such an extent that the proposed action will appreciably reduce the likelihood of the species' survival and recovery, especially when viewed in conjunction with the long term preservation of the high quality habitat in the Headwaters reserve, in the MMCAs, on nearby public lands, and throughout the listed range under the Northwest Forest Plan. It is expected that murrelet nesting densities and reproductive success will eventually increase within the reserve areas due to improving habitat conditions within the permit period.

Effect of the Action on Murrelet Distribution: The proposed action will lead to the removal of occupied habitat on PALCO lands and will reduce the distribution of the murrelet in certain localized portions of the ownership, especially in the southern part of PALCO lands. However, by establishing the MMCAs and the Headwaters reserve, the proposed action adequately maintains distribution of murrelets on the ownership and in the bioregion (Marbled Murrelet Recovery Team, pers. comm., November 30, 1998). The reduction in distribution of murrelets on certain portions of PALCO lands will not appreciably reduce the likelihood of the species' survival and recovery when viewed in conjunction with the long term maintenance of distribution in the Headwaters reserve, in the MMCAs, on nearby public lands, and elsewhere throughout the listed range.

Marbled murrelet critical habitat The proposed action would bring over 70 percent of the timber stand acreage with primary constituent elements in CHU-03 a into the acquired Headwaters Reserve and MMCAs. These reserves would contain all of the best quality habitat uncut old growth redwood habitat existing within the CHU, which would be aggregated with residual habitat and late seral forest to protect the great majority of the existing conservation value in the CHU. The critical habitat left outside the reserves constitutes about 1.1 percent of the critical habitat in Conservation Zone 4 and about 0.3 percent of the critical habitat in the 3-state range. Almost 1/3 of the critical habitat left unprotected by the murrelet strategy would have some degree of protection in RMZs. The habitat being unprotected is primarily of lower quality, so the proportional effect on the CHU is lower than indicated by simple quantitative comparison of habitat removed versus habitat preserved. While there would be some adverse effects to critical habitat at the local level, the function of CHU-03 in providing breeding habitat would be retained. Therefore the effects on critical habitat would not appreciably reduce the value of critical habitat for the survival and recovery of the species.

Western snowy plover

The FWS concludes that the SYP/HCP may affect, but is not likely to adversely affect, the western snowy plover. This conclusion is based on the following: limited potential for impacts to the western snowy plover from activities to be covered under this SYP/HCP; the species conservation measures prescribed in the SYP/HCP; and the information available about the western snowy plover in the vicinity of the project. Currently, the known distribution of the species does not include any habitat under the ownership or vested rights of PALCO. Therefore, no adverse effects to the species from proposed activities are anticipated. Should the species expand its range to include portions of Eel River gravel bars under PALCO ownership or vested rights, conservation measures are established in the SYP/HCP to provide protection to breeding pairs. Should PALCO acquire lands or vested rights in the future on portions of the Eel River within the nesting range of snowy plovers at that time, protocol surveys will be conducted to locate nest locations, and nest protection measures in place at the time will be implemented to minimize the risk of adverse impacts to the species.

Implementation of the SYP/HCP is not anticipated to result in changes to the topography, substrate, or overall function of gravel bars on the Eel River. Thus no significant modification of suitable habitat of this species is anticipated. Long-term impacts of future gravel extraction operations (to be covered under separate permit and consultation) will be considered during the first 3 years of the implementation of this SYP/HCP.

Southern Oregon/Northern California Coast ESU coho salmon

The NMFS concludes that the proposed action may affect and is likely to adversely affect coho salmon in the SONCC ESU. The response of SONCC coho salmon to the proposed action over the 50-year period is assessed and described in relation to essential habitat features in the Effects Common to Pacific Salmonid section. The NMFS concludes that implementation of the aquatic conservation plan and its interrelated strategies will maintain or achieve, over time, properly functioning aquatic habitat conditions, thereby resulting in the long term survival of coho salmon in the SONCC ESU.

PROPOSED SPECIES:

Southern Oregon and California Coastal ESU chinook salmon

The NMFS concludes that the proposed action may affect and is likely to adversely affect SOCC chinook salmon in the SOCC ESU. The response of SOCC chinook salmon to the proposed action over the 50-year period is assessed and described in relation to essential habitat features in the Effects Common to Pacific Salmonid section. The NMFS concludes that implementation of the aquatic conservation plan and its interrelated strategies will maintain or achieve, over time, properly functioning aquatic habitat conditions, thereby resulting in the long term survival of chinook salmon in the SOCC ESU.

Southern Oregon/Northern California Coho salmon critical habitat

The NMFS concludes that the proposed action may affect proposed critical habitat for coho salmon in the SONCC ESU. The aquatic conservation plan will provide for the essential habitat elements necessary for the long term survival of coho salmon.

Chinook salmon critical habitat

The NMFS concludes that the proposed action may affect proposed critical habitat for chinook salmon in the SOCC ESU. The aquatic conservation plan will provide for the essential habitat elements necessary for the long term survival of coho salmon.

UNLISTED SPECIES:

Bank swallow

The proposed action is not likely to adversely affect the bank swallow because the species is not known to occur in the action area and conservation measures will minimize potential impacts on any newly discovered colonies.

Pacific fisher

The proposed action may affect and is likely to adversely affect the Pacific fisher. Covered activities have the potential to directly kill or injure fishers, and may disrupt breeding, feeding, and sheltering, behavior of fishers. Pacific fisher are expected to decrease by some unknown number in the action area due to a reduction and fragmentation of LSH.

The PALCO lands constitute a relatively small proportion of the range of the Pacific fisher. Historic records and recent surveys indicate that coastal redwood forests are apparently low quality habitat for fishers compared to more inland Douglas-fir and mixed conifer forests. It is currently unknown if a sustainable population of Pacific fishers exists within the Coastal Province of Northern California.

Late-seral habitat is considered the highest quality habitat for Pacific fishers on PALCO lands. The amount of LSH is expected to be substantially reduced and fragmented within the ownership. Although several patches of LSH greater than 80 acres in size will be retained on the ownership, patches greater than 475 acres in size will only be retained in the Humboldt and Yager WAAs throughout the permit period. In addition to LSH, coniferous and montane hardwood coniferous habitats typed as CWHR 4D that contain structural components used by fishers for rest and den sites may provided additional resting and denning habitat.

Although the amount of LSH on PALCO lands will be limited at the end of the permit period in the Eel River WAA, State park lands in this WAA are expected to provide large blocks of LSH. The resultant conditions on the PALCO ownership and adjacent public lands at the end of the permit period, in comparison to the **Conservation needs** of the species, are expected to contribute moderately to a sustainable population in the Coastal Province of Northern California, assuming a sustainable population currently exists. Although suitable foraging habitat would be maintained in adequate quantities within all five of the major WAAs, higher quality resting and denning habitat (i.e., LSH) would not be maintained in an adequate quantity, quality, and distribution on PALCO lands. Special habitat components important to fishers will be retained and recruited across PALCO lands in amounts similar to those recommended in the **Conservation needs** identified for this species, and dispersal corridors between patches of LSH within and adjacent to PALCO lands will be provided by RMZs and CMZs. Although road densities on PALCO lands are much higher on average than those recommended in the **Conservation needs** for this species, most of the dirt logging roads on PALCO lands are closed to the public and are expected to maintain a moderate canopy cover.

Red tree vole

The proposed action may affect and is likely to adversely affect the California red tree vole. Covered activities have the potential to directly kill or injure red tree voles, and may disrupt breeding, feeding, and sheltering, behavior of voles. Increased fragmentation of LSH could result in increased predation of red tree voles.

Late-seral habitat is considered the highest quality habitat for red tree voles on PALCO lands. The amount of LSH is expected to be substantially reduced and fragmented within the ownership over the permit period. Although several patches of LSH greater than 80 acres in size will be retained on the ownership, patches greater than 475 acres in size will only be retained in the Humboldt and Yager WAAs throughout the permit period. In addition to LSH, coniferous and montane hardwood coniferous habitats typed as CWHR 4D which contain structural components used by red tree voles may provide additional lower quality habitat.

Although the amount of LSH on PALCO lands will be limited at the end of the permit period in the Eel River WAA, State park lands in this WAA are expected to provide large blocks of LSH. The resultant conditions on the PALCO ownership and adjacent public lands at the end of the permit period, in comparison to the **Conservation needs** of the species, suitable nesting and dispersal habitat would be maintained in an adequate quantity, quality, and distribution to allow a reduced population to persist on the ownership. Habitat conditions would be stable for a limited number of occupied sites, principally within MMCAs. Special habitat components which have the potential to provide suitable nest sites will be retained and recruited throughout the PALCO ownership. Dispersal corridors between patches of LSH within and adjacent to PALCO lands will be provided by RMZs and CMZs.

The proposed action includes effectiveness monitoring and adaptive management for this species. This process will help meet the additional research needs identified in the **Conservation needs** section of this document. The determination of non jeopardy for the California red tree vole is based in part on the expectation that potential changes to conservation measures identified during effectiveness monitoring conducted within years 2 to 7 of the permit will be implemented.

Response common to the northern red-legged and foothill yellow-legged frogs, and the northwestern pond turtle

The SYP/HCP includes riparian protection measures that exceed current CFPR. By the end of the 50 year period, the development of younger and residual stands within RMZs should improve the condition of aquatic habitat. As a result of riparian protection measures, it is assumed these species and subspecies would remain generally distributed throughout the PALCO ownership, occurring in suitable habitat in and adjacent to Class I and Class II streams, and wetlands. Riparian buffers do not provide maximum protection for the species and subspecies, but do reduce the degree of adverse impacts associated with timber harvest. Further fragmentation of forested habitat adjacent to suitable aquatic habitats will limit localized availability of suitable wintering and foraging or nesting habitat, and may lead to localized extirpations of these species' and subspecies' populations on the ownership.

The SYP/HCP includes longer term protection measures that may be developed and enacted through the site-specific watershed analysis processes. All parties to the SYP/HCP are required to adhere to the intent of the process, which is to conserve the included species. As elements of uncertainty are brought into sharper focus through monitoring and research, the relevant information will be incorporated, as needed, into management practices through the watershed analysis process. The FWS expects that improvement of the RMZs will be examined in depth through the watershed analysis and monitoring review processes. The FWS also expects that the proposed road management measures in the SYP/HCP (regarding construction, use limits, repair, and upgrades) should produce positive near term results, if applied diligently, as they will immediately remedy (or minimize) poor drainage conditions originating from road surfaces.

The FWS concludes that the ameliorating effects of the SYP/HCP aquatic provisions will not become apparent until younger stands in riparian areas mature further and become an effective source for instream coarse wood recruitment, and influences of sedimentation caused from past and recent harvest practices are reduced.

Northern red-legged frog

The proposed action would result in the loss of an undetermined number of individuals, potential reduced population size, and loss of recruitment into the population due to timber harvest of terrestrial habitat over a 50 year period.

Direct impacts to individuals may occur primarily outside the RMZs. Adverse impacts are likely to occur as a result of the loss or modification of 92,668 to 126,814 acres. Additional habitat associated with 486 acres of mapped wetlands may be adversely affected. Timber harvest and associated activities may adversely affect foraging and overwintering habitat, and may decrease water quality adversely affecting egg masses. Over time, implementation of the aquatic conservation strategy should improve habitat conditions.

Given the range-wide distribution of the subspecies, the expected distribution of the subspecies on PALCO lands, and the relatively small proportion PALCO lands represents within the subspecies' range, impacts on suitable habitat may result in short- and long-term localized extirpations, but the subspecies is expected to persist on the landscape.

Foothill yellow-legged frog

The proposed action would result in the loss of an undetermined number of individuals, potential reduced population size, and loss of recruitment into the population due to timber harvest of terrestrial habitat over a 50 year period. Aquatic breeding sites and adjacent terrestrial habitat used for foraging and overwintering are critical to maintaining populations of the foothill yellow-legged frog across the landscape. The paucity of data for the species may result in a substantial over-estimation of effects in the assumption of a worst case scenario.

Pre-project surveys are not required, therefore direct impacts to individuals may occur. Adverse impacts are likely to occur as a result of the loss or modification of 16,724 to 50,870 acres. Additional habitat associated with 486 acres of mapped wetlands may be adversely affected. Indirect effects will occur both in the terrestrial and aquatic environment. Timber harvest and associated activities may adversely affect foraging and overwintering habitat, and may decrease water quality adversely affecting egg masses. Over time, implementation of the Aquatic Conservation Strategy should improve habitat conditions.

This species is known to occur in altered habitats however, it is not understood how these altered environments may contribute to the long-term viability of this species. This species is also known to occur in systems profoundly affected by timber harvest, such as the proposed project. However, baseline information prior to this influence is not known, so the level of impact decades of harvest have on local populations is not known. The degree to which this species is prone to change when disturbed is not well understood. The species is assumed able to respond following some level of disturbance, as found in studies on the Trinity River and observations of yellow-legged frogs within the project area. The species is expected to persist on the landscape.

Northwestern pond turtle

The proposed action would result in the loss of an undetermined number of individuals, potential reduced population size, and loss of recruitment into the population primarily due to timber harvest of terrestrial habitat over a 50 year period. Aquatic basking sites and refugia, and adjacent terrestrial habitat used for breeding, foraging and movement between pools are critical to maintaining populations of the northwestern pond turtle across the landscape. The paucity of data for the subspecies may result in a substantial over-estimation of effects in the assumption of a worst case scenario.

Pre-project surveys are not required, therefore direct impacts to individuals may occur. Adverse impacts are likely to occur as a result of the loss or modification of 91,840 to 191,767 acres. Additional habitat associated with 486 acres of mapped wetlands may be adversely affected. Indirect effects will occur both in the terrestrial and aquatic environment. Over time, implementation of the Aquatic Conservation Strategy should improve habitat conditions.

The pond turtle would generally remain distributed throughout the PALCO ownership, occurring in suitable habitat in and adjacent to Class I and Class II streams, and wetlands. Turtles may be eliminated in some localized areas, principally upslope from aquatic habitats during the wintering period. However, if the amphibian and reptile module is implemented during the watershed analysis process as described, it is expected key areas and populations will be identified and appropriate mitigations will be implemented.

Tailed frog and southern torrent salamander

Based on the discussions above (primarily the sections on effects, and the landscape comparison for habitats in the action area), the FWS draws the following conclusions:

(1) Some of the effects of past management actions will persist for several decades. Of particular concern are the long term recruitment of instream LWD, and the sediment storage capability of Class II and III stream channels. Both processes are important in the long-term maintenance of habitats for both species.

(2) The ameliorating effects of the SYP/HCP provisions for RMZs will not become apparent until second-growth stands in riparian areas (approximately 55 percent of the entire RMZ landbase) mature further and become an effective source for instream CWD recruitment. In the interim, the FWS expects some near-term reductions in sediment yield resulting from the road management and mass wasting provisions; but it is expected that the magnitude of those reductions will not offset the background sediment influx in streams originating from surface erosion on recently harvested uplands.

(3) Desirable habitat features, especially coarse substrates, are produced, over time, through stream channel morphological processes which, in turn, are largely regulated by regular influxes of CWD into those channels. There is some concern, in the interim period, that instream CWD accretion via the RMZ's may not keep pace with instream CWD losses due to decomposition and wear. The result of this would be that desirable habitat features associated with this species may not be replaced as rapidly as they are being lost. This trend may not level-off or reverse itself for several decades, contingent on the rates of development in second-growth stands in the RMZ's.

(4) Using the same mechanisms as in (3), above, the FWS also expects to see a similar pattern with sediment influx into streams; that is, persistent effects from past management actions, followed by a leveling-off and eventual recovery, also linked to the rates of stand development in the RMZ's.

(5) The FWS recognizes that dense populations of both species can persist in those localized breeding sites that are relatively unaffected by past management actions. The FWS is unable, from existing data, to estimate the magnitude of the habitat and population losses over the life of the proposed SYP/HCP. However, we are able to make a "worst-case" estimate, for both species, of the amounts of remaining suitable habitat, and occupied suitable habitat, at the point in time when we believe that habitat loss will stabilize (approx. in the year 2043). The estimate requires two assumptions: (a) That remaining populations will be effectively "refuged" in stream

habitats classified as undisturbed by Wroble and Waters (1989) (including high-gradient reaches and geologically stable areas); and (b) That the 16.22 stream miles surveyed by Wroble and Waters (1989) are representative of PALCO's Class II streams. Based on these assumptions the following results would be expected: (a) tailed frog - 73.1 miles of stream reaches containing suitable habitat, of which 51.0 miles contain occupied habitat, and (b) southern torrent salamander - 80.4 miles of stream reaches containing suitable habitat, of which 23.8 miles would contain occupied habitat late in the permit period.

In light of what we know about the spatial distribution and genetic structure of the species, there will be continuing concern over the isolation of those breeding sites and over their future contributions in maintaining gene flow and viable populations throughout the PALCO ownership. However, the FWS concludes that the prospect for stabilizing and reversing the current habitat and population trends is good in the long term for both species. This view is based on two features of the SYP/HCP: First, on the strengths of the interim measures for road management, mass wasting prevention, and riparian management zones in the SYP/HCP; and second, on the mandated watershed analysis processes which provide an opportunity to further refine and improve management practices on a site-specific basis.

The FWS finds that this action will not jeopardize the continued existence of either species. The basis for the finding is related to the population structure of both species in the context of land allocation across the entire species range. We know that substantial portion of both species range are under Federal management (56% of the tailed frog range and 37% of the southern torrent salamander range). Much of this federal land is in reserved or quasi-reserved status (69% of the Federal landbase for both species), and all activities are subject to the riparian guidelines of the Northwest Forest Plan. It is probable that viable populations of both species can be maintained on the Federal lands. Against this background, we also know that the species is a metapopulation, made up of highly sedentary subpopulations. In this light, we conclude that even the worst-case scenario for intensively managed private lands would not appreciably jeopardize the outlook for habitat and population recovery on the Federal lands.

Northern California ESU steelhead

The NMFS concludes that the proposed action may affect and is likely to adversely affect steelhead in the ESU. The response of steelhead to the proposed action over the 50-year period is assessed and described in relation to essential habitat features in the Effects Common to Pacific Salmonid section. The NMFS concludes that implementation of the Aquatic Conservation Plan and its interrelated strategies will maintain or achieve, over time, properly functioning aquatic habitat conditions, thereby resulting in the long term survival of steelhead in the ESU.

Southern Oregon/California Coasts ESU coastal cutthroat trout

The NMFS concludes that the proposed action may affect and is likely to adversely affect coastal cutthroat trout in the SOCC ESU. The response of SOCC coastal cutthroat trout to the proposed action over the 50-year period is assessed and described in relation to essential habitat features in the Effects Common to Pacific Salmonid section. The NMFS concludes that implementation of the Aquatic Conservation Plan and its interrelated strategies will maintain or achieve, over time, properly functioning aquatic habitat conditions, thereby resulting in the long term survival of coastal cutthroat trout in the SOCC ESU.

CUMULATIVE EFFECTS

The Services must consider both the effects of the proposed action and the cumulative effects of other activities in determining whether the action is likely to jeopardize the continued existence of a covered species or result in the destruction or adverse modification of critical habitat. Under the Act, cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in the biological and conference opinions. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The FWS and NMFS believe that listed species and other covered species may be affected by numerous actions by State, tribal, local, or private entities that are reasonably certain to occur in the action area. These actions include, but may not be limited to, those discussed below. Although each of the following actions may reasonably be expected to occur, we lack definitive information on the extent or location of many of these categories of actions. The following discussion provides available information on the expected effects of these activities on covered species. Section 9 of the Act prohibits take of fish and wildlife species listed under the Act, unless authorized by ITPs. Take of State listed species is also prohibited under CESA. In addition to the Act and CESA, other laws regulating certain of these activities provide protections for some covered species, especially the Federal Clean Water Act, the CEQA, the California Fish and Game Code, and the CFPRs. Most of these protections do not apply specifically to those species covered by the permit that are not currently listed; however, they would apply should such species become listed in the future. Enforcement of existing law is expected to minimize the impacts of these activities on listed species, and to a lesser extent, to covered species that are not listed.

Approval of the subject SYP/HCP by agencies of the State of California

The Services anticipate that the SYP/HCP will be approved by the CDF and CDFG. Because the approval of the SYP/HCP by agencies of the State is subject to the CESA and CEQA, which require, respectively, determinations regarding avoidance of jeopardy to listed species and mitigation of significant effects, and because the documents under consideration by the State are the same as those being evaluated herein, the Services do not anticipate that approval of the SYP/HCP by the State agencies will result in cumulative effects that exceed those evaluated elsewhere in this biological opinion.

Timber management

Timber management, with associated activities such as harvest, yarding, loading, hauling, site preparation, planting, vegetation management, and thinning, is the dominant human activity in the action area. Future timber harvest levels in the action area cannot be precisely predicted, however, it is assumed that harvest levels on private lands in Humboldt County in the foreseeable future will be within the approximate range of harvest levels that have occurred since the listing of the northern spotted owl in 1992. Based on data for recent years, the annual harvest level in Humboldt County is expected to be about 500 MMBF (California Board of Equalization 1998).

Information on past THPs have only been collected in three watersheds within the action area, refer to the **Environmental baseline common to all species** (California Department of Forestry and Fire Protection 1999). Using this information, we can predict only rough estimates of future harvest levels within the action area, outside of PALCO's ownership. In the past 12 years, within the Eureka Plain Calwater watershed (123,533 acres total) and excluding PALCO land and the Headwaters Forest, 15,071 acres have been included within approved THPs and an additional 90 acres are within pending THPs. In the past 16 years, within the Mattole River Calwater watershed (52,862 acres total), excluding PALCO land, 4,502 acres have been included within approved THPs, with an additional 349 acres within pending THPs. In the past 12 years, within the Scotia Calwater watershed (12,813 acres total), excluding PALCO land, 329 acres have been included within approved THPs. We assume that this level of THP approval is similar in other watersheds within the action area, and that this level of THP approval will continue in the future. It is assumed that this harvest will occur subject to the CFPRs, Act, and CESA, and thus that take of listed species will be either avoided or conducted according to SYP/HCPs and ITPs. The Services are aware of two other industrial timber companies with property within the action area that have expressed interest in HCPs for listed and unlisted species. Eventual approval of those HCPs would be evaluated under the Act and CESA and take into account effects of approval of PALCO's ITPs.

Implementation of THPs under the CFPRs has not consistently provided protection against unauthorized take in relation to Pacific salmonids listed under the Act by the NMFS, such as coho salmon. The NMFS has informed the CDF of its ongoing concern over the lack of specific provisions for Pacific salmonids in the CFPRs. In April 1997, the CDF issued the document *Coho salmon considerations for timber harvesting under the CFPRs* as guidance to foresters on how to address take of coho salmon. Although this document provides guidance for protecting salmonids, it does not, in many instances, require measures that would avoid take of coho salmon from direct, indirect, and cumulative effects. Discussions continue on this issue between the NMFS, CDF, and California Resources Agency. Until these issues are resolved, unauthorized take from direct, indirect, and cumulative effects of coho salmon from timber harvest and its associated activities may be occurring. The extent and amount of any unauthorized take of coho salmon is unknown.

Reasonably foreseeable effects of timber management activities may also impact designated critical habitat for the marbled murrelet on private lands within the action area. This effect would potentially occur due to private timber harvest on about 7,766 acres outside of PALCO lands that are within the boundaries of critical habitat unit CA-03-a.. The number of acres that contain primary constituent elements of critical habitat within this 7,766 acres is unknown. Designated critical habitat only exists in stands which contain the following primary constituent elements: 1) potential nest trees and 2) one-half site potential tree height stands within 0.5 mile of potential nest trees. Timber harvest could effect critical habitat only to the extent that harvested acres qualify for designation. Where this habitat is directly adjacent to occupied habitat, it is subject to take avoidance measures of the CFPRs, so impacts there are expected to be minimized by those regulations.

Reasonably foreseeable effects of timber management activities may also impact proposed critical habitat for the coho salmon and chinook salmon. An undetermined number of miles of fish bearing streams are on private land outside of PALCO ownership but within the action area. It is expected that these Class I waters would be provide some or all of the essential habitat features of proposed critical habitat. Within the action area, direct, indirect, and cumulative effects of timber harvesting on lands outside of PALCO ownership may degrade the habitat features identified as essential for proposed coho and chinook salmon critical habitat. These effects are expected to be similar to the effects of the covered activities on PALCO's ownership, therefore refer to the aquatic effects section for details on how timber harvesting activities effect the essential habitat features for proposed coho and chinook critical habitat. The extent of the effect to proposed critical habitat is unknown given the uncertainty of protective measures in THPs.

Control of wildfires

The CDF, in conjunction with other State or Federal agencies, may be involved in the control of wildfires. Control measures may include the use of helicopters, aircraft, or other noise-generating equipment at various times of the year. These activities may result in the disturbance of covered species during the breeding season. An undetermined number of individuals may be affected by this activity on an annual basis each year of the permit period.

In addition, control of wildfires may include the removal of modification of vegetation due to the construction of firebreaks or setting of backfires to control the spread of fire. An undetermined amount of suitable habitat for covered species may be removed or modified by this activity. During the past 10 years, an undetermined number and acreage of fires have occurred in the action area.

Industrial activities, sawmills, and associated activities

Most sawmills located in the project area are expected to remain in operation for the foreseeable future, based on a relatively steady supply of timber, as discussed above. The reduction in available old-growth logs will probably result in closure or retooling of those mills designed to process large logs. Facilities are expected to operate within applicable laws. Where waste water discharge may affect habitat for listed species, it is expected that the Act and the CESA will be enforced. Further large-scale industrial development is not anticipated, but if such development should occur, it is expected that all applicable laws will be applied.

Construction, reconstruction, maintenance, and use of roads

While the level of construction of new roads and reconstruction of old roads on private and state lands cannot be anticipated, it is expected to continue at a pace similar to the current pace. The increased emphasis on protection of aquatic resources is expected to result in higher standards for road construction, reconstruction, maintenance, and use as compared to historical standards. Improvement of environmental conditions related to roads throughout the action area is expected over the long term. Noticeable improvements in the short term are unlikely due to a projected increase in the number of road miles per square mile of land, the lack of comprehensive road standards, existence of numerous older ("legacy") roads within the action area, and lack of routine inspections and maintenance of existing roads. These trends will be especially noticeable on industrial timberlands.

Gravel mining, quarrying, and processing

The Services anticipate that river bar gravel mining, and upland quarrying and associated gravel processing, will continue to be conducted by non-Federal parities within the action area. Future demand for rock may increase with increased emphasis on road improvement on private timberlands and ranch lands to protect aquatic species. Eleven gravel operations are currently located along an eight-mile stretch of the lower Eel River, and two additional operations are located on the lower reaches of the Van Duzen River. These gravel operations are under the jurisdiction of Humboldt County, the California Coastal Commission (for those activities conducted within the Coastal Zone), and the COE. Section 7 consultation has been completed on the 13 gravel mining operations and they are not considered a cumulative effect. The incidental take statement associated with this section 7 consultation expires in 2001. The permitted annual level of rock extraction from upland quarries within Humboldt County is 720,000 cubic yards, although actual annual extraction is less. The actual degree of increase in demand cannot be predicted. Commercial rock quarrying will continue to be under the regulation of Humboldt County and the California Coastal Commission (for those activities conducted within the Coastal Zone). If the jurisdiction of the COE over river bar gravel mining is not retained in the future, it is anticipated that the agencies will continue to be engaged in protection of listed species under the Act and CESA.

The effect on covered species from the commercial rock operations in the action area is expected to be similar to that described under the aquatics effects section. The effects of quarries and rock mines on aquatic resources depend on the type of mining, the size of the quarry or mine, and distance from waters. Rock mining can cause increased sedimentation, accelerated erosion, increased streambank and streambed instability, and changes to substrate. Surface mining may result in soil compaction and loss of the vegetative cover and humic layer, increasing surface runoff. Mining may also cause the loss of riparian vegetation. Chemicals used in mining can be toxic to aquatic species if transported to waters. Because the effects of quarries and rock mines depends on several variables, the effects of quarries and other commercial rock operations within the action area on covered species are unknown. Commercial rock quarrying will continue to be under the regulation of Humboldt County and the California Coastal Commission (for those activities conducted within the Coastal Zone).

Stream restoration projects

It is anticipated that, as monitoring information accumulates on past projects, the focus of stream restoration projects will gradually shift toward more effective restoration actions. Because such activities are usually coordinated with one or more of the resource agencies, it is anticipated that all applicable laws will be followed. Restoration activities conducted through CDFG's Fisheries Habitat Restoration Program authorized take of coho salmon through a section 7 consultation with the COE, and are therefore not considered a cumulative effect. Restoration activities that are not conducted pursuant to CDFG's program may cause temporary increases in turbidity, alter channel dynamics and stability, and injure or scare salmonids if equipment is used in the stream during restoration projects. Properly constructed stream restoration projects may increase habitat complexity, stabilize channels and streambanks, increase spawning gravels, decrease sedimentation, and increase shade and cover for salmonids. It is unknown how many restoration projects are completed outside of CDFG's program, therefore the effects of these projects cannot be predicted.

Agricultural activities

Agricultural activities including grazing, dairy farming, and the cultivation of crops.
The recent upward trend in value of dairy-related agricultural products (e.g., milk, cows and calves, pasture, hay, and silage) in Humboldt County is expected to continue as human populations continue to increase (U. S. Department of Agriculture 1998; G. Markegard, pers. comm., January 29, 1999). As a result, the dairy industry in the project area, primarily in the lowlands of the Eel River watershed below the PALCO ownership, is expected to persist. Impacts on water quality would be expected to be regulated under applicable laws.

The impacts of this use on aquatic species is anticipated to be locally intense, but the longevity of the impact depends on the degree of grazing pressure on riparian vegetation, both from dairy and beef-cattle. Grasses, willows, and other woody species can recover quickly once grazing pressure is reduced or eliminated (Platts 1991) through fencing, seasonal rotations, and other measures. Assuming that appropriate measures are not taken to reduce grazing pressure, impacts to aquatic species are expected to increase with the predicted continuation or increase in grazing. Anticipated impacts include decreased bank stability, loss of shade- and cover-providing riparian vegetation, increased sediment inputs, and elevated coliform levels.

Residential development and operation of existing residential infrastructure

The moderate rate of human population growth in Humboldt County (about 2.8 percent increase from 1995 through 1998) and the three north coastal counties (about 3.3 percent overall increase from 1995 through 1998) (California Department of Finance 1997, 1998a, 1998b) is expected to continue. In Humboldt County, most of this growth is expected to occur near the cities of Eureka, Arcata, and McKinleyville, to the north of the project area, while growth in the communities of the project area, including the towns of Carlotta, Fortuna, and Scotia, is expected to be low (J. Baskin, pers. comm., January 29, 1999). Conversion to residential uses of lands zoned for forest production is expected to continue at a similar or slightly slower rate than in the recent past (J. Baskin, pers. comm., January 29, 1999). However, some large timberland owners, such as Simpson, have recently expressed increased interest in conversions of land from forest production to other uses (J. Baskin, pers. comm., January 29, 1999). Impacts on water quality related to residential infrastructure would be expected to be regulated under applicable laws.

Once development and associated infrastructure (roads, drainage, etc) are established, the impacts to aquatic species are expected to be permanent. Anticipated impacts to aquatic resources includes loss of riparian vegetation, changes to channel morphology and dynamics, altered watershed hydrology (increased storm runoff), increased sediment loading, and elevated water temperatures where shade-providing canopy is removed. The presence of structures and/or roads near waters may lead to the removal of LWD in order to protect those structures from flood impacts. The anticipated impacts to aquatic covered species from continued residential development are expected to be sustained and locally intense, but, given the predicted slow growth rate development within the action area, impacts are not expected to increase substantially over current levels.

Human recreation, including hiking, camping, fishing, and hunting

Because most of the project area is private land, most outdoor recreational activities would be expected to be confined to state and county parks, except at scattered fishing access points along major streams. Visitation to HRSP has been slowly increasing in recent years; this trend is expected to continue as the human population of the area increases. Planning is currently underway to increase visitor facilities at HRSP, and these new facilities are expected to be fully utilized by the public (K. Wilbur, pers. comm., January 29, 1999). The potential for human disturbance of wildlife populations, and especially the encouragement of avian scavenger/ predators by human presence, would be expected to also increase (K. Anderson, pers. comm., January 29, 1999). However, the California Department of Parks and Recreation has indicated willingness to implement programs to reduce this effect, and discussions have begun with the CDFG and FWS.

Expected recreation impacts to salmonids include increased turbidity, impacts to water quality, barriers to movement, and changes to habitat structures. Streambanks, riparian vegetation, and spawning redds can be disturbed wherever human use is concentrated. Campgrounds can impair water quality by elevating coliform bacteria and nutrients in streams. Construction of summer dams to create swimming holes causes turbidity, destroys and degrades habitat, and blocks migration of juveniles between summer habitats. Impacts to salmonid habitat are expected to be localized, mild to moderate, and temporary. Fishing within the action area, typically for steelhead or coastal cutthroat trout, is expected to continue subject to the California Fish and Game Code. The level of take of Pacific salmonids within the action area from angling is unknown, but is expected to remain at current levels.

Water withdrawals

An unknown number of permanent and temporary water withdrawal facilities exist within the action area. These include diversions for urban, agricultural, commercial, and residential use, along with temporary diversions, such as drafting for dust abatement. Due to the anticipated slow urban/residential growth within the action area and the expected increase in agriculture (dairy farming), the number of diversions and amount of water diverted is expected to increase gradually within the action area. Impacts to salmonids are expected to include entrapment and impingement of younger salmonid life stages, localized dewatering of reaches, and depleted flows necessary for migration, spawning, rearing, flushing of sediment from the spawning gravels, gravel recruitment, and transport of large woody debris. Water diversions are expected to be conducted under applicable laws, including the Act, California Fish and Game Code, and Clean Water Act.

Chemical use
It is anticipated that chemicals such as pesticides, herbicides, fertilizers, and fire retardants will continue to be used within the action area. Chemical application is under the jurisdiction of several Federal, state, and local agencies and their use is expected to be conducted under applicable laws. The effects of these chemicals on salmonids is expected to be similar to the effects described in the *Interrelated and interdependent effects* section of this Opinion.

CONCLUSION

LISTED SPECIES/CRITICAL HABITAT:
After reviewing the current status of each covered species, the environmental baseline for the action area, the effects of the proposed action (i.e., *Headwaters Forest Acquisition and the PALCO SYP/HCP*), and the cumulative effects, it is the Services' biological and conference opinion that the action as proposed, is not likely to jeopardize the continued existence of any covered species for reasons below.

In addition, the action as proposed, is not likely to destroy or adversely modify designated critical habitat for the marbled murrelet or proposed critical habitat for coho and chinook salmon. No critical habitat has been designated for the bald eagle, therefore, none will be affected. Critical habitat for the northern spotted owl and American peregrine falcon have been designated either outside the action area (i.e., peregrine falcon) or inside the action area but outside of PALCO lands (i.e., northern spotted owl); however, this action does not affect these areas and no destruction or adverse modification of these critical habitats is anticipated.

Justifications for the findings of no jeopardy of the covered species and no destruction or adverse modification of critical habitat are summarized as follows:

<u>American peregrine falcon</u>
Adverse effects to the peregrine falcon may occur in the form of disturbance from activities not associated with timber harvest within 0.5 miles of 3 known nest sites and an unknown number of potential nest sites. In addition, some unknown degree of adverse impacts may be experienced by the species due to changes in habitat for peregrine falcon prey species from forest seral stage changes following timber harvest and stand management activities. These adverse effects are expected to be minor in extent, but may result in the take of one or more peregrines during the 50 year life of the proposed action. However, current population levels of peregrines are at or above recovery goals at both the regional (California, Oregon, Washington and Nevada) level and the range-wide level (that is, for each of the recovery regions throughout the range of the species). In

addition, productivity goals identified in each of the regional recovery plans has been met or exceeded. Although egg shell thinning continues to be a concern in some portions of the species' range, current levels have not precluded achieving productivity goals. The species has been proposed for delisting by the FWS based on the attainment of these recovery goals. The proposed project does not result in DDT or its metabolites being released into peregrine habitats. Availability of suitable habitat has not been identified as a major limiting factor for this species. Conservation measures implemented under the proposed project are designed to minimize any adverse effects from disturbance-related impacts associated with covered activities.

Northern spotted owl

Most conservation needs of the spotted owl would be met. Conservation needs include a cluster of more than 20 activity centers supported by habitat conditions which meet the breeding, feeding, roosting, cover, and dispersal needs of the species. Habitat conditions should be stable and allow interaction between individuals.

The proposed action would result in habitat conditions which support at least 108 activity centers throughout the 50-year period, a reduction of 31 percent from the current level of 156 activity centers. The resultant population would exceed the conservation goal of 60 activity clusters in the southern part of the regional area. Owls would occur well distributed throughout the ownership and be capable of dispersing and interacting with other owls in the action area. The amount of suitable habitat would increase slightly during the permit period, after an initial decline. Population levels and reproduction would be monitored and measures taken to develop and implement new protection measures if population and reproduction goals are not met. Stable or improving conditions would be maintained some sites, mostly in MMCAs, the Headwaters Reserve, and activity centers afforded Level One protection measures.

Bald eagle

The conservation needs of the species should be met if nesting or wintering eagles are detected. The conservation needs of the bald eagle include: conservation of habitat to meet its breeding, roosting, cover, and wintering needs; and protection from disturbance.

The proposed action would not affect the number, distribution, or reproduction of known nest sites, since nests do not occur on PALCO lands. The likelihood of bald eagles nesting in substantial numbers on the PALCO lands is low, based on a small nesting population in the regional area. If detected, conservation measures are adequate to maintain the integrity of nest sites and reduce disturbance of nesting pairs or wintering eagles. The role of PALCO lands probably is limited to supporting a small wintering population. Recovery goals have been met or exceeded in the recovery unit.

Marbled murrelet

After reviewing the current status of the marbled murrelet, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the FWS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the murrelet and is not likely to destroy or adversely modify critical habitat.

This conclusion is based on the following major findings:

1. The proposed action is designed to maintain a viable murrelet population on PALCO lands (including the Headwaters acquisition area) by targeting most harvest to lower quality residual redwood stands while preserving large amounts of the highest quality habitats in multiple reserves.

   a. 91 percent of the highest quality unentered old-growth redwood will not be harvested.

   b. 50 percent of the likely occupied residual old-growth redwood will not be harvested; this reserved residual habitat is higher quality overall than the residual habitat targeted for harvest.

   c. This conserved habitat will be maintained in large, long term reserves that will improve during the permit period due to development of second growth forest within or adjacent to the old growth habitat in the reserves.

2. It is estimated that the proposed action will remove approximately 21.7 percent of the likely occupied habitat in the Bioregion, 3.6 percent in Recovery Zone 4, and 0.67 percent in the listed range. Within the Bioregion the actual impact to the murrelet population is likely to be smaller than the percentage represented by this area estimate, because murrelets are probably nesting in high densities and with greater success in the higher quality reserve areas compared to the proposed harvest areas. Due to a lack of data on murrelet nesting densities the FWS is unable to predict what precise percentage of the Zone or listed range populations will be impacted, but occupied area estimates suggest these percentages will be very small.

3. Based on the conservation principles described in this opinion, the MMCA and Headwaters reserve areas are expected to function in conjunction with other murrelet HCPs and the reserves on Federal lands to stabilize and eventually recover the declining murrelet population. The FWS believes that the MMCAs, the Headwaters stand, and nearby State Parks protect most of the breeding murrelets and have a reasonable likelihood of maintaining a viable subpopulation in the Bioregion. Likewise, this MMCA/Headwaters/State Park network in the Bioregion will function in conjunction with National Park, State Park, and other Federal lands in California and southern Oregon to maintain a viable population in Recovery Zone 4. Finally, this population in Zone 4 should function with other protected Federal lands under the Northwest Forest Plan and other HCPs in California, Oregon, and Washington to support a viable, well-

distributed murrelet population throughout the listed range. Multiple discrete protected areas of good quality habitat that are located throughout the listed range maintain a high probability of the listed population surviving chance events such as oil spills, forest fires, and other catastrophes.

4. The proposed action would leave unprotected about 29 percent of the habitat with primary constituent elements within CHU-030a. This constitutes about 1.1 percent of the critical habitat in Conservation Zone 4 and about 0.3 percent of the critical habitat in the 3-state range. Almost 1/3 of the critical habitat left unprotected by the murrelet strategy would have some degree of protection in RMZs. The habitat being unprotected is primarily of lower quality, so the proportional effect on the CHU is lower than indicated by simple quantitative comparison of habitat removed versus habitat preserved. The acquired Headwaters Reserve and the MMCAS would contain all of the best quality habitat uncut old growth redwood habitat within the CHU, which would be aggregated with residual habitat and late seral forest to protect the great majority of the existing conservation value in the CHU. The function of CHU-03 in providing breeding habitat would be retained. Therefore the effects on critical habitat would not appreciably reduce the value of critical habitat for the survival and recovery of the species.

To fully understand why these conclusions are consistent with the overall Federal murrelet recovery strategy and previous biological opinions on the murrelet, the following information should be considered. The FWS's conservation strategy for murrelet breeding habitat consists of: (1) under the Northwest Forest Plan, protecting all occupied sites on all Federal lands and recruiting more suitable habitat in LSRs on USFS and BLM lands, and (2) protecting as much occupied habitat as possible on non-Federal lands while using HCPs to get long term protection and recruitment of habitat in sufficient amounts where Federal lands are lacking.

The FWS recognizes that the listed murrelet population may be in decline (USDI Fish and Wildlife Service 1997) and that the proposed action is adversely affecting the species by removing a relatively large amount of occupied and unoccupied suitable habitat. During the early phases of PALCO SYP/HCP development, the FWS rejected several less protective HCPs proposals from PALCO or their consultants (e.g., D. Murphy, September 10, 1997). The proposed final SYP/HCP represents a significant improvement from those earlier proposals (P. Karieva, December 1, 1998) and incorporates several recent recommendations made by the Marbled Murrelet Recovery Team (November 30, 1998).

The FWS also recognizes that the most conservative approach to managing non-Federal lands for the benefit of murrelets would be to protect all occupied murrelet habitat. This option was not a practicable alternative to PALCO and is not necessary to meet the criteria for issuance of a section 10(a)(1)(B) permit, which provides for the issuance of ITPs where the impacts of such take are minimized and mitigated to the maximum extent practicable and where such take would not result in jeopardy to the covered species. Similar to previous murrelet HCP efforts, a site-specific plan was therefore needed that conserved as much occupied habitat as necessary to maintain a viable population in Recovery Zone 4, while allowing some harvest of other less valuable occupied habitat to address the applicant's needs. Although some take of occupied habitat could be permissible, the FWS maintained in multiple correspondence to the applicant and others that the Final SYP/HCP must be consistent with section 7 of the Act and could not appreciably reduce the likelihood of the murrelet's survival and recovery (see USDI Fish and Wildlife Service letters dated May 20, 1997, August 8, 1997, November 25, 1997).

During the planning stage for the proposed SYP/HCP, the FWS stressed to the applicant this need to maintain a viable subpopulation of murrelets in the SYP/HCP area, so that this subpopulation could in turn contribute to the maintenance of a viable Zone 4 population. The company convened a qualified and objective scientific panel (W. Murdoch, University of California, Santa Barbara; B. Noon, Colorado State University; P. Karieva, University of Washington; M. Cody, University of California, Los Angeles; M Raphael, USFS) and made several earnest attempts to develop analytical tools such as population viability analysis to precisely estimate how much PALCO habitat would be needed to increase the likelihood of maintaining viable subpopulation to acceptable levels (see R. Ackakaya in Draft SYP/HCP). Due to limited data and life history information for the marbled murrelet, this modeling effort provided limited usable results (Beissinger and Westphal 1998). The FWS, with input from the scientific panel, has therefore continued to rely on basic conservation principles in negotiating and evaluating this SYP/HCP (National Research Council 1995; Karieva, December 1 and December 7, 1998).

Similar to the conservation strategy adopted for the northern spotted owl under the Northwest Forest Plan (Raphael et al. 1996), the murrelet strategy is to conserve much of the remaining suitable and all occupied habitat on Federal lands to provide a system of long term management reserves — the so called "backbone" of the Recovery Plan (USDI Fish and Wildlife Service 1997, page 3). Like the spotted owl, the murrelet is believed to be in a population decline. These reserves, which for the murrelet are augmented on key non-Federal lands where Federal lands are lacking, are expected to stabilize and eventually recover the declining populations. The FWS expects that the protections on Federal lands combined with SYP/HCP protections on important State and private lands will function as intended and will maintain viable Zone populations as recommended in the Recovery Plan (USDI Fish and Wildlife Service 1997).

In Zone 4, the public acquisition of Headwaters and protection of the PALCO MMCAs for the permit period will protect the majority of the most important occupied forest stands on PALCO ownership (91 percent of unentered old growth redwood, and 50 percent of the higher quality residual redwood), while allowing mostly lower or medium quality habitat to be removed. Although the loss of the harvested habitat is a serious adverse affect that may impact 3.6 percent of the occupied habitat in Zone 4, these reserve areas are nevertheless expected to function with other important habitat in the Zone, such as Humboldt Redwoods State Park, the Redwood National Park/State Park complex, the Six Rivers National Forest, the Siskiyou National Forest, and Coos Bay BLM lands to maintain a viable and well distributed murrelet population in this Zone.

This combination of multiple protected areas with good quality habitat that is well distributed should protect the Zone 4 population from stochastic or catastrophic events such as localized oil spills, shifting marine prey distribution, and forest fires. However, the FWS also recognizes that all species, whether healthy or declining, are always at some risk due to chance events. This risk can never be entirely eliminated even under the most favorable conditions — it can only be minimized to some acceptable level. The FWS believes this proposed action adequately minimizes this risk and will allow for the persistence of a viable murrelet population in Zone 4 and in the listed range.

The FWS has applied this same general management strategy with other Federal, State, private, and tribal landowners. The FWS has authorized the take of marbled murrelet occupied habitat as part of several other HCPs or Federal actions (see table 14 in the Environmental Baseline). These plans and the incidental take associated with them vary in degree and kind, reflecting local ecological conditions as well as differing landowner priorities. For example, the FWS authorized the harvest of up to 74,000 acres of potentially occupied habitat for the WDNR HCP. In contrast, the Weyerhaeuser Company declined to seek an ITP take permit for murrelets as part of its Millicoma Tree Farm HCP, instead agreeing to avoid taking murrelets when harvesting potentially suitable habitat on their lands. As these examples illustrate, these various landowners have different goals and strategies when managing murrelets on their lands, and the FWS attempts to work cooperatively with them to avoid jeopardy and achieve positive conservation gains.

The proposed action is also consistent with section 7 biological opinions addressing these HCPs and other Federal actions that affected murrelets. The FWS has issued two important biological opinions that determined proposed harvests of large amounts of known occupied murrelet habitat was likely to jeopardize the species. The first opinion (USDI Fish and Wildlife Service May 11, 1994; reinitiated biological opinion issued June 12, 1995) addressed the so called "section 318" timber sales on USFS lands. The second opinion addressed harvest in the North Boundary Unit on Quinalt Indian Nation lands (USDI Fish and Wildlife Service Jan. 28, 1998). It is worthwhile to review why these two Federal actions were determined likely to jeopardize the species, while the proposed PALCO SYP/HCP and Headwaters acquisition is not likely to jeopardize the species.

In the section 318 biological opinions (May 11, 1994, and June 15, 1995), the FWS concluded that the proposed harvest of 76 timber sales (originally totaling about 6,300 acres, subsequently modified to 57 sales totaling 4,300 acres of known or potential occupied habitat, or at least 119 occupied timber sale units) was likely to jeopardize the marbled murrelet. The primary impacts of this action that justified the jeopardy determination were: (1) the harvest of some of the highest quality old growth murrelet habitat remaining in Oregon and Washington, including important habitat on the Siuslaw National Forest termed the "stronghold" of the Oregon murrelet population; (2) the harvest of these sales would fragment and adversely affect an additional number of murrelets in adjacent, unbuffered high quality habitat; and (3) most of the sales (53 of

77) were located in LSRs, the "backbone" of recovery for the murrelet (USDI Fish and Wildlife Service 1997, page 3); harvest of occupied habitat in these sales was inconsistent with the Federal murrelet recovery strategy under the Northwest Forest Plan, which called for the protection of all occupied sites on Federal lands (Frampton, November 29, 1994; Henson, August 23, 1994).

The FWS also determined that the proposed North Boundary Area harvest on Quinalt Indian Nation lands was likely to jeopardize the murrelet (USDI Fish and Wildlife Service January 28, 1998). Of a total of 4,700 acres of high quality murrelet habitat in the North Boundary Area, the Tribe proposed to harvest approximately 3,100 acres and reserve 1,600 acres in riparian areas. The primary reasons for the jeopardy conclusion included: (1) the proposed action made no provision for the maintenance of the highest quality sites and instead would adversely affect murrelets on all 4,700 acres of the North Boundary Area -- including within riparian reserves -- due to habitat removal and fragmentation; (2) the action would remove between 12 and 21 percent of the high quality occupied habitat in Recovery Zone 2 (page 28); (3) this habitat is some of the highest quality and most productive habitat in Recovery Zone 2 and is likely "source" habitat from which reproductively successful murrelets are dispersing (page 25); and (4) the harvest would seriously impact murrelet distribution within Zone 2 by further widening the distributional gap in southwestern Washington (pages 27, 36). The FWS provided a reasonable and prudent alternative to this jeopardy action (page 37) that permitted the take of 1,125 acres (28 percent) of lower quality occupied habitat, while reserving approximately 2,850 acres of higher quality habitat (72 percent); this take, while an adverse impact to the species, was determined not likely to jeopardize the murrelet.

The proposed PALCO action is similar to these jeopardy actions in that it would harvest approximately 4,700 acres (minus what is protected in riparian reserves) of known or suspected occupied murrelet habitat; the section 318 sales totaled 6,300 acres, and the Quinalt action totaled 4,800 acres. However, the PALCO action is different from these actions in how it will affect the long term survival and recovery of the marbled murrelet. The section 318 timber sales would have had a significant adverse impact on Federal LSRs and would have been inconsistent with both the Northwest Forest Plan and the Recovery Plan. The impacted acreage was the highest quality old-growth murrelet habitat on all USFS lands in the listed range and was expected to have relatively high densities of successfully reproducing murrelets for Oregon and Washington. Adjacent acreage would not have been buffered from the harvest, so it is likely that the affected acres of occupied habitat would have been significantly higher than the total acres harvested. In contrast to this action, the PALCO action protects the majority of high quality habitat and it buffers the reserve areas.

Likewise, the proposed Quinalt action would have removed or adversely affected all 4,800 acres of habitat on the North Boundary Area ownership with no provisions for maintaining high quality habitat for murrelets. This habitat is some of the highest quality habitat in Recovery Zone 2, suspected to be an area that is successfully producing murrelets. In contrast, the PALCO SYP/HCP protects the majority of the local high quality habitat suspected to be areas of high productivity. Also, the Quinalt harvest would have significantly impacted the distribution of the Zone 2 population, while the PALCO SYP/HCP effectively maintains murrelet distribution in

Zone 4. Indeed, the Quinalt reasonable and prudent alternative to jeopardy follows an approach that is very similar to that of the PALCO action: protect most high quality sites, and target harvest to the lower quality occupied habitats that have less relative value to the species but still provide the landowner with some reasonable economic options.

In sum, these jeopardy actions gave no consideration to the short term or long term conservation needs of the murrelet when they where planned, whereas the Headwaters acquisition and PALCO SYP/HCP were planned with the long term survival and recovery needs of the murrelet as a major design objective. Although there are short term adverse effects while meeting the applicant's economic needs, the FWS expects the proposed action to provide long lasting and permanent recovery benefits to the murrelet and concludes issuance of an HCP permit is consistent with section 7 and section 10 of the Act.

Marbled murrelet critical habitat

As detailed above in the effects section, the proposed action will have a moderate quantitative impact on designated critical habitat at the local scale, and small quantitative impacts through removal of designated critical habitat at the Conservation Zone and range-wide scales. Consideration of qualitative aspects substantially reduces the degree of impact to a level below that derived from simple quantitative assessment. Because most of the high quality critical habitat will be retained, and because the acquisition and establishment of the reserve system will provide for aggregation of high quality uncut old-growth, improving residual, and adjacent second growth into the largest available blocks of habitat containing primary constituent elements that exist within CHU CA-03-a, this unit will continue to contribute to the survival and recovery of marbled murrelets in the local area and in Conservation Zone 4. Therefore, the FWS concludes that, while the proposed action is likely to have some adverse effects on designated critical habitat for the marbled murrelet, it will not appreciably reduce the ability of the critical habitat to function in achieving conservation zone goals, and thus, will not result in destruction or adverse modification of critical habitat.

Western snowy plover and proposed critical habitat

No snowy plovers are known to occur on any lands under the control of PALCO within the action area. Conservation measures in place as part of the proposed SYP/HCP provide for the protection of snowy plovers should the species expand its range onto PALCO lands, or should PALCO acquire lands within the range of the plover in the action area. These protection measures would be consistent with measures in place within the action area at that time. No critical habitat has been proposed to date within the action area, although a future proposal and final rule may include gravel bars on the Eel River. A future assessment of PALCO gravel operations will address potential impacts of existing gravel extraction activities on downstream plover habitat.

Coho salmon and proposed critical habitat

After reviewing the current status of the SONCC coho salmon ESU, the environmental baseline for the action area, the effects of the proposed SYP/HCP, and the cumulative effects, it is NMFS's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of coho salmon in the SONCC ESU. In addition, the action as proposed, is not likely to destroy or adversely modify proposed critical habitat for the SONCC coho salmon.

PROPOSED SPECIES:

Chinook salmon and proposed critical habitat

After reviewing the current status of chinook salmon in the SOCC ESU, the environmental baseline for the action area, the effects of the proposed SYP/HCP and the cumulative effects, it is the FWS's conference opinion that the action, as proposed, is not likely to jeopardize the continued existence of proposed chinook salmon in the SOCC ESU, and is not likely to destroy or adversely modify proposed critical habitat for the SOCC chinook salmon.

UNLISTED SPECIES

The Services have reviewed the current status of an additional ten species proposed by the applicant for coverage under the IA. Based on the review and after considering the environmental baseline for the action area, the effects of the proposed issuance of an incidental take permit, and the cumulative effects, it is the opinion of the Services that, should any of these species be listed in the future, the issuance of the subject incidental take permit and execution of the associated IA for the proposed action, as set forth in the SYP/HCP, are not likely to jeopardize the continued existence of the ten covered species. Refer to the **Species response to a proposed action** section above for additional information on the basis for this conclusion.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations adopted pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Services to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The proposed SYP/HCP and its associated documents clearly identify anticipated impacts to affected species likely to result from the proposed taking and the measures that are necessary and appropriate to minimize those impacts. All conservation measures described in the proposed SYP/HCP, together with the terms and conditions described in the associated IA and any section 10(a)(1)(B) permit and permits issued with respect to the proposed SYP/HCP, are hereby incorporated by reference as reasonable and prudent measures and terms and conditions within this incidental take statement as pursuant to 50 CFR 402.14(I). Such terms and conditions are nondiscretionary and must be undertaken for the exemptions under section 10(a)(1)(B) and section 7(o)(2) of the Act to apply. If the permittee fails to adhere to these terms and conditions, the protective coverage of the section 10(a)(1)(B) permit and section 7(o)(2) may lapse. The amount or extent of incidental take anticipated under the proposed SYP/HCP, associated reporting requirements, and provisions for disposition of dead or injured animals are as described in the SYP/HCP and its accompanying section 10(a)(1)(B) permit.

In addition to the measures described in the proposed SYP/HCP and its associated documents, the FWS believes three reasonable and prudent measures are warranted to minimize the take of marbled murrelets; these are described below under Reasonable and Prudent Measures.

AMOUNT OR EXTENT OF TAKE
LISTED SPECIES:

American peregrine falcon
The FWS anticipates that an undetermined number of peregrine falcons associated with 3 known nest sites and an unknown number of potential nest sites could be taken over a 50-year period as a result of this proposed action. The amount taken annually could not be determined. The incidental take is expected to be in the following forms:

Harm - an unknown number of peregrine falcons could be taken due to changes in prey species habitat, and potential prey abundance and availability, within foraging range of the 3 known nest sites and an unknown number of potential nest sites; direct harm to individuals or to nest sites is not expected to occur due to conservation measures being implemented.

Harassment - an unknown number of breeding peregrines may be taken due to disturbance resulting from activities other than timber operations (e.g., vehicle use of existing roads) that could occur within 0.5 miles of 3 known nest sites and an unknown number of potential nest sites; and

Injury - no peregrine falcons are expected to the taken due to timber operations that would destroy nest sites.

<u>Northern spotted owl</u>
The FWS anticipates that an undetermined number of spotted owls could be taken as a result of this proposed action. The amount taken annually could not be determined. The incidental take over 50 years is expected to be in the following forms:

Harm - a loss of at least 48 activity centers due to removal of an undetermined amount of suitable habitat;

Harassment - at least 156 activity centers due to disturbance during the breeding season resulting from timber harvest and its associated activities; and

Injury or death - of an undetermined number of individuals due to timber harvest and its associated activities.

<u>Bald eagle</u>
The FWS anticipates that an undetermined but low number of bald eagles may be taken over a 50-year period as a result of this proposed action. The amount taken annually could not be determined. The incidental take is expected to be in the following forms:

Harm - due to loss of 29,291 acres of suitable nesting and roosting habitat;

Harassment - due to disturbance of an undetermined number of eagles at an undetermined number of nesting sites or wintering areas, due to timber harvest and other covered activities; and

Injury or death - of an undetermined number of individuals (adults or young), due to timber harvest or other covered activities in 29,291 acres in suitable nesting and roosting habitat during the breeding season.

Marbled murrelet

The FWS anticipates the take of an unquantified number of murrelets associated with the removal of 4,696 acres of occupied habitat. Other than quantifying the amount of occupied acres removed, this take is impossible to quantify because the density of nesting murrelets in this habitat is unknown. However, as described in the Effects of the Action, the FWS believes the proposed SYP/HCP reduces much of the potential for take by targeting relatively lower quality habitat for harvest that is likely to have relatively lower densities of nesting murrelets.

The FWS also anticipates an unquantifiable amount of incidental take of murrelets in some occupied habitat due to disturbance associated with projects conducted during the nesting period. The take due to noise disturbance associated with the harvest and other management activities within 0.25 miles of occupied habitat is difficult to detect and quantify. However, the FWS believes the magnitude of this take is likely to be relatively low. If murrelets are nesting in close proximity to areas with relatively high levels of human activities, the FWS anticipates some percentage of these individuals, located in suitable habitat within 0.25 mile of the proposed projects (or within 0.5 mile of aircraft operations), will be subject to harassment as a result of the noise associated with these activities. This take can be qualified in terms of the cumulative probability that (1) suitable, unsurveyed habitat is actually occupied by murrelets; (2) if occupied, nesting birds will in fact be disturbed; and (3) if disturbed, reproductive output will be negatively affected.

Assumptions Regarding the Grizzly Creek Complex: In the development of this biological opinion and its assessment of effects of the proposed SYP/HCP on the marbled murrelet, the FWS assumed that the proposed action does not include any harvest of habitat in the Grizzly Creek Complex, as outlined in section 3.1.2 of the IA. Specifically, if the Grizzly Creek Complex is not purchased and protected during the next five years, subsection 3.1.2(iv) of the IA obligates the FWS at that time to make a determination of whether harvest of the Grizzly Creek Complex will "appreciably reduce the likelihood of the survival and recovery of the marbled murrelet... in accordance with 50 CFR Part 402."

Because take of any murrelets associated with the Grizzly Creek Complex was not considered or evaluated in this biological opinion, such potential take would exceed the amount permitted in this opinion (50 CFR Part 402.14(I)(4)). Therefore, the FWS assumes any future consideration of timber harvest in the Grizzly Creek Complex in 5 years will necessitate the need for reinitiation of formal consultation at that time, as described in 50 CFR Part 402.16. This reinitiation, should it be necessary, will enable the FWS to evaluate the likelihood of whether any additional take of murrelets associated with the modified action will jeopardize the marbled murrelet. This reinitiated consultation would utilize the best scientific information that is available at that time, including any current analysis of murrelet population trends and monitoring information provided by implementation of the SYP/HCP or other research efforts. If the modified action is then determined not likely to jeopardize the marbled murrelet, but take of murrelets would occur in excess of the amount permitted in this biological opinion, the FWS assumes a modification and amendment to the incidental take statement contained in this biological opinion will be necessary.

Western snowy plover
The FWS anticipates that no western snowy plovers or their young will be killed or injured as a result of actions proposed in the SYP/HCP. The FWS further anticipates that no western snowy plovers are likely to be taken as a result of harm due to loss of suitable nesting habitat or to harassment due to disturbance from covered activities.

With proper implementation of the SYP/HCP conservation measures for the western snowy plover, including surveys to detect plovers and delineation of protection buffers around nesting plovers, the FWS anticipates that no incidental take of plovers due to direct harm, killing, or harassment will occur. These conservation measures considered in relation to the known current breeding distribution of the species and the risks associated with the covered activities ensure a very low risk of adverse impacts to the species. Protection buffers to be implemented around future nests sites are designed to ensure that nesting plovers and their young are not disturbed by covered activities. Potential indirect effects of gravel removal will be addressed under future evaluation by PALCO and the agencies, and appropriate mitigation measures determined, within the next 3 years. Activities covered by this plan are not likely to result in significant changes to the current level of predation on the species within the action area. Activities covered under this incidental take permit include only stream crossings (bridges, culverted fills, fords and a variety of temporary crossings), roadbed access preparation, and associated crossing maintenance. Gravel extraction, stockpiling, or other ground-disturbing activities not directly related to stream crossings are not specifically considered to be covered activities under the SYP/HCP and are not therefore covered under this incidental take statement. Any future incidental take associated with activities not specifically covered under the SYP/HCP, including but not limited to gravel extraction, stockpiling, and gravel bar access on the Eel River, will need to be authorized through a section 7 consultation on the issuance of permits pursuant to section 404 of the Clean Water Act, or an amendment to the ITP.

Southern Oregon/Northern California Coast ESU coho salmon
The NMFS anticipates that an undetermined number of SONCC ESU coho salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the 50-year life of the permit. The incidental take of this species is expected to be in the form of harm, harassment, kill, and injury. As analyzed previously in this opinion, the NMFS has determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of proposed critical habitat.

> **Harm** due to habitat modifications resulting from forestry management, road management, the operation of the two permitted quarries, development and operation of borrow pit, and water drafting as described in the SYP/HCP;
>
> **Harassment** due to the use of equipment in streams during stream crossing and road construction, reconstruction, storm-proofing, upgrading activities, maintenance, closure, decommissioning and water drafting;

Kill due to the use of equipment in streams during stream crossings and road construction, reconstruction, storm-proofing, upgrading activities, maintenance, closure, decommissioning, and water drafting;

Injury due to the use of equipment in streams during stream crossings and road construction, reconstruction, storm-proofing, upgrading activities, maintenance, closure, decommissioning, and water drafting.

PROPOSED SPECIES:

Southern Oregon/California Coastal Chinook salmon

The NMFS anticipates that an undetermined number of SOCC ESU chinook salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the 50-year life of the permit. The incidental take of this species is expected to be in the form of harm, harassment, kill, and injury. As analyzed previously in this opinion, the NMFS has determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of proposed critical habitat.

Harm due to habitat modifications resulting from forestry management, road management, the operation of the two permitted quarries, development and operation of borrow pit, and water drafting as described in the SYP/HCP;

Harassment due to the use of equipment in streams during stream crossing and road construction, reconstruction, storm-proofing, upgrading activities, maintenance, closure, decommissioning and water drafting;

Kill due to the use of equipment in streams during stream crossings and road construction, reconstruction, storm-proofing, upgrading activities, maintenance, closure, decommissioning, and water drafting;

Injury due to the use of equipment in streams during stream crossings and road construction, reconstruction, storm-proofing, upgrading activities, maintenance, closure, decommissioning, and water drafting.

UNLISTED SPECIES:

Bank swallow

The FWS anticipates that no bank swallows will be killed, harmed, or harassed as a result of actions proposed in the SYP/HCP. Survey requirements contained in the conservation measures are likely to locate any colonies, which will then be protected by a 200-foot buffer during May and June or by other measures developed during consultation with the FWS and CDFG. Surveys could fail to detect bank swallows, and colony sites could be inadvertently destroyed during road construction or other projects. This would result in take of an unquantifiable number of bank swallows as a result of modification of up to 1 acre of breeding habitat during the permit period.

Pacific fisher

The FWS anticipates that an undetermined number of Pacific fishers associated with approximately 51,400 acres of suitable late-seral habitat, and an additional 5,400 acres of potentially suitable lower quality habitat could be taken over a 50-year period as a result of this proposed action. The amount taken annually could not be determined. The incidental take is expected to be in the following forms:

> **Harm** - due to loss of approximately 51, 500 acres of suitable resting and denning habitat, and an additional 5,400 acres of potentially suitable resting and denning habitat, and fragmentation of remaining resting and denning habitat;
>
> **Harassment** - due to disturbance of reproducing Pacific fishers resulting from timber harvest of approximately 160,870 acres of higher quality resting and denning habitat over the permit period, and an undetermined amount of lower quality habitat over the permit period; and
>
> **Injury** - due to timber harvest of approximately 160,870 acres of higher quality resting and denning habitat over the permit period, and an undetermined amount of lower quality habitat over the permit period.

Red tree vole

The FWS anticipates that an undetermined number of California red tree voles associated with approximately 51,400 acres of suitable late-seral habitat, and an additional 5,400 acres of potentially suitable lower quality habitat could be taken over a 50-year period as a result of this proposed action. The amount taken annually could not be determined. The incidental take is expected to be in the following forms:

> **Harm** - due to loss of 56,900 acres of habitat (51,500 acres of suitable late-seral, and 5,400 acres of potentially suitable lower quality habitat) and the fragmentation of the remaining suitable habitat;
>
> **Harassment** - due to disturbance of reproducing red tree voles resulting from timber harvest of 160, 870 acres of late-seral habitat and an undetermined amount of lower quality habitat over the permit period; and
>
> **Injury** - due to timber harvest of 160,870 acres of suitable late-seral nesting habitat and an undetermined amount of potentially suitable lower quality nesting habitat (CWHR 4D). All suitable habitat is considered nesting habitat since red tree voles reproduce year round.

Northern red-legged frog

The FWS anticipates that an undetermined number of northern red-legged frogs associated with 92,668 to 126,814 acres of potentially suitable habitat adjacent to Class I and Class II streams, and wetlands could be taken over a 50-year period as a result of the proposed action. The amount taken annually could not be determined. The incidental take is expected to be in the following forms:

> **Harm** - due to modification of 92,668 to 126,814 acres of suitable foraging and or overwintering habitat;
>
> **Harassment** - due to disturbance of northern red-legged frogs resulting from timber harvest or other covered activities in 92,668 to 126,814 acres of forested stands; and
>
> **Injury or death** - of an undetermined number of individuals due to timber harvest or other covered activities in 92,668 to 126,814 acres of suitable foraging and or overwintering habitat during the times this subspecies may be utilizing this habitat

Foothill yellow-legged frog
The FWS anticipates that an undetermined number of yellow-legged frogs associated with 16,724 to 50,870 acres of potentially suitable habitat adjacent to Class I and Class II streams, and wetlands could be taken over a 50-year period as a result of the proposed action. The amount taken annually could not be determined. The incidental take is expected to be in the following forms:

> **Harm** - due to modification of 16,724 to 50,870 acres of suitable foraging and or overwintering habitat;
>
> **Harassment** - due to disturbance of foothill yellow-legged frogs resulting from timber harvest or other covered activities in 16,724 to 50,870 acres of forested stands; and
>
> **Injury or death** - of an undetermined number of individuals due to timber harvest or other covered activities in 16,724 to 50,870 acres of suitable foraging and or overwintering habitat during the times this species may be utilizing this habitat

Northwestern pond turtle
The FWS anticipates that an undetermined number of northwestern pond turtle associated with 91,840 to 191,767 acres of potentially suitable terrestrial habitat adjacent to Class I and Class II streams, and wetlands could be taken over a 50-year period as a result of the proposed action. The amount taken annually could not be determined. The incidental take is expected to be in the following forms:

> **Harm** - due to modification of 91,840 to 191,767 acres of suitable nesting, aestivating, or overwintering habitat;
>
> **Harassment** - due to disturbance of northwestern pond turtles resulting from timber harvest or other covered activities in 91,840 to 191,767 acres of forested stands; and

Injury or death - of an undetermined number of individuals due to timber harvest or other covered activities in 91,840 to 191,767 acres of suitable nesting, aestivating, or overwintering habitat during the times the subspecies may be utilizing this habitat

Tailed frog and southern torrent salamander

The FWS anticipates that an undetermined number of tailed frogs and southern torrent salamanders, primarily associated with about 752 miles of Class II waters, could be taken over a 50-year period as a result of the proposed action. The amount taken annually could not be determined. The incidental take is expected to be in the following forms:

Harm - due to direct and indirect effects of timber harvest and other covered activities.

Harassment - by disturbance related to timber harvest and other covered activities.

Injury or death - by actions related to timber harvest and other covered activities.

Northern California steelhead trout

The NMFS anticipates that an undetermined number of Northern California ESU steelhead may be taken as a result of full implementation of the proposed action and associated level of protection over the 50-year life of the permit. The incidental take of this species is expected to be in the form of harm, harassment, kill, and injury. As analyzed previously in this opinion, the NMFS has determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of proposed critical habitat.

Harm due to habitat modifications resulting from forestry management, road management, the operation of the two permitted quarries, development and operation of borrow pit, and water drafting as described in the SYP/HCP;

Harassment due to the use of equipment in streams during stream crossing and road construction, reconstruction, storm-proofing, upgrading activities, maintenance, closure, decommissioning and water drafting;

Kill due to the use of equipment in streams during stream crossings and road construction, reconstruction, storm-proofing, upgrading activities, maintenance, closure, decommissioning, and water drafting;

Injury due to the use of equipment in streams during stream crossings and road construction, reconstruction, storm-proofing, upgrading activities, maintenance, closure, decommissioning, and water drafting.

Southern Oregon/California Coastal cutthroat trout

The NMFS anticipates that an undetermined number of SOCC ESU coastal cutthroat trout may be taken as a result of full implementation of the proposed action and associated level of protection over the 50-year life of the permit. The incidental take of this species is expected to be in the form of harm, harassment, kill, and injury. As analyzed previously in this opinion, the NMFS has determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of proposed critical habitat.

> **Harm** due to habitat modifications resulting from forestry management, road management, the operation of the two permitted quarries, development and operation of borrow pit, and water drafting as described in the SYP/HCP;
>
> **Harassment** due to the use of equipment in streams during stream crossing and road construction, reconstruction, storm-proofing, upgrading activities, maintenance, closure, decommissioning and water drafting;
>
> **Kill** due to the use of equipment in streams during stream crossings and road construction, reconstruction, storm-proofing, upgrading activities, maintenance, closure, decommissioning, and water drafting;
>
> **Injury** due to the use of equipment in streams during stream crossings and road construction, reconstruction, storm-proofing, upgrading activities, maintenance, closure, decommissioning, and water drafting.

To the extent this statement concludes that take of any migratory bird listed as a threatened or endangered species under the Act will result from the FWS's issuance of the ITP, the FWS will not refer the incidental take of any such migratory bird or bald eagle for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 703-712), or the Bald and Golden Eagle Protection Act of 1940, as amended (16 U.S.C. §§ 668-668d), if such take is in compliance with the terms and conditions (including amount and/or number specified herein).

EFFECT OF THE TAKE

In the accompanying biological/conference opinion, the FWS and NMFS determined that this level of anticipated take is not likely to result in jeopardy to any covered species or destruction or adverse modification of designated marbled murrelet critical habitat or proposed coho or chinook salmon critical habitat.

REASONABLE AND PRUDENT MEASURES & TERMS AND CONDITIONS

The proposed SYP/HCP and its associated documents identify anticipated impacts to all covered species likely to result from the proposed takings and the specific measures and levels of species and habitat protection that are necessary and appropriate to minimize those impacts. All of the conservation and management measures of the HCP's Operating Conservation Program, together with the terms identified in the associated IA, are hereby incorporated by reference as reasonable and prudent measures and terms and conditions for this incidental take statement pursuant to 50

CFR 402.14(I). Such terms and conditions are non-discretionary and must be undertaken by PALCO for the exemptions under section 10(a)(1)(B) and section 7(o)(2) of the Act to apply. If PALCO fails to adhere to these terms and conditions, the protective coverage of the section 10(a)(1)(B) permit and section 7(o)(2) may lapse.

Reporting Requirements

In accordance with 50 CFR 402.14(I)(3), the HCP/SYP specifies provisions for monitoring and reporting the effects and the effectiveness of the mitigation and minimization measures on the covered species and their habitat. Each individual species conservation plan delineates the type and extent of monitoring and manner of reporting. The PALCO will also submit an annual report by February 1 of each year, as described in the Implementation Agreement, section 3.4.2.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Services recommend that the following conservation measures be implemented:

1. The Services should provide technical assistance to the applicant throughout the term of the permit.

In order for the Services to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Services request notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation and conference on the action outlined in the request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

LITERATURE CITED

Allendorf, F.W. and R.F. Leary. 1986. Heterozygosity and fitness in natural populations of animals. Chapter 4 in: Soule, M.E. Conservation biology: the science of scarcity and diversity. Sinauer Associates Sunderland, MA.

American Ornithologists' Union. 1957. Check-list of North American birds. Lord Baltimore Press, Inc., Baltimore, MD. 691 p.

Andren, H., P. Angelstam, E. Lindstrom, and P. Widen. 1985. Differences in predation pressure in relation to habitat fragmentation: an experiment. Oikos 45:273-277.

Andrus, C.W., B.A. Long, and H.A. Froelich. 1988. Woody debris and its contribution to pool formation in a coastal stream 50 years after logging. Canadian Journal of Fisheries and Aquatic Sciences 45:2080-2086.

Armstrong, R.H. 1971. Age, food, and migration of sea-run cutthroat trout, *Salmo clarki*, at Eva Lake, Southeastern Alaska. Transactions of the American Fisheries Society 100:302-306.

Ashton, D.T., A.J. Lind, and K.E. Schlick. 1998. *Rana boylii* – foothill yellow-legged frog: a natural history review. Species Tour of California. 7 p [Online]. Available: http://ice.ucdavis.edu/Toads/boylii.html[Last updated on January 17, 1998].

Aubry, K.B. and P.A. Hall. 1991. Terrestrial amphibian communities in the southern Washington Cascade Range. Pages 327-338 in: Ruggiero, L.F., K.B. Aubry, A.B. Carey, and M.H. Huff (technical coordinators). Wildlife and vegetation of unmanaged Douglas-fir forests. General Technical Report PNW-GTR-285. USDA Forest Service, Pacific Northwest Experiment Station, Portland, OR.

Aubry, K.B. and D. B. Houston. 1992. Distribution and status of the fisher (*Martes pennanti*) in Washington. Northwestern Naturalist 73:69-79.

Aubry, K.B., C.M. Raley, T.J. Catton, G.W. Tomb, and F.E. Wahl. 1997. Ecological characteristics of fishers in southwestern Oregon. Pages 1-6 in: Wildlife Ecology Team: 1997 Annual Report. USDA Forest Service, Pacific Northwest Research Station, Olympia, WA.

Aubry, K.B., M.J. Crites and S.D. West. 1991. Regional patterns of small mammal abundance and community composition in Oregon and Washington. Pages 285-294 in: Ruggiero, L.F., K.B. Aubry, A.B. Carey, and M.H. Huff (technical coordinators). Wildlife and vegetation of unmanaged Douglas-fir forests. General Technical Report PNW-GTR-285. USDA Forest Service, Pacific Northwest Experiment Station, Portland, OR.

Barnhart, R.A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest), steelhead. U.S. Fish and Wildlife Service Biological Report 82(11.60). 21 p.

Barnhart, R.A. 1995. Salmon and steelhead populations of the Klamath-Trinity Basin, California. Pages 73-97 in T.J. Hassler, ed., Klamath Basin Fisheries Symposium. California Cooperative Fishery Research Unit, Humboldt State University, Arcata, CA.

Becker, B.H., S.R. Beissinger, and H.R. Carter. 1997. At-sea density monitoring of marbled murrelets in central California: methodological considerations. Condor 99:743-755.

Bedrossian, T.L. 1983. Watersheds mapping in northern California. California Geology 36:140-147.

Behan, B., B. Biswell, A. Center, J. Hayes, and S. Madsen. 1996. Biology and interim survey protocol for the red tree vole in Oregon. Unpublished document on file, Regional Ecosystem Office, Portland, OR. 12 p plus appendices.

Behler, J.L. and F.W. King. 1979. The Audubon Society field guide to North American reptiles and amphibians. Knopf Publishing, New York, NY. 743 p.

Behnke, R.J. 1992. Native trout of western North America. American Fisheries Society Monograph 6. Bethesda, MD. 275 p.

Beissinger, S.B. 1995. Population trends of the marbled murrelet projected from demographic analyses. Pages 385-394 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Beissinger, S.R. and M.I. Westphal. 1998. On the use of demographic models of population viability in endangered species management. Journal of Wildlife Management 62:821-841.

Bell, M.C. 1991. Fisheries handbook of engineering requirements and biological criteria. 3rd Edition. U.S. Army, Corps of Engineers, Office of the Chief of Engineers, Fish Passage Development and Evaluation Program. Portland, OR.

Berbach, M., G. Gould Jr., J. Stenback, H. Eng, and R. Marose. 1993. GIS analysis of northern spotted owl dispersal habitat on private lands in Del Norte, Humboldt, and Mendocino Counties, CA. 1993 Transactions of the Western Section of the Wildlife Society 29: 12-15.

Berman, C.H. and T.P. Quinn. 1991. Behavioral thermoregulation and homing by spring chinook salmon, *Oncorhynchus tshawytscha*, in the Yakima River. Journal of Fish Biology 39:301-312.

Beschta, R.L. 1978. Long-term patterns of sediment production following road construction and logging in the Oregon Coast Range. Water Resources Research 14:1011-1016.

Beschta, R.L. 1991. Stream habitat management for fish in the northwestern United States: the role of riparian vegetation. American Fisheries Society Symposium 10:53-58.

Beschta, R.L. and W.S. Platts. 1986. Morphological features of small streams: Significance and function. Water Resources Bulletin 22:369-378.

Beschta, R.L., R.E. Bilby, G.W. Brown, [and others]. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. Pages 191-232 in E.O. Salo and T.W. Cundy, (editors). Streamside Management: Forestry and Fishery Interactions. Contribution 57. University of Washington, College of Forest Research, Seattle, CA.

Beschta, R.L., J.R. Boyle, C.C. Chambers, [and others]. 1995. Cumulative effects of forest practices in Oregon. Prepared for the Oregon Department of Forestry, Salem. Oregon State University, Corvallis, CA.

Best, D.W., H.M. Kelsey, D.K. Hagans, and M. Alpert. 1995. Role of fluvial hillslope erosion and road construction in the sediment budget of Garrett Creek, Humboldt County, California. Pages C1-C7 in K.M. Nolan, H. Kelsey, and D.C. Marron (editors). Geomorphic processes and aquatic habitat in the Redwood Creek Basin, Northwest California. U.S. Geological Survey Professional Paper 1454.

Beyer, K.M. and R.T. Golightly. 1996. Distribution of Pacific fisher and other forest carnivores in coastal northwestern California. Contract #FG-3156-WM. Unpublished report on file, California Department of Fish and Game, Sacramento, CA. 28 p.

Bilby, R.E. 1984. Removal of woody debris may affect stream channel stability. Journal of Forestry 82:609-613.

Bilby, R.W. and J.W. Ward. 1989. Changes in characteristics and function of woody debris with increasing size of streams in western Washington. Transactions of the American Fisheries Society 118:368-378.

Bilby, R.W., B.R. Franson, and P.A. Bisson. 1996. Incorporation of nitrogen and carbon from spawning coho salmon into the trophic system of small streams: evidence from stable isotopes. Canadian Journal of Fisheries and Aquatic Sciences 50:164-173.

Bingham., B. 1991. Letter to Gail Lucas, Jeff Shellito, and Jim Steel, from Bruce Bingham, Pacific Southwest Experiment Station, Arcata, re: summary of upland old-growth redwood data sets from Humboldt and Mendocino Counties, September 10, 1991. 2 p.

Bisson, P.A. and J.R. Sedell. 1984. Salmonid populations in streams in clearcut vs. old-growth forests of eastern Washington. Pages 121-129 in W.R. Meehan, Jr, T.R. Merrell, and T.A. Hanley (editors). Fish and Wildlife Relationships in Old-growth Forests. Institute of Fisheries Research Biologists, Morehead City, NC.

Bisson, P.A., R.E. Bilby, M.D. Bryant, [and others]. 1987. Large woody debris in forested streams in the Pacific Northwest: Past, present, and future. Pages 143-190 in: Salo, E.O. and T.W. Cundy (editors). Streamside Management: Forestry and Fishery Interactions. Contribution 57. University of Washington, College of Forest Research, Seattle, WA.

Bisson, P.A., J.L. Nielsen, and J.W. Ward. 1988. Summer production of coho salmon stocked in Mount St. Helens streams 3-6 years after the 1980 eruption. Transactions of the American Fisheries Society 117:322-335.

Bisson, P.A., T.A. Quinn, G.H. Reeves, and S.V. Gregory. 1992. Best management practices, cumulative effects, and long-term trends in fish abundance in Pacific Northwest river systems. In Watershed Management: Balancing Sustainability and Environmental Change. Springer-Verlag, New York, NY.

Biswell, B.L. 1996. Ecological characteristics of red tree vole populations in a landscape dominated by late-successional forests (DRAFT). MS thesis. Oregon State University, Corvallis, OR.

Biswell, B. L. and E. Forsman. 1997. The effects of landscape character and stand structure on the distribution and abundance of the red tree vole (*Arborimus longicaudus*) in western Oregon. Draft report submitted to the Wildlife Ecology Team, Pacific Northwest Research Station, Portland OR. 13 p.

Bjornn, T.C. 1968. Survival and emergence of trout and salmon fry in various gravel-sand mixtures. In. Logging and Salmon: proceedings of a forum. American Institute of Fishery Research Biologists, Alaska District, Juneau.

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 in: Meehan, W.R. (editor). Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. American Fisheries Society, Bethesda, MD.

Bjornn, T.C., M.A. Brusven, M. Molnau, [and others]. 1974. Sediment in streams and its effects on aquatic life. Technical Completion Report, Project B-025-IDA. Water Research Institute, University of Idaho, Moscow, ID.

Bockheim, J.G., T.M. Ballard, R.P. Willington, and J.L. Larson. 1973. Impact of clearcutting on soils and watersheds, southwestern British Columbia. Canadian Forestry Service, Pacific Forest Research Center Contract Report, Victoria, BC.

Boles, G. 1988. Water temperature effects on chinook salmon (*Oncorhynchus tshawytscha*) with emphasis on the Sacramento River: a literature review. Report of the California Department of Water Resources, Northern District, Red Bluff, CA. 43 p.

Botkin, D., K. Cummins, T. Dunne, [and others]. 1995. Status and future of salmon in western Oregon and northern California. The Center for the Study of the Environment, Report #8. May, 1995.

Brett, J.R. 1952. Temperature tolerance in young Pacific salmon, genus *Oncorhynchus*. Journal of the Fisheries Resource Board of Canada 9:265-323.

Briggs, J.C. 1953. The behavior and reproduction of salmonid fishes in a small coastal stream. California Department of Fish and Game, Fish Bulletin 94:1-62.

Brode, J.M. 1995. Report to the Fish and Game Commission: Status review of the southern torrent salamander (*Rhyacotriton variegatus*) in California. California Department of Fish and Game, Inland Fisheries Division, Sacramento, CA. 23 p. plus appendices.

Brode, J.M., H.H. Welsh, A.J. Lind, and L. Diller. 1997. Southern torrent salamander (Rhyacotriton variegatus): a summary of ecology and conservation. Pages 3-12 in: Proceedings: Forest Amphibian Workshop, October 28-29, 1997, Korbel, CA.

Brosofske, K.D., J. Chen, R.J. Naiman, and J.F. Franklin. 1997. Effects of harvesting on microclimatic gradients from streams to uplands in western Washington, USA. Ecological Applications 7:1188-1200.

Brown, G.W. and J.T. Krygier. 1970. Effects of clearcutting on stream temperature. Water Resources Bulletin 6:1133-1139.

Brown, G.W. and J.R. Ritter. 1971 Sediment transport and turbidity in the Eel River basin, California. U.S. Geological Survey Water Supply Paper 1986. 67 p.

Brown, L.R., and P.B. Moyle. 1991. Status of coho salmon in California. Report to the National Marine Fisheries Service. Environmental and Technical Services Division, National Marine Fisheries Service, Portland, OR. 114 p.

Brown, L.R., P.B. Moyle, and R.M. Yoshiyama. 1994. Historical decline and current status of coho salmon in California. North American Journal of Fisheries Management 14:237-261.

Brown, R.F. 1988. Assessment of pinniped populations in Oregon April 1984 to April 1985. U.S. Dept. of Commerce, National Marine Fisheries Service, Northwest and Alaska Fisheries Center Processed Report 88-05. National Marine Mammal laboratory, Seattle, WA.

Bryant, M.D. 1980. Evolution of large organic debris after timber harvest: Maybeso Creek, 1949-1978. General Technical Report, PNW-101. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, OR.

Buchanan, D.V., J.E. Sanders, J.L. Zinn, and J.L. Fryer. 1983. Relative susceptibility of four strains of summer steelhead to infection by *Ceratomyxa shasta*. Transactions of the American Fisheries Society 112:541-543.

Buck, S.G., C. Mullis, and A.S. Mossman. 1983. Final report: Corral Bottom–Hayfork Bally fisher study. USDA Forest Service, Pacific Southwest Region, San Francisco, CA. 135 p.

Buck, S.G., C. Mullis, A.S. Mossman, I. Show, and C. Collahan. 1994. Habitat use by fishers in adjoining heavily and lightly harvested forest. Pages 368-376 in: Buskirk, S.W., A.S.

Harestad, M.G. Raphael, and R.A. Powell (editors). Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, NY.

Bull, E.L. and B.E. Carter. 1996. Tailed frogs: distribution, ecology and association with timber harvest in northeastern Oregon. Research Paper PNW-RP-497. USDA Forest Service, Pacific Northwest Research Station. La Grande, OR. 11 p.

Burger, A.E. 1995. Inland habitat associations of marbled murrelets in British Columbia. Pages 151-161 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Burgner, R.L., J.T. Light, L. Margolis, [and others]. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the Pacific Ocean. International North Pacific Fisheries Commission Bulletin Number 51.

Burke, V.J. and J.W. Gibbons. 1995. Terrestrial buffer zones and wetland conservation: a case study in freshwater turtles in a Carolina bay. Conservation Biology 9:1365-1369.

Burner, C.J. 1951. Characteristics of spawning nests of Columbia River salmon. Fisheries Bulletin, U.S. 52:95-110.

Burroughs, E.R., Jr., and B.R. Thomas. 1977. Declining root strength in Douglas-fir after felling as a factor in slope stability. Research Paper INT-RP-190. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Bury, R.B. 1972. Habits and home range of the Pacific pond turtle (*Clemmys marmorata*) in a stream community. PhD dissertation. University of California, Berkeley, CA. 205 p.

Bury, R.B. and P.S. Corn. 1988. Douglas-fir forests in the Oregon and Washington Cascades: abundance of terrestrial herpetofauna related to stand age and moisture. Pages 11-22 in: Szarco, R.C., K.E. Severson, and D.R. Patton (technical coordinators). Management of amphibians, reptiles, and small mammals in North America. General Technical Report GTR-RM-166. USDA Forest Service, Rocky Mountain Experiment Station, Tempe, AZ.

Busby, P.J. T.C. Wainwright, G.J. Bryant, [and others]. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dept of Commerce, NOAA Technical Memorandum NMFS-NWFSC-27. 261 p.

Bustard, D.R., and D.W. Narver. 1975. Preferences of juvenile coho salmon *Oncorhynchus kisutch* and cutthroat trout *Salmo clarki* relative to simulated alteration of winter habitat. Journal of the Fisheries Resource Board Canada: 681-687.

California Advisory Committee on Salmon and Steelhead Trout. 1988. Restoring the balance. California Department of Fish and Game, Sacramento, CA. 84 p.

California Board of Equalization. 1998. California timber harvest by county [Online]. Available: http://www.boe.ca.gov/tpa.htm.

California Board of Forestry. 1992. Letter to members of the public from Board staff, re: 15 day notice requirement of government code section 11346.8(C) - old growth protection, August 8, 1992. 8 p plus appendices.

California Coastal Commission. 1998. Staff Report 1-97-68 – Arcata Readimix. San Francisco, CA. 28 p.

California Department of Finance. 1997. Del Norte County profile [Online]. Available: http://www.dof.ca.gov/html/fs_data/profiles/delnorte.htm [February 13, 1999].

California Department of Finance. 1998a. Mendocino County profile [Online]. Available: http://www.dof.ca.gov/html/fs_data/profiles/MENDO.XLS [February 13, 1999].

California Department of Finance. 1998b. Humboldt County profile [Online]. Available: http://www.dof.ca.gov/html/fs_data/profiles/HUMBOLDT.XLS [February 13, 1999].

California Department of Fish and Game. 1965. California fish and wildlife plan. Three volumes. California Department of Fish and Game, Sacramento, CA.

California Department of Fish and Game. 1980-1989. Unpublished data. Annual seining results, CDFG, Inland Fisheries Administrative Report. California Department of Fish and Game, Sacramento, CA.

California Department of Fish and Game. 1991. Sport fishing for anadromous salmonid fishes. California Department of Fish and Game, Sacramento, CA. 69 p.

California Department of Fish and Game. 1992. Recovery plan: bank swallow (*Riparia riparia*). Nongame and Mammal Section Report 93.02. California Department of Fish and Game, Sacramento, CA. 27 p.

California Department of Fish and Game. 1994. Petition to the California Board of Forestry to list coho salmon (*Oncorhynchus kisutch*) as a sensitive species. California Department of Fish and Game Report, 35 p. + appendices.

California Department of Fish and Game. 1995. Five-year status review: bank swallow (*Riparia riparia*). California Department of Fish and Game, Wildlife Management Division, Sacramento, CA. 20 p.

California Department of Fish and Game. 1996. Biological Opinion for coho salmon south of San Francisco Bay, issued to the California Department of Forestry and Fire Protection pursuant to Fish and Game Code §2090. April 17, 1996. Environmental Services Division, Sacramento, CA.

California Department of Fish and Game. 1997a. Distribution of the California red tree vole: preliminary evaluation. May 20, 1997 Draft. California Department of Fish and Game, Sacramento, CA. 15 p.

California Department of Fish and Game. 1997b. California stream habitat database. Electronic data files, Inland Fisheries Division, California Department of Fish and Game, Sacramento, CA.

California Department of Fish and Game. 1998a. California special animals list, March 1998. California Department of Fish and Game, Division of Natural Heritage, Sacramento, CA.

California Department of Fish and Game. 1998b. Natural Heritage Program natural diversity database. Rarefind Version 6.0. California Department of Fish and Game, Division of Natural Heritage Sacramento, CA.

California Department of Forestry and Fire Protection. 1998. Cumulative watershed effects meeting: agency review of Bear Creek, Jordan Creek, Stitz Creek, Freshwater Creek, and Elk River. Unpublished report.

California Department of Forestry and Fire Protection. 1999. Timber harvest history database, Santa Rosa, CA.

Carey, A.B. 1991. The biology of arboreal rodents in Douglas-fir forests. General Technical Report PNW-GTR-276. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. 46 p.

Carroll, C. 1997. Predicting the distribution of fisher (*Martes pennanti*) in northwestern California, USA, using survey data and GIS modeling. MS thesis. Humboldt State University, Arcata, CA. 162 p.

Cederholm, C.J. 1994. A suggested landscape approach for salmon and wildlife habitat protection in western Washington riparian ecosystems. Pages 78-90 in: A.B. Carey and C. Elliot, eds., Washington Forest Landscape Management Project Progress Report.. Washington Department of Natural Resources, Olympia, WA.

Cederholm, C.J., and N.P. Peterson. 1985. The retention of coho salmon (*Oncorhynchus kisutch*) carcasses by organic debris in small streams. Canadian Journal of Fisheries and Aquatic Sciences 42:1222-1225.

Cederholm, C.J. and L.M. Reid. 1987. Impacts of forest management on coho salmon (*Oncorhynchus kisutch*) populations of the Clearwater River, Washington: a project summary. Pages 373-398 in: Salo, E.O. and T.W. Cundy (editors). Streamside Management: Forestry and Fishery Interactions. Contribution 57. University of Washington, College of Forest Research, Seattle, CA.

Cederholm, C.J., and W.J. Scarlett. 1982. Seasonal immigrations of juvenile salmonids into four small tributaries of the Clearwater, Washington, 1977-1981. Pages 98-110 in: Brannon, E.L. and E.O. Salo, eds., Proceedings of the Salmon and Trout Migratory Behavior Symposium, pgs, 98-110. University of Washington, Seattle, WA.

Cederholm, C.J., L.C. Lestelle, B.G. Edle, [and others]. 1978. The effects of landslide siltation on the salmon and trout resources of Stequaleho Creek and the main Clearwater River, Jefferson County, Washington, 1972-1975. Final Report FRI-UW-7804. Fisheries Research Institute, University of Washington, Seattle, WA.

Cederholm, C.J., L.M. Reid, and E.O. Salo. 1981. Cumulative effects of logging road sediment on salmonid populations in the Clearwater River, Jefferson County, Washington. Pages 38-74 in: Proceedings, Conference on Salmon Spawning Gravel: a Renewable Resource in the Pacific Northwest? Water Research Center Report 39, Washington State University, Pullman, WA.

Chamberlin, T.W., R.D. Harr, and F.H. Everest. 1991. Timber harvesting, silviculture, and watershed processes. Pages 181-206 in: Meehan, W.R. (Editor0. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. Bethesda, MD.

Chapman, D.W. 1988. Critical review of variables used to define effects of fines in redds of large salmonids. Transactions of the American Fisheries Society 117:1-21.

Chapman, D.W. and T.C. Bjornn. 1969. Distribution of salmonids in streams, with special reference to food and feeding. Pages 153-176 in Northcote, T.G. (editor). Symposium on salmon and trout in streams. H.R. MacMillan Lectures in Fisheries, University of British Columbia, Institute of Fisheries, Vancouver.

Chatwin, S.C., D.E. Howes, J.W. Schwab, [and others]. 1994. A guide for management of landslide-prone terrain in the Pacific Northwest, 2nd edition. Research Branch, British Columbia Ministry of Forests. Victoria, BC. 220 p.

Chen, J, J.F. Franklin, and T.A. Spies. 1992. Vegetation responses to edge environments in old-growth Douglas-fir forests. Ecological Applications 2:387-396.

Chen, J., J.F. Franklin, and T.A. Spies. 1993. Contrasting microclimates among clearcut, edge and interior of old-growth forest. Agriculture and Forest Meteorology 63:219-237.

Chen, J., J.F. Franklin, and T.A Spies. 1995. Growing-season microclimate gradients from clearcut edges into old-growth Douglas-fir forests. Ecological Applications 5:74-86.

Cobble, D.W. 1961. Influence of water exchange and dissolved oxygen in redds on survival of steelhead trout embryos. Transactions of the American Fisheries Society 90:469-474.

Cooper, B.A. and R.J. Blaha. 1998. Evaluating the marbled murrelet survey protocol with radar. Poster presented at annual meeting of the Pacific Seabird Group, Monterey, CA.

Cooper, B.A., M.G. Raphael, D.E. Evans, P. Henson, and G. Miller. 1998. Use of radar as an inventory and monitoring tool for marbled murrelets in Washington and Oregon. Paper presented at annual meeting of the Pacific Seabird Group, Monterey, CA.

Corkran, C.C. and C. Thoms. 1996. Amphibians of Oregon, Washington and British Columbia. Lone Pine Publishing, Renton, WA. 175 p.

Corn, P.S. and R.B. Bury. 1986 . Habitat use and terrestrial activity by red tree voles (*Arborimus longicaudus*) in Oregon. Journal of Mammalogy 67:404-406.

Corn, P.S. and R.B. Bury. 1988. Distribution of the voles *Arborimus longicaudus* and *Phenacomy intermedius* in the central Oregon Cascades. Journal of Mammalogy 69:427-429.

Corn, P.S. and R.B. Bury. 1989. Logging in western Oregon: responses of headwater habitat and stream amphibians. Forest Ecology and Management 29:39-57.

Corn, P.S. and R.B. Bury. 1991. Small mammal communities in the Oregon Coast Range. Pages 241-254 in: Ruggiero, L.F., K.B. Aubry, A.B. Carey, and M.H. Huff (technical coordinators). Wildlife and vegetation of unmanaged Douglas-fir forests. General Technical Report PNW-GTR-285. USDA Forest Service, Pacific Northwest Experiment Station, Portland, OR.

Craig, J.L. and T.S. Fletcher. 1994. Annual Report. Klamath River fisheries assessment program 1992. USDI, Fish and Wildlife Service, Arcata, CA. 63 p.

Cramer, F.K. 1940. Notes on the natural spawning of cutthroat trout *Salmo clarki clarki* in Oregon. Proceedings of the Sixth Pacific Science Conference of the Pacific Science Association 3:335-339.

Cramer, S.P. 1994. Status of Oregon's coastal coho and measures for population rebuilding. Final Report, May 1994. Submitted to National Marine Fisheries Service by S.P. Cramer and Associates, Gresham, Oregon. Environmental and Technical Services Division, National Marine Fisheries Service, Portland, OR. 142 p.

Cramer, S.P, [and others]. 1995. The status of steelhead populations in California in regards to the Endangered Species Act. Document prepared for Association of California Water Agencies. Environmental and Technical Services Division, National Marine Fisheries Service, Portland, OR. 167 p.

Csuti, B., A.J. Kimberling, T.A. O'Neil, M.M. Shaughnessy, E.P. Gaines, and M.M. Huso. 1997. Atlas of Oregon wildlife. Oregon State University Press, Corvallis, OR. 492 p.

Cuenco, M.L. 1991. Examples where supplementation has successfully resulted in increasing naturally-reproducing fish populations. Report submitted to Endangered Species Act Administrative Record for petitioned salmon stocks, February 1991. National Marine Fisheries Service, Environmental Services Division, Portland, OR. 22 p.

Cummins, K.W., J.R. Sedell, F.J. Swanson, [and others]. 1983. Organic matter budgets for stream ecosystems: problems in their evaluation. Pages 299-353 in: Minshall, G.W. and J.R. Barnes (editors). Stream ecology: Application and testing of general ecological theory. Plenum Press, New York, NY.

Dark, S. 1997. A landscape-scale analysis of mammalian carnivore distribution and habitat use by fisher. MS thesis. Humboldt State University, Arcata, CA. 67 p.

Dark, S.J., R.J. Gutierrez, and G.I. Gould. 1998. The barred owl (*Strix varia*) invasion in California. Auk:115:50-56.

Daugherty, C.H., and A.L. Sheldon. 1982a. Age determination, growth and life history of a Montana population of the tailed frog (*Ascaphus truei*). Herpetologica 38:461-468.

Daugherty, C.H. and A.L. Shelton. 1982b. Age-specific movement patterns of the frog *Ascaphus truei*. Herpetologica 38:468-474.

Davidson, C. 1993. *Ascaphus truei* – tailed frog. In: The California Amphibian Status Website. 4 p. [Online]. Available: http://ice.ucdavis.edu/Toads/truei.html [Last updated on October 14, 1998].

Davidson, C. 1996. Rana aurora – red-legged frog. In: The California Amphibian Status Website, 4 p [Online]. Available: http://ice.ucdavis.edu/Toads/aurora.html [Last updated on October 14, 1998].

Davis, G.E., J. Foster, C.E. Warren, and P. Doudoroff. 1963. The influence of oxygen concentration on the swimming performance of juvenile Pacific salmon at various temperatures. Transactions of the American Fisheries Society 92:111-124.

Derksen, J. 1997. KRIS- the Klamath Resource Information System Program. Software program and database. Institute for Fisheries Resources, Eugene, OR.

Detrich, P. 1999. Untitled draft memorandum providing updated murrelet habitat data. January 2, 1999. 4 p.

Diller, L.V. and R.L. Wallace. 1996. Distribution and habitat of *Rhyacotriton variegatus* in managed, young growth forests in north coastal California. Journal of Herpetology 30:184-191.

Dillingham, C.P., Miller, R.C., and L.O. Webb. 1995. Marbled murrelet distribution in the Siskiyou National Forest of southwestern Oregon. Northwestern Naturalist 76:33-39.

Divoky, G.J., and M. Horton. 1995. Breeding and natal dispersal, nest habitat loss, and implications for marbled murrelet populations. Pages 83-88 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Dodd, C.K. and R.A. Seigel. 1991. Relocation, repatriation, and translocation of amphibians and reptiles: are they conservation strategies that work? Herpetologia 47: 336-350.

Duellman, W.E. and L. Trueb. 1986. Biology of amphibians. Johns Hopkins University Press, Baltimore, MD.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. The birder's handbook. Simon and Schuster, New York, NY. 785 p.

Everest, F.H. 1973. Ecology and management of summer steelhead in the Rogue River. Oregon State Game Commission. Fishery Research Report 7. 48 p.

Everest, F.H. and D.W. Chapman. 1972. Habitat selection and spatial interaction by juvenile chinook salmon and steelhead trout in two Idaho streams. Journal of the Fisheries Research Board of Canada 29:91-100.

Everest, F.H., and W.R. Meehan. 1981. Some effects of debris torrents on habitat of anadromous salmonids. National Council of the Paper Industry for Air and Stream improvement Technical Bulletin 252:23-30. New York, NY.

Everest, F.H., N.B. Armantrout, S.M. Keller, [and others]. 1985. Salmonids. Pages 199-230 in: Brown, E.R (editor). Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington. Publication R6-F&WL-192-1985. USDA Forest Service, Pacific Northwest Region, Portland, OR.

Everest, F.H., R.L. Beschta, J.C. Scrivener, [and others]. 1987. Fine sediment and salmonid production: a paradox. In: Salo, E.O. and T.W. Cundy (editors). Streamside Management: Forestry and Fishery Interactions. Contribution 57, University of Washington, College of Forest Research, Seattle, WA.

Eyre, F.H., ed. 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington, DC. 148 p.

Fiedler, P.L. and S.R. Jain (editors). 1992. Conservation biology. The theory and practice of nature conservation, preservation and management. Chapman and Hall, New York, NY.

Flint, T. and G. Zillges. 1980. Little Bear Creek coho salmon stream life study. Washington Department of Fisheries Progress Report 124. 40 p.

Flossi, G. and F.L. Reynolds. 1994. California salmonid stream habitat restoration manual, 2nd edition. California Department of Fish and Game, Inland Fisheries Division, Sacramento, CA.

Flossi, G., S. Downie, J. Hopelain, [and others]. 1998. California salmonid stream habitat restoration manual, 3rd edition. California Department of Fish and Game, Inland Fisheries Division, Sacramento, CA.

Folliard, L.1993. Nest site characteristics of northern spotted owls in managed forests of northwest California. MS thesis. University of Idaho, Moscow, ID. 106 p.

Forsman, E.D. 1981. Molt of the spotted owl. Auk 98:735-742.

Forsman, E.D., E.C. Meslow, and H.M. Wight. 1984. Distribution and biology of the spotted owl in Oregon. Wildlife Society Monograph 87:1-64.

Fox, M. 1994. Draft revisions of the WSA Fish Module Diagnostic Matrix: LWD assessment. Muckleshoot Indian Tribe Fisheries Department. June 6, 1994.

Frampton, G.T. 1994. Correspondence to Senator Mark Hatfield. November 29, 1994. 6 p.

Franklin, A.F. 1998a. Population ecology of the northern spotted owl (*Strix occidentalis caurina*) in northwestern California: annual results, 1997. Unpublished report on file, Humboldt State University, Arcata, CA. 15 p.

Franklin, A.F. 1998b. Factors affecting temporal and spatial variation in northern spotted owl populations in northwest California. PhD dissertation. Colorado State University, Fort Collins, CO. 185 p.

Fraser, F.J., E.A. Perry, and D.T. Lightly. 1983. Big Qualicum River salmon development project, Volume I: A biological assessment, 1959-1972. Canadian Technical Report on Fisheries and Aquatic Science 1189. 198 p.

Freel. M. 1991. A literature review for management of the martin and fisher on national forests in California. USDA Forest Service, Pacific Southwest Region, San Francisco, CA. 21 p.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. Pages 297-324 in: Meehan, W.R. (editor). Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. Bethesda, MD.

Fuss, H.J. 1982. Age, growth, and instream movement of Olympic Peninsula coastal cutthroat trout, *Salmo clarki clarki*. MS thesis. School of Fisheries, University of Washington, Seattle, CA. 128 p.

Fyfe, R.W. and R.R. Olendorff. 1976. Minimizing the dangers of nesting studies to raptors and other sensitive species. Canadian Wildlife Service Occasional Paper Number 23. Ottawa, Canada. 16 p.

Gardner, R.B. 1979. Some environmental and economic effects of alternative forest road designs. Transactions of the American Society of Agricultural Engineers 22:63-68.

Garrett, A.M. 1998. Instream movements of coastal cutthroat trout (*Oncorhynchus clarki clarki*) in the Clearwater River, Jefferson County, Washington. MS thesis. The Evergreen State College, Olympia, WA. 212 p.

Gaston, A.J. 1992. The ancient murrelet: a natural history in the Queen Charlotte Islands. T & A D Poyser, London, England. 249 p.

Gates, J.E. and L.W. Gysel. 1978. Avian nest dispersion and fledgling success in field-forest ecotones. Ecology 59:871-883.

Gentry, A.H. 1986. Endemism in tropical versus temperature plant communities. Pages 153-181 in: Soulé, M.E. (editor). Conservation biology: the science of scarcity and diversity. Sinauer Associates, Inc., Sunderland, MA.

Gerstung, E.R. 1997. Status of coastal cutthroat trout in California. Pages 43-56 in: Hall, J.D., P.A. Bisson, and R.E. Gresswell (editors). Sea-run cutthroat trout: biology, management, and future conservation. American Fisheries Society, Oregon Chapter, Corvallis, CA.

Gibbons, D.R. and E.O. Salo. 1973. An annotated bibliography of the effects of logging on fish of the western United States and Canada. General Technical Report GTR-PNW-10. USDA Forest Service, Portland, OR.

Giger, R.D. 1972. Ecology and management of coastal cutthroat trout in Oregon. Oregon State Game Commission. Fishery Research Report Number 6. 61 p.

Gilbert, C.H. 1912. Age at maturity of the Pacific coast salmon of the genus *Oncorhynchus*. Fish Bulletin, U.S. 32:3-22.

Gillesberg, A., and A.B. Carey. 1991. Arboreal nests of *Phenacomys longicaudus* in Oregon. Journal of Mammalogy 72:784-787.

Gilpin, M.E. and M.E. Soule. 1986. Minimum viable populations: processes of species extinction. Chapter 2 in: Soule, M.E. Conservation biology: the science of scarcity and diversity. Sinauer Associates Sunderland, MA.

Glova, G.J. 1984. Management implications of the distribution and diet of sympatric populations of juvenile coho salmon and coastal cutthroat trout in small streams in British Columbia, Canada. Progressive Fish Culturist 46:269-277.

Glova, G.J. 1987. Comparison of allopatric cutthroat trout stocks with those sympatric with coho salmon and sculpins in small streams. Environmental Biology of Fishes 20:275-284.

Glova, G.J. and J.C. Mason. 1976. Interactive ecology of juvenile salmon and trout in streams. Fisheries Board of Canada Manuscript Report 1391.

Goldman, E.A. 1935. North American mustelids of the genera *Martes*, *Gulo*, and *Lutra*. Proceedings of the Biological Society of Washington 48:175-186.

Gomez, D.M. 1993. Small mammal and herptofauna abundance in riparian and upslope areas of five forest conditions. MS thesis. Oregon State University, Corvallis, OR. 118 p.

Good, D.A., and D.B. Wake. 1992. Geographic variation and speciation in the torrent salamanders of the genus *Rhyacotriton* (Caudata: Rhyacotritonidae). University of California Press, Berkeley, CA. 89 p.

Gould, G.I. Jr. 1995. Distribution and numbers of known northern spotted owl sites in northern California. Paper presented at the "Symposium on the Status and Management of the Northern Spotted Owl in California," at Ukiah, CA., on August 16, 1995. 11 p.

Gregory, P.T. 1979. Predator avoidance behavior of the red-legged frog (*Rana aurora*). Herpetologica 35:175-184.

Gregory, S.V. and P.A. Bisson. 1997. Degradation and loss of anadromous salmonid habitat in the Pacific Northwest. Pages 277-314 in: Stroud, D.J., P.A. Bisson, and R.J. Naiman (editors). Pacific Salmon and Their Ecosystems – Status and Future Options.

Gregory, S.V., G.A. Lambertti, D.C. Erman, [and others]. 1987. Influence of forest practices on aquatic production. Pages 233-256 in: Salo, E.O. and T.W. Cundy (editors). Streamside Management: Forestry and Fishery Interactions. Contribution 57. University of Washington, College of Forest Research, Seattle, WA.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. BioScience 41:540-551.

Grenfell, W.E. and M. Fasenfest. 1979. Winter food habits of fishers, *Martes pennanti*, in northwestern California. California Fish and Game 65:186-189.

Grenier, J.J., and S.K. Nelson. 1995. Marbled murrelet habitat associations in Oregon. Pages 191-204 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Gribanov, V.I. 1948. The coho salmon (*Oncorhynchus kisutch* Walb.) - a biological sketch. Izv. Tikhookean. Nauchno-Issled. Inst. Rybn. Khoz. Okeanogr. 28:43-101. Translated from Russian. Fisheries Research Board of Canada Translation Service 370.

Grinnell, J., J.S. Dixon, and J.M. Linsdale. 1937. Fur-bearing mammals of California: their natural history, systematic status, and relations to man. Volume I. University of California Press, Berkeley, CA.

Hagans, D.K., and W.E. Weaver. 1987. Magnitude, cause and basin response to fluvial erosion, Redwood Creek Basin, Northern California. Pages 419-428 in: Beschta, R.L., T. Blinn, G.E.

Grant, F.J. Swanson, and G.G. Ice (editors). Erosion and Sedimentation in the Pacific Rim. International Association of Hydrological Science Pub. No. 165.

Hagmeier, E.E. 1959. A re-evaluation of the subspecies of fisher. Canadian Field-Naturalist 73:185-197.

Hall, E.R. 1991. The mammals of North America. 2nd edition. John Wiley & Sons, New York, NY. 1181 p.

Hall, J.D. P.A. Bisson, and R.E. Gresswell, eds. 1997. Sea-run cutthroat trout: biology, management, and future conservation. American Fisheries Society, Oregon Chapter, Corvallis. 183 p.

Hamer, T.E. 1995. Inland habitat associations of marbled murrelets in western Washington. Pages 163-174 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Hamer, T. E., and S.K. Nelson. 1995. Characteristics of marbled murrelet nest trees and nestig stands. Pages 69-82 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Hanski, I. 1997. Metapopulation dynamics: from concepts and observations to predictive models. Chapter 4 in: Hanski, I. and M.E. Gilpin (editors). Metapopulation biology. Academic Press, New York, NY.

Harden, D.R., S.M. Colman, and K.M. Nolan. 1995. Mass movement in the Redwood Creek Basin, Northwestern California. Pages G1-G11 in: Nolan, K.M., H. Kelsey, and D.C. Marron (editors). Geomorphic Processes and Aquatic Habitat in the Redwood Creek Basin, Northwest California. U.S. Geol. Prof. Paper 1454.

Harr, R.D. 1982. Fog drip in the Bull Run Municipal Watershed, Oregon. Water Resources Bulletin 18:785-789.

Harr, R.D. and R.A. Nichols. 1993. Stabilizing forest roads to help restore fish habitats: a northwest Washington example. Fisheries 18:18-22.

Harris, S.W. 1996. Northwestern California birds: a guide to the status, distribution, and habitats of the birds of Del Norte, Humboldt, Trinity, Northern Mendocino, and western Siskiyou counties, California. 2nd edition. Humboldt State University Press, Arcata, CA. 323 p.

Hartman, G.F., and T.G. Brown. 1987. Use of small, temporary, floodplain tributaries by juvenile salmonids in a west coast rain-forest drainage basin, Carnation Creek, British Columbia. Canadian Journal of Fisheries and Aquatic Science 44:262-270.

Hassler, T.J. 1987. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) -- coho salmon. U.S. Fish and Wildlife Service Biological Reports 82(11.70). 19 p.

Hauge, C.J., M.J. Furniss, and F.D. Euphrat. 1979. Soil erosion in California's coast forest district. California Geology (June):120-129.

Haupt, H.F. 1959. Road and slope characteristics affecting sediment movement from logging roads. Journal of Forestry 57:329-332.

Hawkes, L.A., R.C. Johnsen, W.W. Smith, [and others]. 1991. Monitoring downstream salmon and steelhead at federal hydroelectric facilities - 1990. Annual Report, NOAA, NMFS. Prepared for Bonneville Power Administration.

Hawkins, C.P., M.L. Murphy, N.H. Anderson, and M.A. Wilzbach. 1983. Density of fish and salamanders in relation to riparian canopy and physical habitat in streams of the northwestern United States. Canadian Journal of Fisheries and Aquatic Sciences 40:1173-1185.

Hawkins, C.P., L.J. Gottschalk and S.S. Brown. 1988. Densities and habitat of tailed frog tadpoles in small streams near Mt. St. Helens following the 1980 eruption. Journal of the North American Benthological Society 7: 246-252.

Hayes, J. 1996. Mammalian Species: *Arborimus longicaudus*. Number 532. American Society of Mammalogists. 5 p.

Hayes, M.P. and M.R. Jennings. 1986. Decline of ranid frog species in western North America: are bullfrogs (*Rana catesbiana*) responsible? Journal of Herpetology 20:490-509.

Hayes, M.P. and M.R. Jennings. 1988. Habitat correlates of distribution of the California red-legged frog (*Rana aurora draytonii*) and the foothill yellow-legged frog (*Rana boylii*): implications for management. Pages 144-158 In: R.C. Szaro, K.E. Severson, and D.R. Patton (Tech. Coords.). Management of amphibians, reptiles, and small mammals in North America. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-166.

Hayes, M.P. and D.M. Krempels. 1986. Vocal sac variation among frogs of the genus *Rana* from western North America. Copeia 4:927-936.

Hayes, M.P. and M.R. Tennant. 1985. Diet and feeding behavior of the California red-legged frog *Rana aurora draytonii* (Ranidae). Southwestern Naturalist 30:601-605.

Healey, M.C. 1986. Optimum size and age at maturity in Pacific salmon and effects of size-selective fisheries. Canadian Special Publication Fisheries and Aquatic Sciences 89:39-52.

Healey, M.C. 1991. The life history of chinook salmon (*Oncorhynchus tshawytscha*). Pages 311-393 in: Groot, C. and L. Margolis (editors). Life History of Pacific salmon. University of British Columbia Press, Vancouver, B.C.

Healey, M.C., and F.P. Jordan. 1982. Observations on juvenile chum and chinook and spawning chinook in the Nanaimo River, British Columbia, during 1975-1981. Canadian Ministries Report, Fisheries and Aquatic Sciences 1969. 31 p.

Heifetz, J., M.L. Murphy, and K.V. Koski. 1986. Effects of logging on winter habitat of juvenile salmonids in Alaskan streams. North American Journal of Fisheries Management 6:52-58.

Heinemeyer, K.S. and J.L. Jones. 1994. Fisher biology and management in the western United States: a literature review and adaptive management strategy. Version 1.2. USDA Forest Service, Northern Region, Missoula, MT. 109 p. plus attachments.

Henson, P. 1994. Memorandum to file discussing the May 11, 1994 Biological Opinion on the section 318 timber sales. August 23, 1994. 5 p.

Henson, P., and T. A. Grant. 1991. The effects of human disturbance on trumpeter swan breeding behavior. Wildlife Society Bulletin 19:248-257.

Herman, S.G. 1971. The peregrine falcon decline in California. Part 2. Breeding status in 1970. Administrative Report W-54-R-2. California Department of Fish and Game, Special Wildlife Investigations, Sacramento, CA.

Herman, S.G., M.N. Kirven, and R.W. Risebrough. 1970. The peregrine falcon decline in California. Audubon Field Notes 24:609-613.

Hickey, J.J. 1969. Variations in low water streambed elevations at selected gaging stations in northwestern California. USGS Water Supply Paper 1879-E. 33 p.

Hickey, J.J. and D.W. Anderson. 1969. The peregrine falcon: life history and population literature. Pages 3-42 in: Hickey, J.J. (editor). Peregrine falcon populations, their biology and decline. University of Wisconsin Press, Madison, WI.

Hicks, B.J., J.D. Hall, P.A. Bisson, and J.R. Sedell. 1991. Responses of salmonids to habitat changes. Pages 297-324 in: Meehan, W.R. (editor). Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society, Special Publication 19. Bethesda, MD.

Higgins, P., S. Dobush, and D. Fuller. 1992. Factors in northern California threatening stocks with extinction. Humboldt Chapter of the American Fisheries Society, Arcata, CA. 24 p.

Higley, J.M. 1993. Hoopa Valley Indian Reservation draft fisher survey report 1992-1993. Unpublished report on file Hoopa Tribal Forestry, Hoopa, CA. 20 p.

Higley, J.M. 1998. Hoopa Valley Indian Reservation fisher study: progress report, 22 January 1996 to 5 January 1998. Unpublished report on file, Hoopa Tribal Forestry, Hoopa, CA. 16 p.

Hogan, D.L. 1987. The influence of large organic debris on channel recovery in the Queen Charlotte Islands, British Columbia, Canada. In Proceedings, Erosion and Sedimentation of the Pacific Rim, Symposium, Corvallis, OR. IAHS Publ. No. 165.

Holland, D.C. 1985. An ecological and quantitative study of the western pond turtle (*Clemmys marmorata*) in San Luis Obispo County, California. MA thesis. California State University, Fresno, CA.

Holland, D.C. 1991. A synopsis of the ecology and current status of the western pond turtle (*Clemmys marmorata*) in 1991. Unpublished report on file, USDI Fish and Wildlife Service, National Ecology Research Center, San Simeon, CA. 141 p.

Holland, D.C. 1992. Level and variation in morphological variation: a phylogeographic study of the western pond turtle (*Clemmys marmorata*). Ph.D. dissertation. University of Southwestern Louisiana, Lafayette, LA.

Holland, D.C. 1994. The western pond turtle: habitat and history–final report. Project Number 92-068. Unpublished report on file U.S. Department of Energy, Bonneville Power Administration, Portland, OR. 77 p.

Holland, D.C. 1998. Correspondence to USDI Fish and Wildlife Service and the California Department of Forestry commenting on Draft SYP/HCP and Draft EIS/EIR. November 15, 1998.

Holland, D.C. and R.B. Bury. In press. The conservation biology of freshwater turtles. Chelonian Research Monographs 2. Prichard, P.C.H and A.G.J. Rhodin (editors).

Holtby, L.B. and J.C. Scrivener. 1989. Observed and simulated effects of climatic variability, clear-cut logging, and fishing on the numbers of chum salmon (*Oncorhynchus keta*) and coho salmon (*O. kisutch*) returning to Carnation Creek, British Columbia. Canadian Special Publication of Fisheries and Aquatic Sciences 105:62-81.

House, R.A., and P.L. Boehne. 1987. The effect of stream cleaning on salmonid habitat and populations in a coastal Oregon drainage. Western Journal of Applied Forestry 2:84-87.

Howard, C. and P. Albro. 1995. Mill Creek report. Habitat and fisheries analysis. Rellim Redwood, Crescent City, CA.

Howard, C. and P.Albro. 1997. Juvenile outmigrant monitoring program. Rellim Redwood, Crescent City, CA.

Howell, A.B. 1926. Voles of the genus *Phenacomys*. North American Fauna 48:1-64.

Huff, M., R. Holthausen, and K. Aubry. 1992. Habitat management for red tree voles in Douglas-fir forest. General Technical Report PNW-GTR-302. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. 16 p.

Hunter, J.E., K.N. Schmidt, H.B. Stauffer, S.L. Miller, C.J. Ralph, and L. Roberts. 1998. Status of the marbled murrelet in the inner North Coast ranges of California. Northwestern Naturalist 79:92-103.

Institute for Fisheries Resources. 1998. KRIS Coho CD-ROM. Klamath Resource Information System Program for the PALCO Habitat Conservation Plan. Funded by the Mennen Environmental Foundation through the Institute for Fisheries Resources.

Janda, R.J. 1978. Recent modifications of the physical resources of the Redwood Creek unit of Redwood National Park, California, and the processes responsible for those modifications. USGS open-file report. 10 p.

Jennings, M.R. and M.P. Hayes. 1994. Amphibian and reptile species of special concern in California. California Department of Fish and Game, Rancho Cordova, CA.

Johnson, A.W., and D.M. Ryba. 1992. A literature review of recommended buffer widths to maintain various functions of stream riparian areas. King County Surface Water management Division, Seattle, WA.

Johnson, M.L. and S.B. George. 1991. Species limits within the *Arborimus longicaudus* species-complex (Mammalia: Rodentia) with a description of a new species from California. Natural History Museum of Los Angeles County. Contributions in Science 429:1-16.

Johnson, O.W., R.S. Waples, T.C. Wainwright, [and others]. 1994. Status review for Oregon's Umpqua River sea-run cutthroat trout. U.S. Dept. of Commerce, NOAA Technical Memorandum NMFS-SWFSC-32. 280 p.

Johnson, O.W., M.H. Ruckelshaus, W.S. Grant, [and others]. 1999. Status review of coastal cutthroat trout from Washington, Oregon, and California. U.S. Dept. of Commerce, NOAA Technical Memorandum NMFS-NWFSC-37. 292 p.

Johnson, R.C., L.A. Hawkes, W.W. Smith, [and others]. 1990. Monitoring of downstream salmon and steelhead at federal hydroelectric facilities - 1989. Annual Report NOAA, NMFS, ETSD. 18 p plus appendices.

Johnston, J.M. 1982. Life histories of anadromous cutthroat trout with emphasis on migratory behavior. Pages 123-127 in: Brannon, E.L. and E.O. Salo (editors). Proceedings of the Salmon and Trout Migratory Behavior Symposium. University of Washington, Seattle, WA.

Jones, D.E. 1973. Steelhead and sea-run cutthroat trout life history in Southeast Alaska. Alaska Department of Fish and Game. Annual Progress Report, Volume 14, Project AFS-42 (AFS-42-1). 18 p.

Jones, D.E. 1974. The study of cutthroat-steelhead in Alaska. Alaska Department of Fish and Game. Annual Progress Report, Volume 15, Project AFS-42 (AFS-42-2):15-31.

Jones, D.E. 1975. Steelhead and sea-run cutthroat trout life history in Southeast Alaska. Alaska Department of Fish and Game. Annual Progress Report, Vol. 16, Project AFS-42 (AFS-42-3-B):23-55.

Jones, D.E. 1976. Steelhead and sea-run cutthroat trout life history in Southeast Alaska. Alaska Department of Fish and Game. Annual Progress Report, Volume 17, Project AFS-42(AFS-42-4-B):29-52.

Jones, D.E. 1978. A study of cutthroat and steelhead in Alaska. Alaska Department of Fish and Game. Anadromous Fish Studies, Volume 19, Completion Report 1971-1977. Study AFS-42-6 (AFS-42-6-B):69-100.

June, J.A. 1981. Life history and habitat utilization of cutthroat trout (*Salmo clarki*) in a headwater stream on the Olympic Peninsula, Washington. MS Thesis, University of Washington, Seattle, CA.112 p.

Kaczynski, V.W. and J.F. Palmisano. 1993. Oregon's wild salmon and steelhead trout: a review of the impact of management and environmental factors. Oregon Forest Industries Council, Salem Oregon. 328 p.

Karieva, P. 1998a. Correspondence to Steve Courtney, Sustainable Ecosystems Institute. December 7, 1998.

Karieva, P. 1998b. Correspondence to Steve Courtney, Sustainable Ecosystems Institute. December 1, 1998.

Keller, E.A. and F.J. Swanson. 1979. Effects of large organic material on channel form and fluvial processes. Earth Surf. Proces. 4:361-380.

Keller, E.A., A. MacDonald, T. Tally, N.J. Merrit. 1995. Effects of large organic debris on channel morphology and sediment storage in selected tributaries of Redwood Creek, Northwest California. Pages P1-P29 in: Nolan, K.M., H. Kelsey, and D.C. Marron (editors). Geomorphic Processes and Aquatic Habitat in the Redwood Creek Basin, Northwest California.. U.S. Geol. Prof. Paper 1454.

Kelsey, H.M. 1978. Earthflows in Franciscan melange, Van Duzen River basin, California. Geology 6:361-364.

Kelsey, H.M. 1980. A sediment budget and an analysis of geomorphic process in the Van Duzen River basin, North Coastal California, 1941-1975: Summary. Geological Society of America Bulletin 91:190-195.

Kelsey, H.M, M.A. Madej, J. Pitlick, [and others]. 1981. Major sediment sources and limits to the effectiveness of erosion control treatments in highly erosive watersheds of north coastal

California. Pages 493-509 in: Davies, T.R.H. and A.J. Pearce (editors). Erosion and Sediment Transport in Pacific Rim Steeplands, Christchurch, New Zealand, January 1981. International Association of Hydrological Sciences IAHS-AISH Publication 132.

Kesner, W.D. and R.A. Barnhart. 1972. Characteristics of the fall-run steelhead trout (*Salmo gairdneri gairdneri*) of the Klamath River system with emphasis on the half-pounder. California Department of Fish and Game 58:204-220.

King, J.G. and L.C. Tennyson. 1984. Alteration of streamflow characteristics following road construction in north central Idaho. Water Resources Research 20:1159-1163.

Kirven, M.N. 1978. Phase I field study: Peregrine falcons on Mount St. Helena in the Geysers-Calistoga known geothermal resources area. Unpublished report to Geothermal Resources Impact Project Study Joint Power Agency and U. S. Department of Energy. 50 p.

Klug, R.R, Jr. 1996. Occurrence of Pacific fisher (*Martes pennanti pacifica*) in the redwood zone of northern California and the habitat attributes associated with their detections. MS thesis. Humboldt State University, Arcata, CA. 50 p.

Knopp, C. 1993. Testing indices of cold water fish habitat. North Coast Regional Water Quality Control Board in cooperation with the California Department of Forestry and Fire Protection.

Knudsen, F. R., P. S. Enger, and O. Sand. 1992. Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, *Salmo salar* L. Journal of Fisheries Biology 40:523-534.

Kostow, K. 1995. Biennial report on the status of wild fish in Oregon. Oregon Department of Fish and Wildlife Report. 217 p + appendices.

Krammes, J.S. and L.F. DeBano. 1965. Soil wettability: a neglected factor in watershed management. Water Resources Research 1:283-286.

Kress, S.W., and D.N. Nettleship. 1988. Re-establishment of Atlantic puffins (*Fratercula arctica*) at a former breeding site in the Gulf of Maine. Journal of Field Ornithology 59:161-170.

Kupferberg, S.J. 1996. Hydrologic and geomorphic factors affecting conservation of a river-breeding frog (*Rana boylii*). Ecological Applications 6:1332-1344.

LaHaye, W. S. 1988. Nest site selection and nesting habitat of the northern spotted owl (*Strix occidentalis caurina*) in northwestern California. MS thesis, Humboldt State University, Arcata CA. 111 p.

Ledwith, T. 1996. The effects of buffer strip width on air temperature and relative humidity in a stream riparian zone. WMC Networker. 2 p.

Leidy, R.A. and G.R. Leidy. 1984. Life stage periodicities of anadromous salmonids in the Klamath River Basin, northwestern California. U.S. Fish and Wildlife Service, 38 p.

Leonard W.P., H.A. Brown, L.L.C. Jones, K.R. McAllister, and R.M. Storm. 1993. Amphibians of Washington and Oregon. Seattle Audubon Society, Seattle, WA.

Lichatowich, J.A. and J.D. McIntire. 1987. Use of hatcheries in the management of Pacific anadromous salmonids. American Fisheries Society Symposium 1:131-136.

Licht, L.E. 1969. Unusual aspects of anuran sexual behavior as seen in the red-legged frog, *Rana aurora aurora*. Canadian Journal of Zoology 47:505-509.

Licht, L.E. 1971. Breeding habits and embryonic requirements of the frogs, *Rana aurora aurora* and *Rana pretiosa pretiosa* in the Pacific Northwest. Ecology 52:116-124.

Light, J.T. 1987. Coastwide abundance of North American steelhead trout. Document submitted to the annual meeting of the INPFC, 1997. Fisheries Research Institute Report FRI-UW-8710. University of Washington, Seattle, WA. 18 p.

Light, J.T., S. Fowler, and M.L. Dahlberg. 1988. High seas distribution of North American steelhead as evidenced by recoveries of marked or tagged fish. Fisheries Research Institute, FRI-UW-8816. University of Washington, Seattle, WA. 21 p.

Lind, A.J., R.A. Wilson, and H.H. Welsh, Jr. 1992. Distribution and habitat associations of the willow flycatcher, western pond turtle, and foothill yellow-legged frog. Interim report prepared for Wildlife Working Group-Trinity River Restoration Project, USDI Fish and Wildlife Service, and Bureau of Reclamation. 47 p.

Lind, A.J., H.H. Welsh and R.A. Wilson. 1996. The effects of a dam on breeding habitat and egg survival of the foothill yellow-legged frog (*Rana boylii*) in northwestern California. Herpetological Review 27:62-67.

Lindquist, J.L., and M.N. Palley. 1963. Empirical yield tables for young-growth redwood. California Agricultural Experiment Station Bulletin 796, Division of Agricultural Sciences, University of California, Berkeley. 47 p.

Lisle, T.E. 1981. The recovery of aggraded stream channels at gauging stations in northern California and southern Oregon. Pages 189-211 in: Davis, R.H., and A.J. Pearce (editors). Proceedings of the Symposium on Erosion and Sediment Transport in Pacific Rim Steeplands, Christchurch, New Zealand, January 1981. International Association of Hydrological Sciences IAHS-AISH Pub. 132.

Lisle, T.E. 1983. Roughness elements: a key resource to improve anadromous fish habitat. In Proceedings: Propagation, Enhancement, and Rehabilitation of Anadromous Salmonid Populations and Habitat in the Pacific Northwest, Symposium; Humboldt State University, Arcata, CA.

Lisle, T.E. 1986. Effects of woody debris on anadromous salmonid habitat, Prince of Wales Island, Southeast Alaska. North American Journal of Fisheries Management 7:18-33.

Lister, D.B. and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of chinook (*Oncorhynchus tshawytscha*) and coho (*Oncorhynchus kisutch*) salmon in the Big Qualicum River, British Columbia. Journal Fisheries Resource Board Canada 27:1215-1224.

Loch, J.J., and D.R. Miller.1988. Distribution and diet of sea-run cutthroat trout captured in and adjacent to the Columbia River plume, May-July 1980. Northwest Science 62:41-48.

Loeffel, R.E., and H.O. Wendler. 1968. Review of the Pacific coast chinook and coho salmon resources with special emphasis on the troll fishery. Prepared by the U.S. working group of the Informal Committee on Chinook and Coho. Oregon Department of Fish and Wildlife, Portland, OR. 107 p.

Lowry, G.R. 1965. Movement of cutthroat trout (*Salmo clarki clarki* Richardson) in three Oregon coastal streams. Transaction of the American Fisheries Society 94:334-338.

MacDonald, L.H, A.W. Smart, and R.C. Wissmar. 1991. Monitoring guidelines to evaluate effects of forestry activities on streams in the Pacific Northwest and Alaska. EPA/910/9-91-001. U.S. Environmental Protection Agency, Region X, Seattle, WA.

Marbled Murrelet Recovery Team. 1998. Correspondence to Michael Spear, USDI Fish and Wildlife Service, Sacramento, CA. November 30, 1998. 7 p.

Marcus, W.D., M.K. Young, L.E. Noel, and B.A. Mullan. 1990. Salmonid-habitat relationships in the western United States: a review and indexed bibliography. Technical Report RM-188. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

Marshall, D.B. 1988. Status of the marbled murrelet in North America: with special emphasis on populations in California, Oregon, and Washington. Biological Report 88(30). USDI Fish and Wildlife Service, Portland, OR. 19 p.

Martin, D.J. 1984. Growth, food consumption, and production of cutthroat trout in relation to food supply and water temperature. Pages 135-144 in: Walton, J.M. and D.B. Houston (editors). Proceedings of the Olympic Wild Fish Conference, March 23-25, 1983. Fisheries Technology Program, Peninsula College and Olympic National Park, Port Angeles, WA.

Martin, D.J., M.E. Robinson, and R.A. Grotefendt. 1998. The effectiveness of riparian buffer zones for protection of salmonid habitat in Alaska coastal streams. Prepared for the Sealaska Corporation and Alaska Forest Association. 85 p.

Marzluff, J.M., J.M. Luginbuhl, M.G. Raphael, E.M. Evans, D.E. Varland, L.S. Young, S.P. Horton, and S.P. Courtney. 1996. The influence of stand structure, proximity to human activity, and forest fragmentation on the risk of predation to nests of marbled murrelets on the Olympic Peninsula. Unpublished report submitted to the USDI Fish and Wildlife Service, OR. 63 p.

Maser, C.O. 1966. Life histories and ecology of *Phenacomys albipes, Phenacomys longicaudus, Phenacomys silvicola.* MS thesis. Oregon State University, OR. 221 p.

Maser, C.O. and J.M. Trappe (technical editors). 1984. The seen and unseen world of the fallen tree. General Technical Report PNW-GTR-164. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, OR. 56 p.

Mathews, S.B. 1980. Trends in Puget Sound and Columbia River coho salmon. Pages 133-145 in: McNeill, W.S. and D.C. Hamsworth (editors). Salmonid Ecosystems of the North Pacific. Oregon State University Press, Corvallis, CA.

Mattole Restoration Council. 1989. Elements of recovery. An inventory of upslope erosion. Mattole Restoration Council, Petrolia, CA.

Mattole Restoration Council. 1992. Hatchbox proposal to California Department of Fish and Game, 1991-1992. Contract #1247. Mattole Restoration Council, Petrolia, CA.

Mattole Salmon Group. 1997. Mattole salmon recovery progresses. Press release dated March 7, 1997. Mattole Salmon Group, Petrolia, CA.

Mattole Sensitive Watershed Group. 1996. A nomination from concerned citizens of the Mattole River Watershed of the State of California – Proposing the Mattole River as a sensitive watershed under 14 CCR 916.8, 936.8, and 956.8. 93 p. plus appendices.

Mayer, K.E. and Laudenslayer, W.F., Jr. (editors). 1988. A guide to wildlife habitats of California. California Department of Forestry and Fire Protection, Sacramento, CA. 166 p.

McDade, M.H., F.J. Swanson, W.A. McKee [and others]. 1990. Source distances for coarse woody debris entering small stream in western Oregon and Washington. Canadian Journal of Forest Research 20:326-330.

McEwan, D. and T.A. Jackson. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game, Sacramento, CA. 222 p.

McGarry, E.V. 1994. A quantitative analysis and description of the delivery and distribution of large woody debris in Cummins Creek, Oregon. MS Thesis. Oregon State University, Corvallis, CA.

McIntosh, B.A., J.R. Sedell, J.E. Smith, [and others]. 1994. Management history of eastside ecosystems: changes in fish habitat over 50 years, 1935 to 1992. USDA Forest Service General Technical Report PNW-GTR-321, Pacific Northwest Research Station, Portland, OR.

McNeil, W.J. 1964. Effect of the spawning bed environment on reproduction of pink and chum salmon. Fishery Bulletin 65:495-523.

Meehan, W.R. (editor). 1991. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. Bethesda, MD.

Meehan, W.R. and T.C. Bjornn. 1991. Salmonid distributions and life histories. Pages 47-82 in: Meehan, W.R. (editor). Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. Bethesda, MD.

Megahan, W.F. and G.L. Ketcheson. 1996. Predicting downslope travel of granitic sediments from forest roads in Idaho. Water Resources Bulletin 32(N2):371-382.

Meiselman, N. 1992. Nest-site characteristics of red tree voles in Douglas-fir forests of northern California. MS thesis. Humboldt State University, Arcata, CA. 59 p.

Meiselman, N., and A.T. Doyle. 1996. Habitat and microhabitat use by the red tree vole (*Phenacomys longicaudus*). American Midland Naturalist 135:33-42.

Metter, D.E. 1964. A morphological and ecological comparison of two populations of the tailed frog, *Ascaphus truei* Stejneger. Copeia 1:181-204.

Metter, D.E. 1967. Variation in the ribbed frog *Ascaphus truei* Stejneger. Copeia 3:634-649.

Metter, D.E., and R.J. Pauken. 1969. An analysis of the reduction of gene flow in *Ascaphus truei* in the northwest US since the Pleistocene. Copeia 2:301-307.

Michael, H. 1980. Sea-run cutthroat trout. Pages 187-190 in: DeShazo, J.J. (editor). Sea-run Cutthroat Trout Status Report. Report 80-14, Washington State Game Department, Fish Management Division, Olympia, WA.

Miller, S.L. and C.J. Ralph. 1995. Relationship of marbled murrelets with habitat characteristics at inland sites in California. Pages 205-215 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Miller, W.H., T.C. Coley, H.L. Burge, and T.T. Kisanuki. 1990. Analysis of salmon and steelhead supplementation: emphasis on unpublished reports and present programs, part 1. W.H Miller, preparer, Analysis of Salmon and Steelhead Supplementation, Technical Report 1990. Prepared for US Department of Energy and Bonneville Power Administration, Portland, OR.

Mitchell, W.T. 1988. Microhabitat utilization and spatial segregation of juvenile coastal cutthroat and steelhead trout in the Smith River drainage, California. MS Thesis, Humboldt State University, Arcata, CA.

Monk, G. 1981. California peregrine falcon reproductive outcome and management effort in 1981. Unpublished report on file USDI Fish and Wildlife Service. 27 p.

Moring, J.R., and R.L. Lantz. 1975. The Alsea watershed study: Effects of logging on the aquatic resources of three headwater streams of the Alsea River, Oregon. Oregon Department of Fish and Wildlife. Fisheries Resource Report No. 9, Project AFS-58, Final Report. 66 p.

Moyle, P.B. and R.M. Yoshiyama. 1992. Fishes, aquatic diversity management areas, and endangered species: A plan to protect California's native aquatic biota. California Policy Seminar Report, California Policy Seminar, University of California, Berkeley. The California Policy Seminar, Berkeley, CA. 22 p.

Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish species of special concern in California, 2nd edition. California Department of Fish and Game. 272 p.

Mundie, J.H. 1969. Ecological implications of the diet of juvenile coho in streams. Pages 135-152 in: Northcote, T.G. (Editor). Symposium on Salmon and Trout in Streams. H.R. MacMillan Lectures in Fisheries, University of BC, Institute of Fisheries, Vancouver.

Murphy, D. 1997. Correspondence to the California Resources Agency. September 10, 1997. 8 p.

Murphy, G.I. and L. Shapovalov. 1951. A preliminary analysis of northern California salmon and steelhead runs. California Fish and Game 37:497-507.

Murphy, M.L. 1995. Forestry impacts on freshwater habitat of anadromous salmonids in the Pacific Northwest and Alaska -- requirements for protection and restoration. NOAA Coastal Ocean Program Decision Analysis Series No. 7. NOAA Coastal Ocean Office, Silver Spring, MD. 156 p.

Murphy, M.L. and K.V. Koski. 1989. Input and depletion of woody debris in Alaska streams and implications for streamside management. North American Journal of Fisheries Management 9:427-436.

Murphy, M.L. and W.R. Meehan. 1991. Stream ecosystems. In W.R. Meehan, ed., Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, pgs. 17-46. American Fisheries Society Special Publication 19. Bethesda, MD.

Murphy, M.L., J. Heifetz, S.W. Johnson, [and others]. 1986. Effects of clearcut logging with and without buffer strips on juvenile salmonids in Alaskan streams. Canadian Journal of Fisheries and Aquatic Sciences 43:1521-1533.

Murray, M.A. 1995. Biochemical systematics of the genus Arborimus. MA thesis. Humboldt State University, Arcata, CA. 46 p.

Myers, J.M., R.G. Kope, G.J. Bryant [and others]. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. of Commerce, NOAA Technical Memorandum NMFS-NWFSC-35. 433 p.

Naiman, R.J., T.J. Beechie, L.E. Benda, [and others]. 1992. Fundamental elements of ecologically healthy watersheds in the Pacific Northwest coastal ecoregion. Pages 127-188 in: Naiman, R.S. (editor). Watershed Management -- Balancing Sustainability and Environmental Change. Springer-Verlag, New York, NY.

Nakamura, F., and F.J. Swanson. 1993. Effects of coarse woody debris on morphology and sediment storage of a mountain stream system in western Oregon. Earth Surf. Proc. Land., 18:43-61.

National Marine Fisheries Service. 1996. Factors for decline: A supplement to the Notice of Determination for West Coast steelhead under the Endangered Species Act. National Marine Fisheries Service, Protected Species Branch, Portland, OR. 82 p. plus appendices.

National Marine Fisheries Service. 1997a. Impact of California sea lions and Pacific harbor seals on salmonids and on the coastal ecosystems of Washington, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-28. NMFS Northwest Fisheries Science Center, Seattle, WA.

National Marine Fisheries Service. 1997b. Proposed recovery plan for the Sacramento River winter-run chinook salmon. National Marine Fisheries Service, Southwest Region, Long Beach, California. 288 p. plus appendices.

National Marine Fisheries Service. 1997c. Draft: Aquatic properly functioning condition matrix. National Marine Fisheries Service, Southwest Region, Santa Rosa, CA. 21 p.

National Marine Fisheries Service. 1997d. Coastal coho habitat factors for decline and protective efforts in Oregon. National Marine Fisheries Service, Habitat Conservation Division, Portland, OR.

National Marine Fisheries Service. 1998a. Draft: Effectiveness of the California Forest Practice Rules to conserve anadromous salmonids: Analysis by the National Marine Fisheries Service, Protected Resources Division, Santa Rosa and Arcata, CA. May 22, 1998

National Marine Fisheries Service. 1998b. A draft proposal concerning Oregon forest practices. Submitted by the National Marine Fisheries Service to the Oregon Board of Forestry Memorandum of Agreement Advisory Committee and the Office of the Governor. Portland, OR. 152 p.

National Research Council. 1995. Science and the Endangered Species Act. National Academy Press, Washington, D.C. 271 p.

National Research Council. 1996. Upstream: Salmon and society in the Pacific Northwest. National Academy Press, Washington, DC.

National Weather Service. 1998. World Wide Web site: Climatological data page, National Weather Service, San Francisco Bay Area. Http://www.nws.mbay.net/climate.html#eka.

Nehlsen, W., J.E. Williams, and J.A. Lichatowich. 1991. Pacific salmon at the crossroads: Stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16:4-21.

Nelson, R.L., M.L. McHenry, and W.S. Platts. 1991. Mining. Pages 425-482 in: Meehan, W.R. (Editor). Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. Bethesda, MD.

Nelson, S.K. 1997a. Marbled murrelet (*Brachyramphus marmoratus*). In: Poole, A. and F. Gill (editors). The birds of North America. Number 276. The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists' Union, Washington, D.C. 32 p.

Nelson, S.K. 1997b. Correspondence to Paul Henson, USDI Fish and Wildlife Service. October 31, 1997. 2 p.

Nelson, S.K. 1998. Correspondence to USDI Fish and Wildlife Service and the California Department of Forestry commenting on the Draft SYP/HCP and Draft EIS/EIR. November 12, 1998. 13 p.

Nelson, S.K. and T.E. Hamer. 1995a. Nesting biology and behavior of the marbled murrelet. Pages 57-67 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Nelson, S.K. and T. Hamer. 1995b. Nest success and the effects of predation on marbled murrelets. Pages 89-98 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Nelson, S.K., T.E. Hamer, and P. Henson. 1998. Designing studies to examine the effects of human disturbance on nesting murrelets and summary of preliminary results. Paper presented at Pacific Seabird Group Annual Meeting, Monterey, CA.

Nettleship, D.N. and T.R. Birkhead (editors). 1985. The Atlantic Alcidae: the evolution, distribution and biology of the auks inhabiting the Atlantic ocean and adjacent water areas. Academic Press, London. 574 p.

Newbold, J.D., R.V. O'Neill, J.W. Elwood, and W. Van Winkle. 1982. Nutrient spiraling in streams: implications for nutrient limitation and invertebrate activity. American Naturalist 120:628-653.

Nicholas, J.W. 1978. Life history differences between sympatric populations of rainbow and cutthroat trout in relation to fisheries management strategy. Pages 181-188 in: Moring, J.R. (editor). Proceedings of the Wild Trout – Catchable Trout Symposium. Oregon Department of Fish and Wildlife, Portland, OR..

Nicholas, J.W., and D.G. Hankin. 1988. Chinook salmon populations in Oregon coastal river basins: Descriptions of life histories and assessment of recent trends in run strengths. Oregon Department of Fish and Wildlife, Fisheries Division Information Report No. 88-1, 359 p.

Nicholson, A.J. 1954. An outline of the dynamics of animal populations. Australian Journal of Zoology 2:9-65.

Nickelson, T.E., J.W. Nicholas, A.M. McGie, [and others]. 1992. Status of anadromous salmonids in Oregon coastal basins. Oregon Department of Fish and Wildlife, Research and Development Section and Ocean Salmon Management. 83 p.

Nielsen, J.L. T.E. Lisle, and V. Ozaki. 1994. Thermally stratified pools and their use by steelhead in northern California streams. Transactions of the American Fisheries Society 123:613-626.

Noble, G.K. and P.G. Putnam. 1931. Observations on the life history of *Ascaphus truei* Stejneger. Copeia 1:181-204.

Norris, L.A., H.W. Lorz, and S.V. Gregory. 1991. Forest chemicals. Pages 207-296 in: Meehan, W.R. (Editor). Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. Bethesda, MD.

North Coast Regional Water Quality Control Board. 1996. Water quality control plan for the North Coast Region, as amended. 23 May 1996. Santa Rosa, CA.

Northcote, T.G. 1997. Why sea-run? An exploration into the migratory/residency spectrum of coastal cutthroat trout. Pages 20-26 in: Hall, J.D., P.A. Bisson, and R.E. Gresswell, eds., Sea-run Cutthroat Trout: Biology, Management, and Future Conservation. American Fisheries Society, Oregon Chapter, Corvallis, OR.

Nussbaum, R.A. and C.K. Tait. 1977. Aspects of the life history and ecology of the Olympic salamander, *Rhyacotriton olympicus*. American Midland Naturalist 98:176-199.

Nussbaum, R.A., E.D. Bordie, and R.M. Storm.1983. Amphibians and reptiles of the Pacific Northwest. University of Idaho Press, Moscow, ID.

Nuttal, P.M. And G.H. Bielby. 1973. The effect of china-clay waste on stream invertebrates. Environmental Pollution 5:77-86.

Odum, E.P. 1971. Fundamentals of ecology, 3rd Ed. Saunders College Publishing, Philadelphia, PA.

Odum, E.P. 1989. Ecology and our endangered life-support systems. Sinauer Associates, Inc. Sunderland, MA.

O'Laughlin, J. and G.H. Belt. 1994. Functional approaches to buffer strip design. Western Forester 27:12-14.

O'Loughlin, C.L. 1972. An investigation of the stability of the steepland forest soils in the Coast Mountains, southwest British Columbia. PhD dissertation, University of British Columbia, Vancouver, BC.

Oregon Natural Resources Council, The Wilderness Society, and Umpqua Valley Audubon Society. 1993. Petition for a rule to list the North and South Umpqua River sea-run cutthroat trout as threatened or endangered under the Endangered Species Act and to designate critical habitat. National Marine Fisheries Service, Northwest Regional Office, Seattle, WA. Oregon Natural Resources Council, Portland, OR. 11 p.

Oregon Natural Resources Council, California Sport Fishing Protection Alliance, Coast Range Association, [and others]. 1994. Petition for a rule to list steelhead trout as threatened or endangered under the Endangered Species Act and to designate critical habitat. National Marine Fisheries Service, Northwest Regional Office, Seattle, WA, February. Oregon Natural Resources Council, Portland, OR.

Oregon Natural Resources Council, Coast Range Association, Native Fish Society, [and others]. 1997. Petition to list sea-run cutthroat trout (*Oncorhynchus clarki clarki*) as threatened or endangered throughout its range in the states of California, Oregon, and Washington, under the Endangered Species Act (ESA) and to designate critical habitat. National Marine Fisheries Service, Northwest Regional Office, Seattle, WA. Oregon Natural Resources Council, Portland, CA. 38 p.

Oregon State Archives. 1998. Guide to provisional and territorial records: Curry County [Online]. Available: http://arcweb.sos.state.or.us/provisionalguide/CurryCounty.html [last updated on October 30, 1998].

Pacific Fishery Management Council. 1997. Review of the 1996 ocean salmon fisheries. Pacific Fishery Management Council, Portland, OR. 275 p.

Pacific Lumber Company. 1998. Sustained Yield Plan/Habitat Conservation Plan. Public Review Draft, July 1998. 6 volumes. Available at http://www.palco.com/habitat_conservation_plan.htm.

Pacific Lumber Company. 1999. Vegetation inventory. Unpublished technical information.

Pacific Watershed Associates. 1998. Sediment source investigation and sediment reduction plan for the Bear Creek watershed, Humboldt County, California. Report prepared for the Pacific Lumber Company. Pacific Watershed Associates, Arcata, CA.

Page, G.W. and L.E. Stenzel. 1981. The breeding status of the snowy plover in California. Western Birds 12:1-40.

Page, G.W., J.S. Warriner, J.C. Warriner, and R.M. Halbeisen. 1977. Status of the snowy plover on the northern California coast: Part I: Reproductive timing and success. California Department of Fish and Game, Non-game Wildlife Investigations, Sacramento, CA. 10 p.

Page, G.W., L.E. Stenzel, W.D. Shuford, and C.R. Bruce. 1991. Distribution and abundance of the snowy plover on its western North American breeding grounds. Journal of Field Ornithology 62:245-255.

Page, G.W., J.S. Warriner, J.C. Warriner, and P.W.C. Paton. 1995. Snowy Plover (*Charadrius alexandrinus*). In: Poole, A. and Gill, F.(editors). The Birds of North America. Number 154. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C. 24 p.

Pagel, J. E. 1992. Protocol for observing known and potential peregrine falcon eyries in the Pacific Northwest. Proceedings: symposium on peregrine falcons in the Pacific Northwest. USDA Forest Service, Medford, OR.

Pagel, J. E. 1998. Project design criteria: protection measures for peregrine falcons. Unpublished report on file Rogue River National Forest, Medford, OR. 5 p.

Paton, P.W.C. 1994. The effect of edge on avian nesting success: how strong is the evidence? Conservation Biology 8:17-26.

Paton, P.W.C. 1995. Marbled murrelet inland patterns of activity: defining detections and behavior. Pages 113-116 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Paton, P.W.C., C.J. Zabel, B. Bingham, et al. 1990. Examination of home range size and habitat use of the spotted owl in the Klamath province. Unpublished document on file USDI Fish and Wildlife Service, Northern Spotted Owl Recovery Team, Portland, OR.

Pauley, G.B., K. Oshima, K.L. Bowers, and G.L. Thomas. 1989. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest): sea-run cutthroat trout. U.S. Army Corps of Engineers, TR EL-82-4. U.S. Fish and Wildlife Service, Biological Report 82 (11.86). 21 p.

Pearcy, W.G., R.D. Brodeur, and J.P. Fisher. 1990. Distribution and biology of juvenile cutthroat trout *Oncorhynchus clarki clarki* and steelhead *O. mykiss* in coastal waters off Washington and Oregon. Fisheries Bulletin, U.S. 88:697-711.

Perry, D.A. 1995. Status of forest habitat of the marbled murrelet. Pages 381-384 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Peters, J. 1998. What amounts of canopy closure are represented by the riparian area diameter distribution tables in the PALCO HCP, Vol. 1, Table 17? Report prepared for the Intra-agency consultation on the PALCO HCP, U.S. Fish and Wildlife Service, Yreka, CA. 4 p. plus appendices.

Peterson, N.P., A. Hendry, and T.P. Quinn. 1992. Assessment of cumulative effects on salmonid habitat: some suggested parameters and target conditions. Prepared for the Washington Department of Natural resources and the cooperative Monitoring, Evaluation and Research Committee Timber/Fish/Wildlife Agreement. University of Washington, Seattle, WA.

Phillips, R.W. and H.J. Campbell. 1961. The embroynic survival of coho salmon and steelhead trout as influenced by some environmental conditions in gravel beds. Annual Report, Pacific Marine Fisheries Commission 14:60-73.

Phillips, R.W., R.L. Lantz, E.W. Claire, and J.R. Moring. 1975. Some effects of gravel mixtures on emergence of coho salmon and steelhead trout fry. Transactions of the American Fisheries Society 104:461-466.

Platts, W.S. 1991. Livestock grazing. Pages 389-424 in: Meehan, W.R. (Editor). Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, pgs. 389-424. American Fisheries Society Special Pub. 19. Bethesda, MD.

Powell, R.A. 1993. The fisher: life history, ecology, and behavior. 2nd edition. University of Minnesota Press, Minneapolis, MN. 237 p.

Powell, R.A. and W.J. Zielinski. 1994. Fisher. Pages 38-73 in: Ruggiero, L.E., K.E. Aubry, S.W., Buskirk, L.J. Lyon, and W.J. Zielinski (editors). The scientific basis for conserving forest carnivores: American martin, fisher, lynx, and wolverine in the western United States. General Technical Report GTR-RM-254. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Pritchard, A.L. 1940. Studies on the age of the coho salmon (*Oncorhynchus kisutch*) and the spring salmon (*Oncorhynchus tschawytscha*) in British Columbia. Transactions of the Royal Society of Canada, Service 3, 34(V):99-120.

R2. 1997. Literature for summary of large woody debris. Prepared for PALCO. Redmond, WA.

R2. 1998. Analysis of Pacific Lumber Company's Watershed Analysis Areas. Prepared for PALCO. Redmond, WA.

Ralph, C.J., G.L. Hunt, M.G. Raphael, and J.F. Piatt. 1995. Ecology and conservation of the marbled murrelet in North America: an overview. Pages 3-22 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Ralph, C.J. and S.L. Miller. 1995. Offshore population estimates of marbled murrelets in California. Pages 353-360 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Ralph, S.C., G.C. Poole, L.L. Conquest, R.J. Naiman. 1994a. Stream channel morphology and woody debris in logged and unlogged basins of western Washington. Canadian Journal of Fisheries and Aquatic Sciences 51:37-51.

Ralph, C.J., S.K. Nelson, M.M. Shaughnessy, S.L. Miller, and T.E. Hamer (compilers). 1994b. Methods for surveying for marbled murrelets in forests: a protocol for land management and research. Marbled Murrelet Technical Committee, Pacific Seabird Group. 52 p.

Ralph, C. J., S.L. Miller, T. Matsumoto, and William Hogoboom. 1998. Calculating relative bird values for the proposed murrelet conservation areas in southern Humboldt County. Part B, Section 10 *in*: Pacific Lumber Company. 1998. Sustained Yield Plan/Habitat Conservation Plan. Public Review Draft, July 1998. Volume IV [Online]. Available at: http://www.palco.com/habitat_conservation_plan.htm.

Rand, G.M. and S.R. Petrocelli (editors). 1985. Fundamentals of Aquatic Toxicology: Methods and Applications. Hemisphere Publishing Corp, Washington DC.

Raphael, M.G. 1988. Long-term trends in abundance of amphibians, reptiles, and mammals in Douglas-fir forests of northwestern California. Pages 23-32 in: Szarco, R.C., K.E. Severson, and D.R. Patton (technical coordinators). Management of amphibians, reptiles, and small mammals in North America. General Technical Report GTR-RM-166. USDA Forest Service, Rocky Mountain Experiment Station, Tempe, AZ.

Raphael, M.G., R.G. Anthony, S. DeStafano, E.D. Forsman, A.B. Franklin, R. Holthausen, E.C. Meslow, and B.R. Noon. 1996. Use, interpretation, and implications of demographic analyses of northern spotted owl populations. Pages 102-112 in: Forsman, E.D., S. DeStefano, M.G. Raphael, and R.J. Gutierrez (editors). Demography of the northern spotted owl. Studies in Avian Biology Number 17.

Raphael, M.G., J.A. Young, and B.M. Galleher. 1995. A landscape-level analysis of marbled murrelet habitat in western Washington. Pages 177-189 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Rathbun, G.B., N. Siepel, and D. Holland. 1992. Nesting behavior and movements of western pond turtles, *Clemmys marmorata*. Southwestern Naturalist 37:319-324.

Redwood National Park.1983, 1988-1993. Unpublished data. Weekly beach seining operations in Redwood Creek Estuary. Redwood National and State Parks, Orick CA

Reese, D.A. 1996. Comparative demography and habitat use of western pond turtles in northern California: the effects of damming and related alterations. PhD dissertation. University of California, Berkeley, CA. 253 p.

Reese, D.A., and H.H. Welsh. 1997. Use of terrestrial habitat by western pond turtles, *Clemmys marmorata*: implications for management. Pages 352-357 in: Proceedings Conservation, Restoration and Management of Tortoises and Turtles-An International Conference.

Reese, D.A. and H.H. Welsh. 1998. Habitat use by western pond turtles in the Trinity River, California. Journal of Wildlife Management 62:842-853.

Reeves, G.H., F.H. Everest, and J.D. Hall. 1987. Interactions between the redside shiner (*Richardsonius balteatus*) and the steelhead trout (*Salmo gairdneri*) in western Oregon: the influence of water temperature. Canadian Journal of Fisheries and Aquatic Sciences 44:1603-1613.

Reeves, G.H., L.E. Benda, K.M. Burnett, [and others]. 1995. A disturbance-based approach to maintaining and restoring freshwater habitats of evolutionarily significant units of anadromous salmonids in the Pacific Northwest. American Fisheries Society Symposium 17:334-349.

Reid, L.M. 1998. Review of the Sustained Yield Plan/Habitat Conservation Plan for the Properties of The Pacific Lumber Company, Scotia Pacific Holding Company and Salmon Creek Corporation. Unpublished document on file USDA Forest Service, Pacific Southwest Research Station, Arcata, CA.

Reid, L.M., and T. Dunne. 1984. Sediment production from forest road surfaces. Water Resources Research 20:1753-1761.

Reid, L.M. and S. Hilton. 1998. Buffering the buffer. Pages 71-80 in: Ziemer, R.M. (editor). Proceedings of the conference on coastal watersheds: The Caspar Creek story. General Technical Report PSW-GTR-168. USDA Forest Service, Pacific Southwest Research Station, Albany, CA.

Reijnen, T., R. Foppen, C.Ter Braak, and J. Thissen. 1995. The effects of car traffic on breeding bird populations in woodland. III. Reduction of density in relation to the proximity of main roads. Journal of Applied Ecology 32:187-202.

Reiser, D.W., and T.C. Bjornn. 1979. Habitat requirements for anadromous salmonids. In: Meehan, W.R. (Editor). Influence of Forest and Rangeland Management on Anadromous Fish Habitat in the Western United States and Canada. USDA Forest Service General Technical Report PNW-96.

Remsen, J.V., Jr. 1978. Bird species of special concern. California Department of Fish and Game, Wildlife Management Branch, Sacramento, CA. 54 p.

Reynolds, F.L. T.J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley streams: a plan for action. California Department of Fish and Game, Inland Fisheries Division, Sacramento. 129 p.

Rhodes, J.J., D.A. McCullough, and F.A. Espinosa. 1994. A course screening process for potential application in ESA consultations. Submitted to NMFS, NMFS/BIA Inter-Agency Agreement 40 ABNF3.

Robison, E.G., and R.L. Beschta. 1990. Identifying trees in riparian areas that can provide coarse woody debris to streams. Forest Science 36:790-801.

Rodgers, J.A. Jr., and H.T. Smith. 1995. Set-back distances to protect nesting bird colonies from human disturbance in Florida. Conservation Biology 9:89-99.

Roelofs, T.D. 1983. Current status of California summer steelhead (*Salmo gairdneri*) stocks and habitat, and recommendations for their management. Report to U.S. Forest Service, Region 5. 77 p.

Rood, K.M. 1984. An aerial photograph inventory of the frequency and yield of mass wasting on the Queen Charlotte Islands, British Columbia. British Columbia Ministry of Forests, Land Management Report 34. Victoria, BC.

Rosenberg, K.V. and M.G. Raphael. 1986. Effects of forest fragmentation on vertebrates in Douglas-fir forests. Pages 263-272 in: Verner, J., M.L. Morrison, and C.J. Ralph (editors). Wildlife 2000. University of Wisconsin Press, Madison, WI.

Rosgen, D.L. 1996. Applied river morphology. Wildland Hydrology, Pagosa Springs, CO.

Rounsefell, G.A. 1957. Fecundity of North American Salmonidae. U.S. Fish and Wildlife Service Fishery Bulletin 57:451-468.

Salo, E.O. and T.W. Cundy (editors). 1987. Streamside Management: Forestry and Fishery Interactions. Contribution 57. University of Washington, College of Forest Research, Seattle, CA.

Sandercock, K.F. 1991. Life history of coho salmon (*Oncorhynchus kisutch*). Pages 396-445 in: Groot, C. and L. Margolis (editors). Pacific Salmon Life Histories. University of British Columbia Press, Vancouver, BC.

Sanders, J.E., J.J. Long, C.K. Arakawa, [and others]. 1992. Prevalence of *Renibacterium salmoninarum* among downstream-migrating salmonids in the Columbia River. Journal of Aquatic Animal Health 4:72-75.

Sauer, J. R., J. E. Hines, G. Gough, I. Thomas, and B. G. Peterjohn. 1997. The North American breeding bird survey results and analysis [Online]. Version 96.4. Patuxent Wildlife Research Center, Laurel, MD. Available: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html [October 23, 1998].

Schempf, P.F. and M. White. 1977. Status of six furbearer populations in the mountains of northern California. USDA Forest Service, California Region, San Francisco, CA. 51 p.

Schieck, J., K. Lertzman, B. Nyberg, and R. Page. 1995. Effects of patch size on birds in old-growth montane forests. Conservation Biology 9:1072-1084.

Schlosser, I.J. 1991. Stream fish ecology: a landscape perspective. Bioscience 41:704-712.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Bulletin of the Fisheries Resources Board Canada. 966 p.

Scrivener, J.C. 1991. An update and application of the production model for Carnation Creek chum salmon. Pages 210-219 in: White, B. and I Guthrie (editors). Proceedings of the 15th Northeast Pacific Pink and Chum Salmon Workshop. Pacific Salmon Commission, Vancouver, BC.

Sedell, J.R., and R.L. Beschta. 1991. Bringing back the "bio" in bioengineering. Pages 160-175 in: Colt, J. and S. Dendall (editors). Fisheries Bioengineering: Proceedings of a Symposium, Bethesda, MD. American Fisheries Society Publication 10. Bethesda, MD.

Sedell, J.R. and J.L. Froggatt. 1984. Importance of streamside forests to large rivers: the isolation of the Willamette River, Oregon, U.S.A., from its floodplain by snagging and streamside forest removal. Internationale Vereinigung für theoretische und angewandte Limnologie Verhandlungen 22:1828-1834.

Sedell, J.R., P.A. Bisson, F.J. Swanson and S.V. Gregory. 1988. What we know about large trees that fall into streams and rivers. Pages 47-81 in: Maser, C., R.F. Tarrant, J.N. Trappe and J.F. Franklin (editors). From the forest to the sea: a story of fallen trees. General Technical Report PNW-GTR-229. USDA Forest Service, Pacific Northwest Research Station, Portland, OR.

Seglund, A.E. 1995. The use of resting sites by the Pacific fisher. MS thesis. Humboldt State University, Arcata, CA. 66 p.

Self, S.E. and S.J. Kerns. 1995. Pacific fisher use of a managed forest landscape in northern California. Unpublished report on file, Sierra Pacific Industries, Redding, CA. 26 p. plus attachments.

Washington State Department of Wildlife. Fisheries Research Institute, University of Washington, Seattle, WA. 217 p.

Snyder, J.O. 1931. Salmon of the Klamath River, California. California Fish and Game Fisheries Bulletin 34:130.

Solis, D.M. 1983. Summer habitat ecology of spotted owls in northwestern California. MS thesis. Humboldt State University, Arcata CA. 168 p.

Soulé, M.E. (editor). 1986. Conservation biology: the science of scarcity and diversity. Sinauer Associates, Inc., Sunderland, MA.

Soulé, M.E., (editor). 1987. Viable populations for conservation. Cambridge University Press, Cambridge, United Kingdom.

Speich, S.M. and T.R. Wahl. 1995. Marbled murrelet populations of Washington– marine habitat preferences and variability of occurrence. Pages 313-326 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Noviztki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR.

Stanley, A. 1998. A reanalysis of population trends for marbled murrelets in northern California. Unpublished document on file, USDI Fish and Wildlife Service, Arcata, CA. 19 p.

Stebbins, R.C. 1985. A field guide to western reptiles and amphibians. Houghton Mifflin, New York, NY. 336 p.

Steward, C.R. and T.C. Bjornn. 1990. Supplementation of salmon and steelhead stocks with hatchery fish: a synthesis of published literature. W.H. Miller, preparer, Analysis of Salmon and Steelhead Supplementation, Technical Report 1990. Prepared for US Dept of Energy and Bonneville Power Administration, Portland, OR.

Stone, L. 1897. Artificial propagation of salmon on the Pacific Coast of the United States with notes on the natural history of the quinnat salmon. Bulletin of the U.S. Fish Commission for 1896 16:203-235.

Storm, R. M. 1960. Notes on the breeding biology of the red-legged frog (*Rana aurora aurora*). Herpetologica 16:251-259.

Strickland, M.A., C.W. Douglas, M. Novak, and N.P. Hunzinger. 1982. Fisher: *Martes pennanti*. Pages 586-598 in: Chapman, J.A. and G.A. Feldhamer (editors). Wild mammals of North America: biology, management, and economics. Johns Hopkins University Press, Baltimore, MD.

Strong, C.S., B.K. Keitt, W.R. McIver, C.J. Palmer, and I. Gaffney.1995. Distribution and population estimates of marbled murrelets at sea in Oregon during the summers of 1992 and 1993. Pages 339-352 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Sullivan, K., T.E. Lisle, C.A. Dolloff, G.E. Grant, and L.M. Reid. 1987. Stream channels: the link between forests and fishes. Pages 191-232 in: Salo, E.O. and T.W. Cundy (editors). Streamside Management: Forestry and Fishery Interactions. Contribution 57. University of Washington., Inst. of Forest Resources, Seattle, WA.

Sumner, F.H. 1953. Migrations of salmonids in Sand Creek, Oregon. Transactions of the American Fisheries Society 82:139-150.

Sumner, F.H. 1962. Migration and growth of coastal cutthroat trout in Tillamook County, Oregon. Transactions of the American Fisheries Society 91:77-83.

Sumner, F.H. 1972. A contribution to the life history of the cutthroat trout in Oregon with emphasis on the coastal subspecies, *Salmo clarki clarki* Richardson. Oregon State Game Commission, Corvallis, OR. 142 p.

Swanson, F.J., and C.T. Dyrness. 1975. Impact of clear-cutting and road construction on soil erosion by landslides in the western Cascade Range, Oregon. Geology 3:393-396.

Swanson, F.J., M.D. Bryant, G.W. Lienkaemper, and J.R. Sedel. 1984. Organic debris in Pacific Northwest streams. General Technical Report PNW-69. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, OR.

Swanson, F.J., L.E. Benda, S.H. Duncan, [and others]. 1987. Mass failures and other processes of sediment production in Pacific Northwest forest landscapes. Pages 9-38 in: Salo, E.O, and T.W. Cundy (editors). Streamside Management: Forestry and Fishery Interactions. Contribution 57. University of Washington, College of Forest Research, Institute of Forest Resources, Seattle, WA.

Swanston, D.N. 1974. Slope stability problems associated with timber harvesting in mountainous regions of the western United States. General Technical Report PNW-GTR-21. USDA Forest Service, Pacific Northwest Experiment Station, Portland, OR.

Swanston, D.N. 1991. Natural processes. Pages 139-179 in: Meehan, W.R. (editor). Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. Bethesda, MD.

Swanston, D.N. and F.J. Swanson. 1976. Timber harvesting, mass erosion, and steepland forest geomorphology in the Pacific Northwest. Pages 199-221 in: Coates, D.R. (editor). Geomorphology and Engineering. Dowden, Hutchinson, and Ross, Stroudsburg, PA.

Trotter, P.C., P.A. Bisson, and B. Fransen. 1993. Status and plight of the sea-run cutthroat trout. Pages 203-212 in: Cloud, J.G. and G.H. Thorgaard (editors). Genetic Conservation of Salmonid Fishes. Plenum Press, New York, NY.

Tschaplinski, P.J. and G.F. Hartman. 1983. Winter distribution of juvenile coho salmon (*Oncorhynchus kisutch*) before and after logging in Carnation Creek, British Columbia, and some implications for overwinter survival. Canadian Journal of Fisheries and Aquatic Sciences 40:452-461.

Tuttle, D.C., R. Stein, and G. Lester. 1997. Snowy plover nesting on Eel River gravel bars, Humboldt County. Western Birds 28:174-176.

Twedt, B. 1993. A comparative ecology of *Rana aurora* (Baird and Girard) and *Rana catesbiana* (Shaw) at Freshwater Lagoon, Humboldt County, California. MA thesis. Humboldt State University, Arcata, CA.

Twitty, V.C., D. Grant, and O. Anderson. 1967. Amphibian orientation: an unexpected observation. Science 155:352-353.

US Department of Agriculture. 1998. Humboldt County crop values [Online]. Available: http://www.nass.usda.gov/ca/bul.

USDA Forest Service. 1994. Neotropical migratory reference book. Volume I. Pacific Southwest Region, San Francisco, CA. 832 p. plus appendices.

USDA Forest Service. 1998. Regional forester's sensitive species list. Pacific Southwest Region, San Francisco, CA.

USDA Forest Service and USDI Bureau of Land Management. 1994a. Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. USDA Forest Service and USDI Bureau of Land Management, Portland, OR.

USDA Forest Service and USDI Bureau of Land Management. 1994b. Record of Decision for amendments to Forest Service and BLM planning documents within the range of northern spotted owl; standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. USDA Forest Service and USDI, Bureau of Land Management, Portland, OR.

USDA Forest Service, USDI Fish and Wildlife Service, Bureau of Land Management, National Park Service, USDC National Oceanic and Atmospheric Administration, National Marine Fisheries Service, and Environmental Protection Agency. 1993. Forest ecosystem management: an ecological, economic, and social assessment. Report of the Forest Ecosystem Management Assessment Team. Portland, OR.

Proposed endangered status for two chinook salmon ESUs and proposed threatened status for five chinook salmon ESUs; proposed redefinition, threatened status, and revision of critical habitat for one chinook salmon ESU; proposed designation of chinook salmon critical habitat in California, Oregon, Washington, Idaho. Federal Register 63:11482-11520.

USDC National Oceanic and Atmospheric Administration. 1998b. Final rule; notice of determination. Threatened status for two ESUs of steelhead in Washington, Oregon, and California. Federal Register 63:13347-13371.

USDI Fish and Wildlife Service. 1967. Native fish and wildlife; endangered species. Federal Register 32:4001.

USDI Fish and Wildlife Service. 1978. Endangered and threatened wildlife and plants; determination of certain bald eagle populations as endangered. Federal Register 43:6230-6233.

USDI Fish and Wildlife Service. 1982. Pacific coast recovery plan for the American peregrine falcon. USDI Fish and Wildlife Service, Portland, OR. 87 p.

USDI Fish and Wildlife Service. 1986. Pacific bald eagle recovery plan. USDI Fish and Wildlife Service, Portland, OR.

USDI Fish and Wildlife Service. 1987. The northern spotted owl: a status review. USDI Fish and Wildlife Service, Portland, OR. 47 p.

USDI Fish and Wildlife Service. 1989. The northern spotted owl: a status review supplement. U.S. Department of the Interior, Fish and Wildlife Service, Portland, OR. 113 p.

USDI Fish and Wildlife Service. 1990a. Endangered and threatened wildlife and plants; determination of threatened status for the northern spotted owl; final rule. Federal Register 55:26114-26194.

USDI Fish and Wildlife Service. 1990b. 1990 status review; northern spotted owl; Strix occidentalis caurina. USDI Fish and Wildlife Service, Portland, OR. 95 p.

USDI Fish and Wildlife Service. 1991. Endangered and threatened wildlife and plants; notice of 90-day finding on petition to list the Pacific fisher as endangered. Federal Register 56:1159-1161.

USDI Fish and Wildlife Service. 1992a. Draft recovery plan for the northern spotted owl. Portland, OR.

USDI Fish and Wildlife Service. 1992b. Endangered and threatened wildlife and plants; determination of threatened status for the marbled murrelet, final rule. Federal Register 57:45328-45337.

USDI Fish and Wildlife Service. 1993. Endangered and threatened wildlife and plants; determination of threatened status for the Pacific coast population of the western snowy plover. Federal Register 58:12864-12874.

USDI Fish and Wildlife Service. 1994a. Endangered and threatened wildlife and plants; proposed designation of critical habitat for the marbled murrelet. Federal Register 59:3811-3823.

USDI Fish and Wildlife Service. May 11, 1994. Biological opinion on section 318 timber sales, US Forest Service. (Ref. # 1-7-95-F-211).

USDI Fish and Wildlife Service. 1995a. Endangered and threatened wildlife and plants; final rule to reclassify the bald eagle from endangered to threatened in all of the lower 48 states; final rule. Federal Register 60:36000-36010.

USDI Fish and Wildlife Service. 1995b. Endangered and threatened wildlife and plants; proposed designation of critical habitat for the marbled murrelet; supplemental proposed rule. Federal Register 60:40892-40954.

USDI Fish and Wildlife Service. 1995c. Endangered and threatened wildlife and plants; proposed designation of critical habitat for the Pacific coast population of the western snowy plover; proposed rule. Federal Register 60:11767-11809.

USDI Fish and Wildlife Service. 1995d. Endangered and threatened wildlife and plants; notice of 90-day petition finding, southern torrent salamander. Federal Register 60:33785-33786.

USDI Fish and Wildlife Service. June 12, 1995. Reinitiated biological opinion on section 318 timber sales, USDA Forest Service. (Ref. # 1-7-95-F-211).

USDI Fish and Wildlife Service. 1996a. Endangered and threatened wildlife and plants; determination of critical habitat for the marbled murrelet, final rule. Federal Register 61:26255-26320.

USDI Fish and Wildlife Service. 1996b. Endangered and threatened wildlife and plants; 90-day finding for a petition to list the fisher in the western United States as threatened. Federal Register 61:8016-8018.

USDI Fish and Wildlife Service. 1996c. Endangered and threatened wildlife and plants; determination of threatened status for the California red-legged frog. Federal Register 61: 25813-25833.

USDI Fish and Wildlife Service. 1997a. Recovery plan for the threatened marbled murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Portland, OR. 203 p.

USDI Fish and Wildlife Service. 1997b. Correspondence to PALCO. May 20.

USDI Fish and Wildlife Service. 1997c. Correspondence to PALCO. August 8.

USDI Fish and Wildlife Service. 1997d. Correspondence to PALCO. November 25.

USDI Fish and Wildlife Service. 1998a. Endangered and threatened wildlife and plants; proposed rule to remove the peregrine falcon in North America from the list of endangered and threatened wildlife; proposed rule. Federal Register 63:45446-45463.

USDI Fish and Wildlife Service. 1998b. Biological Opinion on the Quinalt North Boundary Area Unit Management Plan, Quinalt Indian Nation. January 28, 1998.

USDI Fish and Wildlife Service and California Department of Forestry and Fire Protection. 1998. Draft environmental impact statement/environmental impact report for the Headwaters Forest acquisition and the PALCO sustained yield plan and habitat conservation plan, Volume IV. Sacramento, CA.

USDI Fish and Wildlife Service and California Department of Forestry and Fire Protection. 1999. Final environmental impact statement/environmental impact report and habitat conservation plan/sustained yield plan for the Headwaters Forest Project. Sacramento, CA.

USDI National Park Service. 1998. Facts about Redwood National and State Parks [Online]. Available: http://www.nps.gov/redw/redwfact.htm [Last updated July 9, 1998].

Van Sickle, J, and S.V. Gregory. 1990. Modeling inputs of large woody debris to streams from falling trees. Canadian Journal of Forest Research 20:1593-1601.

Vannote, R.L., G.W. Minshall, K.W. Cummin, [and others]. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37:130-137.

Varoujean, D.H. and W.A. Williams. 1995. Abundance and distribution of marbled murrelets in Oregon and Washington based on aerial surveys. Pages 327-338 in: Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (technical editors). Ecology and conservation of the marbled murrelet. General Technical Report PSW-GTR-152. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Voight, H.N. and T.R. Hayden. 1997. Direct observation assessment of coastal cutthroat trout abundance and habitat utilization in the South Fork Smith River, California. Pages 175-176 in: Hall, J.D., P.A. Bisson, and R.E. Gresswel, eds., Sea-run Cutthroat Trout: Biology, Management, and Future Conservation. American Fisheries Society, Oregon Chapter, Corvallis, OR.

Wagner, E. and P. Ingram. 1973. Evaluation of fish facilities and passage at Foster and Green Peter Dams on the South Santiam River drainage in Oregon. Financed by the U.S. Army Corps of Engineers - Portland district. Contract No. DACW57-68-C-0013.

Wallace, R.L. and L.V. Diller. 1996. Growth and development of tailed frogs in coastal streams of the redwood region. Pages 107-108 in: LeBlanc, J. (editor). Proceedings: Conference on

Coast Redwood Ecology and Management. June 18-20, 1996, Arcata CA. University of California, Cooperative Extension. Berkeley, CA.

Warriner, J. S., J. C. Warriner, G. W. Page, and L. E. Stenzel. 1986. Mating systems and reproductive success of a small population of polygamous snowy plovers. Wilson Bulletin 98:15-37.

Washington Department of Natural Resources. 1997. Washington forest practices board manual; standards methodology for conducting watershed analysis. Version 4.0. Washington Department of Natural Resources, Seattle, WA.

Washington, P.J. 1985. Survey of artificial production of anadromous salmonids in the Columbia River Basin. Final Report to Bonneville Power Administration, Portland, OR. 221 p.

Weaver, W.E., and D.H. Hagans.1994. Handbook for forest and ranch roads: A guide for planning, designing, constructing, reconstructing, maintaining and closing wildland roads. Mendocino County Resource Conservation District. 161 p.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant [and others]. 1995. Status review of coho salmon from Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-24. 258 p.

Welsh, H.H. 1990. Relictual amphibians and old-growth forests. Conservation Biology 4:309-319.

Welsh, H.H. and L.M. Ollivier. 1998. Stream amphibians as indicators of ecosystem stress: a case study from California's redwoods. Ecological Applications 8:1118-1132.

Welsh Jr., H.H. and A.J. Lind. 1992. Population ecology of two relictual salamander from the Klamath Mountains of northwestern California. Pages 419-437 in: McCullough, D. and R. Barrett (editors). Wildlife 2001: Populations. Elsevier Press, London.

Welsh Jr., H.H. and A.J. Lind. 1996. Habitat correlates of the southern torrent salamander, *Rhyacotriton variegatus* (Caudata: Rhyacotritonidae), in northwestern California. Journal of Herpetology 30:385-398.

Welsh, H.H., A.J. Lind, L.M. Ollivier and D.L. Waters. 1993. A hierarchical analysis of the habitat associations of the tailed frog (*Ascaphus truei*) in the mixed coniferous/hardwood forests of northwestern California. Contract No. 8CA74674 Report to the Strategic Planning Program, California Department of Forestry and Fire Protection.

Welsh, H.H., A.J. Lind, L.M. Ollivier, G.R. Hodgson and N.E. Karraker. 1998. Comments on the PALCO Draft SYP/HCP and Draft EIS/EIR with regard to the maintenance of riparian, aquatic and late seral ecosystems and their associated amphibian and reptile species. Unpublished document on file USDA Forest Service, Pacific Southwest Research Station, Arcata, CA.

Wemple, B.C. 1994. Economics issues in ecosystem restoration. In R.L. Everest, ed., Eastside Forest Ecosystem Health Assessment, Volume IV: Restoration of Stressed Sites, and Processes, pgs. 6-12. USDA Forest Service General Technical Report PNW-GTR-330. Pacific Northwest Research Station, Portland, OR.

Wemple, B.C., J. A. Jones, and G.E. Grant. 1996. Channel network extension by logging roads in two basins, western Cascades, Oregon. Water Resources Bulletin 32:1-13.

Whitaker, J.O., Jr. 1998. The Audubon society field guide to North American mammals. Alfred A. Knopf Inc., New York, NY. 745 p.

Wiens, J.A. 1996. Wildlife in patchy environments: metapopulations, mosaics and management. Chapter 4 in: McCullough, D.R. (editor) Metapopulations and Wildlife Conservation. Island Press, Washington, D.C.

Williams, D.F. 1986. Mammalian species of special concern in California. Administrative Report Number 86-1. California Department of Fish and Game, Sacramento, CA. 111 p. plus appendices.

Wroble, J. and D. Waters. 1989. Summary of tailed frog (*Ascaphus truei*) and Olympic salamander (*Rhyacotriton olympicus variegatus*) stream surveys for the Pacific Lumber Company, October 1987 to September 1988. Unpublished report on file, PALCO, Scotia, CA.

Wu, T.H. and D.N. Swanston. 1980. Risk of landslides in shallow soils and its relation to clearcutting in Southeastern Alaska. Forest Science 26:495-510.

Wyatt, B. 1959. Observations on the movements and reproduction of the Cascade form of cutthroat trout. MS thesis, Oregon State College, Corvallis, OR.

Yahner, R.H. and D.P. Scott. 1988. Effects of forest fragmentation on depredation of artificial nests. Journal of Wildlife Management. 52:158-161.

Yocom, C.F. and M.T. McCollum. 1973. Status of the fisher in northern California, Oregon, and Washington. California Fish and Game 59:305-309.

Young, M..K. 1994. Movement and characteristics of stream-borne coarse woody debris in adjacent burned and undisturbed watersheds in Wyoming. Canadian Journal of Forest Research 24:1933-1938.

Zeiner, D.C., W.F. Laudenslayer, Jr., and K.E. Mayer (compiling editors).1988. California's wildlife. Volume I: Amphibians and reptiles. California Department of Fish and Game, Sacramento, CA. 272 p.

Zeiner, D.C., W.F. Laudenslayer, K.E. Mayer, and M. White (editors). 1990. California's Wildlife, Volume II, Birds. California Statewide Wildlife Habitats Relationships System. California Department of Fish and Game, Sacramento, CA. 732 p. plus attachments.

Zentner, P. L. 1977. The nest of *Phenacomys longicaudus* in northwestern California. M.A. thesis. California State University, Sacramento, CA. 59 p.

Zielinski, W.J. 1995. Six Rivers National Forest fisher study progress report II. Unpublished document on file, Pacific Southwest Experiment Station, Arcata, CA. 29 p.

Zielinski, W.J. and R. Barrett. 1995. Southern Sierra Nevada fisher and martin study: progress report III. Unpublished document on file Pacific Southwest Experiment Station, Arcata, CA. 28 p.

Zielinski, W.J. and R. Barrett. 1997. Southern Sierra Nevada fisher and martin study: progress report IV. Unpublished document on file Pacific Southwest Experiment Station, Arcata, CA. 27 p.

Zielinski, W.J., Kucera, T.E., and R.H. Barrett. 1995. Current distribution of the fisher, *Martes pennanti*, in California. California Fish and Game 81:104-112.

Ziemer, R.R. and D.N. Swanston. 1977. Root strength changes after logging in southeast Alaska. Research Note PNW-RN-306. USDA Forest Service, Pacific Northwest Experiment Station, Portland, OR.

Ziemer, R.R., J. Lewis, E.T. Keppeler. 1996. Hydrologic consequences of logging second-growth watersheds. Pages 131-133 in: JeBlanc, J. (editor). Conference on Coast Redwood Forest Ecology and Management, 1996 June 18-20 Arcata, CA. University of California, Berkeley, CA.

Personal Communications

Anderson, K. January 29, 1999. Personal Communication. Resource Ecologist. North Coast Redwoods District, California Department of Parks and Recreation, Eureka, CA.

Aubry, K.B. November 5, 1998. Personal communication. Wildlife Biologist. USDA Forest Service, Pacific Northwest Experiment Station, Olympia, WA.

Baskin, J. January 29, 1999. Personal communication. Senior Planner. Humboldt County Planning Department, Eureka, CA.

Bury, B. August 4, 1998. Personal communication. Research Zoologist. USDI National Biological Survey, EPA Environmental Research Lab, Corvallis, OR 97333.

Chinnici, S. December 1, 1998. Personal communication. Wildlife Biologist. Pacific Lumber Company, Scotia, CA.

Chinnici, S. January 14, 1998. Personal communication. Wildlife Biologist. Pacific Lumber Company, Scotia, CA.

Chinnici, S. November 23,1998. Personal communication. Wildlife Biologist. Pacific Lumber Company, Scotia, CA.

Detrich, P. July 28, 1998. Personal communication. Wildlife Biologist. USDI Fish and Wildlife Service, Yreka, CA.

Flora, J. January 11, 1999. Personal communication. Geographic Information Systems Specialist, Bureau of Land Management, Coos Bay, OR.

Haas, J. January, 1999. Personal communication between J. Haas, FWS, and K. Young, NMFS.

Hawks, S. February 3, 1999. Personal communication. Wildlife Biologist. USDI Bureau of Land Management, Arcata, CA.

Holland, D.C. October 21, 1998. Personal communication. Principal Investigator. Camp Pendleton Amphibian and Reptile Survey, 334A East Fallbrook, Fallbrook, CA 92028.

Jackson, T. 1995. Personal communication between T. Jackson, Fish Biologist, California Department of Fish and Game and G. Bryant, National Marine Fisheries Service. October 1995.

Jennings, M. 1993. Personal communication. Fish and Wildlife Biologist. National Biological Service.

Klug, R.R., Jr. January 15, 1999. Personal communication. Wildlife Biologist. Simpson Timber Company, Korbell, CA.

Lyke, D. January 22, 1999. Personal communication. Geographic Information Systems Specialist, Siskiyou National Forest, Grant's Pass, OR.

Markegard, G. January 29, 1999. Personal communication. Farm Advisor. University of California Cooperative Extension, Eureka, CA.

Mesta, R. August 6, 1998. Personal communication. Wildlife Biologist. USDI Fish and Wildlife Service, Ventura California.

Meyers, C. 1995. Personal communication. Wildlife Biologist. Pacific Southwest Experiment Station, Arcata, CA.

Moore, K. January 18, 1999. Personal communication. Wildlife Biologist. California Department of Fish and Game, Eureka, CA.

Murphy, D. September 22, 1997. Personal communication. Professor of Biology. Interagency meeting at TRA, Palo Alto, CA.

Ollivier, L. November 4, 1998. Personal communication. Wildlife Biologist. Pacific Southwest Experiment Station, Arcata, CA.

Opalach, D. September, 9 1998. Personal communication. Timberlands Manager. Pacific Lumber Company, Scotia, CA.

Rand, O. February 4, 1999. Personal communication. GIS Biologist. Foster Wheeler Environmental Corp., Bellveue, WA.

Rand, O. February 5, 1999. Personal communication. GIS Biologist. Foster Wheeler Environmental Corp., Bellveue, WA.

Reid, T. December 16, 1998. Personal communication. Biologist. Thomas Reid Associates, Palo Alto, CA.

Reid, T. February 5, 1998. Personal communication. Biologist. Thomas Reid Associates, Palo Alto, CA.

Reid. T. January 11, 1999. Personal communication. Biologist. Thomas Reid Associates, Palo Alto, CA.

Reigel, L. Undated 1997. Personal communication. GIS Technician. USDI Fish and Wildlife Service.

Schmidt, G.A. January 8, 1999. Personal communication. Ecologist. USDA Forest Service, Six Rivers National Forest. Eureka, CA.

Schmidt, K. Undated. Personal communication. Wildlife Biologist. USDA Forest Service, Six Rivers National Forest. Eureka, CA.

Wantuck, R. 1999. Personal communication between R. Wantuck, National Marine Fisheries Service (Engineering) and K. Young, National Marine Fisheries Service (PRD).

Wilbur, K. January 29, 1999. Personal communication. Chief Ranger. North Coast Redwoods District, California State Parks and Recreation, Eureka, CA.

Yancheff, M. January 1999. Personal communication between M. Yancheff, CALTRANS, and K. Young, National Marine Fisheries Service.

APPENDICES

Appendix A. Table provided to USFWS by T. Reid, Jan. 11, 1999. Summary of habitat acres in various habitat categories for the PALCO SYP/HCP and Headwaters acquisition.

7. A	Summary of Old Growth Redwood and HCP Status – With Final December MMCA Extension												
	Area in acres												
			Othe	OG Dou Fir	REDOG	REDOG	REDOG	All Uncut OGR	REDRS 2	REDRS	All Residual	All OG	Total Area
PL Land													
	Avail for Harvest		175,970	8,304	148	217	81	460	222	7,784	8,225	8,452	192,725
	Buffer Zones		1,963	0	0	0	0	0	0	295	295	295	2,258
	MCA Options												
		Grizzley	410		73	44		117	48	482	530	647	1,057
		Owl Crk	350	19	240	77		317	10	230	239	556	925
	MCA reserve Subtotal		2,849	197	902	98	86	1,087	242	2,155	2,397	3,483	6,529
	Extension												
		Augment Grizzley	120		13			13	42	177	219	232	352
		Augment Owl	136		42			42		97	97	138	274
		Subtotal	255	0	55	0	0	55	42	274	316	371	626
	HCP Reserve Options												
		Preserve Grizzley	3,259	197	976	142	86	1,204	290	2,636	2,927	4,131	7,586
		Preserve Owl	3,199	216	1,142	175	86	1,404	252	2,384	2,636	4,040	7,454
		Preserve Both	3,609	216	1,215	220	86	1,521	300	2,866	3,166	4,687	8,511
	Total Reserve with Extension		3,864	216	1,270	220	86	1,576	342	3,140	3,482	5,058	9,137
	Headwaters		1,927		2,288	584	245	3,117	0	664	665	3,782	5,709
	PL TOTAL		183,724	8,519	3,706	1,021	413	5,139	565	11,882	12,447	17,586	209,830
ERTC Lands													
	Avail for Harvest		7,674					0			0	0	7,674
	Buffer Zones		26					0			0	0	26
	Headwaters		1,769					0			0	0	1,769
	ERTC TOTAL		9,469					0			0	0	9,469
	HCP Study Area TOTAL		193,193	8,519	3,706	1,021	413	5,139	565	11,882	12,447	17,586	219,299
ALL HCP and Purchase Conservation													
		Preserve Grizzley	6,955	197	3,264	726	332	4,321	291	3,301	3,591	7,913	15,064
		Preserve Owl	6,895	216	3,430	759	332	4,521	252	3,049	3,301	7,822	14,932
		Preserve Both	7,305	216	3,503	803	332	4,638	301	3,530	3,831	8,469	15,989
		Reserve with Ext	7,560	216	3,558	803	332	4,693	343	3,804	4,147	8,840	16,616
		Reserve as % of	3.9%	2.5%	96.0%	78.7%	80.3%	91.3%	60.7%	32.0%	33.3%	50.3%	7.6%
ALL Available for Harvest													
		Option Cut Grizzle	186,299	8,304	276	262	81	619	312	8,834	9,146	9,765	204,367
		Option Cut Owl	186,238	8,323	442	295	81	818	274	8,582	8,855	9,674	204,235
		Cut Neither	185,889	8,304	203	217	81	501	264	8,352	8,616	9,117	203,310
		Available with Ex	185,633	8,304	148	217	81	446	222	8,078	8,300	8,746	202,684
		Available as % of	96.1%	97.5%	4.0%	21.3%	19.7%	8.7%	39.3%	68.0%	66.7%	49.7%	92.4%

Appendix B (version1). Height growth in second-growth coastal redwood and Douglas-fir: timing and emergence of habitat features associated with the marbled murrelet (J. Peters, USDI Fish and Wildlife Service, February 1999). **Editor's note**: Due to short deadline, App. B (vers. 1) tables and figures may appear to be out of order in document, but text references are to appropriate table and figure numbers.

Background

(1) The final rule (U.S. Fish & Wildlife Service, 1996) designating critical habitat for the marbled murrelet (*Brachyramphus marmoratus*) discusses the importance of emergent second-growth forests within one-half mile of potential nest sites. Stands with a canopy height of at least one-half the site-potential tree height are considered to reduce the differences in microclimates between forested and unforested sites, to reduce the potential for windthrow during storms, and to provide a landscape that a higher probability of occupancy by marbled murrelets. Forested stands, within one-half mile of potential nest sites, that attain one-half site-potential tree height, based on species-specific site index tables, are designated as critical habitat under the final rule (U.S. Fish & Wildlife Service, 1996).

(2) Even-aged, second-growth stands and even-aged, second-growth cohorts within mixed-age stands immediately adjacent existing and potential nest trees in the Marbled Murrelet Conservation Areas (MMCA's) may make a substantial contribution to habitat quality. Hamer and Nelson (1995) evaluated habitat attributes on and around marbled murrelet nest trees and found that mean nest height in the California sample (n = 10) was 47 meters (154 feet) with a standard deviation of 11 meters (36 feet). Adjacent second-growth approaching a height of 118 feet (the mean value minus one standard deviation) have attained enough size to conceal some nests. Nelson and Hamer (1995a) note that the avoidance of predation is an important adaptive trait in marbled murrelets and outline fifteen predator avoidance strategies observed in that species, including nest concealment. Nelson and Hamer (1995b) review their own data for marbled murrelet nest sites, compare it to the results of several studies of other avian species, and conclude that nest concealment is probably an important factor in limiting murrelet nest predation and in maintaining reproductive efficiency. The marbled murrelet habitat association model by Grenier and Nelson (1995) includes several attributes correlated with occupancy that can be construed as providing nest concealment.

Questions Addressed

(1) What portion of the second-growth landbase within one-half mile of potential marbled murrelet nest sites will attain an average height of one-half site potential tree height (SPTH) within the 50-year life of the proposed Habitat Conservation Plan submitted by the Pacific Lumber Company? The immediate task, addressed here, is to identify database search parameters to enable a solution to the landbase question.

(2) Over the next 50 years, what portion of the second-growth cohorts, in mixed-age, mosaic-pattern stands in the Marbled Murrelet Conservation Areas (MMCA's), will attain an average

height of 120 feet, thereby providing nest concealment and improving the reproductive potential of breeding adults? Again, the immediate task is to identify database search parameters to enable a quantitative solution.

Summary and Explanation of the Attached Tables and Figures

Figure 1

The figure (from Oliver and Larson, 1990) illustrates stratification in a forest canopy. The consensus view within the FWS is that the height of the upper continuous canopy should be the standard for determining if a stand has attained a reference height (such as one-half SPTH). In the figure, this canopy level is termed the "B-stratum." Other descriptors are coined and used for this level of the canopy and are reasonably interchangeable (main canopy, codominant canopy); provided there is a clear understanding that the stratum of interest is the tallest, continuous canopy level that does not include dominants or emergents ("A-stratum").

Figure 1

Canopy Stratification
(The "B-Stratum" is Treated as the General Canopy Height)

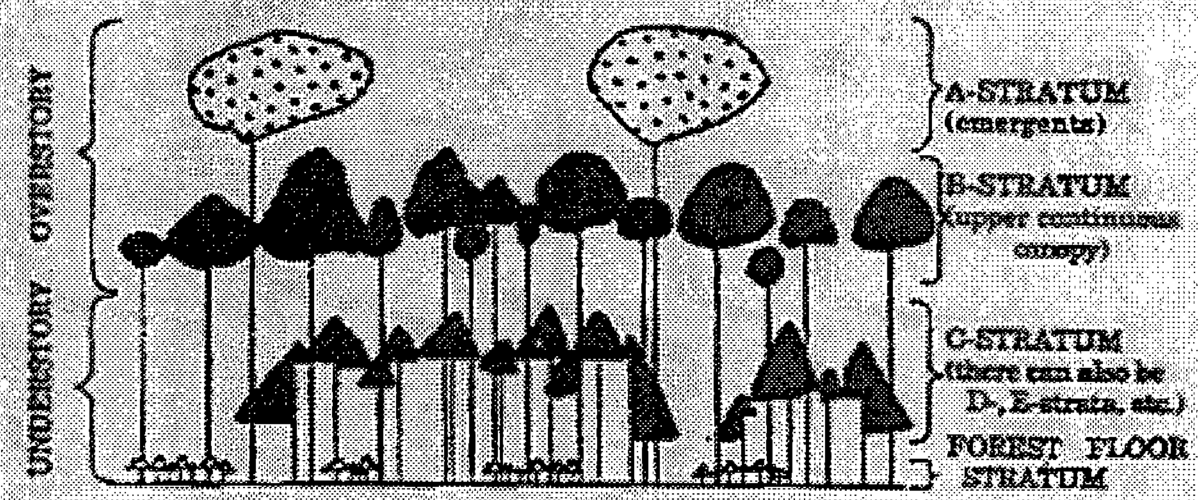


Table 1

A summary of the descriptive attributes of the successional (or seral) stages used in the Pacific Lumber Co. Draft HCP (1998). The stages are based on the ones used in the California wildlife habitat relations system (Mayer and Laudenslayer, 1988). Note that tree diameter is the defining attribute. Other attributes are for descriptive purposes only. The Service added right-hand column (stratification stage) for additional descriptive power.

Table 1. Successional (seral) stage descriptions used in the PALCO Draft HCP (1998).

Seral stage[1]	Age range (years)[2]	Dbh range (inches)[3]	WHR Equivalent[4]	Stratification stage[5]
Opening	0 to 10	0 to 1.0	seedling[1]	stand initiation
Young	10 to 20	1.1 to 6.0 6.1 to 11.0	sapling[2] pole[3]	stem exclusion
Mid-seral	20 to 50	11.1 to 24.0	small tree[4]	stem exclusion
Late-seral	>55 (± 5)	>24.0	medium to large tree[5]	possible understory reinitiation
Old-growth	none given	>30.0	multi-layered tree[6]	well developed strata

[1]– PALCO Draft HCP (1998), Volume I, page 17.
[2]– Age ranges are for descriptive purposes only. They do not define the seral stage in the Draft HCP, nor in the underlying State of California Wildlife Habitat Relations system (Mayer and Laudenslayer 1988).
[3]– Dbh ranges define the seral stages in the Draft HCP and in Mayer and Laudenslayer (1988).
[4]– Equivalent terminology (with code numbers in parentheses) from Mayer, K. E. and W. F. Laudenslayer. 1988. A guide to the wildlife habitats of California. The Resources Agency, Sacramento CA.
[5]– Equivalent stand development descriptors used in: Oliver, C. D. and B. C. Larson. 1990. Forest stand dynamics. McGraw-Hill, Inc., New York.

Figure 2 and Table 4

Illustrates mean height and mean diameter (breast height, or DBH) ranges for the seral stages used in the Pacific Lumber Co. Draft HCP (1998). Transition diameters for the seral stages come from the Pacific Lumber Co. Draft HCP (1998), as derived from Mayer and Laudenslayer (1988). The mean height curve and height intercepts were generated from a mean height-DBH equation provided by Vestra Resources, Inc. (1998). The equation, below, is based on Pacific Lumber Co. timber inventory data.

$$\text{Mean Height} = (5.552468 * \text{DBH}) - (0.0438 * \text{DBH}^2) \quad [\text{correlation coefficient} = 0.753]$$

Table 4 shows a sample of mean heights for DBH's ranging from 20.0 inches to 40.6 inches.

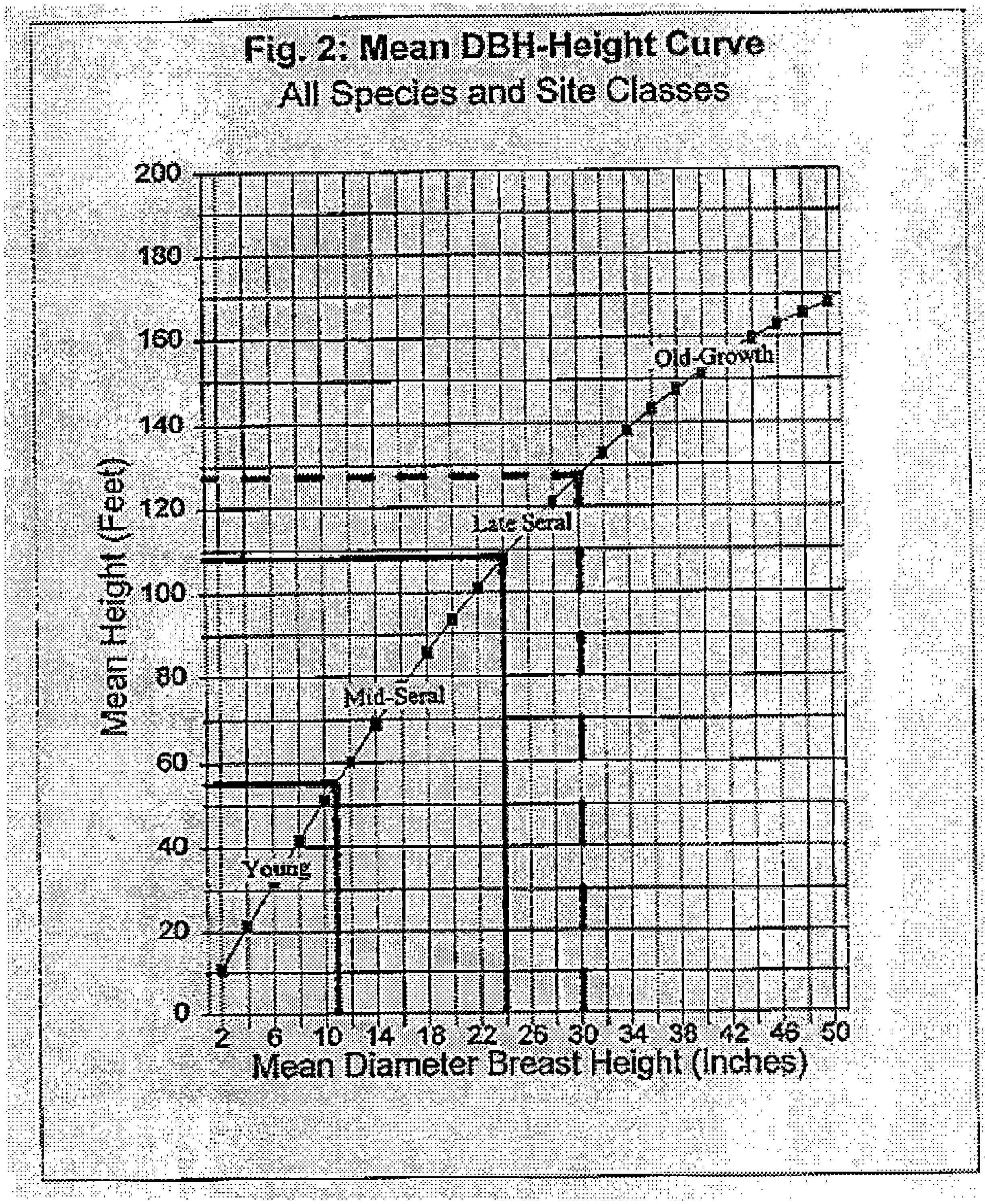


Fig. 2: Mean DBH-Height Curve
All Species and Site Classes
Mean Height (Feet)
200
180
160
140
120
100
80
60
40
20
0
Young
Mid-Seral
Late Seral
Old-Growth
2
6
10
14
18
22
26
30
34
38
42
46
50
Mean Diameter Breast Height (Inches)

Table 4. Relationship of average height to average diameter breast height (dbh)							
Avg dbh (inches)	**Avg height (feet)**	**Avg dbh (inches)**	**Avg height (feet)**	**Avg dbh (inches)**	**Avg height (feet)**	**Avg dbh (inches)**	**Avg height (feet)**
20.0	93.5	25.2	112.1	30.4	128.3	35.6	142.2
20.2	94.3	25.4	112.8	30.6	128.9	35.8	142.6
20.4	95.0	25.6	113.4	30.8	129.5	36.0	143.1
20.6	95.8	25.8	114.1	31.0	130.0	36.2	143.6
20.8	96.5	26.0	114.8	31.2	130.6	36.4	144.1
21.0	97.3	26.2	115.4	31.4	131.2	36.6	144.5
21.2	98.0	26.4	116.1	31.6	131.7	36.8	145.0
21.4	98.8	26.6	116.7	31.8	132.3	37.0	145.5
21.6	99.5	26.8	117.3	32.0	132.8	37.2	145.9
21.8	100.2	27.0	118.0	32.2	133.4	37.4	146.4
22.0	101.0	27.2	118.6	32.4	133.9	37.6	146.9
22.2	101.7	27.4	119.3	32.6	134.5	37.8	147.3
22.4	102.4	27.6	119.9	32.8	135.0	38.0	147.8
22.6	103.1	27.8	120.5	33.0	135.5	38.2	148.2
22.8	103.8	28.0	121.1	33.2	136.1	38.4	148.6
23.0	104.5	28.2	121.7	33.4	136.6	38.6	149.1
23.2	105.2	28.4	122.4	33.6	137.1	38.8	149.5
23.4	105.9	28.6	123.0	33.8	137.6	39.0	149.9
23.6	106.6	28.8	123.6	34.0	138.2	39.2	150.4
23.8	107.3	29.0	124.2	34.2	138.5	39.4	150.8
24.0	108.0	29.2	124.8	34.4	139.2	39.6	151.2
24.2	108.7	29.4	125.4	34.6	139.7	39.8	151.6
24.4	109.4	29.6	126.0	34.8	140.2	40.0	152.0
24.6	110.1	29.8	126.6	35.0	140.7	40.2	152.4
24.8	110.8	30.0	127.2	35.2	141.2	40.4	152.8
25.0	111.4	30.2	127.7	35.4	141.7	40.6	153.2

The height equation, based on Pacific Lumber Co. inventory data, was provided by Vestra Resources, Inc., Redding CA (1998). The equation is: Avg height = (5.52468 * Avg dbh) + (- 0.04358 * (avg dbh^2) [r-square = 0.753].

Table 2, Figures 4, 5, 6 and 7

The top half of Table 2, along with Figures 4 and 6, show the relationship of dominant height to age (breast height) for redwood and Douglas-fir. Height-age tables and curves were computed for each species for site classes 1, 2 and 3. The mean site index (height at the reference age of 50-years) for each site class is shown in Table 3, based on information in the Pacific Lumber Co. draft HCP (1998), Volume III, Part B, page 7. Height solutions are based on dominant height equations by Wensel and Krumland (1986) for redwood and by King (1966) for Douglas-fir.

The bottom half of Table 2, along with Figures 5 and 7, show the relationship of mean (or average) height to age (breast height) for redwood and Douglas-fir. Mean-height-age tables and curves were computed for site classes 1, 2 and 3, in the same format as dominant height. Mean-height solutions for Douglas-fir and redwood are based on a ratio of mean height to dominant height (m/d) such that, for a given stand age and site index,

$$\text{Mean Height} = \text{Dominant Height} * (\text{m/d})$$

The ratio of mean to dominant height for both species resulted from a review of modeling results for Douglas-fir (Curtis, et al., 1982). The DFSIM Douglas-fir stand simulator (Curtis, et al., 1981) yields two stand height outputs in each simulation cycle; the "Ht40" (defined as the mean height of the tallest forty trees per acre, equivalent to dominant height), and the "Lorey Height" (defined as the height of the tree of mean cubic foot volume, the closest equivalent we could find to the height of the "B-stratum" or codominant layer). We selected these as surrogates for dominant and mean height, respectively. Lacking the means to compute mean tree volumes, we then searched for a more direct relationship between "Lorey height" and "Ht40" in the simulation output tables (Curtis, et al., 1982). The search revealed that m/d ratios clustered around 0.78 at age 20, and 0.89 at age 100, and that the trend in ratios appeared to be independent of site index and prior thinning history. The increasing trend in ratios with increasing age indicates that mean and dominant heights would converge at around age 200. We then drew a small number of data points from the simulation tables in Curtis, et al. (1982) and constructed a simple linear regression solving the m/d ratio as a function of stand age. The resulting equation is,

$$\text{m/d Ratio} = 0.7555 + (0.001222 * \text{Age}),$$

and the final mean height equation becomes,

$$\text{Mean Height} = \text{Dominant Height} * (0.7555 + (0.001222 * \text{Age})).$$

Table 2. Age-height relationship for coastal redwood and Douglas-fir.						
Part 1– Dominant height table						
Species and site class	**Redwood**			**Douglas-fir**		
	Site 1	**Site 2**	**Site 3**	**Site 1**	**Site 2**	**Site 3**
Breast-height age	**(dominant height in feet)**					
0	0	0	0	0	0	0
20	60	52	43	69	59	49
40	101	86	71	121	103	85
60	131	112	93	158	134	110
80	154	132	111	184	156	128
100	172	149	125	204	172	141
120	186	161	136	220	185	151
140	197	172	146	233	195	159
160	206	180	154	243	204	165
180	213	187	160	252	211	170
200	219	193	166	260	216	175
Part 2– Mean, or average, height table						
Species and site class	**Redwood**			**Douglas-fir**		
	Site 1	**Site 2**	**Site 3**	**Site 1**	**Site 2**	**Site 3**
Breast-height age	**(mean height in feet)**					
0	0	0	0	0	0	0
20	47	40	34	54	46	38
40	81	69	57	97	83	69
60	108	93	77	131	111	91
80	131	113	94	157	133	109
100	151	130	110	179	151	123
120	168	146	123	199	167	136
140	183	159	135	216	181	147
160	196	172	146	232	194	157
180	208	183	156	246	205	166
200	219	193	166	260	216	175

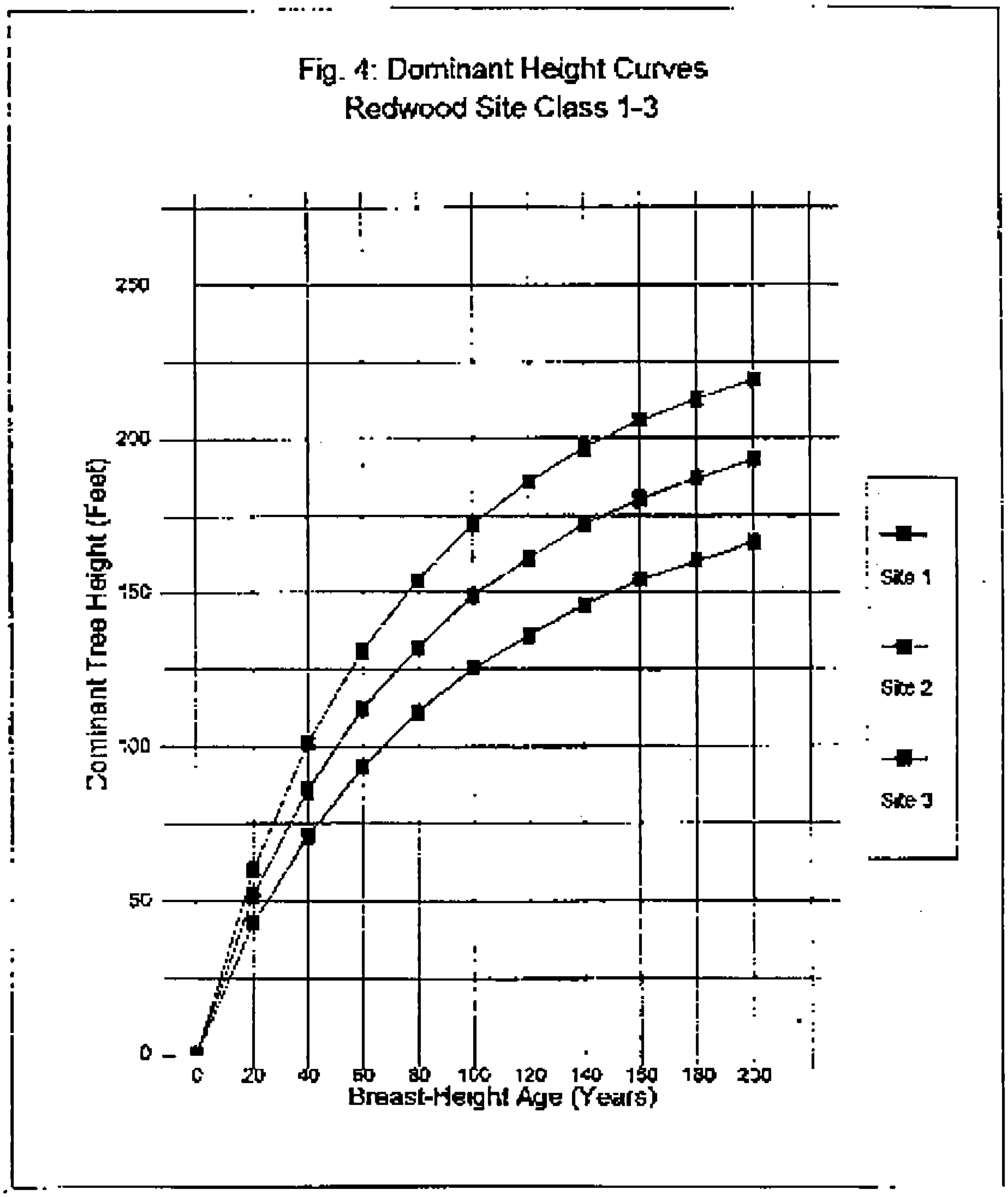


Fig. 4: Dominant Height Curves
Redwood Site Class 1-3
Dominant Tree Height (Feet)
0
50
100
150
200
250
0
20
40
60
80
100
120
140
160
180
200
Breast-Height Age (Years)
Site 1
Site 2
Site 3

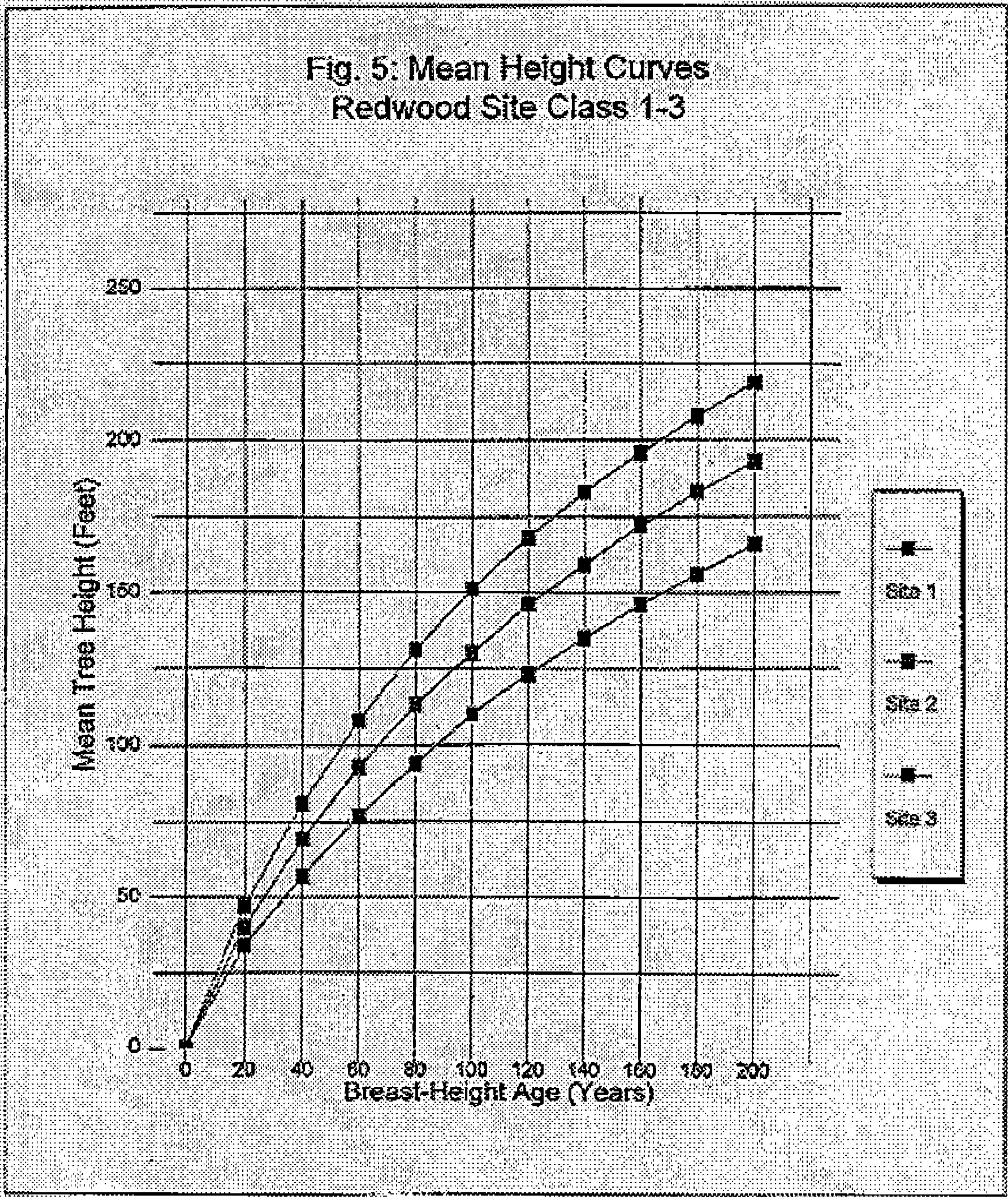


Fig. 5: Mean Height Curves
Redwood Site Class 1-3
Mean Tree Height (Feet)
250
200
150
100
50
0
0
20
40
60
80
100
120
140
160
180
200
Breast-Height Age (Years)
Site 1
Site 2
Site 3

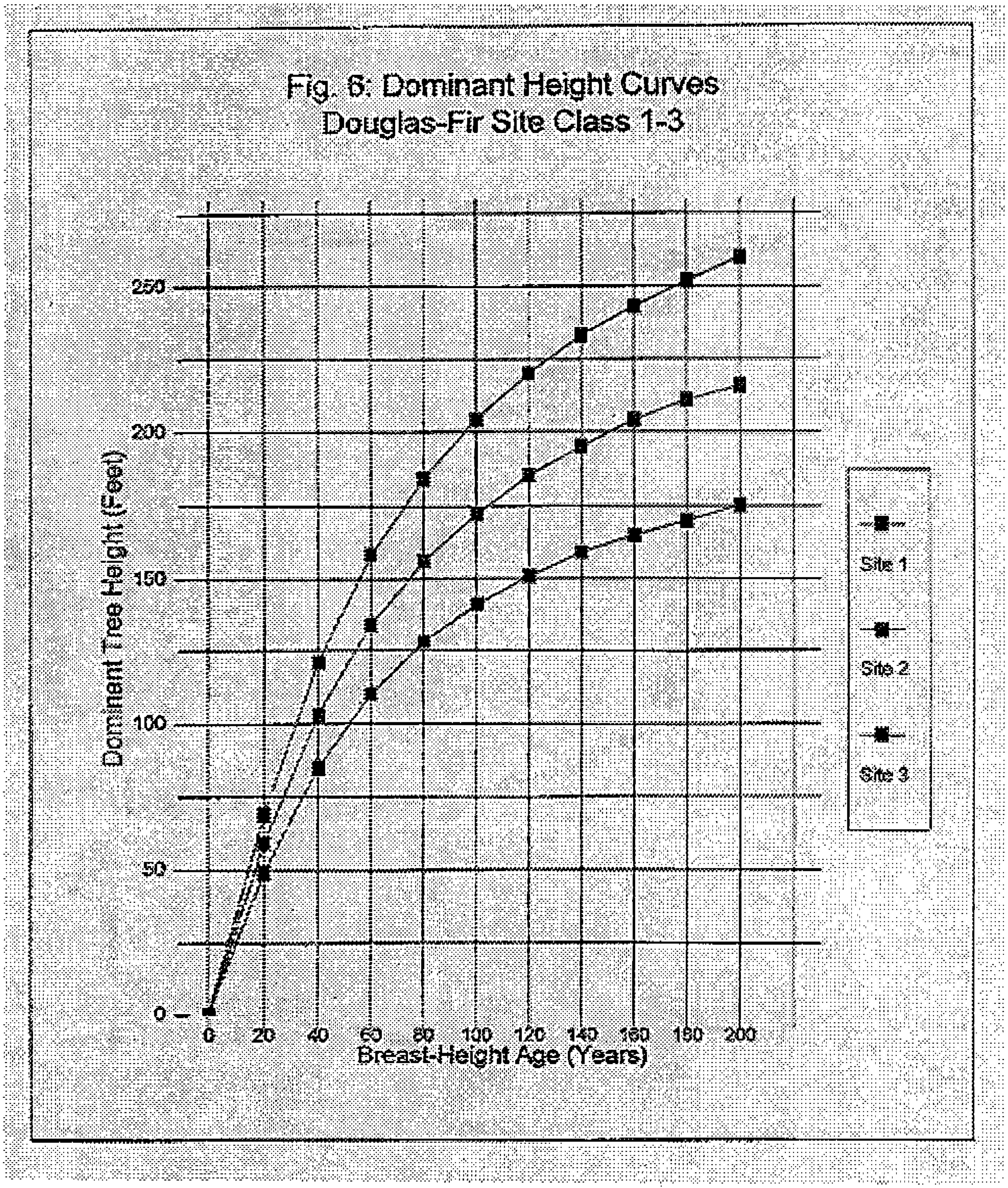


Fig. 6: Dominant Height Curves
Douglas-Fir Site Class 1-3
Dominant Tree Height (Feet)
0
50
100
150
200
250
0 20 40 60 80 100 120 140 160 180 200
Breast-Height Age (Years)
Site 1
Site 2
Site 3

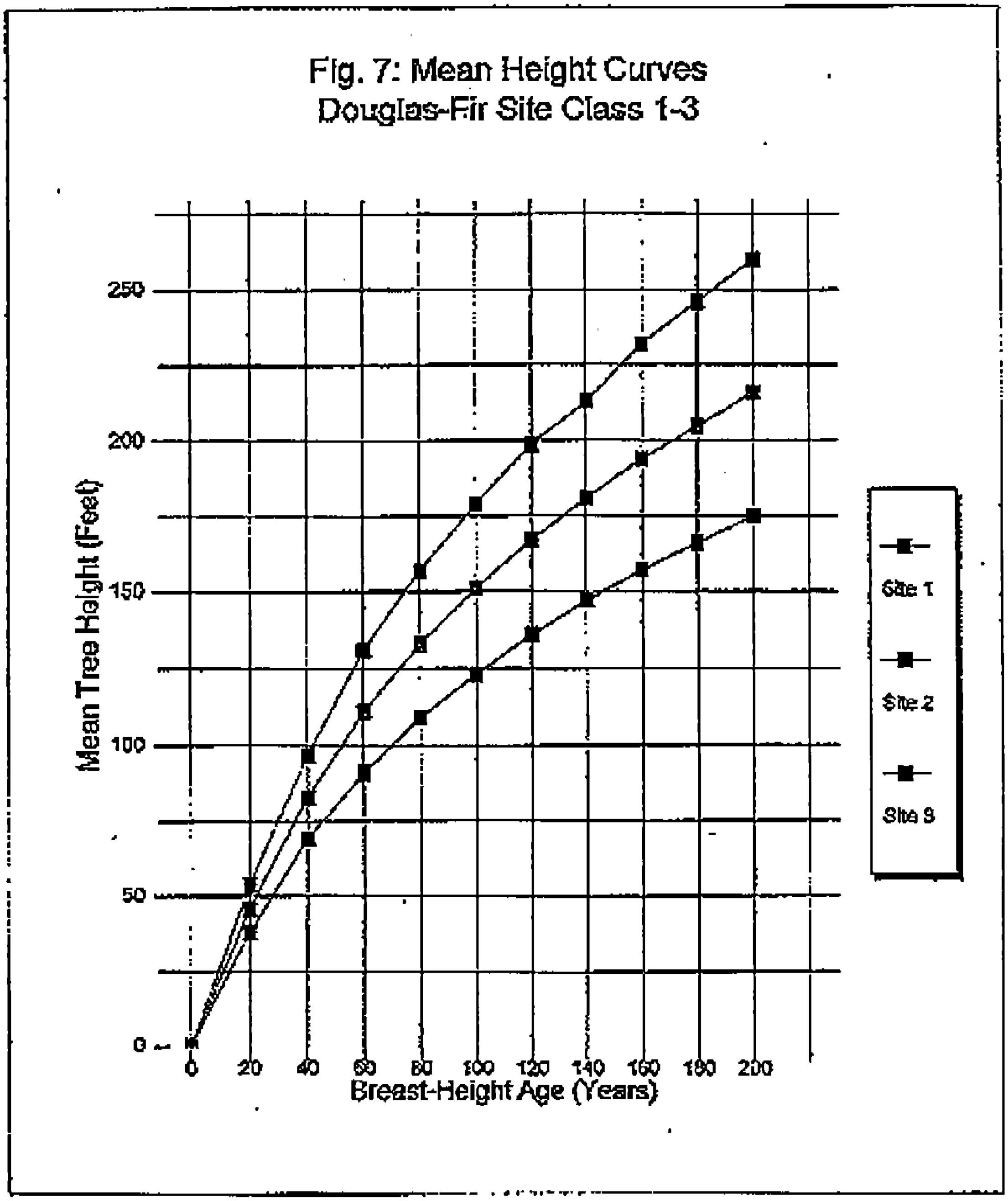


Fig. 7: Mean Height Curves
Douglas-Fir Site Class 1-3
250
200
150
100
50
0
Mean Tree Height (Feet)
0
20
40
60
80
100
120
140
160
180
200
Breast-Height Age (Years)
Site 1
Site 2
Site 3

Figure 3 and Table 3

Site-potential tree heights were estimated for site classes 1, 2 and 3 using dominant height growth equations for redwood (Wensel and Krumland, 1986) and Douglas-fir (King, 1966). Each species and site class was projected 600 years or more until annual height growth approached zero, or a very low number. Figure 3 is a sample 600-year projection for redwood, site class 2 (notice in Table 3 that SPTH for redwood site class 2 was attained at 625 years. Figure 3 was one of several iterations used to establish that SPTH and corresponding age). Redwood dominant-height projections arrived at zero height growth at ages of 500, 625 and 675 years for sites classes 1, 2 and 3, respectively. Douglas-fir height projections did not attain zero height growth at any age (the longest projection was 1,500 years), but did closely approach zero. It is not known whether this reflected biological reality or if it was an artifact of the equations, which were not designed to simulate growth in older age classes. In order to set a definitive height and age for Douglas-fir, I set an arbitrary standard that SPTH was attained when annual height growth diminished to 0.2 feet per year. This occurred at 450, 400 and 350 years for site classes 1, 2 and 3, respectively. Site potential tree heights, age at SPTH, age at one-half SPTH and the breast-height age corresponding to a mean tree height of 120 feet (along with other parameters) are summarized for redwood and Douglas-fir (all site classes) in Table 3.

One significant issue with this method (for determining SPTH) is the use of contemporary (polymorphic) height growth equations (e.g., Wensel and Krumland, 1986; King, 1966) to estimate future heights at ages of 350 years, and beyond, while the source publications indicate the equations were derived from much younger sample trees (e.g., 10-80 years for Wensel and Krumland, 1986). While this approach is an unavoidable compromise, there is also evidence that the compromise is justified. Following are the three major points in that line of reasoning.

(a) The use of polymorphic height growth equations, based on younger sample trees, is becoming unavoidable. Because of their computational flexibility, polymorphic height equations are a critical subroutine in stand growth models. For example, the Wensel and Krumland (1986) height equations are embedded in the CRYPTOS and CRYPT2 models (Krumland and Wensel, 1982) for the redwood region, and the King (1966) equations are mimicked in the DFSIM model (Curtis, et al., 1981) for Pacific northwest Douglas-fir. As a consequence of these technological linkages, public and private forestland managers are increasingly collecting and reporting their site index information to conform with the most current site index and height growth models applicable to their landholding.

(b) In contrast, the earlier site index and height growth models (e.g., Dunning, 1942; McArdle, et al., 1949; Lindquist and Palley, 1963) used a mechanical plotting technique, called the guide curve method, that yielded graphical outputs, but no least-squares solutions and no equations. Some of the older guide curve-based graphs are instructive because they plot height and age out to 250 years and beyond (e.g., Dunning, 1942; McArdle, et al., 1949), and clearly show the older regions of the curves where annual height growth levels-off. This enables the user to graphically visualize the meaning of site potential tree height as defined in FEMAT (1993). However, others (e.g., Lindquist and Palley, 1963) only plot height growth to 100 years, an age-region where growth is still fairly rapid, leaving the user with no ready means to project the curves to the age of maximum of maximum height.

(3)Even though the polymorphic height equations of Wensel and Krumland (1986) and King (1966) rely on a young tree sample base, they appear to perform reasonably well in long projections of 300 years and more. In their general form, the polymorphic height curves closely resemble the published long-age-span height projections by Dunning (1942) and McArdle, et al. (1949). I made a test projection of 500 years using the highest redwood site index (160 feet at 50 years) in Wensel and Krumland (1986). That projection attained a site potential tree height of 300 feet at 480 years and did not surpass any of the documented "giant" redwoods on alluvial flats in State and National Parks; including the "big tree" in Redwood National Park (386 ft), the Dyersville Giant (372 ft) and the Montgomery Woods "giant" (367 ft). We consider this a credible outcome for two reasons: (a) alluvial flats supporting "giant" trees are exceptional sites, many in public ownership, so we would not expect sites of this quality to be well-represented in Wensel and Krumland's (1986) sample base; and (b) because the coefficients in the height growth equation are a product of sample means. Consequently, the equation solutions should be expected to fall short of the upper limit of tallest trees in a second-growth stand, let alone the tallest trees on record anywhere.

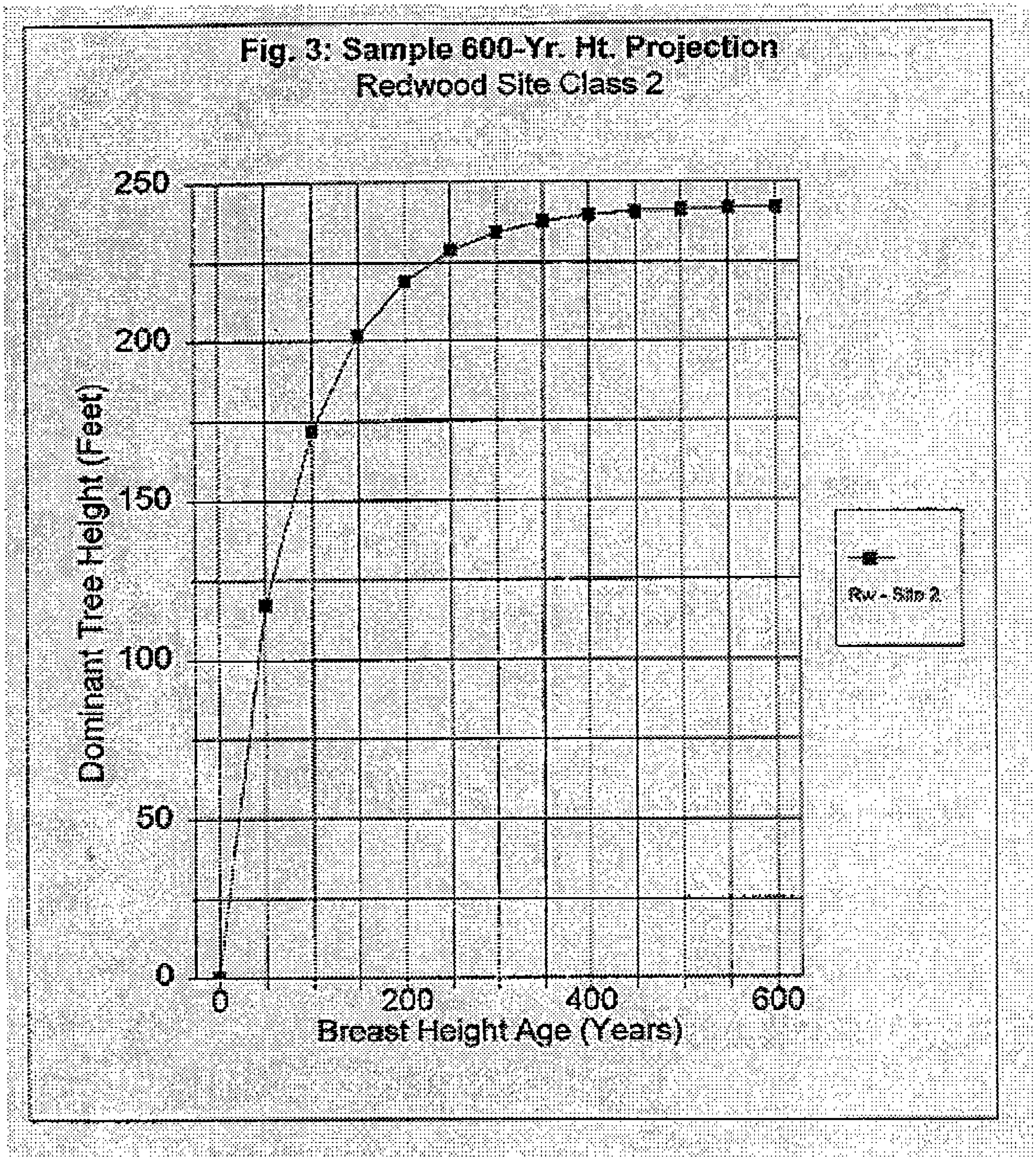


Fig. 3: Sample 600-Yr. Ht. Projection
Redwood Site Class 2
Dominant Tree Height (Feet)
250
200
150
100
50
0
0
200
400
600
Breast Height Age (Years)
Rw - Site 2

Table 3. Height growth and age attributes of coast redwoods and Douglas-fir.						
Site attribute	**Redwood**			**Douglas-fir**		
Site class[1]	**Site 1**	**Site 2**	**Site 3**	**Site 1**	**Site 2**	**Site 3**
Site index, height at 50 years[1, 2, 3]	117 ft	100 ft	83 ft	141 ft	120 ft	99 ft
Site potential tree height (SPTH)[4, 5]	242 ft	218 ft	192 ft	304 ft	248 ft	194 ft
Estimated age at SPTH [4, 5]	500 yrs	625 yrs	675 yrs	450 yrs	400 yrs	350 yrs
One-half SPTH[6]	121 ft	109 ft	96 ft	152 ft	124 ft	97 ft
Estimated age at one-half SPTH[7]	71 yrs	76 yrs	82 yrs	76 yrs	71 yrs	66 yrs
Mean dbh at one-half SPTH[8]	28.0 in	24.3 in	20.6 in	40.0 in	28.9 in	20.9 in
Estimated age at 120' height[7]	70 yrs	88 yrs	115 yrs	53 yrs	68 yrs	95 yrs
Seral Stage[9]	**Does the seral stage dbh exceed the mean dbh above?**					
Forest opening (0.0 - 1.0" dbh)	no	no	no	no	no	no
Young (1.1 - 11.0" dbh)	no	no	no	no	no	no
Mid-seral (11.1 - 24.0" dbh)	no	no	partly	no	no	partly
Late-seral (>24" dbh)	partly	partly	fully	partly	partly	fully
Old-growth (includes trees>30" dbh)	fully	fully	fully	fully	fully	fully

[1]– Published in the PALCO Draft HCP (1998), Volume III, page 7.
[2]– Redwood site index and height equations from Wensel, L. C. and B. Krumland. 1986. Hilgardia 54(8):1-14.
[3]– Douglas-fir site index and height equations from King, J. E. 1966. Weyerhaeuser Forestry Paper No. 8. Centralia, WA.
[4]– Redwood age and height was projected 600 years using Wensel and Krumland (1986) height growth equations. Site potential tree height, and corresponding age, were set where annual height growth diminished to zero.
[5]– Douglas-fir age and height was projected 600 years using King (1966) height growth equations. Site potential tree height, and corresponding age, were set where annual height growth diminished to 0.2 feet per year.
[6]– Site potential tree height divided by two.
[7]– Minimum age at one-half site potential tree height, and 120 ft. height, was read from the 600-year age-height projections in [4] and [5] above.
[8]– A dbh-height equation, based on PALCO inventory data, was supplied by Vestra Resources Inc., Redding CA (1998). The equation is: Avg ht = (5.52468 * Avg dbh) + (- 0.04358 * (avgdbh^2) [r-square = 0.753].
[9]– Based on Mayer, K. E. and W. F. Laudenslayer. 1988. A guide to wildlife habitats of California. The Resources Agency, Sacramento CA.

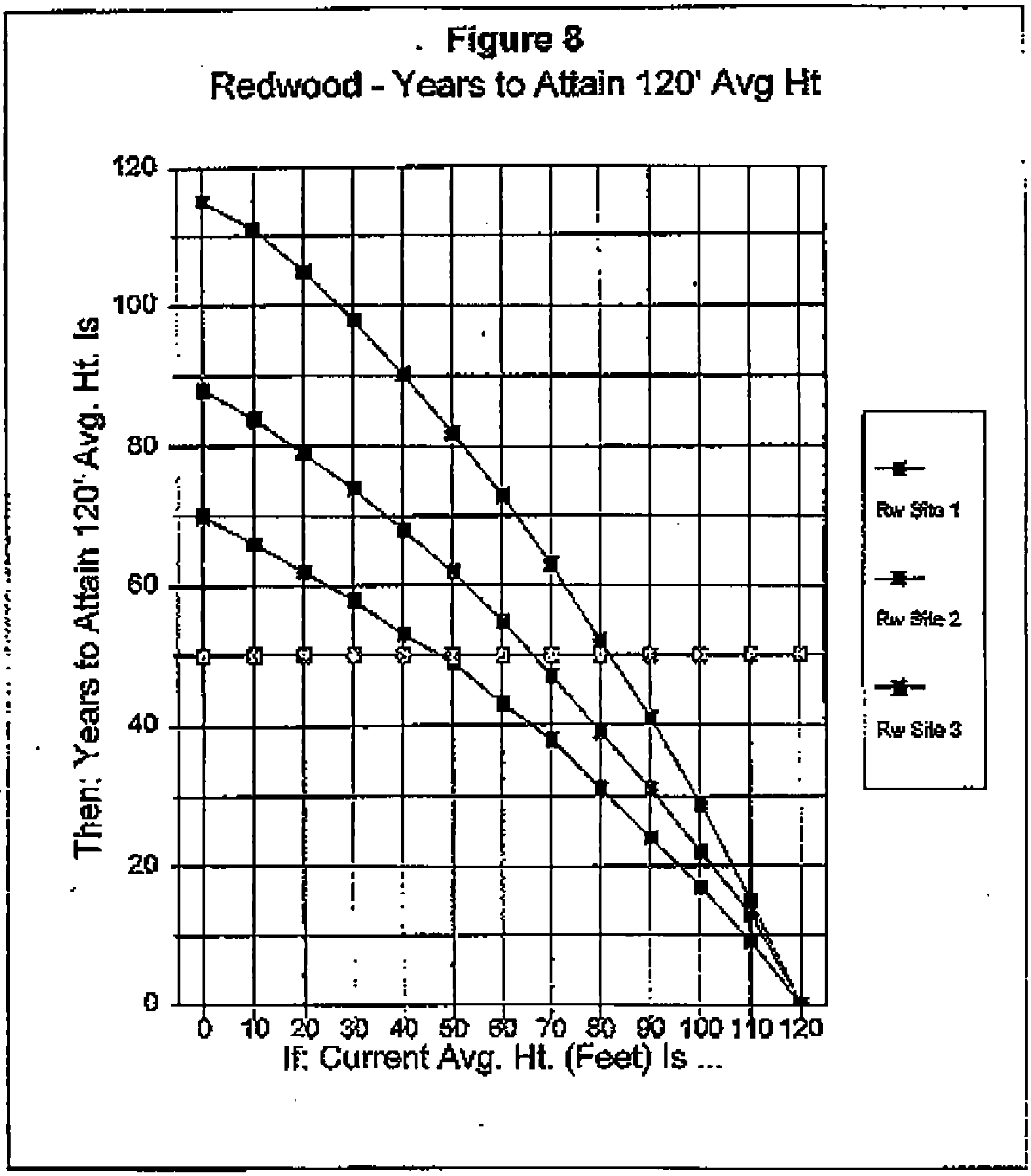
Tables 5 and 6, Figures 8, 9, 10 and 11

I next made 150-year projections, in 5-year intervals, for redwood and Douglas-fir (all site classes). At each 5-year interval, the projection displayed breast-height age, dominant height and mean height. In the tables, I used the current mean height of trees (in 10-foot increments) as a starting point to represent the variety of height classes that may be present in the field. Then using the 150-year projections, I calculated, by subtraction, the years that would elapse between the current mean height and the reference mean height; either 120 feet (Table 5, Figures 8 and 9), or one-half SPTH (Table 6, Figures 10 and 11). All mean height and age values falling between the 5-year intervals were corrected to the nearest year and the nearest foot by interpolation. On Figures 8, 9, 10 and 11, a horizontal line is projected at 50-years, representing the 50-year timespan of the proposed HCP. All curve segments that lie below the 50-year line encompass the current mean height classes that will attain reference mean height (120 feet or one-half SPTH) within the life of the proposed HCP.

Table 5. Years to grow from current average height to an average height of 120 feet.

Species and site class	**Rw site 1**	**Rw site 2**	**Rw site 3**	**Df site 1**	**Df site 2**	**Df site 3**
Reference height	120 feet	120 feet	120 feet	120 feet	120 feet	120 feet
Reference age	70	88	115	53	68	95
	Years required to attain an average height of 120 feet					
Average height today (feet)	**Rw site 1**	**Rw site 2**	**Rw site 3**	**Df site 1**	**Df site 2**	**Df site 3**
0	70	88	115	53	68	95
10	66	84	111	51	64	90
20	62	79	105	46	60	85
30	58	74	98	42	56	80
40	53	68	90	38	51	74
50	49	62	82	34	46	68
60	43	55	73	30	41	62
70	38	47	63	26	36	54
80	31	39	52	21	30	46
90	24	31	41	17	23	36
100	17	22	29	12	17	26
110	9	13	15	6	9	14

Table 6. Years to grow from current average height to one-half site potential tree height.						
Species and site class	**Rw site 1**	**Rw site 2**	**Rw site 3**	**Df site 1**	**Df site 2**	**Df site 3**
Reference height	121 feet	109 feet	96 feet	152 feet	124 feet	97 feet
Reference age	71 years	76 years	82 years	76 years	71 years	66 years
	Years required to attain one-half site potential tree height					
Average height today (feet)	**Rw site 1**	**Rw site 2**	**Rw site 3**	**Df site 1**	**Df site 2**	**Df site 3**
0	71	76	82	76	71	66
10	67	72	78	72	67	60
20	63	67	72	69	62	55
30	59	62	65	65	58	50
40	55	56	57	61	54	45
50	49	50	49	57	49	39
60	44	43	40	53	44	33
70	38	35	30	49	39	25
80	30	27	19	45	33	17
90	25	19	8	40	27	7
100	18	9	–	35	20	–
110	10	–	–	29	14	–
120	1	–	–	23	3	–
130	–	–	–	16	–	–
140	–	–	–	9	–	–
150	–	–	–	2	–	–
160	–	–	–	–	–	–



. Figure 8
Redwood - Years to Attain 120' Avg Ht
Then: Years to Attain 120' Avg. Ht. Is
If: Current Avg. Ht. (Feet) Is ...
0
20
40
60
80
100
120
0 10 20 30 40 50 60 70 80 90 100 110 120
Rw Site 1
Rw Site 2
Rw Site 3

Figure 9
Doug-Fir - Years to Attain 120' Avg Ht

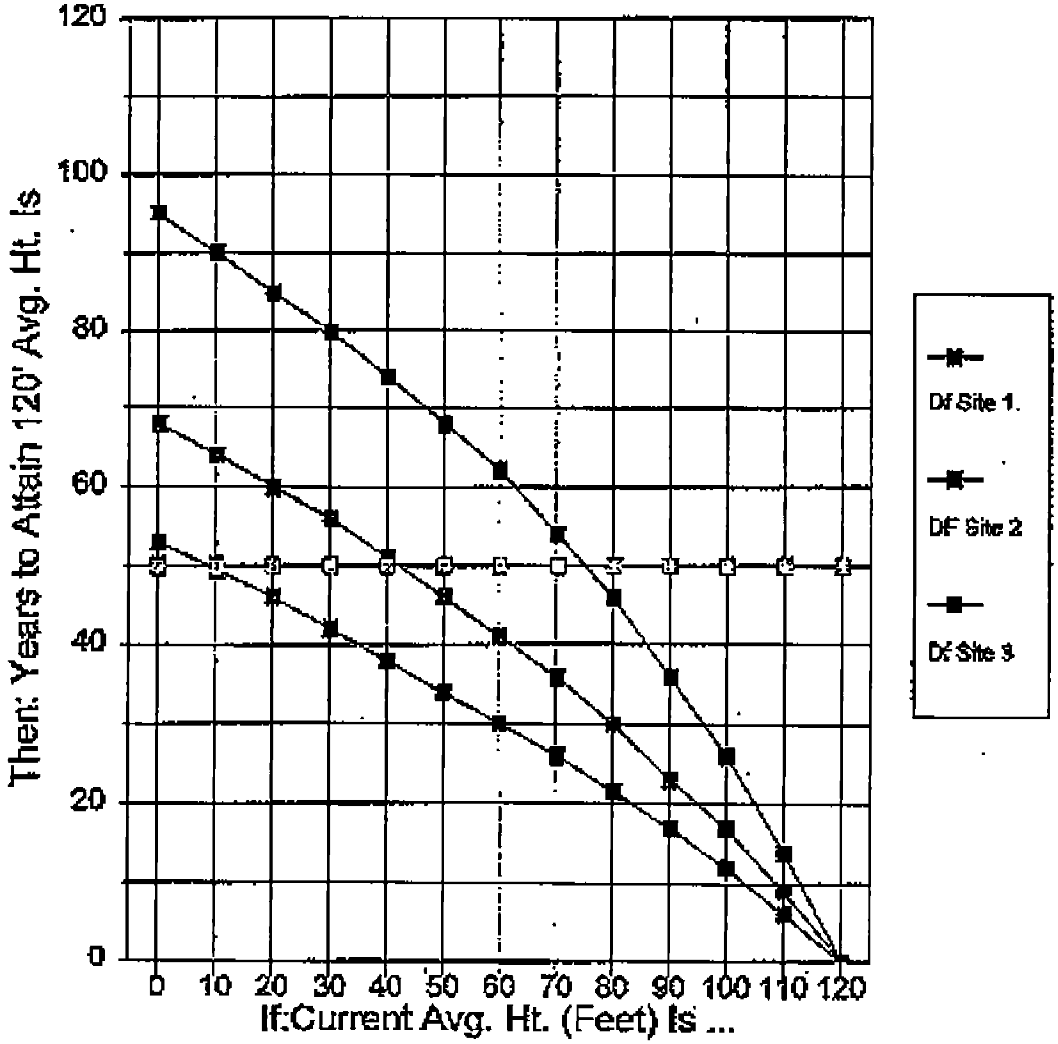


Figure 10

Redwood - Years to Attain 50% SPTH

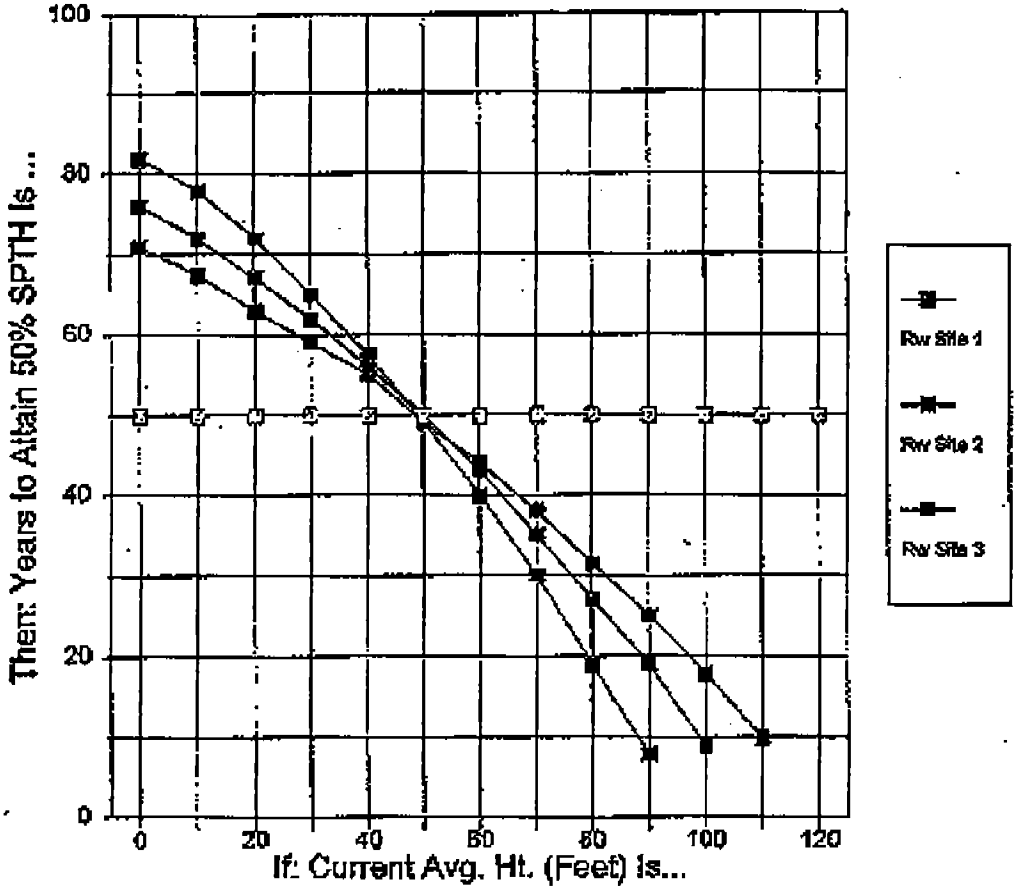


Figure 11

Doug-Fir - Years to Attain 50% SPTH

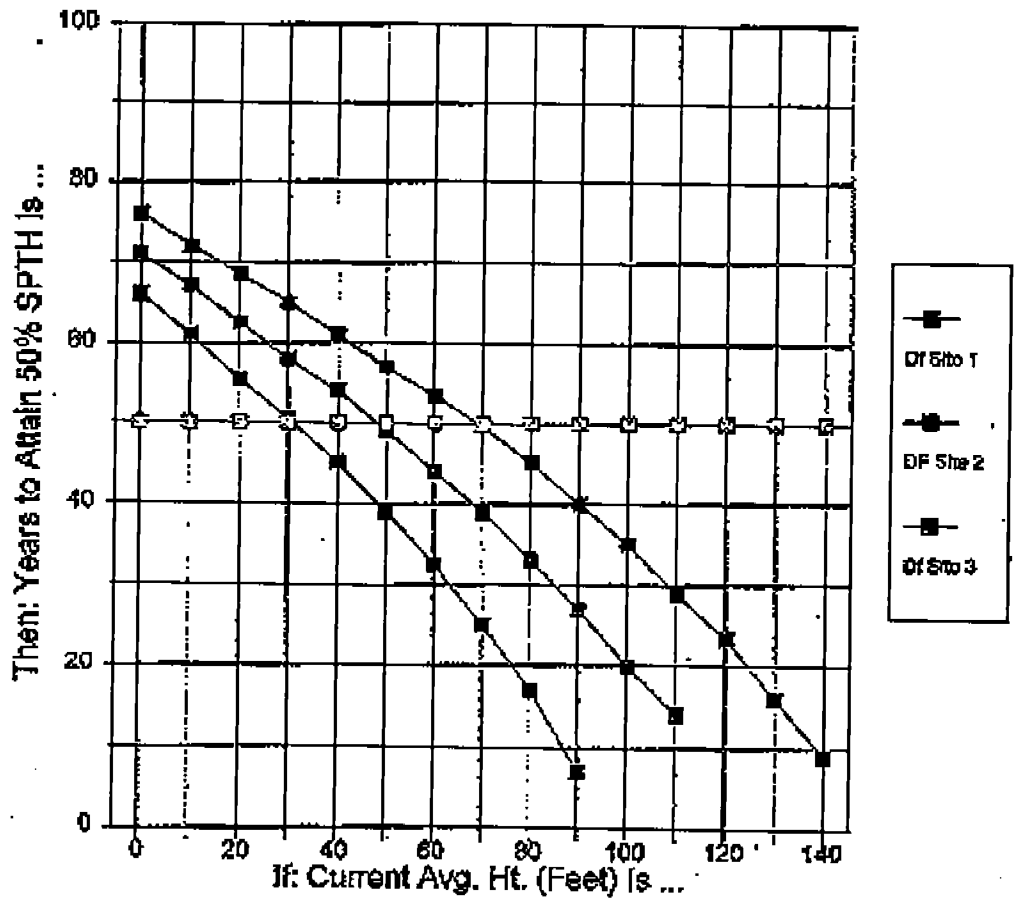


Table 7

This table shows minimum attributes for stands expected to attain references heights (120' or one-half SPTH) within 50 years. Mean stand height, dominant stand height and breast height age were drawn from the 5-year interval projections that were used to build Tables 5 and 6. Total, or groundline, age was calculated from the breast height age using adjustment factors in Wensel and Krumland (1986). Mean diameter (breast height) was reverse-computed from the mean stand height table entry, using the Vestra (1998) equation.

Table 7. Database search attributes for coast redwood and Douglas-fir height attainment.

Part 1– Minimum current attributes for stands expected to attain an average height of 120 feet in the 50-year life of the HCP.

Current stand attributes [1]	Redwood			Douglas-fir		
Site class	**Site 1**	**Site 2**	**Site 3**	**Site 1**	**Site 2**	**Site 3**
Mean stand height (feet)	47	66	82	8	42	65
Dominant stand height (feet)	60	82	98	11	54	81
Breast height age (years) [2]	27	37	84	4	24	50
Total, or groundline, age (years) [2]	34	45	93	10	31	58
Mean dbh (inches)	9.2	13.3	17.1	1.5	8.1	13.1

Part 2– Minimum current attributes for stands expected to attain one-half site potential tree height in the 50-year life of the HCP.

Current stand attributes [1]	Redwood			Douglas-fir		
Site class	**Site 1**	**Site 2**	**Site 3**	**Site 1**	**Site 2**	**Site 3**
Mean stand height (feet)	50	50	49	31	48	69
Dominant stand height (feet)	64	63	61	41	62	85
Breast height age (years) [2]	22	26	32	12	21	40
Total, or groundline, age (years) [2]	29	34	41	18	28	48
Mean dbh (inches)	9.8	9.8	9.6	5.9	9.4	14.0

[1]– Use the following guidelines in database search: (a) All attribute values, above, are minima; the database search is for stand or inventory attributes greater than or equal to the minima. (b) Stands retrieved through database search must be well stocked, even-aged, second-growth, or must contain well stocked, even-aged second-growth cohorts in a multi-aged stand. © Dominant height and average height are the most reliable search attributes– use them first. (d) If the database does not contain height information, the next most reliable attributes are breast height and total age. (e) If height or age information is not available, use average diameter breast height. (f) before data retrieval, know how current the inventory data is; young stand growth is quite rapid and the results will be significantly downward-biased if they are based on data more than about 5 years old. This will produce a systematic underestimate of the amount of land expected to attain reference heights in the 50-year life of the HCP.

[2]– Breast height age is the age of the tree at 4.5 feet above the groundline. This is the standard height where increment corings are usually extracted. Total age is the age at groundline. In many second-growth databases, this is usually set at the date when the prior stand was harvested and regenerated. Be certain of which type of age data is in the database. Incorrect assumptions about the age data in the database may result in systematic overestimates or underestimates of the amount of land that will attain reference heights (also see remarks in footnote 1). The height growth equations used in this analysis (King 1966; Wensel and Krumland 1986) are based on breast height age. Total age estimates, above, are based on adjustment factors in Wensel and Krumland (1986).

Table 8

This table shows which current seral stages can be expected to attain reference heights (120 feet or one-half SPTH) within the 50-year life of the proposed HCP. The information is based on data in Table 7 and on the time-series curves in Figures 8, 9, 10 and 11. Table 8 was developed using the following procedure: (a) Transition mean heights were computed for the maximum diameter (breast height) in each seral stage (see Table 1) using the Vestra (1998) equation. The transition heights are 5.5 feet for forest opening, 55.8 feet for young, and 108.0 feet for mid-seral. (b) The transition heights were then projected onto Figures 8 through 11, from the x-axis to the 50-year line. This produced four rectangular polygons between the x-axis and the 50-year line corresponding to the opening, young, mid-seral and late-seral stages. © If the time series curve for a given species and site class fails to intersect a seral stage polygon below the 50-year line, then none of the seral stage landbase will attain reference height within 50 years. (d) If a time-series curve enters a seral stage polygon from the left (through a transition height line), then the entire seral stage landbase will attain the reference height within 50 years. (e) If a time-series curve enters a seral stage polygon through the top line (or 50-year line), then only a portion of the seral stage landbase will attain reference height within 50 years. In that case, the breakpoint diameter from Table 7 is entered in Table 8.

Table 8. Expected seral stage transitions for coast redwood and Douglas-fir height attainment.[1]

Part 1– Portion of the seral stages, below, which will attain an average height of 120 feet in the 50-year life of the HCP.

Forest species	Redwood			Douglas-fir		
Site class	**Site 1**	**Site 2**	**Site 3**	**Site 1**	**Site 2**	**Site 3**
Forest opening (0.0 - 1.0" dbh)	none	none	none	none	none	none
Young (1 - 11" dbh)	□9.2" dbh	none	none	□1.5" dbh	□8.1" dbh	none
Mid-seral (11 - 24" dbh)	all	□13.3" dbh	□17.1" dbh	all	all	□13.1" dbh
Late-seral (>24" dbh)	all	all	all	all	all	all
Old-growth (includes >30" dbh)	all	all	all	all	all	all

Part 2– Portion of the seral stages, below, which will attain one-half site potential tree height in the 50-year life of the HCP.

Forest species	Redwood			Douglas-fir		
Site class	**Site 1**	**Site 2**	**Site 3**	**Site 1**	**Site 2**	**Site 3**
Forest opening (0.0 - 1.0" dbh)	none	none	none	none	none	none
Young (1 - 11" dbh)	□9.8" dbh	□9.8" dbh	□9.6" dbh	□5.9" dbh	□9.4" dbh	none
Mid-seral (11 - 24" dbh)	all	all	all	all	all	□14.0" dbh
Late-seral (>24" dbh)	all	all	all	all	all	all
Old-growth (includes >30" dbh)	all	all	all	all	all	all

[1]– The data table above was made in the following steps:
(a) Transition mean heights were computed from maximum diameter (breast-height) in each seral stage using the Vestra (1988) equation. The transition heights are as follows: Forest opening, 5.5 feet; young, 55.8 feet; mid-seral, 108.0 feet.
(b) The transition heights were projected onto figures 8, 9, 10, and 11, from the x-axis to the 50-year line. This produced four rectangular polygons below the 50-year line corresponding to the opening, young, mid-seral, and late-seral stages.
(c) If the time-series curve for each site class fails to intersect a seral stage polygon below the 50-year line, then none of the seral stage landbase will attain the reference height within the 50-year life of the proposed Habitat Conservation Plan.
(d) If the time-series curve enters a seral stage polygon from the left, then the entire seral stage landbase will attain the reference height within 50 years.
(e) If a time-series curve enters a seral stage polygon from the top, then only a portion of the seral stage landbase will attain reference height within 50 years. In that case, the breakpoint diameter (breast-height) from table 7 is entered.

References

Curtis, R.O., G.W. Clendenen and D.J. DeMars. 1981. **A New Stand Simulator for Coast Douglas-Fir: DFSIM User's Guide**. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station. General Technical Report PNW-128. Portland, OR.

Curtis, R.O., G.W. Clendenen, D.L. Reukema and D.J. DeMars. 1982. **Yield Tables for Managed Stands of Coast Douglas-Fir**. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station. General Technical Report PNW-135. Portland, OR.

Dunning, D. 1942. **A Site Classification for the Mixed Conifer Selection Forests of the Sierra Nevada**. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station. Research Note No. 28. Berkeley, CA.

FEMAT (Forest Ecosystem Management Assessment Team). 1993. **Forest Ecosystem Management: An Ecological, Economic and Social Assessment**. USDA Forest Service; USDI, Bureau of Land Management; USDI Fish and Wildlife Service; USDI, National Park Service; USDoC, National Oceanic and Atmospheric Administration; USDoC, National Marine Fisheries Service; Environmental Protection Agency. Portland, OR.

Grenier, J.J. and S.K. Nelson. 1995. Marbled murrelet habitat associations in Oregon. Chapter 19, *In* C.J. Ralph, G.L. Hunt, Jr., M.G. Raphael and J.F. Piatt (eds.). **Ecology and Conservation of the Marbled Murrelet**. USDA Forest Service, Pacific Southwest Experiment Station. General Technical Report PSW-GTR-152. Albany, CA.

Hamer, T.E. and S.K. Nelson. 1995. Characteristics of marbled murrelet nest trees and nesting stands. Chapter 6, *In* C.J. Ralph, G.L. Hunt, Jr., M.G. Raphael and J.F. Piatt (eds.). **Ecology and Conservation of the Marbled Murrelet**. USDA Forest Service, Pacific Southwest Experiment Station. General Technical Report PSW-GTR-152. Albany, CA.

King, J.E. 1966. **Site Index Curves for Douglas-Fir in the Pacific Northwest**. Weyerhaeuser Forestry Paper No. 8. Weyerhaeuser Forestry Research Center, Centralia, WA.

Krumland, B. and L.C. Wensel. 1982. **CRYPTOS/CRYPT2 Users Guide, Version 4.0**. Redwood Research Note No. 20. Department of Forestry and Resource Management, University of California, Berkeley.

Lindquist, J.L. and M.N. Palley. 1963. **Empirical Yield Tables for Young-Growth Redwood**. California Agricultural Experiment Station, Bulletin No. 796. Berkeley, CA.

McArdle, R.E., W.H. Meyer and D. Bruce. 1949 (Revised 1961). **The Yield of Douglas-Fir in the Pacific Northwest**. U.S. Department of Agriculture, Technical Bulletin 201. Washington, D.C.

Mayer, K.E. and W.F. Laudenslayer. 1988. **A Guide to the Wildlife Habitats of California**. The Resources Agency. Sacramento, CA.

Nelson, S.K. and T.E Hamer. 1995a. Nesting biology and behavior of the marbled murrelet. Chapter 5, *In* C.J. Ralph, G.L. Hunt, Jr., M.G. Raphael and J.F. Piatt (eds.). **Ecology and Conservation of the Marbled Murrelet**. USDA Forest Service, Pacific Southwest Experiment Station. General Technical Report PSW-GTR-152. Albany, CA.

Nelson, S.K. and T.E Hamer. 1995b. Nest success and the effects of predation on marbled murrelets. Chapter 8, *In* C.J. Ralph, G.L. Hunt, Jr., M.G. Raphael and J.F. Piatt (eds.). **Ecology and Conservation of the Marbled Murrelet**. USDA Forest Service, Pacific Southwest Experiment Station. General Technical Report PSW-GTR-152. Albany, CA.

Oliver, C.D. and B.C. Larson. 1990. **Forest Stand Dynamics** (First Edition). McGraw-Hill, New York.

Pacific Lumber Co. 1998. **Draft Sustained Yield Plan and Habitat Conservation Plan, Volume III**. Scotia, CA.

U.S. Fish and Wildlife Service (Dept. of the Interior). 1996. Final designation of critical habitat for the marbled murrelet; final rule. **Federal Register** 61(102): 26256-26320.

Vestra Resources, Inc. 1998. (Unpublished) **Mean DBH-height equation, based on Pacific Lumber Co. inventory data**. Redding, CA.

Wensel, L.C. and B. Krumland. 1986. A site index system for redwood and Douglas-fir in California's north coast. **Hilgardia** (54(8): 1-14.

Appendix C. Habitat Stages for Tree Dominated Habitats in California

Available Habitat Stages for Tree Dominated Habitats

Tree Habitat		Habitat Stage																	
		1	2S	2P	2M	2D	3S	3P	3M	3D	4S	4P	4M	4D	5S	5P	5M	5D	6
SCN	Subalpine Conifer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
RFR	Red Fir	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
LPN	Lodgepole Pine	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
SMC	Sierran Mixed Conifer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
WFR	White Fir	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
KMC	Klamath Mixed Conifer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
DFR	Douglas-fir	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
JPN	Jeffrey Pine	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
PPN	Ponderosa Pine	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
EPN	Eastside Pine	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
RDW	Redwood	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
PJN	Pinyon-Juniper	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
JUN	Juniper	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
CPC	Closed-Cone Pine-Cypress	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
ASP	Aspen	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
MHC	Montane Hardwood-Conifer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
MHW	Montane Hardwood	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
BOW	Blue Oak Woodland	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
BOP	Blue Oak—Digger Pine	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
VOW	Valley Oak Woodland	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
COW	Coastal Oak Woodland	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
MRI	Montane Riparian	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
VRI	Valley Foothill Riparian	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Standards for tree size

WHR	WHR Size Class	Conifer Crown Diameter	Hardwood Crown Diameter	dbh
1	Seedling tree	n/a	n/a	<1"
2	Sapling tree	n/a	<15'	1"-6"
3	Pole tree	<12'	15'-30'	6"-11"
4	Small tree	12'-24'	30'-45'	11"-24"
5	Medium/large tree	>24'	>45'	>24"
6	Multi-layered tree	Size class 5 trees over a distinct layer of size class 4 or 3 trees, total tree canopy exceeds 60% closure		

Standards for canopy closure

WHR	WHR Closure Class	Ground Cover (Canopy Closure)
S	Sparse cover	10-24%
P	Open cover	25-39%
M	Moderate cover	40-59%
D	Dense cover	60-100%

Source: Mayer, K. E. and W. F. Laudenslayer. 1988. A Guide to Wildlife Habitats of California. California Department of Forestry and Fire Protection, State of California. 166 pp.

Appendix D. Spatial data analysis sources.

The Resources Agency, California Timberland Task Force. 1993. Report of the California Timberland Task Force, 78 pp. This product is classified LandSat imagery, based on a modified WHR classification, with a resolution of 40 acres. A comprehensive accuracy assessment accompanies the product.

Vestra Resources, Inc. Modeling of vegetation for Pacific Lumber Lands. This product contains seral stages, northern spotted owl habitat, WHR types, silvicultural prescriptions, and other labels with future projections by decade, derived from Pacific Lumber Company's timber inventory data.

Pacific Lumber Company. Several GIS coverages used in this analysis were obtained from the Company, including: ownership boundary, streams, roads, watershed analysis areas, slope classifications, marbled murrelet survey results, marbled murrelet conservation areas, rock pit locations,

Humboldt State University. The 1:100,000 scale stream data assembled by Humboldt State University as part of the Klamath Basin Ecosystem Restoration Office contract for GIS data development was used to analyze the action area outside of Pacific Lumber Company ownership. This data was used as a surrogate for the Class1/Class2 stream data available for Pacific Lumber Company ownership, for the purposes of quantifying habitat for riparian associated species.

North Coast Geographic Information Cooperative. Additional data sets, obtained from various sources, and maintained by the NCGIC were used in analyzing the action area, the bioregion, marbled murrelet conservation zone 4, and the regional area. These coverages included: 1:100,000 scale ownership boundaries, Calwater watershed boundaries, and the marbled murrelet conservation zone boundary.

U.S. Fish and Wildlife Service. Several GIS coverages developed by the U.S. Fish and Wildlife Service were used in analyzing the action area, the bioregion, the marbled murrelet conservation zone 4, and the regional area. These include; marbled murrelet zones, marbled murrelet critical habitat, northern spotted owl critical habitat.

Oregon State northern spotted owl and bald eagle point location data. These points were obtained from the U.S. Fish and Wildlife Service Office of Technical Support, Portland, OR.

California Department of Fish and Game, Wildlife Management Division. Statewide GIS data coverages depicting northern spotted owl and bald eagle point locations were obtained, and used in the analysis on Pacific Lumber Company ownership, the action area, and the regional area.