Memorandum For: The Record

From: Laurie Allen
Director, Office of Protected Resources

Subject: Biological Opinion on proposed Marine Mammal Permits which would authorize various research activities on Steller sea lions.

This document constitutes the National Marine Fisheries Service's (NOAA Fisheries) biological opinion on the effects of three new permits and major amendments to five existing Marine Mammal Permits. The new permits include: The North Pacific Universities Marine Mammal Research Consortium, University of British Columbia, Vancouver, B.C. (NPUMMRC: File No. 715-1784); the National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA (NMML: File No. 782-1768 and File No. 782-1702); and the Alaska Department of Fish and Game, Anchorage, AK (ADF&G: File No. 358-1769). The new permits would be valid until May, 2010. The major amendments include: Alaska SeaLife Center, Seward, AK (ASLC: Permit No. 881-1668); the Aleutians East Borough, Juneau, AK (AEB: Permit No. 1010-1641); the Oregon Department of Fish and Wildlife, Corvallis, OR (ODFW: Permit No. 434-1669); and Dr. Randall Davis, Texas A&M University, Galveston, TX (Permit No. 800-1664). These major amendment applications are to extend the duration of the permits for three years, through 2008.

These proposed permits and amendments would authorize permittees to “take” threatened or endangered Steller sea lions (*Eumetopias jubatus*) during various research activities. These activities would occur in coastal areas of the States of Alaska, Washington, Oregon, and California. This biological opinion has been prepared in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq*.). This biological opinion is based on information provided in the application for the proposed permits, published and unpublished scientific information on the biology and ecology of Steller sea lions, and other sources of information.

Biological Opinion

Description of the Proposed Action

The National Marine Fisheries Service (NOAA Fisheries) proposes to issue 3 new permits and amend 5 permits, pursuant to ESA and Marine Mammal Protection Act, that authorize the take of threatened and endangered Steller sea lions for scientific purposes. The permittee, permit numbers, and expiration dates are provided in the table below.

Permit Number	**Permit Holder**	**Expiration Date**
881-1668-04	**Alaska SeaLife Center**	**December 30, 2008**
434-1669-02	**Oregon Dept. Fish & Wildlife (ODFW)**	**December 30, 2008**
800-1664-02	**Randall Davis, Texas A&M University**	**December 30, 2008**
1010-1641-01	**Aleutians East Borough (AEB)**	**December 30, 2008**
358-1564-06	**Alaska Dept. Fish & Game (ADFG)**	**May 31, 2010**
782-1702-03	**NMML**	**September 30, 2008**
782-1768	**NMML**	**May 31, 2010**
715-1784	**North Pacific Universities Marine Mammal Research Consortium (NPUMMRC)**	**May 31, 2010**

NOAA Fisheries received a variety of proposals for research and monitoring activities that would result in take of threatened or endangered Steller sea lions. These activities include (1) surveys from aircraft or vessels, (2) scat collection, (3) remote biopsy sampling, (4) marking sea lions (5) capture and collection of tissue and fluid samples, (6) monitoring the condition of pup and juvenile Steller sea lions; (7) studying the behavior and ecology of sea lions using a variety of scientific instruments; and (8) measuring body composition.

The studies involve all age groups, with specific activities targeted at particular cohorts. For the purposes of this Opinion, pups are those animals less than 1 year old, juveniles are between 1 and 3 years old, and individuals older than 3 years are considered adults.

The proposed activities listed above involve harassment (e.g., aerial and vessel surveys and during scat collection or tissue sampling activities), capture by traps, hoop net, underwater lasso, or injection of Telazol (an immobilizing agent), handling for tissue and blood sampling, tagging with flipper tags or scientific instruments, hot-branding, administration of deuterated water or Evans blue dye, enema or stomach intubation, bioelectric impedance analysis, and fecal loops of threatened and endangered Steller sea lions. Tables 1 and 2 summarize the types of activities that would be authorized by the permits.

Proposed Action Activity Table 1. All takes are authorized on an annual basis. Where "Season" is marked as "year-round" the total "number of animals taken per year" could be used by the permit holder any time during the year, according to the objectives and protocols described in their application and mitigation measures required by the permit. Where "season" is marked with a number of months, the total "number of animals taken per year" would be used entirely during those months. NOTE: The ADF&G, NMML (782-1768), and NPUMMRC permits would be valid for five years from date of issuance (i.e., through spring 2010); the amendment to NMML Permit No. 782-1702 would be valid through the current expiration date of September 30, 2008; the amendments to the AEB, ASLC, ODFW, and Davis permits would be valid through December 2008.

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
Aerial survey: breeding season					
NMML (782-1768)	pups	10k	U	June '05-'09	West of 144°W
	non-pups	29k	U	June '06 & '08	
	non-pup	15k	U	Jun-Jul '05, '07, '09	
	pup	6k	U	June '05-'09	East of 144°W
	non-pup	18k	U	June '06 & '08	
	non-pup	10k	U	Jun-Jul '05, '07, '09	
NMML (782-1702)	all	4500	Up to 40	Year round	WA and OR
NPUMMRC	pups	5k	2	once in Jun & once in Jul	SEAK
	non-pups	15k	2	once in Jun & once in Jul	SEAK
Aerial survey: non-breeding season					
NMML-1768	all	25k	U	Aug-May '05-'09	West of 144°W
	all	10k	U	Aug-May '05-'09	East of 144°W
NPUMMRC	non-pup	20k	Up to 10	monthly Aug-May	SEAK
Aerial survey: other					

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
ADFG	non-pups	15k	U	Mar-Apr ’05-‘10	SEAK-Alsek & Akwe River
NMML-1768	all	25k	U	Mar, Jun, Sep, Dec ’05-‘09	West of 144°W
	all	55k	U	Jan-Dec ’05-‘09	East of 144°W
AEB	all	28k 77k	4 4	Sep, Dec, Mar, Jun ’05, ‘07 Sep, Dec, Mar, Jun ‘06	GOA, East Aleutian Is., AK Peninsula
Vessel survey					
AEB	all	1600	4	Sep, Dec, Mar, Jun	GOA, East Aleutian Is., AK Peninsula
Ground counts (may include incidental scat collection)					
ADF&G	non-pups	15k	U	Jun-Jul ’05-‘10	SEAK
	pups	10k	U	Jun-Jul ’05-‘10	
NMML-1768	pups	4,100	U	Jun-Jul ’05, ’07, ‘09	West of 144°W
	non-pups	15k	U	Jun-Jul ’05, ’07, ‘09	
	pups	6k	U	Jun-Jul ’06, ‘08	West of 144°W
	non-pups	18k	U	Jun-Jul ’06, 08	
ODFW	non-pups	5k	U	June – July annually	CA/OR/WA
	pups	2k	U	June – July annually	CA/OR/WA
Incidental disturbance during scat collection, capture/sampling, instrument retrieval, or observational activities					
ADF&G	all	15k	U	year-round	Alaska-wide
NMML-1768	all	20k	U	year-round	Alaska-wide
NMML-1702	all	4500	Up to 30	Year-round	WA/OR
ODFW	all	10k	U	year-round	CA/OR/WA
NPUMMRC	all	3k	Up to 12	monthly	SEAK
Davis	adults	1200	U	year-round	GOA & Aleutian Is.

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
	pups and juveniles	1200	U	year-round	GOA & Aleutian Is.
ASLC	all	15k	U	year-round	Alaska-wide
AEB	all	1600	4	Sep, Dec, Mar, Jun	GOA, East Aleutian Is., AK Peninsula
Incidental disturbance during studies of other marine mammal species					
SWFSC	all	3k	3	Year-round	CA, OR, WA, AK east of 144ºW
NMML-1702	all	4,500	30	Year-round	WA and OR
Matkin	all	750	U	Year-round	AK
Straley	all	100	U	Year-round	AK
Wynne	all	100	U	Year-round	AK
Collect carcasses/parts of carcasses of dead sea lions					
ADF&G	all	unlimited	1	year-round	Alaska-wide
ASLC	all	unlimited	1	year-round	Alaska-wide
Receive tissue samples from subsistence harvested sea lions					
ADF&G	all	unlimited	1	year-round	Alaska-wide
Behavioral and demographic observations on rookeries					
NMML-1768	all	0	0	year-round	Range-wide
ADFG	all	0	0	year-round	Alaska-wide
Remote monitoring stations on rookeries and haulouts					
NMML-1768	all	0	0	year-round	Range-wide
ODFW	all	0	0	year-round	CA/OR/WA

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
Imaging sea lion/prey interactions with multi-beam sonar					
NMML-1768	all	0	0	year-round	Range-wide
Tracking animals at sea					
NPUMMRC	1-3 yrs	30	1	Sep-Dec	SEAK
Incidental mortality					
ADF&G	all	10	1	year-round	Alaska-wide, NTE 5 from western population
NMML-1768	all	10	1	year-round	Alaska-wide, NTE 5 from western population
NMML-1702	all	1	1	year-round	WA/OR
ODFW	all	10	1	year-round	CA/OR/WA
NPUMMRC	all	5	1	year-round	SEAK
Davis	6 mos to 3 years	10	1	year-round	GOA & Aleutian Is. NTE 2 from western pop
	females > 3 years	3	1	year-round	
ASLC	all	10	1	year-round	Alaska-wide, NTE 5 from western population
AEB	All	1	1	year-round	GOA, East Aleutian Is., AK Peninsula
Remote marked (pelage dye, bleach, or paint) or remote tagged (with dart tags fired from CO_2 rifle or pistol)					
NMML-1702	>1 year	3	3	Year-round	WA/OR
Capture/Recapture (various methods) and Restraint (various methods) with Standard Morphometric Measurements					
ADF&G	>5 days to 2 mos	700	1	June-July	Alaska-wide
	>2 mo to 3 years	300	4	year-round	

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
	> 3 years	30	2	year-round	
NMML-1768	> 5 days to 2 mo	1100	1	June-July	Alaska-wide
	> 2 mo to 3 yrs	120	4	year-round	
	> 3 yrs	60	2	year-round	
NMML-1702	> 1 year	12	2	Year-round	WA/OR
Davis	6 mos to 3 years	30	4	year-round	GOA & Aleutian Is.
	females > 3 years	15	4	year-round	GOA & Aleutian Is.
ODFW	1 week to 6 weeks	200	1	Jun-Jul	CA/OR/WA
	≥4 mos to 3 yrs	30	1	Year-round	CA/OR/WA
ASLC	>5 dys to 2 mos	40 20 60 40	1 5 1 5	Jun-Jul ‘05 Breeding season ‘05 Jun-Jul ’06 & ‘07 Breeding season ’06 & ‘07	Selected rookeries Selected rookeries Selected rookeries Alaska-wide
	2 mos to 1 yr	220 20 40	1 3 3	year-round ’05, ’06, ‘07 year-round ‘05 year-round ’05, ’06, ‘07	Alaska-wide
	> 1 yr to 4 yrs	210 20 40	1 3 3	year-round ’05. ’06, ‘07 year-round ‘05 year-round ’06, ‘07	Alaska-wide
	Adult females	20 20 60 40	1 3 1 3	year-round ‘05 year-round ‘05 year-round ’06, ‘07 year-round ’06, ‘07	Alaska-wide Alaska-wide Alaska-wide Alaska-wide
Note that the following takes are a subset of those animals authorized for capture and, thus, do not represent additional animals but additional procedures per animal.					
Blood collection					

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
NMML-1768	> 5 days to 2 mo	450	1	June-July	Alaska-wide
	> 2 mo to 3 yrs	120	4	year-round	
	> 3 yrs	60	2	year-round	
NMML-1702	> 1 year	12	2	year-round	WA/OR
ADF&G	newborn to 2 mos	700	2	June-July	Alaska-wide
	2 months to 3 yrs	300	4	year-round	
	> 3 years	30	2	year-round	
Davis	6 mos to 3 years	30	4	year-round	GOA & Aleutian Is.
	females > 3 years	15	4	year-round	GOA & Aleutian Is.
ODFW	1 week to 6 weeks	50	1	June - July	CA/OR/WA
	≥4 mos to 3 yrs	30	1	year-round	
ASLC	>5 dys to 2 mos	40 20 40 40	1 5 1 5	June – July ’05 Breeding season ‘05 June – July ’06, ‘07Breeding season ‘05	Selected rookeries Selected rookeries Alaska-wide Alaska-wide
	2 mos to 1 yr	220 20 40	1 3 3	year-round year-round ‘05 year-round ’06, ‘07	Alaska-wide
	> 1 yr to 4 yrs	134 20 40	1 3 3	year-round ’05, ’06, ‘07 year-round ‘05 year-round ’06, ‘07	Alaska-wide
	Adult females	20 20 40	1 3 3	year-round ’05, ’06, ‘07 year-round ‘05 year-round ’06, ‘07	Alaska-wide Alaska-wide Alaska-wide
Muscle biopsy					

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
ADF&G	≥ 4 mos to 3 years	90	4	year-round	Alaska-wide
	> 3 yrs	30	4	year-round	Alaska-wide
NMML-1768	> 2 mo to 3 yrs	60	4	year-round	Alaska-wide
	> 3 yrs	30	2	year-round	Alaska-wide
Tissue samples for genetic analysis (i.e., skin biopsy)					
NMML-1768	> 5 days to 2 mo	450	1	June-July annually	Alaska-wide
	> 2 mo to 3 yrs	120	1	year-round	
	> 3 yrs	60	1	year-round	
ADF&G	> 5 days to 2 mos	700	1	June-July annually	Alaska-wide
	≥2 mos to 3 yrs	300	4	year-round	
	> 3 years	30	1	year-round	
ODFW	1 week to 6 weeks	200	1	June-July annually	CA/OR/WA
	≥4 mos to 3 yrs	30	1	year-round	
Blubber biopsy (may include skin)					
ADF&G	> 5 days to 2 mos	20	1	June-July annually	Alaska-wide
	≥2 mos to 3 years	300	4	year-round	
	> 3 years	30	1	year-round	
NMML-1768	> 2 mo to 3 yrs	120	4	year-round	Alaska-wide
	> 3 yrs	60	2	year-round	Alaska-wide
NMML-1702	> 1 year	12	2	Year-round	WA/OR
Davis	6 mos to 3 years	30	4	year-round	GOA & Aleutian Is.
	females > 3 years	15	4	year-round	GOA & Aleutian Is.

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
ASLC	>5 dys to 2 mos	40 20 40 40	1 3 1 3	Jun- Jul '05 Breeding season '05 June –July '06, '07 Breeding season '06, '07	Selected rookeries Selected rookeries Alaska-wide Alaska-wide
	2 mos to 1 yr	220 20 40	1 3 3	year-round '05, '06, '07 year-round '06, '07 year-round '06, '07	Alaska-wide
	> 1 yr to 4 yrs	134 20 40	1 3 3	year-round '05, '06, '07 year-round '05 year-round '06, '07	Alaska-wide
	Adult females	20 20 20 40	1 3 1 3	year-round '05 year-round '05 year-round '06, '07 year-round '06, '07	Selected rookeries Selected rookeries Alaska-wide Alaska-wide
Fecal loops/culture swabs, skin and mucousal swabs					
ADF&G	> 5 days to 2 mos	350	2	June-July annually	Alaska-wide
	>2 mos to 3 years	300	4	year-round	
	> 3 years	10	2	year-round	
NMML-1768	> 5 days to 2 mo	1100	1	June-July annually	Alaska-wide
	> 2 mo to 3 yrs	120	4	year-round	
	> 3 yrs	60	2	year-round	
NMML-1702	> 1 year	12	2	Year-round	WA/OR
Davis	6 mos to 3 years	30	4	year-round	GOA & Aleutian Is.
	females > years	15	4	year-round	GOA & Aleutian Is.
ODFW	≤ 1.5 months	200	1	June – July annually	CA/OR/WA

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
	≥4 mos to 3 yrs	30	1	year-round	CA/OR/WA
ASLC	>5 dys to 2 mos	40 20 40 40	1 3 1 3	June- July ’05 Breeding season ‘05 June –July ’06, ‘07 Breeding season ’06, ‘07	Selected rookeries Selected rookeries Alaska-wide Alaska-wide
	2 mos to 1 yr	220 20 40	1 3 3	year-round ’05, ’06, ‘07 year-round ’06, ‘07 year-round ’06, ‘07	Alaska-wide
	> 1 yr to 4 yrs	134 20 40	1 3 3	year-round ’05, ’06, ‘07 year-round ‘05 year-round ’06, ‘07	Alaska-wide
	Adult females	20 20 20 40	1 3 1 3	year-round ’05 year-round ‘05 year-round ’06, ‘07 year-round ’06, ‘07	Selected rookeries Selected rookeries Alaska-wide Alaska-wide
Tooth extraction (only 1 tooth is taken over the life of an animal)					
ADF&G	6 mos to 3 years	300	1	year-round	Alaska-wide
	> 3 years	30	1	year-round	Alaska-wide
NMML-1768	> 2 mo to 3 yrs	120	1	year-round	Alaska-wide
	> 3 yrs	60	1	year-round	Alaska-wide
Davis	6 mos to 3 years	30	1	year-round	GOA & Aleutian Is.
	females > years	15	1	year-round	GOA & Aleutian Is.
ASLC	2 mos to 1 yr	240 260	1 1	year-round ‘05 year-round ’06, ‘07	Alaska-wide

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
	> 1 yr to 4 yrs	154 174	1 1	year-round ‘05 year-round ’06, ‘07	Alaska-wide
	Adult females	60 100	1 1	year-round ‘05 year-round ’06, ‘07	Alaska-wide
Collect vibrissae, hair and nails					
ADF&G	>5 days to 2 mos	20	1	June-July annually	Alaska-wide
	>2 mos to 3 yrs	350	2	year-round	
	> 3 years	10	2	year-round	
NMML-1768	> 2 mo to 3 yrs	120	4	year-round	Alaska-wide
	> 3 yrs	60	2	year-round	Alaska-wide
NMML-1702	>1 year	12	2	Year-round	WA/OR
Davis	6 mos to 3 years	30	4	year-round	GOA & Aleutian Is.
	females > years	15	4	year-round	GOA & Aleutian Is.
Flipper tag or other temporary mark (e.g., bleach, paint, dye, glued patch)					
ADF&G	>5 days to 2 mos	700	1	June-July annually	Alaska-wide
	>2 mos to 3 yrs	300	1	year-round	Alaska-wide
NMML-1768	> 5 days to 2 mo	700	1	June-July annually	Alaska-wide
	> 2 mo to 3 yrs	120	4	year-round	
	> 3 yrs	60	2	year-round	
NMML-1702	> 1 year	12	2	Year-round	WA/OR
Davis	6 mos to 3 years	30	1	year-round	GOA & Aleutian Is.
	females > years	15	1	year-round	GOA & Aleutian Is.
ODFW	pups < 6 weeks	200	1	June – July annually	CA/OR/WA

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
ASLC	>5 dys to 2 mos	60 100	1 1	June – July '05 June – July '06, '07	Selected rookeries Alaska-wide
	2 mos to 1 yr	240 260	1 1	year-round '05 year-round '06, '07	Alaska-wide
	> 1 yr to 4 yrs	154 174	1 1	year-round '05 year-round '06, '07	Alaska-wide
	Adult females	60 100	1 1	year-round '05 year-round '06, '07	Alaska-wide
Hot-brand (only one brand over life of animal)					
ADF&G	>5 days to 2 mos	600	1	June-July annually	Alaska-wide
	>2 mos to 3 yrs	300	1	year-round	
	> 3 years	30	1	year-round	
NMML-1768	> 5 days to 2 mo	400	1	June-July annually	Alaska-wide
	> 2 mo to 3 yrs	120	1	year-round	
	> 3 yrs	60	1	year-round	
NMML-1702	> 1 year	12	1	Year-round	WA/OR
Davis	6 mos to 3 years	30	1	year-round	GOA & Aleutian Is.
	females > 3 years	15	1	year-round	GOA & Aleutian Is.
ODFW	< 1.5 months	200	1	June – July annually	CA/OR/WA
	≥4 mos to 3 yrs	30	1	year-round	CA/OR/WA
ASLC	> 5 dys to 2 mos	60 100	1 1	June – July '05 June- July '06, '07	Selected rookeries Alaska-wide
	2 mos to 1 yr	240 260	1 1	year-round '05 year-round '06, '07	Alaska-wide

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
	> 1 yr to 4 yrs	154 174	1 1	year-round '05 year-round '06, '07	Alaska-wide
	Adult females	60 100	1 1	year-round '05 year-round '06, '07	Alaska-wide
Attachment of scientific instruments (e.g., VHF, SLTDR, UTPR, video system/data logger, sonic tag, drag/buoyancy blocks)					
ADF&G	>5 days to 2 mos	130	1	June-July annually	Alaska-wide
	>2 mos to 3 yrs	65	4	year-round	
	> 3 yrs	30	1	year-round	
NMML-1768	> 2 mo to 3 yrs	120	4	year-round	Range-wide
	> 3 yrs	60	2	year-round	Range-wide
NMML-1702	> 1 year	6	2	Year-round	WA/OR
Davis	6 mos to 3 years	30	4	year-round	GOA & Aleutian Is.
	females > 3 years	15	4	year-round	GOA & Aleutian Is.
ODFW	≥4 mos to 3 yrs	30	1	year-round	CA/OR/WA
	1 week to 2 months	80	1	June – July annually	CA/OR/WA
ASLC	2 mos to 1 yr	20 40	3 3	year-round '05 year-round '06, '07	Alaska-wide
	>1 yr to 4 yrs	20 40	3 3	year-round '05 year-round '06, '07	Alaska-wide
	Adult female	20 40	3 3	year-round '05 year-round '06, '07	Alaska-wide Alaska-wide
Insert stomach temperature transmitters					
ASLC	>2 mos to 1 yr	20 40	1 1	Year-round '05 Year-round '06 and '07	Alaska-wide

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
	>1 year to 4 yrs	20 40	1 1	Year-round ‘05 Year-round ’06 and ‘07	Alaska-wide
	Adult females	40 80	1 1	Year-round ‘05 Year-round ’06 and ‘07	Alaska-wide
Bioelectric impedance analysis					
NMML-1768	> 2 mo to 3 yrs	120	4	year-round	Alaska-wide
	> 3 yrs	60	2	year-round	Alaska-wide
ADF&G	≥2 mos to 3 yrs	300	2	year-round	Alaska-wide
	> 3 yrs	30	2	year-round	Alaska-wide
Davis	6 mos to 3 years	30	4	year-round	GOA & Aleutian Is.
	females > 3 years	15	4	year-round	GOA & Aleutian Is.
ASLC	> 5 days to 2 mos	20 40	5 5	Breeding season ‘05 Breeding season ’06, ‘07	Selected rookeries Alaska-wide
	2 mos to 1 yr	220 20 40	1 3 3	year-round ’05, ’06, ‘07 year-round ‘05 year-round ‘05	Alaska-wide
	> 1 year to 4 years	134 20 40	1 3 3	year-round ’05, ’06, ‘07 year-round ‘05 year-round ’06, ‘07	Alaska-wide
	Adult females	20 20 40	1 3 3	year-round ’05, ’06, ‘07 year-round ‘05 year-round ’06, ‘07	Alaska-wide Alaska-wide Alaska-wide
Inject stable isotopes (e.g., H-3, O-18) and collect serial blood samples					
ADF&G	>2 mos to 3 yrs	300	4	year-round	Alaska-wide

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
NMML-1768	> 2 mo to 3 yrs	120	4	year-round	Alaska-wide
	> 3 yrs	60	2	year-round	Alaska-wide
ASLC	> 5 dys to 2 mos	20 40	5 5	Breeding season ‘05 Breeding season ’06, ‘07	Selected rookeries Alaska-wide
	2 mos to 1 yr	220 20 40	1 3 3	year-round ’05, ’06, ‘07 year-round ‘05 year-round ’06, ‘07	Alaska-wide
	> 1 year to 4 years	134 20 40	1 3 3	year-round ’05, ’06, ‘07 year-round ‘05 year-round ’06, ‘07	Alaska-wide
	Adult females	20 20 40	1 3 3	year-round ’05, ’06, ‘07 year-round ‘05 year-round ’06, ‘07	Alaska-wide Alaska-wide Alaska-wide
Davis	6 mos to 3 years	30	4	year-round	GOA & Aleutian Is.
	females > 3 years	15	4	year-round	GOA & Aleutian Is.
Inject Evans blue dye and collect serial blood samples					
ADF&G	> 2 mos to 3 yrs	300	4	year-round	Alaska-wide
NMML-1768	> 2 mo to 3 yrs	120	4	year-round	Alaska-wide
	> 3 yrs	60	2	year-round	Alaska-wide
Enema or stomach intubation					
ADF&G	>5 days to 2 mos	350	2	June-July annually	Alaska-wide
	>2 mos to 3 yrs	300	4	year-round	
	> 3 yrs	30	2	year-round	
NMML-1768	> 2 mo to 3 yrs	120	4	year-round	Alaska-wide

Activity	Age Class	Number of animals taken per year	Number of takes per animal per year	Season	Location
	> 3 yrs	60	2	year-round	Alaska-wide
ODFW	4 months to 3 years	30	1	year-round	CA/OR/WA
ASLC	2 mos to 1 yr	20 40	3 3	year-round ‘05 year-round ’06, ‘07	Alaska-wide
	>1 yr to 4 yrs	20 40	3 3	year-round ‘05 year-round ’06, ‘07	Alaska-wide
	Adult females	20 40	3 3	Year-round ‘05 Year-round ’06, ‘07	Alaska-wide Alaska-wide
Portable metabolic chamber measurements					
ADFG	2 mos to 3 yrs	200	4	year-round	Alaska-wide
	> 3 yrs	30	2	year-round	Alaska-wide
Ultrasonic imaging [note: (R) means animals will be sampled with remote device on rookery)					
ADFG	2 mos to 3 yrs	300	2	year-round	Alaska-wide
	> 3 yrs	30	2	year-round	Alaska-wide
NMML-1768	> 2 mo to 3 yrs	120	4	year-round	Alaska-wide
	> 3 yrs	60	2	year-round	Alaska-wide
ASLC	> 5 days to 1 yr	60 (R) 250 (R)	4 4	year-round ‘05 year-round ’06, ‘07	Chiswell Is Alaska-wide
	>1 yr to 4 yrs	100 (R) 400 (R) 134	4 4 1	year-round ‘05 year-round ’06, ‘07 year-round ’05, ’06, ‘07	Chiswell Is Alaska-wide Alaska-wide
	Adult female	60 (R) 240 (R)	4 4	year-round ‘05 year-round ’06, ‘07	Chiswell Is Alaska-wide

Activity	**Age Class**	**Number of animals taken per year**	**Number of takes per animal per year**	**Season**	**Location**
	Adult male	20 (R) 80 (R)	4 4	year-round '05 year-round '06, '07	Chiswell Is Alaska-wide
	1 year to 4 yrs	134	1	year-round	Alaska-wide
Davis	6 mos to 3 years	30	4	year-round	GOA & Aleutian Is.
	females > 3 years	15	4	year-round	GOA & Aleutian Is.
Removal from wild with temporary captivity at ASLC and associated sampling (see Table 2 for captive procedures) -- see Table 2 for associated sampling activities					
ASLC	>1 yr to 4 yrs	16	1	Year round	Alaska-wide

Proposed Action Activity Table 2. This table represents activities that would be conducted with juvenile Steller sea lions (ages >1 year to 4 years) captured in Alaska and brought to the Alaska SeaLife Center for temporary captivity under Permit No. 881-1668.

Activity	Number of animals taken per year	Number of takes per animal	Frequency
1. Transport and temporary maintenance at ASLC for up to 3 months followed by return to wild	16[1] (not more than 4 at once)	1	Capture may occur at any time of year
2. Physical Restraint	16	Up to 13	Up to weekly as needed for "health assessments" and activities #20-23
3. Anesthesia	16	Up to 13	Up to weekly as needed for "health assessments" and activities #20-23
4. Sedatives	16	Up to 13	Up to weekly as needed for "health assessments" and activities #20-23
5. Body mass/morphometrics/3D-photogrammetry for "health assessment"	16	Up to 13	At entrance, exit, and weekly in between
6. Blood sampling for "health assessment"	16	Up to 13	At entrance, exit, and weekly in between
7. Blubber/skin biopsy for "health assessment"	16	2	At entrance and exit
8. Inject labeled water & collect serial blood samples for "health assessment"	16	4	At entrance and exit, plus twice more according to research timetable of the group
9. Inject Na Br and collect serial blood samples for "health assessment"	16	Up to 4	At entrance and exit, plus twice more according to research timetable of the group
10. Bioelectric impedance analysis for "health assessment"	16	Up to 13	At entrance, exit, and weekly in

			between
11. Diagnostic ultrasound for "health assessment"	16	Up to 13	At entrance and exit, and weekly in between
12. Fecal collection (fecal loop) for "health assessment"	16	Up to 13	At entrance and exit, and weekly in between
13. Skin & mucosal swabs for "health assessment"	16	Up to 13	At entrance, exit, and weekly in between
14. Diagnostic x-ray for "health assessment"	16	2	At entrance and exit
15. Diagnostic endoscopy for "health assessment"	16	2	At entrance and exit
16. Urinalysis (with catheter) for "health assessment"	16	2	At entrance and exit
17. Flipper tag	16	1	Once – before exit
18. Hot brand	16	1	Once – before exit
19. Attach external data logger	16	1	Once – before exit
20. Food assimilation and protein turnover studies with 48 hours dry holding, dosing with Cr^2O^3 and Co-EDTA and injection of ^{15}[N]Glycine and associated blood sampling	Up to 10 over duration of permit	Up to 2 trials[2]	Up to 10 trials[2] over 3 years with no animal undergoing more than 2 trials
21. Doubly-labeled water technique validation study with 4 days dry holding, injection of isotopes and serial blood samples	4 out of 16 in #1	1	Once over life of permit
22. Controlled fasting (includes pre/post D_2O and 3 pre-fast and 3 post-fast blubber biopsies)	4 out of 16 in #1	1	Up to 8 animals over duration of permit[3]
23. ACTH challenge (includes serial blood samples over 2 hour period plus one more sample 24-hrs post dosing)	4 out of 16 in #1	1	Up to 8 animals over duration of permit[4]
24. Surgically implant dual "Life History Transmitters"	16	1	Once – before exit

1. Animals captured in field by ASLC under Permit No. 881-1668. See Proposed Action Activity Table 1.
2. For the "food assimilation and protein turnover studies" in Activity #20, a trial is one complete sequence of dosing (with Cr^2O^3 and Co-EDTA and injection of ^{15}[N]Glycine) and associated 48 hour dry holding and blood sampling.
3. Note the ASLC has already completed this study with 4 animals in 2004 so they would not use more than 4 more over the duration of the permit.
4. Note the ASLC has already completed this study with 4 animals in 2004 so they would not use more than 6 more over the duration of the permit.

The permit applications and permit modification requests include citations of literature that discuss some of the effects of the proposed activities and proposed methodologies on Steller sea lions in particular, or pinnipeds generally. Readers should refer to these citations for specific information related to the proposed permits, which are summarized below.

Permit No. 782-1768-00: National Marine Mammal Laboratory

The proposed Permit No. 782-1768-00 would allow the National Marine Mammal Laboratory (NMML) to (1) continue aerial surveys, and associated incidental harassment of Steller sea lions in non-breeding season; (2) disturb Steller sea lions during scat collection; (3) conduct monthly aerial surveys of Steller sea lions in southeast Alaska in addition to those flown in Gulf of Alaska and Aleutian Islands; (4) hot-brand any Steller sea lions captured; (5) administer Evan's blue dye and deuterium oxide to Steller sea lions; (6) collect muscle biopsies from Steller sea lions; (7) use bioelectric impedance analysis on Steller sea lions; and (8) pull vibrissae and teeth from Steller sea lions. Additional information on these activities can be found in the attached draft Environmental Assessment (EA) and application. Permit No. 782-1768-00 would expire May 31, 2010.

The permit to NMML would include takes by accidental mortality of up to 10 Steller sea lions per year.

Permit No. 358-1769-00: Alaska Department of Fish and Game

The purpose of the research proposed by the applicant is to continue monitoring the status of the Alaskan Steller sea lion population and to identify causes of the population decline so as to provide for the population's recovery. Permit No. 358-1769-00 would authorize ADF&G to continue to harass Steller sea lions in Alaska during biennial aerial surveys; to capture, restrain (chemically and physically), hot-brand, tag, and attach satellite transmitters to Steller sea lions; to take tissue and blood samples from Steller sea lions; to collect scat from Steller sea lion rookeries and haulouts; to collect carcasses and parts of carcasses; to receive samples from Steller sea lions taken by subsistence harvest; to administer deuterated water to Steller sea lions; and to set up remote monitoring stations on rookeries and haulouts to conduct behavioral studies on Steller sea lions. Additional information on these activities can be found in the attached draft EA and application. Permit No. 358-1769-00 would expire May 31, 2010.

The permit to ADFG would include takes by accidental mortality of up to 10 Steller sea lions per year.

Permit No. 1010-1641-01: Aleutians East Borough

The permit for Aleutians East Borough (AEB; Permit No. 1010-1641-01; PI: Kate Wynne) would authorized take of endangered Steller sea lions in Alaska by harassment during aerial and vessel surveys of Steller sea lion rookeries and haulouts, collection of scat samples from Steller sea lion rookeries and haulouts, and placement of observers on Steller sea lion rookeries and haulouts. The purpose of the research proposed by the AEB is to provide additional information on seasonal prey consumption by Steller sea lions through analysis of scat collected at rookeries and haulouts along the Alaska Peninsula and Eastern Aleutian Islands, and to improve the accuracy and precision of population indices through expanded aerial and vessel surveys in the western Gulf of Alaska. Additional information on these activities can be found in the attached draft EA and application. Permit No. 1010-1641-01 would expire December 30, 2008.

Permit No. 800-1664: Dr. Randall Davis

Dr. Randall Davis (Permit No. 800-1664-02) would be authorized to take threatened and endangered Steller sea lions in the Gulf of Alaska and Aleutian Islands by harassment, capture, hot-branding, flipper tagging, blood and tissue sampling, scientific instrument attachment, and research-related accidental mortality. The purpose of the research proposed by Dr. Davis is to study the hunting behavior and three-dimensional movements of Steller sea lions. Additional information on these activities can be found in the attached draft EA and application. Permit No. 1010-1641-01 would expire December 30, 2008.

The permit to Dr. Davis would authorize a total of 13 takes by accidental mortality including up to 3 pups, 5 juveniles, and 5 adult female Steller sea lions per year.

Permit No. 881-1668-04: Alaska SeaLife Center

Permit No. 881-1668-04 to the Alaska SeaLife Center would authorize take of threatened and endangered Steller sea lions throughout their range in Alaska by harassment during remote monitoring, capture, hot-branding, flipper tagging, collection of blood and tissue samples from, attachment of external scientific instruments, implant of scientific instruments, and conducting controlled feeding and endocrinology experiments on pups and juvenile Steller sea lions. The overall purpose of the research proposed by the ASLC is to collect information related to health (e.g., morphometrics, body composition, immunology, epidemiology, endocrinology, viral serology), physiology (e.g., vitamin requirements, stress responses to capture, handling, and captivity), life history (e.g., ontogenetic and annual cycles, population dynamics), and foraging behavior and habitat use of Steller sea lions.

Activities authorized by Permit No. 881-1668-04 include scat collection, collection of sea lion carcasses, capture of animals and remote monitoring activities. Up to 5,850 sea lions of all ages throughout Alaska would be incidentally harassed during these activities. Up to 300 pups (more than 6 weeks old), 230 juveniles (between 1 and 3 years), and 80 adult females could be captured each year under the permit. Capture of pups is only authorized outside of the peak breeding season. Issuance of a permit to ASLC would authorize takes by accidental mortality of up to 10 sea lions of any age per year in Alaska resulting from research activities. Additional information on these activities can be found in the attached draft EA and application. Permit No. 881-1668-04 would expire December 30, 2008.

Permit No. 434-1669-02: Oregon Department of Fish and Wildlife

Permit No. 434-1669-02 for Oregon Department of Fish and Wildlife (PI: Robin Brown) would authorize the take of threatened Steller sea lion pups and juveniles in Washington, Oregon and

California by harassment during remote monitoring, capture, hot-branding, flipper tagging, collection of blood and tissue samples from, and attachment of external scientific instruments. The proposed permit represents an administrative shift of lead research authority for the field work conducted in the Pacific Northwest from the NMML to the ODFW. Like the research NMML proposes to conduct, the purpose of this research is to continue monitoring the status of the Alaskan Steller sea lion population and to identify causes of the population decline so as to provide for the population's recovery.

The permit to ODFW would authorize incidental harassment of up to 10,000 sea lions of all ages in California, Washington, and Oregon per year during capture and sampling of older pups and juveniles, scat collection, behavioral observations and remote monitoring activities. Additional information on these activities can be found in the attached draft EA and application. Permit No. 434-1669-02 would expire December 30, 2008.

Issuing a permit to ODFW as requested in the application would authorize takes by accidental mortality of up to 10 sea lions of any age per year from research activities. These potential mortalities would be from the threatened eastern stock of Steller sea lions.

File No. 715-1784: The NPUMMRC has requested a five-year permit to collect data on sea lion distribution and diet compositions through aerial surveys of sea lion rookeries and haul outs in Southeast Alaska; collection of scat from rookeries and haul outs in Southeast Alaska; conducting behavioral observations of sea lions on rookeries, haul outs and tagged sea lions at sea; and mortality incidental to research. The objectives of the study are to understand how diets vary temporally and spatially, and how this variation is related to population trends and abundance, nutritional stress, and commercial fishing activities. Additional information on these activities can be found in the attached draft EA and application. Permit No. 434-1669-02 would expire May 31, 2010.

Issuance of a permit to NPUMMRC would authorize takes by accidental mortality of up to 5 sea lions of any age per year in Alaska resulting from research activities.

Permit Conditions

NMFS and MMC believe there is a need for close coordination of the research to avoid unnecessarily duplicative research or unnecessary adverse effects on the animals. All marine mammal research permits issued by NMFS contain conditions requiring permit holders to coordinate their activities with those of others doing similar work on the same species and/or in the same area or seasons to avoid unnecessary duplication of research and adverse effects on the marine mammals.

There are a number of measures that are considered "good practice" and that are commonly followed by qualified, experienced personnel to minimize the potential risks associated with various of the proposed procedures. In addition to the measures identified by researchers in their applications, all NMFS marine mammal research permits contain conditions intended to minimize the potential adverse effects of the research activities on the animals. These conditions are specific to the type of research authorized and the species involved. The following mitigation measures are based on information in the literature, and from the researchers themselves, about the effects of particular research techniques and the responses of animals to the activities.

Mitigation for aerial surveys: Survey planes should approach from a kilometer or more offshore and without banking, which is believed to reduce the incidence of hauled out animals entering the water prior to the survey photographs, because the animals would only be within hearing range of the plane for 1-2 minutes.

Mitigation for capture and restraint: These procedures should be performed or directly supervised by qualified personnel and it is recommended that an experienced marine mammal veterinarian be present to carry out or provide direct on-site supervision of all activities involving use of anesthesia and sedatives. Researchers should carry out activities efficiently, such that the total time that researchers are occupying the rookery/haul out, and total number of times a site is disturbed, are minimized. Stays on rookeries longer than five hours are justified only when it prevents additional disturbance of the site on subsequent days. Permit holders should use personnel experienced in capture and sampling techniques to complete the activities as quickly as possible.

To avoid respiratory distress, ischemia (restricted blood flow), or nerve damage, it is considered important that animals be properly positioned, i.e. ventrally recumbent, during anesthesia (Dierauf 1990). Respiration and pCO_2 should be monitored and oxygen administered, as needed to avoid prolonged breath holding during gas anesthesia, which can result in cardiac hypoxia (lack of oxygen to the heart muscle). Qualified personnel (i.e., experienced veterinarians, biologists, or other highly trained personnel) should be prepared to control or assist ventilations when using Valium, isoflurane, or Tiletamine. An emergency kit with equipment and supplies for responding to complications or emergencies should be readily available. The animal's body temperature should be closely monitored and steps taken to avoid hypo- and hyperthermia (e.g. cooling with water or covering to keep warm, as necessary). Drug doses should be calculated on the basis of the researcher's best estimate of an animal's lean body mass and metabolic rate.

If an animal is showing signs of acute or protracted alarm reaction (*e.g.*, overexertion, constant muscle tensions, abnormal respiration or heart rate) that may lead to serious injury, capture myopathy, other disease conditions, or death, research-related procedures must immediately cease and the animals should be monitored or the symptoms treated as determined appropriate by the Principal Ivestigator, Co-Investigator, or attending veterinarian. Similarly, caution should be exercised when approaching all Steller sea lions, particularly mother/pup pairs, and efforts to approach and handle a particular animal or mother/pup pair should be immediately terminated if there is any evidence that the activity(ies) may be life-threatening.

To reduce the risk of unintentional injection of drugs by projectile syringe (darts) into blubber, intravenously, or into vital organs, the length of the needle used should be appropriate for the size of the animal and its blubber thickness. In addition, care should be taken in darting animals to avoid accidental drownings of animals that either flee into the water prior to induction or slump into pools of water at induction.

Researchers should ensure that animals that have been captured or are recovering from anesthesia have an opportunity to recover without undue risk of injury from other animals. Animals should be processed in groups small enough that all animals can be adequately monitored (*e.g.*, 2 physically restrained but not chemically immobilized animals per observer). Handling and restraint time should be minimized to the maximum extent practicable. For example, if multiple procedures are to be performed on the same animal, there should be enough qualified personnel available to conduct as many activities simultaneously as possible without resulting in undue stress on the animal. When pups are collected, they should be sufficiently separated from each other and monitored to ensure that they are not suffocating, being crushed, or aspirating milk.

There is no indication that fostering is common in Steller sea lions. It is reasonable to assume that if a lactating female dies as a result of research, her dependent pup will starve. Therefore, researchers should take reasonable steps to identify pups of lactating females before attempting to immobilize a lactating female. In the event a lactating female dies or is seriously injured as a result of the research activities, the orphaned pup, when it can be identified, should be humanely provided for (i.e. salvaged [placed in a Stranding facility for rehabilitation and eventual release], or if salvage is not possible, euthanized).[1]

To the maximum extent practical without causing further disturbance of the rookery/haulout, researchers shall conduct post-handling monitoring of animals captured or sampled, for signs of acute stress or injury. To the maximum extent practical without causing further disturbance of animals, researchers shall also monitor rookeries/haul outs following any disturbance (e.g., capture activities) to determine if any animals have been injured or pups abandoned.

[1] Pups humanely euthanized would count against the total number of animals authorized for incidental mortality under the permit. If the dependent pup of a lactating female could not be identified prior to sampling the female, and the female dies as a result of the research, the pup should be assumed dead and counted against the total number of animals authorized for incidental mortality under the permit. Similarly, if a pregnant female dies as a result of the research, the fetus should also be counted against the total number of animals authorized for incidental mortality.

Mitigation for intrusive sampling and surgical procedures (e.g., blood collection, biopsy, tooth pulling, fecal loops/culture swabs, enemas, stomach intubation, BIA, surgical implants): These procedures should performed or directly supervised by qualified personnel and it is recommended that an experienced marine mammal veterinarian be present to carry out or provide direct on-site supervision of all activities involving use of anesthesia and sedatives.

To the maximum extent practical, the animal should be restrained on a smooth surface. An attending veterinarian or other qualified personnel should be present during these procedure to monitor the physiologic state of each animal (e.g., by monitoring respiratory rate and character, heart rate, body temperature, and behavioral response to handling and sampling procedures). Animals that are physically restrained but continue to struggle or show signs of stress should be released immediately to minimize the risk that continued stress would lead to capture myopathy.

The volume of blood taken from individual animals should not exceed 1 ml blood per kg body mass, either as a single blood draw or over the course of several days.[2] Qualified researchers should not need to exceed three attempts (needle insertions) per animal when collecting blood. When conducting isotopically labeled water trials, additional needle insertions may be allowed, but the use of a catheter is strongly encouraged to minimize impacts on the animal. If an animal cannot be adequately immobilized for blood sampling, particularly when drawing blood from the intervertebral sinus, efforts to collect blood should be discontinued to avoid the possibility of serious injury or mortality from stress.

Sterile, disposable needles, biopsy punches, etc., should be used to minimize the risk of infection and cross-contamination. Where disposable equipment is not available (i.e., enema and stomach tubes, flipper punch, dental elevators) liquid chemical sterilants should be used with adequate contact times (as indicated on the product label) to affect proper sterilization, and instruments should be rinsed with sterile water or saline before use on animals. Care should be taken to avoid contact of equipment disinfectants with an animal's skin, and disinfectant agents should be changed periodically to avoid growth of resistant strains of microorganisms.

Only experienced, qualified personnel (veterinarians, biologists) who know how to properly pass a stomach tube to avoid introduction of liquid into the trachea.[3]should attempt this procedure. Because proper cold sterilization takes some time, researchers should bring an adequate number of stomach tubes to ensure all tubes are properly sterilized between animals, or that there is one tube per animal.

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[2] Based on veterinary established guidelines for safe removal of blood from research animals. [McGuill, M.W. and A.N. Rowan. 1989. Biological effects of blood loss: implications for sampling volumes and techniques. ILAR News 315-20. *and* Morton, D.B. et al. 1993. Removal of blood from laboratory animals and birds. First report of the BVA/FRAME/RSPCA/UFAW joint working group on refinement. Laboratory Animals 27: 1-22.]

[3] The proper procedure is to first estimate the length of the stomach tube necessary by measuring the distance to the stomach along the outside of the animal's body. The tube should be smoothly inserted into the mouth, down the left side of the animal's throat, into the stomach. If the animal cannot vocalize, the tube has been inserted into the trachea. To further verify that the tube is in the stomach, a small amount of air should be blown down the tube while listening for gurgling either through the tube or via a stethoscope placed on the left abdominal wall. Dierauf, L.A. 1990. Pinniped husbandry. *In* L.A. Dierauf (editor). CRC Handbook of Marine Mammal Medicine: Health, Disease, and Rehabilitation. CRC Press, Inc. Boca Raton, FL

Mitigation for flipper tagging: Care should be taken to avoid placing the tag so low as to have the animal walking on it or so high as to have it irritating the animal's flank area (Dierauf 1990).

Mitigation for hot-branding: Pups that are very young or in poor physical condition (e.g. under 20kg) should not be branded. It is recommended that isoflurane gas be used during branding, both as a temporary anesthetic and to ensure that animals remain still for optimal brand quality.

Mitigation for attachment of scientific instruments: When epoxy hardener is mixed with resin catalyst, heat is generated, and the mix can cause thermal burns. Therefore, care should be used in adjusting the proportions of epoxy hardener and resin catalyst to prevent a "hot" mix and the minimum practical amount of epoxy should be used to prevent burning the animal. The weight and dimensions of the instrument package relative to the animal's size and mass, and duration of attachment, are important considerations in choosing a tag. Tag size and placement should be selected that will not interfere significantly with an animal's ability to forage or conduct other vital functions.

Mitigation for behavioral/demographic observations and remote monitoring: To minimize the potential for disturbance caused by the placement of observers on rookeries and haulouts or for set-up and maintenance of remote monitoring stations, researchers should, to the maximum extent practicable, either access the locations concurrent with other research activities, or from points or by means that would not disturb sea lions (e.g. approaching from the other side of the island, where no animals are hauled out).

Mitigation for temporary captivity
The mitigation measures in Permit No. 881-1668-03 specific to minimizing adverse effects the transport, short-term captivity, sampling, and subsequent release of juvenile sea lions at the ASLC would remain in effect in the amendment under the Proposed Action. As with all NMFS permits for research on pinnipeds used in captive experiments, the Steller sea lions must be maintained only in Animal and Plant Health Inspection Service (APHIS), USDA certified research facilities and a copy of the APHIS license(s) must be provided to NMFS. No research on captive animals may occur until the research protocols have been reviewed and approved by the ASLC's Institutional Animal Care and Use Committee (IACUC).

Any cages used to transport animals between facilities and/or to a release site must meet the standards set forth by the APHIS, "Primary enclosures used to transport marine mammals" (9 CFR §3.113 attached). During transport, researchers must keep the animal(s) at a comfortable temperature, using fresh or salt water as needed to cool the animal. Every effort must be made to minimize transport time, and animals should be transported during the cooler part of the day (where applicable), and during minimal traffic (when by ground), to the maximum extent possible. An emergency kit must accompany the animals during transport in the event an animal is injured or otherwise needs medical treatment. All transports of animals must be done by qualified personnel experienced in pinniped handling and medical procedures.

All animals must be held in quarantine conditions during captivity. All animals undergoing research must be closely monitored to determine if research activities are having an adverse effect on the individual(s). A licensed marine mammal veterinarian must be available for emergencies, illnesses, and for health screening prior to release.

Sea lions undergoing fasting at the ASLC would be monitored daily and the permit would require that they be removed from the trial (*i.e.*, returned to feeding) if there was any indication they were becoming ill. The permit would also be conditioned to require cessation of the experiment for any animal whose rate of mass loss was greater than 3% of their initial mass per day or whose total mass loss exceeds 15% of initial body mass. Finally, any sea lions subjected to the controlled fasting experiments would be allowed time to recover and readjust metabolism prior to being returned to the wild.

To minimize the potential adverse behavioral effects of captivity, sea lions must be isolated from unnecessary direct human contact (*e.g.*, hand feeding) to the maximum extent practical prior to release, and exposed to live prey species and demonstrate that they will capture and eat live prey, without humans visually present if possible. All sea lions must be flipper tagged for identification purposes prior to release. All sea lions must be monitored for a minimum of two weeks following any intrusive research procedures (with the exception of attachment of flipper tags and external scientific instruments), or until the site where the intrusive procedure was performed has healed. To allow sea lions to recover from the stress of handling and minimize the potential adverse effects of any drugs used during the research and ensure adequate healing without excessive inflammation, all sea lions must be off drugs (excluding vitamins/dietary supplements in the food, sedation for attachment of tags immediately prior to transport, and sedation for transport itself) for at least two weeks prior to return to the wild. In addition, all sea lions must be examined and approved by a qualified veterinarian to insure that the animal is in good health, is likely to survive in the wild, and does not pose a threat to the wild marine mammal population(s).

The ASLC's protocol for disease screening prior to release and for behavioral de-conditioning of animals for release into the wild must be provided to NMFS Office of Protected Resources. The ASLC must have a plan to provide permanent holding in the event that any sea lions are deemed non-releasable, and subsequent disposition of the animal(s) must be decided in consultation with NMFS Office of Protected Resources. The amended permit would require the ASLC to cease all research and not bring any additional sea lions into captivity if two sea lions are found unsuitable for return to the wild as result of the research or captivity. Any sea lions that are determined unsuitable for release as a result of the research or captivity would count against the mortalities allowed in the current permit. The ultimate disposition (euthanasia or permanent captivity under a scientific research and enhancement permit) of any non-releasable animals would be determined by the Office Director. Since they are listed under the ESA, permanent captivity for any non-releasable sea lions would have to be authorized under a permit for enhancement or scientific research. The terms and conditions of such permits, including whether the animals would be allowed to reproduce in captivity, would be determined by NMFS pursuant to the MMPA, ESA and their implementing regulations, including consultation under Section 7 of the ESA.

To prevent any artificial mixing of genetic stocks and to maximize their chances for successful reintegration into the wild population, animals would only be released in Alaska and every effort would be made to release them: (1) in groups; and (2) at the original capture site(s), in the vicinity of con-specifics of the same population, or in an area where they would normally be found given the time of year. The ASLC must notify NMFS Regional Administrator and/or Regional Stranding Coordinator of the date and location of the release two weeks prior to releasing animals to the wild.

Mitigation for incidental mortality

To ensure that the total number of observed mortalities under all permits does not exceed permitted levels, all permit holders would be required to notify NMFS of research-related mortalities by phone as soon as possible after the incident, preferably within 24-72 hours. Within two weeks of the incident, unless other arrangements have been made, the permit holder must submit a written report that includes a complete description of the events surrounding the incident and identification of steps that will be taken to reduce the potential for additional accidents.

In the event that research-related mortality of sea lions reaches the number specified in a permit, research must be immediately suspended and the protocol must be reviewed, and, if necessary, revised to the satisfaction of NMFS in consultation with the Marine Mammal Commission.

In addition, activities under all permits for takes of Steller sea lions would be suspended, pending review, if the total number of research-related mortalities of endangered Steller sea lions reaches 10 animals under any combination of permits. In the event that research is suspended because combined mortalities of endangered Steller sea lions reaches 10, research may recommence upon review of the information submitted by permit holders on the cause(s) of the deaths and authorization by the Chief, Permits, Conservation and Education Division. If the total number of research-related mortalities of endangered Steller sea lions reaches 20 animals under any combination of permits in a year, research under all permits would be halted pending review and if necessary modification of the permits.

Status of the Species and Environmental Baseline

NMFS has determined that the action being considered in this biological opinion may affect the following species and critical habitat provided protection under the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq*.; ESA):

Steller sea lion [western population]	*Eumetopias jubatus*	Endangered
Steller sea lion [eastern population]		Threatened

By regulation, environmental baselines for biological opinions include the past and present impacts of all state, Federal or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02). Because the action area for this consultation encompasses the known distribution of the threatened and endangered populations of Steller sea lions, the *Status of the Species* summarizes the same information as the *Environmental Baseline*. Therefore, we have combined these two sections for this biological opinion,

The following summary presents information that has been discussed in greater detail in numerous biological opinions NMFS has issued over the past four years. In particular, NMFS' November 30, 2000, biological opinion on the effects of Authorization of Bering Sea/Aleutian Islands groundfish fisheries based on the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish; and Authorization of Gulf of Alaska groundfish fisheries based on the Fishery Management Plan for Groundfish of the Gulf of Alaska thoroughly reviews how human activities from the late-1700s to present may have affected the ecology of the action area and Steller sea lions in particular. For more detailed discussions of the biology, ecology, status and trends, and global threats to these species, readers should refer to the November 30, 2000, biological opinion.

Species description

Steller sea lions (*Eumetopias jubatus*) are the only extant species of the genus *Eumetopias*, and are members of the subfamily Otariinae, family Otariidae, superfamily Otarioidea, order Pinnipedia. The closest extant relatives of Steller sea lions appear to be the other sea lion genera, including *Zalophus*, *Otaria*, *Neophoca*, and *Phocartos*, and the fur seals of the genera *Callorhinus* and *Arctocephalus*. Loughlin *et al*. (1987) briefly summarize the fossil record for *Eumetopias*. Repenning (1976) suggests that a femur dated 3 to 4 million years old may have been from an ancient member of the *Eumetopias* genus, thereby indicating that the genus is at least that old. Presumably, *Eumetopias jubatus* evolved entirely in the North Pacific (Repenning 1976).

Distribution

Steller sea lions are distributed around the rim of the North Pacific Ocean from the Channel Islands off Southern California to northern Hokkaido, Japan. In the Bering Sea, the northernmost major rookery is on Walrus Island in the Pribilof Island group. The northernmost major haulout is on Hall Island off the northwestern tip of St. Matthew Island. Their distribution also extends northward from the western end of the Aleutian chain to sites along the eastern shore of the Kamchatka Peninsula. Their distribution is probably centered in the Gulf of Alaska and the Aleutian Islands (NMFS 1992).

Within their range, land sites used by Steller sea lions are referred to as rookeries and haulouts. Rookeries are used by adult sea lions for pupping, nursing, and mating during the reproductive season (generally from late May to early July). Haulouts are used by all ages classes of both genders but are generally not where sea lions reproduce. The continued use of particular sites may be due to site fidelity, or the tendency of sea lions to return repeatedly to the same site, often the site of their birth. Presumably, these sites were chosen and continue to be used because they protect sea lions from predators, some measure of protection from severe climate or sea surface conditions, and (perhaps most importantly) are in close proximity to prey resources.

The movement patterns of Steller sea lions are not yet well understood but we can provide a general picture of the information we have. Sea lions move on and offshore for feeding excursions. At the end of the reproductive season, some females may move with their pups to other haulout sites and males may “migrate” to distant foraging locations (Spaulding 1964, Mate 1973, Porter 1997). Sea lions may make semi-permanent or permanent one-way movements from one site to another (Chumbley *et al*. 1997, their Table 8; Burkanov *et al*. unpublished report [cited in Loughlin 1997]). Calkins and Pitcher (1982) reported movements in Alaska of up to1500 km. They also describe wide dispersion of young animals after weaning, with the majority of those animals returning to the site of birth as they reach reproductive age.

Reproduction

Steller sea lions have a polygynous reproductive strategy in which a single male may mate with multiple females. As mating occurs on land (or in the surf or intertidal zones), males are able to defend territories and thereby exert at least partial control over access to adult females and mating privileges. The pupping and mating season is relatively short and synchronous, probably due to the strong seasonality of the sea lions’ environment and the need to balance aggregation for reproductive purposes with dispersion to exploit distant food resources (Bartholomew 1970). In May, adult males compete for rookery territories. In late May and early July, adult females arrive at the rookeries, where pregnant females give birth to a single pup. The sex ratio of pups at birth is assumed to be approximately 1:1 (e.g., York 1994) or biased toward slightly greater production of males (e.g., Pike and Maxwell 1958, Lowry *et al*. 1982, NMFS 1992).

Mating occurs about one to two weeks later (Gentry 1970). The gestation period is probably about 50 to 51 weeks, but implantation of the blastocyst is delayed until late September or early October (Pitcher and Calkins 1981). Due to delayed implantation, the metabolic demands of a developing fetus are not imposed until well after fertilization.

For females with a pup, the nursing period continues for months to several years. The transition to nutritional independence may, therefore, occur over a period of months as the pup begins to develop essential foraging skills, and depends less and less on the adult female. The length of the nursing period may also vary as a function of the condition of the adult female. The nature and timing of weaning is important because it determines the resources available to the pup during the more demanding winter season and, conversely, the demands placed on the mother during the same period. The maintenance of the mother-offspring bond may also limit their distribution or the area used for foraging.

The reproductive cycle includes mating, gestation, parturition, and nursing or post-natal care. The adult female’s ability to complete this cycle successfully depends largely on the prey available to her. While much of the effort to explain the Steller sea lion decline has focused on juvenile survival rates, considerable evidence suggests that the decline may also be due, in part, to decreased reproductive success by adult females.

- Younger females collected in the 1970s were larger than females of the same age collected in the 1980s (Calkins *et al*. 1998). As maturity is likely related to size, females in the 1980s would also be more likely to mature and begin to contribute to population productivity at a later age.

- Pitcher *et al*. (in review) provide data from the 1970s and 1980s that suggests a much higher pregnancy rate after the mating season (97%; both periods), which declined to 67% for females collected in the 1970s and 55% for females collected in the 1980s. These changes in pregnancy rate suggest a large fetal mortality rate that could be a common feature of the Steller sea lion reproductive strategy (i.e., may occur even when conditions are favorable and population growth is occurring), but is more likely an indication of stress (possibly nutritional) experienced by individual females.

- The observed late pregnancy rates (67% in the 1970s and 55% in the 1980s) were not significantly different statistically. However, the direction of the difference is consistent with the hypothesis that reproductive effort in the 1980s was compromised.

- Pitcher *et al*. (in review) did observe a statistical difference in late season pregnancy rates of lactating females in the 1970s (63%) versus lactating females in the 1980s (30%). This difference indicates that in contrast to lactating females in the 1970s, lactating females in the 1980s were less able to support a fetus and complete a consecutive pregnancy.

- Males appear to reach sexual maturity at about the same time as females (i.e., 3 to 7 years of age; Perlov 1971 reported in Loughlin *et al*. 1987), but generally do not reach physical maturity and participate in breeding until about 8 to 10 years of age (Pitcher and Calkins 1981). A sample of 185 harem bulls from the Marmot, Atkins, Ugamak, Jude, and Chowiet Islands in 1959 included animals 6 to 17 years of age, with 90% from 9 to 13 years old (Thorsteinson and Lensink 1962).

Survival

Much of the recent effort to understand the decline of Steller sea lions has been focused on juvenile survival, or has assumed that the most likely proximate explanation is a decrease in juvenile survival rates. This contention is supported by direct observations and a modeling study, and is consistent with the notion that juvenile animals are less adept at avoiding predators and obtaining sufficient resources (prey) for growth and survival.

Direct observations consist of extremely low resighting rates at Marmot Island of 800 pups tagged and branded at that site in 1987 and 1988 (Chumbley *et al*. 1997) and observations of relatively few juveniles at Ugamak (Merrick *et al*. 1988). Low resighting rates do not themselves confirm that the problem was a corresponding drop in juvenile survival, but only that many of the marked animals were lost to the Marmot Island population. These animals could have migrated to other sites where they were not observed, although this is unlikely. If the “loss” of these animals is viewed in the context of the overall sea lion decline in the central Gulf of Alaska (from 1976 to 1994 the number of non-pups counted at Marmot Island declined by 88.9% and by

76.9% at the 14 other trend sites in the Gulf; Chumbley *et al*. 1997), then a significant increase in juvenile mortality is a much more plausible conclusion. This conclusion was affirmed by simulations conducted by York (1994).

However, juvenile survival may not be the only factor influencing the decline of the western population of Steller sea lions. Evidence indicating a decline in reproductive success was presented above. In addition, changes in adult survival may also have contributed to the decline. At present, survival rates for adult animals can not be determined with sufficient resolution to determine if those rates have changed over time or are somehow compromised to the extent that population growth and recovery are compromised.

Listing Status

On 26 November 1990, the Steller sea lion was listed as threatened under the Endangered Species Act of 1972 (55 FR 49204). The listing followed a decline in the U.S. population of about 64% over the three decades prior to the listing. In 1997, the species was split into two separate stocks on the basis of demographic and genetic dissimilarities (Bickham *et al*. 1996, Loughlin 1997), the status of the western stock was changed to endangered, and the status of the eastern stock was left unchanged (62 FR 30772).

Predation

Killer whales and sharks prey on Steller sea lions. Anecdotal evidence of such predation is available, but the rate of predation and the potential impact on trends of the western population can not be determined with any measure of confidence. Given the reduced abundance of sea lions at multiple sites (rookeries and haulouts), predation by killer whales and other sources of natural mortality may exacerbate the decline in local areas (e.g., Barrett-Lennard *et al*. 1995).

Disease

Disease and parasitism are also potential causes of population decline, and evidence is available indicating that animals have been exposed to diseases and carry parasites. However, none of the evidence available at this time provides any indication that disease or parasitism caused the decline or are impeding recovery. Disease and parasitism are common in all pinniped populations and have been responsible for major die-offs (e.g., Osterhaus *et al*. 1997), but such events are usually relatively short-lived and provide more evidence of morbidity or mortality. The ramifications of disease and parasitism remain a concern, both as primary and secondary problems, but do not appear to be significant impediments to recovery at this time or on the basis of the information currently available.

Impacts of Human Activities on Steller Sea Lions

A large number of human activities have contributed to the current status of the eastern and western populations of Steller sea lions. Some of those activities occurred in the past, ended, and no longer appear to affect either sea lion population; other activities ended, but had effects on the structure or composition of Steller sea lion populations that continue to hinder their ability to reverse their decline toward extinction. Still other human activities appeared to affect Steller sea lion populations after their decline and continue to affect them. The following section summarizes the principal phenomena that are known to affect the likelihood that Steller sea lion populations will survive and recover in the wild.

Commercial harvest of Steller sea lions

In 1959, the Bureau of Commercial Fisheries awarded a contract to a commercial fishing company to develop techniques for harvesting sea lions in Alaskan waters. The two-fold purpose of the contract was to reduce the sea lion herds (because of alleged depredations on salmon and halibut fisheries) and to provide an economical source of protein for fur farms, fish hatcheries, and similar purposes (Thorsteinson and Lensink 1962). In 1959, 630 sea lion bulls were killed in an experimental harvest, but the harvest proved to be uneconomical. Another study was contracted by the Bureau of Indian Affairs of the Department of Interior to analyze the feasibility of a commercial sea lion harvest in Alaska (BIA 1964). A total of 45,178 pups of both sexes were killed in the eastern Aleutian Islands and Gulf of Alaska between 1963 and 1972 (Merrick *et al*. 1987). Such harvests could have depressed recruitment in the short term and may have explained declines noted at some sites in the eastern Aleutian Islands or the Gulf of Alaska. These harvests do not appear to explain declines in other regions.

Subsistence harvest of Steller sea lions

The MMPA authorizes the taking of any marine mammal by Alaska Natives for subsistence purposes or for the purpose of creating and selling authentic native articles of handicrafts and clothing, given that it is not done in a wasteful manner (MMPA, Section 101[b]). The ESA also contains provisions that allow for the continued subsistence use of listed species. Both the ESA and the MMPA contain provisions that allow regulation of the subsistence harvest of endangered, threatened, or depleted species, if necessary (NMFS 1995).

Subsistence harvest of Steller sea lions from 1960 to 1990 has been estimated at 150 animals per year (Alverson 1992), but the estimate was subjective and not based on any referenced data. This estimate is well below the levels observed in the 1990s (Hill and DeMaster *in prep*), which seems inconsistent with the fact that sea lion populations are at their lowest recorded levels. In 1986, a working group organized by Dr. Pitcher suggested that subsistence harvest had a potentially low impact on recent Steller sea lion population declines in Alaska (Loughlin 1987). More recent estimates (Wolfe and Mishler 1993, 1994, 1995, 1996) indicate a mean annual subsistence take of 448 animals from the Western U.S. stock (i.e., the endangered population) from 1992 to 1995. The majority (79%) of sea lions were taken by Aleut hunters in the Aleutian and Pribilof Islands. The great majority (99%) of the statewide subsistence take was from west of 144°W long. (i.e., the range of the western population).

Current subsistence harvests represent a large proportion of the potential biological removal that was calculated for the western stock of the Steller sea lion pursuant to the Marine Mammal Protection Act (Hill and DeMaster *in prep*). However, subsistence harvests account for only a relatively small portion of the Steller sea lions lost to the population each year.

Toxic substances

Several studies indicate that organochlorine pollutant residues in the tissues of California sea lions and harbor seals have been associated with reproductive failure (NMFS 1992). These pollutants have also been reported in association with impaired immune systems (Becker *et al*. 1997). A number of studies (Varanasi *et al*. 1992, Lee *et al*. 1996, Krahn 1997, Krone 1997, Becker *et al*. 1997) have also indicated relatively high concentrations of organochlorine compounds in Steller sea lions in Alaska, although these levels have not yet been associated with any changes in health or vital rates. Steller sea lions were undoubtedly exposed to oil after the Exxon Valdez oil spill, but no significant adverse effects of the oil were confirmed (Calkins *et al*. 1994; see the next section). At the present time, the available information does not support the hypothesis that contaminants are a significant contributor to the decline of sea lions, or an impediment to their recovery.

Oil and gas or mineral development

Previous NMFS biological opinions for both the Bering Sea and Aleutian Islands and the Gulf of Alaska analyzed this factor under the heading of "human development" (NMFS 1991, 1996). In each case it was noted that human development activities that result in aquatic habitat destruction or the release of contaminants and pathogens (e.g., mineral exploration and extraction, effluent discharges into the marine environment) could directly diminish the health and reproductive success of Steller sea lions or cause them to abandon feeding, breeding, or resting sites. Development and discharge proposals typically undergo ESA section 7 consultation during the Federal permitting process.

On October 15, 1993, NMFS completed a biological opinion on the leasing and exploration activities of the Minerals Management Service in the Cook Inlet/Shelikof Strait region (lease sale Number 149). The opinion concluded that such activities were not likely to jeopardize the continued existence of any listed or proposed species, nor were they likely to destroy or adversely modify critical habitats (NMFS 1993). In 1995, NMFS conducted another section 7 consultation with the Minerals Management Service and concluded that the lease sale and exploration activities for the proposed oil and gas Lease Sale Number 158, Yakutat were not likely to jeopardize the continued existence of any listed or proposed species, nor were the activities likely to destroy or adversely modify critical habitats (NMFS 1995).

Oil spills are expected to adversely affect Steller sea lions if they contact individual animals, haulouts, or rookeries when occupied, or large proportions of major prey populations (Minerals Management Service 1996). Potential effects could include: oil exposure, including surface contact and pelage fouling, inhalation of contaminant vapor, and ingestion of oil or oil-contaminated prey. Because the insulation of nonpup sea lions is provided by a thick fat layer rather than pelage whose insulative value could be destroyed by fouling, oil contact is not expected to cause death from hypothermia; however, sensitive tissues (e.g., eyes, nasal passages, mouth, lungs) are likely to be irritated or ulcerated by exposure to oil or hydrocarbon fumes.

Oiled individuals probably will experience effects that may interfere with routine activities for a few hours to a few days; movement to clean water areas is expected to relieve most symptoms. Females returning from feeding trips may transfer oil to pups, which probably are more sensitive to oil contact.

The extent to which sea lions avoid areas that have been oiled is not known; individuals observed in Prince William Sound and the Gulf of Alaska after the Exxon Valdez oil spill did not appear to avoid oiled areas (Calkins and Becker 1990). Sea lions were sighted swimming in or near oil slicks, oil was seen near numerous haulout sites, and oil fouled the rookeries at Seal Rocks and Sugarloaf Island (Calkins *et al*. 1994). All of the sea lions collected in Prince William Sound in October 1989 had high enough levels of metabolites of aromatic hydrocarbons in the bile to confirm exposure and active metabolism at the tissue level. But as noted above, no evidence indicated damage caused to sea lions from toxic effects of the oil (Calkins *et al*. 1994).

Although Alaska is estimated to contain large petroleum resources on its outer continental shelf and in state waters, the only oil produced from Alaska's outer continental shelf to date has come from Cook Inlet south of Anchorage. In the foreseeable future, the kind of extensive oil and gas activities that characterize the outer continental shelf of the central Gulf of Mexico is not likely for the Gulf of Alaska. Little or no oil and gas exploration or production is occurring or likely to occur soon on the Russian outer continental shelf area of the Bering Sea. The National Research Council recently concluded, therefore, that oil and gas activities in the Bering Sea have not significantly affected the Bering Sea ecosystem (NRC 1996).

Disturbance by activities unrelated to fishing

Several studies investigating the potential effects of oil and gas exploration and development on the Steller sea lion have noted human disturbance as a potential factor. Calkins and Pitcher (1982) found that disturbance from aircraft and vessel traffic has extremely variable effects on hauled-out sea lions. Sea lion reaction to occasional disturbances ranges from no reaction at all to complete and immediate departure from the haulout area. The type of reaction appears to depend on a variety of factors. When sea lions are frightened off rookeries during the breeding and pupping season, pups may be trampled or even abandoned in extreme cases. Sea lions have temporarily abandoned some areas after repeated disturbance (Thorsteinson and Lensink 1962), but in other situations they have continued using areas after repeated and severe harassment. Johnson *et al*. (1989) evaluated the potential vulnerability of various Steller sea lion haulout sites and rookeries to noise and disturbance and also noted a variable effect on sea lions. Kenyon (1962) noted permanent abandonment of areas in the Pribilof Islands that were subjected to repeated disturbance. A major sea lion rookery at Cape Sarichef was abandoned after the construction of a light house at that site, but then has been used again as a haulout after the light house was no longer inhabited by humans. The consequences of such disturbance to the overall population are difficult to measure. Disturbance may have contributed to or exacerbated the decline, although it is not likely to have been a major factor. At present, concern about the effects of disturbance focuses on disturbance as an impediment to the study of sea lions and other potential causes of the decline (NMFS 1998).

Entanglement in marine debris

Observations of Steller sea lions entangled in marine debris have been made throughout the Gulf of Alaska and in southeast Alaska (Calkins 1985), typically incidental to other sea lion studies. Two categories of debris, closed plastic packing bands and net material, accounted for the majority of entanglements. Loughlin *et al*. (1986) surveyed numerous rookeries and haulout sites to evaluate the nature and magnitude of entanglement in debris on Steller sea lions in the Aleutian Islands. Of 30,117 animals counted (15,957 adults; 14,160 pups) only 11 adults showed evidence of entanglement with debris, specifically, net or twine, not packing bands or other materials. Entanglement rates of pups and juveniles appear to be even lower than those observed for adults (Loughlin *et al*. 1986). It is possible that pups were too young during the survey to have encountered debris in the water or that pups and juveniles were unable to swim to shore once entangled and died at sea. Trites and Larkin (1992) assumed that mortalities from entanglement in marine debris were not a major factor in the observed declines of Steller sea lions and estimated that perhaps fewer than 100 animals are killed each year.

Natural environmental change

Studies of atmospheric and oceanic circulation and physical properties indicate that the Gulf of Alaska and Gulf of Alaska ecosystems shift between at least two types of climatic regimes (Ebbesmeyer *et al*. 1990, Trenberth 1990, Brodeur and Ware 1992, Beamish 1993, Francis and Hare 1994, Miller *et al*. 1994, Trenberth and Hurrell 1994; Ingraham *et al*. 1998). While these regimes differ in many ways, they can be simply categorized as “warm” and “cold” depending on atmospheric and oceanic temperatures. One factor inducing the shift between regimes is changes in the position of the Aleutian Low Pressure system, which leads to changes in atmospheric temperature, storm tracks, ice cover, and wind direction (Wyllie-Echeverria and Wooster 1998). Shifts between regimes can be reflected in such indices as the Southern Oscillation Index, Pacific Decadal Oscillation, and the North Pacific Index. Historical studies suggest that over the last 500 years, the system has oscillated between the two distinct regimes every 10-30 years (Ingraham *et al*. 1998).

A well-documented shift from a cold to a warm regime in 1976-77 was associated with dramatic changes in the structure and composition of the invertebrate and fish communities as well as the distribution of individual species in the North Pacific ocean and Bering Sea (Brodeur and Ware 1992, Beamish 1993, Francis and Hare 1994, Miller *et al*. 1994, Hollowed and Wooster 1992; 1995; Wyllie-Echeverria and Wooster 1998). For instance, many groundfish stocks, particularly pollock, Atka mackerel, cod and various flatfish species increased in abundance as a result of strong year-classes spawned in the mid to late 1970s. Many of the long-lived flatfish species (e.g., arrowtooth flounder, Pacific halibut, yellowfin sole, and rock sole) remained in high abundance since then, while other shorter lived groundfish species (pollock, Atka mackerel, and Pacific cod) have oscillated in abundance. Based on these patterns, researchers have associated “warm” years (and other related environmental conditions, such as southwest winds in April [Wyllie-Echeverria and Wooster 1998]), with the production of strong year-classes of gadids (Hollowed and Wooster 1992; 1995; Wespestad *et al*. 1997).

Increases in many broadly distributed benthic (e.g., arrowtooth flounder, Pacific halibut) and semi-demersal (e.g., pollock and Pacific cod) piscivorous groundfish species since the late 1970s has been associated with either (or both) a decline in abundance (at least in nearshore environments; Anderson *et al*. 1997) or a change in distribution of short-lived pelagic species such as capelin. Anderson and Piatt (*in prep*) describe an almost complete disappearance of capelin from bays and the nearshore environment of the western and central Gulf of Alaska beginning in the late 1970s and early 1980s, and increases in cod and flatfish. During this time, the prevalence of capelin in the diets of many piscivorous birds and pinnipeds in the Gulf of Alaska also declined. However, Livingston *et al*. (*in prep*) estimated that capelin consumption in 1990 in the Gulf of Alaska by the groundfish species was at least 300,000 mt. This suggests that capelin didn't necessarily disappear from the Gulf of Alaska (since so much was eaten), but changed its vertical distribution (went deeper), possibly in response to the warm conditions. If this change occurred, capelin would have been more susceptible to predation by piscivorous groundfish and less available to birds and pinnipeds that begin their foraging excursions from the water's surface.

As in the Gulf of Alaska, the prevalence of capelin in the diets of puffins, kittiwakes and other birds on the Pribilof Islands in the Gulf of Alaska also declined in the mid-1980s. Furthermore, the prevalence of juvenile pollock tended to increase during this time period (Byrd *et al*. 1992, Springer 1993). Further north in the eastern Bering Sea, capelin remains a dominant feature of the kittiwake diet on St. Lawrence Island. This suggests that capelin distribution contracted to the north in response to warming conditions in the Eastern Bering Sea in the 1980s and 1990s. As a result, capelin in the Eastern Bering Sea may have redistributed horizontally (or geographically) in response to warming, while in the Gulf of Alaska, the redistribution may have been more in the vertical dimension. Regardless, these changes in prey distribution in response to changes in environmental conditions may have reduced the availability of capelin to Steller sea lions in the SE Bering Sea and Gulf of Alaska. During warm regimes, Steller sea lions may then depend on the availability and abundance of other resident prey in these areas for their survival.

Sea lions may have lived through many regime shifts in the few million years that they have existed. What may be different about this most recent shift is the coincident development of extensive fisheries targeting the same prey that sea lions depend on during warm regimes. Fisheries in the Bering Sea and Gulf of Alaska expanded enormously in the 1960s and 1970s. The existence of a strong environmental influence on sea lion trends does not rule out the possibility of significant fisheries-related effects. The cause of the sea lion decline need not be a single factor. To the contrary, strong environmental influences on Gulf of Alaska and Gulf of Alaska ecosystems could increase the sensitivity of sea lions to fisheries or changes in those ecosystems resulting from fisheries.

Incidental take of Steller sea lions in fisheries

Steller sea lions have been caught incidentally in foreign commercial trawl fisheries in the Gulf of Alaska and Gulf of Alaska since those fisheries developed in the 1950s (Loughlin and Nelson 1986, Perez and Loughlin 1999). Alverson (1992) suggested that from 1960 to 1990, incidental take may have accounted for over 50,000 animals, or almost 40% of his estimated total mortality due to various fishery and subsistence activities. Perez and Loughlin (1991) reviewed fisheries and observer data and reported that from 1973 to 1988, sea lions comprised 87% (over 3,000) of the marine mammal incidental take reported by observers. They extrapolated the take rate to unobserved fishing activities and suggested that the incidental take during 1978 to 1988 was over 6,500 animals. Using the average observed incidental rates during 1973 to 1977, they also estimated that an additional 14,830 animals were incidentally taken in the trawl fisheries in Alaska during 1966 to 1977. Finally, they concluded that incidental take was a contributing cause of the population decline of Steller sea lions in Alaska, accounting for a decline of 16% in the Gulf of Alaska and 6% in the Gulf of Alaska. However, because the actual decline has exceeded 80% since 1960, incidental mortalities of Steller sea lions does not appear to be the only or principal factor in the decline.

Estimates for more recent years indicate that incidental take levels have been reduced. The mean estimated annual mortality for Gulf of Alaska and Gulf of Alaska groundfish trawl and longline fisheries for 1990 to 1996 is 11 animals and the estimate from the Prince William Sound salmon drift gillnet fishery is 15 animals; resulting in a total estimated mean mortality rate in observed fisheries of 26 sea lions per year from the endangered Western stock (Hill and DeMaster *in prep*).

Satellite tracking studies suggest that Steller sea lions rarely go beyond the U.S. EEZ into international waters. Given that the high-seas gillnet fisheries have ended and other net fisheries in international waters are minimal, the probability that significant numbers of Steller sea lions are taken incidentally in commercial fisheries in international waters is low. NMFS has concluded that the number of Steller sea lions taken incidental to commercial fisheries in international waters is insignificant (Hill and DeMaster *in prep*).

Intentional take of Steller sea lions in fisheries

Historically, Steller sea lions and other pinnipeds were seen as nuisances to the fishing industry and management agencies because they damaged catch and fishing gear and were thought to compete for fish (Mathisen 1959). Sea lion numbers were reduced through bounty programs, controlled hunts, and indiscriminate shooting. Steller sea lions were also killed for bait in the crab fishery. Government sanctioned control measures and harvests stopped in 1972 with the introduction of the MMPA.

The total number of sea lions killed since the early part of this century is unknown. Alverson (1992) suggested that intentional take may have reached or exceeded 34,000 animals from 1960 to 1990. Fishermen were seen killing adult animals at rookeries, haulout sites, and in the water near boats. The loss of that many animals would have an appreciable effect on the population dynamics of sea lions, but the effect would not account for the total decline of the western population. The effect was likely concentrated in areas closer to fishing communities and less important in more isolated areas (e.g., central and western Aleutian Islands).

Sea lion populations appear to be growing slowly in southeast Alaska, where considerable commercial fishing occurs. Expanded observer coverage in the domestic groundfish fishery after 1989 and increased public awareness of the potential economic and conservation impacts of continued sea lion declines have probably reduced the amount of shooting.

Nevertheless, anecdotal reports of shootings continue and a small number of prosecutions have occurred or are occurring. The full extent of incidental killing is undetermined and therefore should be considered a potential factor in the decline of sea lions at some locations.

Competition with Commercial Fisheries

Numerous fisheries are conducted in Federal and State waters off Alaska that may adversely affect Steller sea lions. In Federal waters off Alaska, NMFS and the North Pacific Fishery Management Council prosecute groundfish fisheries (including fisheries for Atka mackerel, walleye pollock, and Pacific cod) that affect both Steller sea lion populations. The State of Alaska prosecutes fisheries for herring, crab, shrimp, groundfish, Pacific cod, and Pacific salmon throughout state waters. These fisheries may interact with Steller sea lions in a wide variety of ways, including operational conflicts (e.g., incidental kill, gear conflicts, sea lion removal of catch) and biological conflicts (e.g., competition for prey). Operational conflicts are assessed by observers and have been reduced to low levels (Hill and DeMaster *in prep*) that are considered to be negligible at a sea lion population level.

The potential biological effects of these fisheries on listed Steller sea lions, particularly the endangered western population, have been the subject of extensive debate since the mid-1990s. Some authors have argued that the fisheries may adversely affect Steller sea lions by (a) competing with sea lions for prey, particularly, walleye pollock, and (b) affecting the structure of the fish community in ways that reduce the availability of alternative prey (for example, Alaska Sea Grant 1993, National Research Council 1996). Other authors have argued that Steller sea lions may be harmed by diets that are dominated by walleye pollock (Rosen and Trites 2000a, 2000b). Still others suggest that the fisheries are not the primary cause of the Steller sea lion's decline and, instead, point to environmental changes (the regime shift that was discussed previously) and increased predation (primarily by killer whales) as the causative agents (for example, see Estes *et al*. 1998, Saulitis et al. 2000).

For many years, investigators have analyzed the available data in a search for conclusive evidence, with no success (Alverson 1991, Ferrero and Fritz 1994, Fritz 1993, Loughlin and Merrick 1989, Merrick *et al*. 1987, Merrick *et al*. 1997, Springer 1992, Trites 1992). Workshops that specifically addressed the issue of the effects of groundfish fisheries on food in the Aleutian Island, Bering Sea, and Gulf of Alaska ecosystems have been held by the Alaska Sea Grant (1993, 2001) and National Research Council (1996) only to conclude that there is no conclusive evidence available to resolve the issue and associated questions.

Suggestions that one or more of the proposed fisheries may compete with Steller sea lions by reducing the abundance of Steller sea lion prey at local scales relevant to individual sea lions raises questions of local depletions. NMFS and others have not been able to conclusively demonstrate that the pollock fisheries depletes the remaining pollock resource or that the pollock biomass remaining in local areas after fishing effort is limiting to Steller sea lions. Nevertheless, assertions that the fisheries compete with Steller sea lions are supported by ecological theory and empirical studies of interactions between fisheries and other, marine vertebrates.

First, there is no "surplus" production in the marine ecosystems waiting for humans to exploit. Therefore, the groundfish fisheries can be expected to reduce the biomass of the various groundfish species that remains in the marine ecosystem of the Bering Sea, Aleutian Islands, and Gulf of Alaska. Reducing the available biomass of the various groundfish species would be expected to reduce the survival and reproduction of other species in the ecosystem that historically depended on those fish for food. Continuously removing groundfish species from the marine ecosystem, reducing their biomass to about half of its pristine levels, and altering the age and size structure of those groundfish species would be expected to affect other members of the marine ecosystem through cascade effects and competition (Odum 1971). Since the fisheries are responsible for these removals, they would be expected to compete with the other organisms that once preyed upon the groundfish species (Chase et al. 2002).

Empirical studies of other marine vertebrates have demonstrated that marine consumers deplete the biomass of their prey on localized scales. Although reductions in biomass at these spatial scales have the shortest duration, they last long enough to affect the foraging success of other, individual consumers of the prey species. In 1963, Ashmole suggested that seabirds could deplete the prey base around their nesting colonies, which would reduce the supply of food available to the entire colony and reduce breeding success by limiting food available to fledglings. Ashmole (1963) called this depletion a "halo" around the colony that contained low densities of prey. Furness and Birkhead (1984) verified this effect with seabird colonies in the North Sea. Furness (1984a) concluded that seabirds can consume almost one-third of the pelagic fish production within 45 kilometers of their nesting colonies, which would place them in competition with commercial fisheries, predatory fish, and marine mammals. Barlow et al. (2002) demonstrated that Antarctic fur seals (*Arctocephalus gazella*) compete with macaroni penguins (*Eudyptes chrysolophus*) for krill (*Euphausia superba*) in the Southern Ocean, that the fur seals appear to have a competitive advantage over the penguins, and that the penguin populations have probably declined as a result of this competition.

Oro and Furness (2002) demonstrated that food supply affects the survival rate and reproductive success of adult kittiwakes (*Rissa tridactyla*) and concluded that fisheries that reduce the food supplies of seabirds would have to be managed to avoid impacting vulnerable seabird and mammal species. Tasker *et al* (2000) summarized numerous studies that demonstrated that, by reducing the available biomass of prey organisms, fisheries indirectly caused populations of several seabird species to collapse. Bjørge *et al* (2002), Goňi (1998), Harwood and Croxall (1988), Jennings and Kaiser (1998), and Yodzis (2001) summarized similar information on the indirect effects of fisheries on seabirds, and marine mammals, each concluding that the fisheries were in "competition" with other marine vertebrates and that populations of those other vertebrates can and have suffered because of that competition.

Based on the body of evidence resulting from studies of the interactions between other fisheries and other marine vertebrates, it seems reasonable to infer that the reductions in the biomass of groundfish species associated with the fisheries in the Bering Sea, Aleutian Islands, and Gulf of Alaska would reduce the food supplies of marine vertebrates in the action area. As a result, these fisheries would be expected to reduce the reproduction and survival of vulnerable populations of marine vertebrates. Although additional studies would be necessary to demonstrate that Steller sea lions, particularly the endangered western population, are vulnerable to the effects of the groundfish fisheries (Harwood and Croxall 1988), the correlation between fishery removals and the foraging areas of Steller sea lions suggest a possible causal relationship. In particular, studies of the sea lions' food habits have identified (1) strong preferences for Atka mackerel (*Pleurogrammus monopterygius*), walleye pollock (*Theragra chalcogramma*), and Pacific cod (*Gadus macrocephalus*); (2) considerable overlap between the sizes of the fish consumed by the sea lions and targeted by the fisheries; and (3) overlap between the depths and geographic locations used by both the sea lions and the fisheries (Ferrero and Fritz 2002). Because of the parallel between these patterns and the patterns that led other investigators to conclude that fisheries were competing with one or more marine invertebrates, we assume that the groundfish fisheries in the action area may compete with Steller sea lions and may have contributed to their population decline.

Research

Steller sea lions have been captured, handled, wounded, and killed during the course of scientific research for almost 50 years (Thorsteinson and Lensink 1962, Calkins and Pitcher 1982, Calkins and Goodwin 1988, and Calkins *et al*. 1994):

- In 1959, 630 sea lion bulls were killed in an experimental, commercial harvest. Life history information (age, size, reproductive condition, food habits) was collected.

- Between 1975 and 1978, researchers shot 250 sea lions in nearshore waters and on rookeries and hauling areas of the Gulf of Alaska. Stomachs were removed and examined for food content, reproductive organs were preserved for examination, blood samples were taken for disease and parasite studies, body measurements were recorded for growth studies, skulls were retained for age determination, tissue samples were preserved for elemental analysis and pelage samples were taken for molt studies.

- In 1985 and 1986, researchers killed 178 sea lions in the Gulf of Alaska and southeastern Alaska to compare food habits, reproductive parameters, growth and condition, and diseases, with the same parameters from animals which were collected in the 1970s. The study was designed to address the problem of declining numbers of sea lions in the North Pacific and particularly in the Gulf of Alaska.

- In 1989, following the Exxon Valdez oil spill, sixteen Steller sea lions were killed as part of the Natural Resources Damage Assessment study.

Since 1956, Steller sea lions have been counted by airplanes, boats, and on foot. By the late 1990s, research activities began to focus on the status and trend of Steller sea lions in the western portion of their range; once the western population of Steller sea lions was identified and reclassified as endangered, research activities began to focus on interactions between the sea lions and commercial fisheries in the Aleutian Islands, Bering Sea, and Gulf of Alaska. In 1995, 7,500 Steller sea lions were disturbed during research activities, but no mortalities were reported. Research activities conducted in 1996 followed a similar pattern, although there was 1 mortality. In 1997, 31,150 Steller sea lions were approached by researchers, 14,550 were disturbed, 137 were captured, and 121 were tagged, but no mortalities were detected or reported. In 1998, 48,000 Steller sea lions were disturbed by these investigations, 384 pups were captured, tagged, and branded, but no mortalities were reported.

Status and Trends of Steller Sea Lion Populations

Numbers of Steller sea lions declined dramatically throughout much of the species' range, beginning in the mid- to late 1970s (Braham *et al*. 1980, Merrick *et al*. 1987, National Marine Fisheries Service 1992, National Marine Fisheries Service 1995). For two decades prior to the decline, the estimated total population was 250,000 to 300,000 animals (Kenyon and Rice 1961, Loughlin *et al*. 1984). The population estimate declined by 50-60% to about 116,000 animals by 1989 (Loughlin *et al*. 1992), and by an additional 15% by 1994 (Sease *et al*., in press).

The decline has been restricted to the western population of Steller sea lions which has declined by about 5% per year during the 1990s. Counts for this population have fallen from 109,880 animals in the late 1970s to 22,167 animals in 1996, a decline of 80% (Hill and DeMaster *in prep,* and based on NMFS 1995, Strick *et al*. 1997, Strick *et al*. *in press*). Although the number of animals lost appears to have been far greater from the late 1970s to the early 1990s, the rate of decline has remained high. The 1996 count was 27% lower than the count in 1990. Results from trend sites between the Kenai Peninsula to Kiska Island indicate a decline of about 9% in nonpups since 1996, and 19% in pups since 1994.

During this same time, the eastern population has remained stable or increased by several percent per year, in Southeast Alaska (Sease *et al*. 1993, Strick *et al*. 1997, Sease *et al*. 1999, Sease and Loughlin 1999), in British Columbia, Canada (P. Olesiuk, Department of Fisheries and Oceans, unpubl. data), and in Oregon (R. Brown, Oregon Department of Fish and Wildlife, unpubl. data). Approximately 60% of Steller sea lions belong to the western stock, 40% to the eastern stock (Sease *et al*., in press). Counts in Russian territories have also declined and are currently estimated to be about one-third of historic levels (NMFS 1992).

Population projections

Population viability analyses have been conducted by Gerber and VanBlaricom (2001), Merrick and York (1994), Taylor (1995), and York *et al*. (1996). While each of these analyses required different assumptions, they provide a context for management and an indication of the severity and urgency of the sea lion dilemma, given the set of assumptions made in the analyses. The results of these analyses indicate that the next 20 years may be crucial for the Steller sea lion, if the rates of decline observed in 1985 to 1989 or 1994 continue. Within this time frame, it is possible that the number of adult females in the Kenai-to-Kiska region could drop to less than 5000. If historic trends continue extinction rates for rookeries or clusters of rookeries could increase sharply in 40 to 50 years, and extinction for the entire Kenai-to-Kiska region could occur in the next 100-120 years.

Integration and synthesis of Species' Status and Baseline

The two listed populations of Steller sea lions appear to be following two different trajectories. The eastern population appears to be stable to slightly increasing, although it is still unclear why this population did not decline as much as the western population and why it appears to be recovering at a faster rate. The endangered western population of Steller sea lions, however, still has a higher risk of extinction in the foreseeable future. The western population has declined by about 90 percent since the early 1970s and continues to decline throughout its range. This population is declining for many reasons and may now face threats that are different from the ones that caused the populations' initial decline. From the 1950s through the 1980s, animals from this population were killed intentionally and unintentionally by fishers, in commercial harvests, and in subsistence harvests which may have begun to destabilize the population. The harvest of over 45,000 pups from 1963 to 1972 probably changed the number of animals that recruited into the adult, breeding population in that region and contributed to local population trends in the 1960s through the early 1980s in the Gulf of Alaska and the eastern Aleutian Islands. Similarly, subsistence harvests prior to the 1990s were not measured but may have contributed to population decline in localized areas where such harvests were concentrated.

There is general scientific agreement that the declines of the western population of Steller sea lions results primarily from declines in the survival of juvenile Steller sea lions (Alaska Sea Grant 1993, 2001, National Research Council 1996). There is also general scientific agreement that the cause of the decline in the survival of juvenile Steller sea lions probably has a dietary or nutritional cause. There is much less agreement on the cause or causes of the recent declines and whether fishery-induced changes in the forage base of Steller sea lions have contributed to and continues to contribute to the decline of the Steller sea lion.

In the mid-1970s, portions of the North Pacific Ocean experienced major changes in ocean temperatures that probably contributed to a shift in the trophic structure of the fish community in the Aleutian Islands, Bering Sea, and Gulf of Alaska. This shift may explain the shift from marine systems dominated by herring and capelin to systems dominated by pollock and flatfish. At the same time, the marine ecosystems of the Aleutian Islands, Bering Sea, and Gulf of Alaska experienced the development and expansion of major fisheries for species that were important in the diets of sea lions. The fisheries probably contributed to changes in the trophic structure of these ecosystems, but as is the case with natural changes, the extent of these fisheries-related can not be determined with the available information. To date, neither our research activities nor our management regimes are structured to distinguish natural change from fishery-related effects on these ecosystems.

Nevertheless, based on the body of evidence resulting from studies of the interactions between other fisheries and other marine vertebrates, it seems reasonable to infer that the reductions in the biomass of groundfish species associated with the fisheries in the Bering Sea, Aleutian Islands, and Gulf of Alaska would reduce the food supplies of marine vertebrates in the action area. As a result, these fisheries would be expected to reduce the reproduction and survival of vulnerable populations of marine vertebrates. Although additional studies would be necessary to demonstrate that Steller sea lions, particularly the endangered western population, are vulnerable to the effects of the groundfish fisheries (Harwood and Croxall 1988), fisheries in the action area consistently target important prey resources at times and in areas where sea lions forage and may compete with Steller sea lions and contribute to the decline of this population. However, a chain of causation that links the fisheries to the sea lion's decline has not been described.

In the face of all these changes and influencing factors, the western population of Steller sea lions has not been able to maintain itself. The available evidence suggests that a significant part of the problem is lack of available prey. Studies of animals collected in the Gulf of Alaska in 1975-1978 and 1985-1986 indicate that animals in the latter collection were smaller, took longer to reach reproductive maturity, produced fewer offspring, tended to be older, and exhibited signs of anemia. In addition, survival of juvenile animals appeared to have dropped in both the eastern Aleutian Islands (Ugamak Island; Merrick *et al*. 1987) and the Gulf of Alaska (Marmot Island; Chumbley *et al*. 1997).

As discussed earlier, several population viability analyses for Steller sea lions have been conducted (Gerber and VanBlaricom 2001, Merrick and York 1994, Taylor 1995, York *et al*. 1996). The results of these analyses suggest that the next 20 years may be crucial for the western population of Steller sea lions, if the rates of decline observed in 1985 to 1989 or 1994 continue. Within two decades, it is possible that the number of adult females in the Kenai-to-Kiska region could drop to less than 5,000. Once the western population of Steller sea lions crosses this threshold, the small population size, by itself, could accelerate the populations' decline to extinction. Extinction rates for rookeries or clusters of rookeries could increase sharply in 40 to 50 years and Steller sea lions could become extinct throughout the entire Kenai-to-Kiska region in the next 100-120 years. Based on these analyses, it is not reasonable to expect the western population of Steller sea lions to survive the various human-caused threats that led to their listing as an endangered species if these threats are not abated in the immediate future. Therefore, additional research is warranted because we need to better understand the causes of decline of the western population.

Effects of the Proposed Actions

As discussed previously, this biological opinion assesses the effects of NMFS' proposal to issue permits (under the Marine Mammal Protection Act and Endangered Species Act) that would allow various investigators to harass, harm, pursue, capture, shoot, would, kill, trap, or capture Steller sea lions for research purposes.

In this section of a biological opinion, NMFS assesses the probable direct and indirect effects of these activities on the threatened eastern population of Steller sea lions and the endangered western population of Steller sea lions. The purpose of this assessment is to determine if it is reasonable to expect that the proposed research permits, individually or collectively, will have direct or indirect effects on threatened and endangered species that appreciably reduce their likelihood of surviving and recovering in the wild (which is the jeopardy standard established by

50 CFR 402.02). Since the proposed permits are not likely to adversely affect critical habitat that has been designated for Steller sea lions, critical habitat will not be addressed further.

NMFS generally approaches these analyses by first evaluating the available evidence to identify the direct and indirect physical, chemical, and biotic effects of a proposed action on individual members of listed species or aspects of a species' environment. Once these effects have been identified, NMFS then evaluates the available evidence to identify a species' probable responses (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). NMFS then uses the evidence available to determine if these reductions, if there are any, would reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

1. Effects of aerial surveys

Aerial surveys can be expected to disturb virtually every member of the eastern and western population of Steller sea lions (because an estimated 275,000 Steller sea lions are expected to be disturbed by these surveys, individual animals will be disturbed multiple times each year, see Table 1). Calkins and Pitcher (1982) found that disturbance from aircraft and vessel traffic has extremely variable effects on hauled-out sea lions ranging from no reaction at all to complete and immediate departure from the haulout. Reactions ranged from none to complete and immediate departure from the haulout, i.e. a stampede. When sea lions are frightened off rookeries during the breeding and pupping season, pups may be trampled or, in extreme cases, abandoned. Juvenile and adult animals can also be injured during stampedes as animals run over each other or slide or crash into cliff facings or underwater rocks in their haste to escape the researchers. The flight response in pinnipeds has been described as "unrelenting and reckless" such that animals that are chased before capture (or which flee in response to the presence of researchers or low-flying aircraft) are placed in significant jeopardy, not only from the excessive metabolic heat generated from the flight itself, but also from a variety of potentially dangerous situations encountered in their escape attempts (Sweeney 1990). In two separate instances, captive sea lions jumping from elevations of 4-5 feet landed on their chest areas, rupturing the brachiocephalic vein located in the left shoulder area (Sweeney 1990). The hemorrhage resulting from this injury was fatal for one animal and severely debilitating in the other. Jaw fractures, which could impede feeding, are also a common result of the flight response. In the absence of adequate post-activity monitoring, such serious injuries or deaths would not be recorded.

Sea lions have temporarily abandoned haulouts after repeated disturbance (Thorsteinson and Lensink 1962), but in other situations they have continued using areas after repeated and severe harassment. Johnson *et al*. (1989) evaluated the potential vulnerability of various Steller sea lion haulout sites and rookeries to noise and disturbance and also noted a variable effect on sea lions. Kenyon (1962) noted permanent abandonment of areas in the Pribilof Islands that were subjected to repeated disturbance. A major sea lion rookery at Cape Sarichef was abandoned after the construction of a light house at that site, but the sea lions used the site as a haulout after the light house was no longer inhabited by humans. The consequences of such disturbance to the overall population are difficult to measure. Disturbance may have contributed to or exacerbated the decline, although Federal, State, and private researchers familiar with the data do not believe disturbance has been a major factor in the decline of Steller sea lions.

The incidence of stampedes in response to aerial surveys flown as described in the application are not known. Researchers report that only a small percentage (less than 1%) of sea lions have been observed to be affected by the approaching survey planes. Using these results, of the 60,000 to 120,000 Steller sea lions that might be disturbed during aerial surveys, between 600 and 1,200 sea lions would respond.

2. Effects of ground counts

About 42,000 Steller sea lions in both the eastern and western populations would be disturbed during ground-based counts (as discussed previously, it is not clear whether specific rookeries or haulouts would be disturbed more than others). Like reactions to aerial surveys, reactions to ground-based counts can be expected to range from none to complete and immediate departure from the haulout, i.e. a stampede.

Parturition in Steller sea lions occurs from mid-May until mid-July, with the highest frequency of births occurring mid-June. As a result, the majority of pups on a rookery at the time these ground counts occur would be a few days to six weeks old, depending on the timing. Because the motor skills of pups at this age are not as well developed as in older pups, they would likely be unable to move out of the way and may get trampled or knocked into the water if adults stampeded. Young pups are not adept swimmers and are usually unable to climb the rocky cliffs common to many rookeries. Even pups who are successful at climbing back onshore may suffer subsequent hypothermia and respiratory complications as a result of aspirating water while being tossed about in intertidal waves.

If researchers have not identified which mothers are in attendance and which are at sea, there is no way to determine whether a pup has been abandoned as the result of the disturbance unless they remain to monitor the rookery for several days. Foraging trips of lactating females may last several days or more (Brandon 2000). Even if mother-pup pairs have been identified, if researchers do not monitor a rookery after the disturbance until all the adult females that entered the water return to their pups, it will not be possible to determine if pups have been abandoned as a result of the disturbance. Fostering is very rare in Steller sea lions, thus the majority of abandoned pups will starve to death. Further, if pups (or adults) were injured during a stampede, they may not die from their injuries immediately. Death may not occur for several days, or weeks, in the case of infections or hemorrhages resulting from injuries, or injuries that affect an animal’s ability to forage.

Steller sea lions in Alaska demonstrate site fidelity with respect to rookeries. The arrivals of males and pre-parturant females are closely timed and fairly predictable from one year to the next. Large males of reproductive age are usually the first to arrive, establishing territories by aggressive competition with other males. Presumably, the holders of the "best" territories gain access to more females, and are therefore more successful at mating. When adult animals are displaced from the rookery during breeding season at least some males will likely have to re-establish their territories by fighting with other males. As a result, each disturbance that displaces the males from their territories increases the likelihood of aggressive interactions among males and the possibility of injury. Adult male Steller sea lions have large canines and powerful jaws and are capable of inflicting serious puncture and laceration wounds on opponents. These wounds may become infected. In addition, other sea lions on the rookery, including pups, may be injured during these aggressive competitions among males. Along with the possibility of physical trauma, the heightened aggressive interactions and resulting psychological effects can result in secondary disease manifestations (Sweeney 1990).

The magnitude of the disturbance effects on the animals may be affected by the number of personnel who come ashore, the amount of time the rookery or haulout is occupied by researchers (which usually means the amount of time the animals remain in the water or the pups are separated from their mothers), the frequency of these disturbances (both between and within years) and the timing of the disturbance (with respect to breeding, pupping, etc.).

3. Effects of incidental disturbance during scat collection, capture, and observational activities

About 39,250 Steller sea lions from both the eastern and western populations would be disturbed each year when researchers enter rookeries or haulouts to collect scat, capture individual animals, and conduct behavioral observations. This typically disturbs animals in the same way, and has the same potential affects, as described for ground counts above (as discussed previously, it is not clear whether specific rookeries or haulouts would be disturbed more than others). The majority of scat collection coincides with other shore-based activities, so disturbance is often incidental to these activities rather than the direct result of the scat collection itself, with the exception of some samples collected in winter when no capture activities are planned.

4. General Effects of Capture and Restraint

"Restraint procedures constitute one of the most stressful incidents in the life of an animal, and intense or prolonged stimulation can induce detrimental responses (Fowler 1978)." Each restraint incident has some effect on the behavior, life, or activities of an animal. A variety of somatic, psychological, and behavioral stressors can be associated with capture and restraint of wild animals. These include strange sounds, sights, and odors, the effects of chemicals or drugs, apprehension (which may intensify to become anxiety, fright, or terror), and territorial or hierarchical upsets associated with displacement of animals by researchers who come onto rookeries and haulouts. Animals that are stressed can incur contusions, concussions, lacerations, nerve injuries, hematomas, and fractures in their attempts to avoid capture or escape restraint (Fowler 1978). The stress response can change an animal's reaction to many drugs, including those commonly used for chemical restraint, which can have lethal consequences. The annual reports from the current and previous permits held by NMML and ADF&G indicate that some animals showing distress and/or adverse reactions to drugs or handling that were not immediately released, subsequently died. Continuous stimulation of the adrenal cortex, as from stress associated with chronic disturbance or repeated capture, can cause muscle weakness, weight loss, increased susceptibility to bacterial infections, and poor wound healing, and can lead to behavioral changes including increased aggressive and antisocial tendencies (Fowler 1986). Capture myopathy is a possible consequence of the stress associated with chase, capture, and handling in numerous mammal species (Fowler 1978). Capture myopathy is characterized by degeneration and necrosis of striated and cardiac muscles and usually develops within 7 to 14 days after capture and handling. It has been observed both in animals that exert themselves maximally and those that remain relatively quiet, and occurs with either physical or chemical restraint. Fear, anxiety, overexertion, repeated handling, and constant muscle tensions such as may occur in protracted alarm reaction are among the factors that predispose an animal to this disease. A variety of factors may function in concert or individually. The muscle necrosis is likely due to acidemia resulting from a build up of lactic acid following profound muscle exertion: once necrosis has occurred, the prognosis for recovery is not favorable. The number of times an animal is captured, the method(s) of restraint, as well as the age and general condition of the animal are all factors that will affect an animal's response to capture.

5. Effects of Chemical Immobilization (General Anesthesia/Sedation)

A fairly high mortality rate caused by anesthesia has been reported in otariids (Gage 1993). Delivery of anesthesia in pinnipeds can be complicated by their particular anatomical and physiological specializations to the marine environment and by the logistics of working with wild animals. Determining the proper dose is dependent on a fairly accurate assessment of the animal's weight and condition, as miscalculation of an animal's weight can lead to an overdose, which can have lethal consequences (Fowler 1986). The typical induction time for most chemical restraint agents is 10 to 20 minutes following intramuscular injection. As a result, darting can be dangerous because it can spook an animal into the water before the immobilization has taken affect, which can result in drowning. In February 1993, under Permit No. 771 (64), an adult female darted with Telazol died.[4].

The safest injection site for projectile syringes (darts) are in the deep muscle areas of the hind limbs (Scott and Ayars 1980). However, the blubber layer on pinnipeds can make delivery of an injectable drug into the muscle, where needed for proper absorption and distribution, difficult. In addition, inadvertent injection of drugs into the blubber frequently results in aseptic necrosis, sometimes leading to large abscesses (Geraci and Sweeney 1986). Injections into the chest cavity or stomach region can result in puncture of the lungs or stomach, which may kill the animal. In February 1993, under Permit No. 771(64), issued to NMML, a pup that was accidentally darted with Telazol when it unexpectedly moved in front of the target adult animal died, apparently as a result of inadvertent intravenous injection of a drug intended for

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[4] Memorandum for the Record from R.L. Merrick, dated 10 March 1993, RE: Steller sea lion mortalities during field work, February 1993. Permit No. 771(64)

intramuscular administration in a larger animal.[5] According to the report, the dart struck on the left flank, about 5 inches forward of the hip and about 2 inches off the spine, which apparently, as indicated by necropsy, entered the kidney, effectively causing an intravenous injection. Necropsy also revealed slight trauma to the kidney. The pup had also regurgitated approximately a liter or more of milk following the darting and may have aspirated some, which could have contributed to the death.

Hyperthermia (over-heating) can occur in animals under anesthesia because the blubber layer can make heat dissipation a problem, even at ambient temperatures that are comfortable for the researchers: otariids over 25 kg tend to become hyperthermic during anesthesia (Gage 1990). Hypothermia can also occur in sedated animals, during anesthesia or post-recovery, as many drugs can affect thermoregulation. In hypothermia, the reduction in body temperature reduces tissue metabolism, while hyperthermia increases it. Both of these can have implications for the animal's reaction to any drugs administered, as well as any pathological conditions that may exist.

In one study bout 10% of animals induced with Telazol (tiletamine-zolazepam) or gas were observed to become apneic (stop breathing) within five minutes of induction (Gage 1990). Tiletamine is a cyclohexamine, which is a dissociative anesthetic that induces catatonia. It also has an analgesic effect through its action on the spinal cord, but it does not block visceral pain. Both hyperthermia and hypothermia are possible consequences of immobilization with tiletamine, depending on ambient temperatures. Respiratory depression is also possible, as is hypersalivation, which can lead to choking or aspiration of fluid. There is an excitatory phase seen with tiletamine characterized by occasional muscle spasms resembling seizures, due to spinal reflex firings, which can be minimized by using tiletamine in combination with diazepam. Zolazepam is a benzodiazepine, or antianxiety drug, that has a sedative effect and is a skeletal muscle relaxant. Zolazepam slightly depresses cardiovascular function. Both tiletamine and zolazepam are excreted in the kidneys and are contraindicated in animals with severe renal or hepatic disease. The safety of these drugs is adversely affected in animals that are ill, stressed, or which have suffered from physical exertion (e.g. have been chased) prior to administration of the drug. There is no antidote (reversal agent) for tiletamine. Diazepam, which is a benzodiazepine similar to zolazepam, is metabolized slowly, with clinical effects typically disappearing within 60 to 90 minutes (Fowler 1986). There is a reversal agent for zolazepam, flumazenil. However, because zolazepam is used in combination with tiletamine to reduce the effects of the excitatory phase, reversing the effects of zolazepam in the absence of a reversal agent for tiletamine could result in convulsions and other side effects.

Inhalation anesthetics such as isoflurane gas are used to induce anesthesia in animals that can be manually restrained, and are commonly used to augment analgesia or increase the depth of anesthesia in animals previously immobilized by injectable agents. Prolonging immobilization by administering repeated doses of injectable agents is associated with a high risk of mortality,

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[5] Memorandum for the Record from R.L. Merrick, dated 10 March 1993, RE: Steller sea lion mortalities during field work, February 1993. Permit No. 771(64)

and an additional dose of Telazol should never be given (Gage 1990).[6] Isoflurane, a halogenated ether with potent anesthetic action (Stedman's Medical Dictionary 2000), is an inhaled general anesthetic that induces reversible depression of the central nervous system, resulting in unconsciousness, analgesia, voluntary muscular relaxation, and suppression of reflex activity (Fowler 1986). Isoflurane is especially useful for short procedures in which rapid recovery and few aftereffects are desirable. The effects of inhalation anesthetics increase predictably with increased dose, unlike injectable agents, which tend to be unpredictable and idiosyncratic among animals (Fowler 1986). In general, captive animals have been observed to fully recover from anesthesia with isoflurane after 8 hours (Gage 1990). Isoflurane gas appears to have the best recovery characteristics, and be safe and reliable, in otariids (Haulena and Heath 2001).

6. Effects of blood collection (venipuncture)

The risks of blood collection are largely incidental to capture and restraint, as are described above. However, multiple attempts to obtain a blood sample are not only stressful and cause some degree of pain, they can result in damage to the vein, clotting, and abscess. Removing a volume of blood too large relative to the animal's mass and ability to replace what was taken can result in fatigue, anemia, weakened immunity, and problems with clotting.

7. Effects of skin and blubber biopsy

Skin and blubber biopsies will be taken from about 825 Steller sea lions in both the eastern and western populations. Biopsy sampling would require animals to be captured and restrained for the sample. Biopsy samples can produce wounds that, as with any wound, has the potential for infection after any of these procedures, particularly given the unsanitary environment of the rookeries. An otherwise healthy animal should be able to heal and recover from a properly performed procedure, but animals with compromised immune systems may develop major complications.

8. Effects of muscle biopsy

Muscle biopsies will be taken from Steller sea lions in both the eastern and western populations each year (biospy samples may be taken from individual animals between 2 and four times each year). The small diameter of the puncture created by the biopsy, combined with the depth of the biopsy, should cause a wound that would tend to close on the surface prior to deep tissue healing. This increases the chances of abscess formation, particularly if the biopsy needle or dart was not properly sterilized. Biopsy wounds, as with any wounds including those acquired during intra-species aggressive interactions, can become contaminated despite use of sterile equipment. Therefore, leaving the wound open to drain should an abscess form, rather than suturing closed, is preferable. As with skin and blubber biopsies, unhealthy animals or those with compromised immune systems may develop major complications from such an infection. The potential

[6] Note that several of the animals that died under previous permits issued to ADF&G were given repeat injections of medetomidine and/or ketamine, the injectable agents used to immobilize them. See annual reports for Permits No. 771 and 965.

adverse effects of this procedure include more than momentary pain, risk of infection, and the stress and risks associated with capture and restraint, as described above.

9. Effects of ultrasound

This procedure, by itself, poses no risk of injury to an animal. The greatest risk associated with this procedure occur when animals are captured and restrained for the procedure (see discussion above).

10. Effects of fecal loops and culture swabs

Fecal loops and culture swabs will be taken from about 1,550 Steller sea lions in both the eastern and western populations, although individual animals will be subjected to this procedure several times during a season. The potential adverse affects relate primarily to the risks of capture and restraint, as described above. In addition, there is the slight potential to introduce or spread infection if the loops and swabs are not used properly. There is the potential for perforation, and subsequent infection, when fecal loops are inserted into the rectum. There is the possibility for damage to the cornea of the eye if ocular swabbing is done incorrectly. When performed by a qualified, experienced person using commonly accepted standards of good practice, these risks are likely negligible.

11. Effects of tooth extraction

A tooth will be extracted from about 720 Steller sea lions in both the eastern and western populations. The potential adverse effects of tooth extractions relate to the risks of capture, anesthesia, and the possibility of infection following extraction. The procedure may result in more than momentary pain, which could temporarily interfere with the animal's ability to forage. However, there are no data on the long-term effects of this procedure.

12. Effects of collecting vibrissae, hair, and nails

The whiskers (vibrissae), hair, and nails will be clipped or pulled from about 480 Steller sea lions from both the eastern and western populations. Clipping whiskers, hair and nails is not likely to result in any pain. The effects on the animal of clipping a whisker, toenail or patch of hair or pulling a whisker are probably largely incidental to the effects of capture and restraint.

13. General effects of marking (e.g., flipper tags and branding)

Measures of natality and rearing success, sex and age ratios, mortality, and survival are important indicators of population health. Studies of these vital rates are often facilitated by the ability to recognize individual animals in a population. For example, although natality can be estimated by counting newborns, observing deaths is more difficult and is therefore usually estimated using mark-recapture techniques that use mathematical formulas to correlate capture probability with survival rates. Mark-recapture studies require that individual animals be easily recognized. In a large number of marine and terrestrial species, natural marks have been and are used to identify individual animals. For example, individual humpback whales can be recognized by the patterns of pigment on their tail flukes, right whales are known by their callosities, lions have been identified by vibrissae patterns (Pennycuick and Rudnai 1970), and individual differences in appearance have been used to identify dolphins (*Tursiops truncatus*) and several primate species. In general, the use of natural marks and individual appearance requires familiarity with the subject animals, which typically means many hours of personal observation. When the use of natural marks to identify individual animals is not suitable or practical for achieving study objectives, there are a variety of methods for marking animals available. Marking devices can be divided into temporary, semi-permanent, and permanent. Although the permit holders and applicants have only requested authorization for the use of flipper tags, hot-branding, and various scientific instruments as methods for identifying individual sea lions, the Permits Division anticipates additional permit applications that may request authorization for alternative, less intrusive methods of marking, including the use of bleach/dyes in place for temporary marks and freeze-branding for permanent marking. Therefore, the effects of these methods are also described.

Temporary marks: Paints, bleaches, and dyes have been used successfully to temporarily mark Steller sea lions and other pinnipeds. The duration of the mark depends on, among other things, the type of paint or dye used, and the season applied, because all pinnipeds molt (shed their coats) annually. As a result, paints and dyes can be used to identify individuals for weeks to months. Paint marks can be applied remotely using a paint gun that fires pellets filled with pigment that burst on impact and leave a spot on the animal's fur. This method does not allow use of alphanumeric characters and is therefore not practical when other than the crudest of marks are needed. In addition, it may be very difficult to get the paint to adhere to the fur sea lions. If animals can be captured and restrained, bleaches and dyes can be used to make unique alphanumeric marks on their fur. This method likely involves more stress to the animal than remote marking, and may cause incidental disturbance of conspecifics. However, the marks can be made large enough to be easily read from a distance, making it unnecessary to recapture the animal for identification, or cause additional disturbance to conspecifics. A variation on painting or dying the animal's fur is to capture animals and glue (using epoxy) a colored tag to their fur. This tag would fall off when the animal molts, and could have unique alphanumeric information written on it that could be read if researchers could get close enough or recapture the animal. Attaching a scientific instrument that emits a unique signal to the fur is also a method of temporary marking that has been used in a variety of species, including Steller sea lions.

Semi-permanent marks: There are numerous plastic, aluminum, and plated-steel tags available in a variety of colors, sizes, and identifying symbols that can be affixed to animals to allow identification of individuals. All of these techniques require capture and restraint of the animal. Plastic cattle ear tags have been used for many years to mark numerous pinniped species, including Steller sea lions. The tags are attached through the flippers. While these tags may remain attached for the life of the animal, they can and do pull out. In addition, they can become faded or otherwise difficult to read over time. These plastic tags cannot necessarily be read from as a great a distance as large paint or dye marks, thus recapture of animals may be required for positive identification of individuals. However, when the study objectives require identification of individuals for longer than a few months or a season, or when animals will need to be recaptured for other reasons, plastic tags are the alternative of choice for many researchers. Another method of identifying individual animals is to attach scientific instruments, such as VHF and satellite transmitters, that broadcast signals on unique frequencies and allow tracking of animals or remote monitoring of their movement and activities. In pinnipeds, these tags are glued to the fur, or affixed to plastic tags that are attached through the flippers. These are considered temporary (if glued to fur) or semi-permanent (if affixed to flipper tags) because they will fall off when the animal molts or be lost when the flipper tag pulls out. In addition, the life of the tag is limited by the battery capacity, which, in turn, is limited by the size of the tag.
As described above, flipper tags are best considered semi-permanent markers as they can and do pull out because sea lions use their foreflippers in both aquatic and terrestrial locomotion. In addition to the effects of capture and restraint as described above, it is likely that affixing these tags to the flippers of sea lions causes more than momentary pain. When the tag is affixed there is the potential for infection at the wound site, particularly because the environment on the rookery is not aseptic and because the activity of the animal may prolong or prevent healing by producing repetitive stress on the wound. There is also the potential for infection when a tag pulls out of the flipper, for whatever reason. In moving about on a rookery or haulout, or swimming, there is the potential for a tag to be torn out of the flipper by abrasion on the substrate or by hydrodynamic pressure (Fowler 1986). There is no information on long-term tag retention or average retention rates in the annual reports from NMFS permits holders who use these tags on Steller sea lions. There is also no quantitative information on the rate of infection caused by

flipper tagging. Both applicants report that tag-related mortality does not add significantly to natural mortality.

Merrick et al. (1996) report that flipper tags can become difficult to read as the colors and markings on them fade over time and that they are not readily visible from any distance, partially because the gregarious nature of sea lions causes them to group together and obscure the flippers.

In addition to the effects of capture and restraint described above, the attachment of an instrument can have both short- and long-term adverse effects. Possible chronic, short-term effects can include a reduction in foraging activity or an increase in grooming at the expense of other behaviors (Kenward 1987). These types of effects are likely present after most tagging events and may be as much a delayed result of the capture and handling as of the tag's presence. Short-term effects can lead to acute problems for animals of various species: the presence of a tag has exacerbated capture shock and led to death in hares; the disturbance of tagging has resulted in desertion by incubating birds; abandonment or rejection of young in birds and ungulates was seen following tagging; and tagging may be enough to stop a dispersing animal from securing a territory, or push an animal over the brink of starvation when food is short (Kenward 1987). The hydrodynamic drag created by the instrument can exert an additional energetic demand on an animal which could, over time, result in reduced foraging success, increased metabolic load, and resultant stress to the animal. Reactions of pinnipeds fitted with Crittercams ranged from apparent curiosity about the instrument, to attempts to dislodge it, and aggressive reactions (Marshall 1998). The attachment of instruments to the hair with epoxy should not cause any pain if done properly, but may result in discomfort if the placement of the instrument causes pulling of the hair or skin as the animal moves. In addition, if the ratio of resin and catalyst is not correctly measured, the resultant exothermic (heat-producing) reaction can burn the animal's skin. Both the resin and hardener (catalyst) can cause skin irritation (itching, rashes, hives) and prolonged or repeated skin contact may cause sensitivity (itching, swelling, rashes). The low vapor pressure of the resin by itself makes inhalation unlikely in normal use. There is the possibility that an instrument could be knocked or torn off, pulling out the hair and/or some of the underlying skin, which would then be open to infection.

Permanent marks: When study objectives require recognition of individual animals for more than a season or a few years, temporary or semi-permanent marks must be re-applied, or a permanent mark can be used. As discussed above, applying both temporary and semi-permanent marks usually requires capture and restraint of the animal. Given that each capture event is stressful, and has the potential to injure the animal, when the objective is only to have animals that can be individually recognized from a distance, it is more advantageous to apply a permanent mark from the start. Using permanent marks is also favored over re-applying temporary marks when the interval between capture events is longer than the duration of the temporary mark. Hot brands have been used for many years to permanently mark domestic livestock and some species of wildlife, including Steller sea lions and other pinnipeds. Cryo-branding, or freeze branding has also been used successfully to permanently mark numerous species, including white-tail dear, horses, and harbor seals.

Freeze branding is considered by some to be more acceptable for marking wildlife than hot branding because, if done correctly, there is a negligible risk of infection (Day et al., 1980). In the 1993 EA on the effects of branding, hot-branding was said to be preferred over freeze branding because freeze branding required longer restraint times that could result in increased stress on the animals. There was also concern about the safety of using anesthesia to restrain the sea lions. The NMML and ADF&G have been using isoflurane gas to anesthetize Steller sea lions for many years, with few complications. Since the animals being hot-branded under existing permits are anesthetized, a longer restraint time would not necessarily result in more stress. However, the use of anesthesia is not entirely without risks, and the risk of adverse effects increases with the duration of use. As a result, if pups needed to be under anesthesia for significantly longer for freeze-branding than for hot-branding, the risk of adverse effects from anesthesia might outweigh the potential benefit of decreased risk of infection from freeze branding. In addition, if it takes significantly more time to freeze-brand Steller sea lions than to hot brand the same number of animals, the rookeries would be disturbed for longer, or fewer animals would be marked. The applicants state it currently takes about one minute per animal [exclusive of preparation time and anesthesia] to apply a four-character hot-brand.

There are two techniques for producing a freeze brand. One method involves application of a coolant, such as liquid nitrogen, to destroy the pigment cells in an area such that unpigmented hair grows back. The other method also uses a coolant, but the contact time is longer such that a "bald" brand where hair does not grow back, similar to a hot brand, results. To produce the best results on animals with lighter pelage, a bald brand is preferred. There is more preparation required for producing bald freeze brands than hot brands. To achieve optimal results, the area to be branded must be clipped or shaved and the skin swabbed with methylated spirits (an alcohol/glycerin mixture). The freeze branding tool then needs to remain in contact with the animal's skin for 25-60 seconds per character to produce a bald brand (Hobbs and Russell 1979) versus 2-4 seconds per character for a hot brand (Merrick et al. 1996). As a result, freeze branding could take several minutes longer per animal than hot branding due to the extra preparation of the fur and the longer contact times required for a bald brand. The 1993 EA also found that freeze branding was less preferable than hot branding because of concerns about the visibility of freeze-brands on the "light" pelage of Steller sea lions and evidence that freeze brands may disappear over time and with molting. However, freeze-brands have been effectively used on a variety of livestock, including light-colored horses, as well as cetaceans, sirenians, and pinnipeds, including light-colored harbor seals. In a study on spatial structure of harbor seals in Sweden, 163 harbor seals were freeze-branded as pups (less than one year old) and juveniles/young adults (1-4 years old) and tracked for up to 14 years, including during periods of molting (Härkönen and Harding 2001).

The practicality of hot-branding as a means of permanently marking pinnipeds in the wild has been demonstrated in several studies. However, there has been insufficient resight effort of the more than 15,000 sea lions branded by ADF&G and NMML since 1975 to validate the merits of hot-branding versus the potential for adverse impacts to individual sea lions. Further, cryo-branding or freeze branding is considered by some to be more acceptable for use in marking wildlife because, when done correctly, there is virtually no chance of infection (Scott and Ayars 1980). In addition, no pain reactions were observed in cetaceans during the freeze-branding procedures (Needham 1993). The applicants state there is no evidence suggesting increased mortality of pups after branding.

In addition to the possible adverse effects of disturbing a rookery, as described for pup counts above, the branding activity itself has the potential for adverse effects. To achieve the desired scarring, the burns must be second-degree, although third-degree burns are possible if the branding is done improperly. As a result, hot branding produces an acute burn wound involving a varying thickness of the skin and underlying tissue. This procedure, when performed correctly, produces 2^{nd} degree burns (i.e., burns that penetrate the entire outer layer of the skin and into the inner skin layer, characterized by formation of blisters, swelling, and fluids seeping from the burned area). For a one-week old pup measuring 95 cm standard length and 65 cm axillary girth, the total area affected is less than 2% of the animal's skin surface.

The degree of trauma caused by a brand will depend on a variety of factors including the temperature of the branding iron, the pressure with which the brand is applied, the time for which the iron is applied, the position of the brand, the condition, immunological status and behavior of the animal during and after the branding event, and infection rates and types (Gales 2000). Because it is difficult to control for many of these variables in the field, a wide range of wound healing scenarios can be expected. The procedure likely causes more than momentary pain, and there is the potential for infection of the burned area, especially because the environment on rookeries and haulouts is not aseptic.

Further, in order to facilitate branding a large number of pups, researchers gather them into large groups for processing. Moving pups into large groupings and leaving them this way can result in deaths by suffocation as smaller, younger or weaker animals may become buried under others. Some injuries to pups left in these centralized piles may occur when the adult females return to the rookery. Female Steller sea lions are very discriminating about suckling their pup, and only their pup. Females have been observed to grab and toss pups who have come too close and that are not theirs. If the pup lands too close to another lactating female that is not its mother, it may get tossed again. As noted above, very young pups are not well able to move away from hostile females because their motor skills are not sufficiently developed. Females have also been observed to fight over ownership of a pup following disturbance, by tugging it back and forth between them. Pups sustain injuries during these episodes. On a rookery, females choose and defend "territories" in which they give birth and nurse their young. Females with newborn and very young pups defend their pups, and their space, aggressively. When females with young pups leave on foraging trips the young pups do not usually move far from the spot where their mother left them. As a result, when adults are driven from the rookery and pups are placed in large groups in central locations for branding or other research activities, the potential for injury to or abandonment of pups as females return ashore is greater than if they were left more widely spaced or near their original spots.

Following discovery of elephant seals with open, weeping and infected wounds caused by hot brands, the Australian Environment Minister ordered an end to hot branding on sub-Antarctic Macquarie Island. Branded "weaners" - newly weaned elephant seals, were found to be almost three times as likely to be in poor physical condition as their unbranded counterparts

(Environment News Service 2000). The Antarctic Animal Ethics Committee (AAEC) also expressed concern over the high proportion of one year old seals with unhealed brands, the proportion of animals that reportedly could not be identified by their brands, and the error rate reported in the transcription of brands.[7] The AAEC states that an animal that cannot be recognized by its brand is "obviously an animal that has suffered unnecessarily." In a review of the Macquarie Island elephant seal hot branding program it was found that: (1) the majority of brands (50.2%) were healed, but had some component of excessive scarring, (2) 19.8% of brands had an "unhealed component that was open, but with no discharge from the wound, and (3) 1.7% of the brands had an open, discharging (pus or blood) component to the wound (Gales 2000). The proportion of unhealed brands was higher in younger animals: 54.4% of animals in the one year old age class had unhealed wounds compared to 35.3% of one to three year olds. This report further stated that the wounds, both healed and unhealed, were characteristic of processes that have led to excessive superficial scarring and that the protracted chronic nature of the healing process raises concerns about the potential of this methodology to adversely affect the welfare and fitness of the elephant seals.

In 1993, 399 Steller sea lion pups were branded on Forrester Island in Southeast Alaska. Four to five days after branding six dead, branded pups were collected during pup counts. Necropsy revealed blunt trauma as the probable cause of death for two of the pups, and starvation was the likely cause of death for the other four. Although the pathologist stated that these deaths could not be linked to branding, it is not apparent how this possibility could be ruled out. In a subsequent report from the permit holder, it was stated that it was unclear whether branding operations contributed to abandonment of pups, and their subsequent starvation. An additional 36 dead pups were recovered on this rookery 4-5 days after branding. Five of these pups were from a growth study in which pups were marked to be recaptured regularly for weighing and other measurements: at least four of these pups appeared to have starved, possibly as the result of abandonment. Of the remaining 26 dead pups, 1 was still born, 3 were neonatal deaths of unknown cause, 15-16 were emaciated and probably starved to death, 4 died of trauma, 1 from pneumonia, and 1 drowned. The possibility that the deaths of the emaciated animals, or those that died from trauma, pneumonia or drowning were related to the branding and research activities cannot be ruled out.

In a recent (June 2001) branding of Steller sea lion pups on rookeries in Oregon (under Permit No. 782-1532), approximately 1/3 of the pups present were captured and branded. Several days later 7 pup carcasses were observed on the rookery: 6 of the dead pups were branded. It is not known what percentage of these mortalities could be attributed to the research activities vs. natural causes. Necropsy indicated that one of the dead branded pups probably died as the result of trauma associated with a bite wound on the head.[8] An additional dead pup was recovered during the branding operations whose death was believed to be due to suffocation as a result of being trapped in a crevice beneath another pup: this is being counted against the total number of accidental mortalities allowed under their permit.

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[7] Covering letter to the Minister from the Antarctic Animal Ethics Committee. Available at http://www.antdiv.gov.au/science/a...al/vet%5Freport/ministerletter.asp.

[8] Memo from D.P. DeMaster to Ann Terbush, dated July 25, 2001 regarding Steller sea lion pup mortality during and after handling activity at Rogue Reef, Oregon.

14. General Effects of Administering Drugs and Other Substances

As with the other activities, the potential adverse affects of administering drugs in general are related to the effects of capture and restraint, as described above. In addition, because the blubber in some areas is not well vascularized, inadvertent injection of drugs into the blubber frequently results in aseptic necrosis, sometime leading to large abscesses (Fowler 1986). As a result, subcutaneous administration of drugs is usually problematic in marine mammals. There is the possibility of accidentally injecting drugs subdurally (beneath the dura matter, a fibrous membrane covering the central nervous system) when attempting to inject into the extradural vein (Stoskopf 1990).

Effects of deuterium oxide injection: Deuterium oxide (^2H_2O) is a stable, relatively non-toxic and naturally occurring isotope: up to 20-25% of body water can be replaced by deuterium oxide in mice before toxic effects are observed (Oftedal and Iverson 1987). The effects of injecting deuterium are probably largely incidental to the capture and restraint as described above. However, because a post-equilibration sample must be collected, the use of deuterium increases the amount of time an individual animal must be held and the amount of time researchers are occupying a rookery. As with any procedure that breaks the skin, there is also the potential to introduce infection during injection.

Effects of lidocaine: A surface anesthetic effect, e.g. loss of feeling or sensation, can be achieved by subcutaneous injection. Lidocaine hurts for several seconds to a minute following injection into the skin. Lidocaine can produce serious side-effects if injected intravascularly, and if accidentally swallowed, can cause convulsions.[9] The use of lidocaine with epinephrine is contraindicated as it may cause tachycardia (rapid heart rate). As a surface anesthetic, lidocaine is relatively safe, as evidenced by its available in a variety of over-the-counter topical preparations for relieving pain and itching in humans.

Effects of valium: The effects are dose-related, and cumulative. It is metabolized by the liver and excreted by the kidneys. Possible side effects include bradycardia (slowed heart rate), respiratory depression, tremor, confusion, photo-phobia, blurred vision, nausea, vomiting, depressed gag reflex, lethargy, and ataxia (inability to coordinate muscle activity during voluntary movement). It should be used with caution in animals experiencing shock.[10] Injectable valium is irritating to the vein and tissue, and may cause pain during administration. It has a rapid onset when given intravenously.

Effects of injecting Evans blue dye: Evans blue is a diazo dye used for determination of blood volume on the basis of dilution of a standard solution of the dye in plasma following intravenous injection. The dye binds to albumin in the blood stream and remains bound long enough to circulate and distribute in the entire plasma volume of the blood stream. Evans blue was carcinogenic in one study in rats when administered intraperitoneally, the only species and route tested. It produced sarcomas of the reticuloendothelial system in the liver.[11] This dye is

[9] Lidocaine: adverse reactions. http://www.infomed.org/100drugs/lidotoc.html
[10] http://www.kcmetro.cc.mo.us/pennvalley/emt/diazep.htm
[11] Animal carcinogenicity data. http://193.51.164.11/htdocs/Monographs/Vol08/EvansBlue.html

considered a teratogen at high doses, which can cause abnormal prenatal development. However, although there are no references to the safety of this dye in Steller sea lions, this dye is currently used safely for numerous human medicine applications.

Effects of Betadine: Following contact with skin, a burning sensation and itching can occur. Severe complications are rare following application on intact skin.

15. Effects of bioelectric impedence analysis

Because the animals would be anesthetized, there will be no pain associated with the insertion of the needles. The insertion of needles does pose a risk of infection: bacteria or other infectious agents that may be present on the animal's skin or hair can be introduced under the skin. When performed by a qualified, experienced person using commonly accepted standards of good practice, these risks are likely negligible. The effects of this procedure are probably largely incidental to those associated with capture and restraint, as described above. However, the 2000 annual report for Permit No. 881-1443 (Alaska Sea Life Center) reported development of a subcutaneous abscess on a captive adult female Steller sea lion, apparently resulting from tissue necrosis induced by the focal electrical current at the site of a bioimpedence electrode implant.

16. Effects of enemas

Any time a foreign object is inserted into the rectum there is the possibility of perforation, which can lead to peritonitis that may result in death. When performed by a qualified, experienced person using commonly accepted standards of good practice, these risks are likely negligible. As animals must be restrained for this procedure, and are usually chemically restrained, the risks associated with capture and restraint are also associated with this procedure.

17. Effects of stomach intubation

In addition to the effects of capture and restraint, as described above, there is the risk of introduction of liquid into the trachea, initiating aspiration pneumonia or death. There is also a risk of cross-contamination if equipment is not properly disinfected between animals. When performed by a qualified, experienced person using commonly accepted standards of good practice, these risks are likely negligible.

C. Mitigating measures to minimize the effects of the research activities

1. Standard Permit Conditions

In addition to measures identified by researchers in their applications and otherwise considered "good practice", all NMFS marine mammal research permits contain conditions intended to minimize the potential adverse effects of the research activities on the animals. These conditions are specific to the type of research authorized and the species involved. The conditions are based on information in the literature, and from the researchers themselves, about the effects of particular research techniques and the responses of animals to the activities.

Permits for research on pinnipeds contain the following general conditions for minimizing the potential negative effects of research: (1) caution must be exercised when approaching mother-pup pairs, and efforts to approach and handle a particular animal or mother-pup pair must be terminated if there is any evidence that the activities may be life-threatening or interfering with the animals' vital functions; (2) in the event of accidental mortality in excess of that authorized, research activities shall be suspended until the protocol and handling procedures have been reviewed and, if necessary, revised to the satisfaction of the NMFS, so as to ensure that the risk of additional mortality is minimized; (3) in the event that a female dies or is seriously injured as a result of the activities, the orphaned pup shall be humanely provided for (i.e. salvaged by placing in a Stranding facility for eventual release, or, if salvage is not possible, euthanized) and pups that are humanely euthanized shall count against the total number of animals authorized for accidental mortality.

For minimizing the impacts of pup counts, capture and handling activities, Steller sea lion scientific research permits contain the following conditions: (1) researchers will not survey or capture pups until the end of the pupping season (late June or early July), after mother-pup bonds are well established; (2) researchers will minimize the time that they occupy the rookery (≤ 2 hours for counting, ≤ 5 hours if capturing pups); (3) researchers will use biologists experienced in herding to slowly move adults out of the way and experienced in capture techniques to complete the activities as quickly as possible; (4) researchers shall process pups in small groups (10-20), allow animals to rest before handling, and release animals showing signs of distress; (5) researchers shall restrain pups by hand, without using either a restraint board or drugs and minimize handling time; and (6) researchers shall allow only personnel highly experienced and well-trained in the use of branding techniques to brand pups.

To minimize the potential negative effects of sampling activities in general, pinniped scientific research permits contain the following standard conditions: (1) researchers shall select target animals far enough away from other animals to minimize the possibility of having other sea lions interfere with the target animals; and (2) clean darts, enemas, and all needles thoroughly between uses, and sterilize them with alcohol or betadine immediately prior to use.

All NMFS scientific research permits contain these general conditions to ensure research coordination and minimize the potential for unnecessarily duplicative research: (1) the Permit Holder must coordinate research authorized with other researchers conducting the same or similar studies on the same species and in the same locations; and (2) prior to each field season, the Permit Holder must notify the appropriate Regional Administrator at least two weeks in advance, and such notification shall include the dates and specific locations of the research.

2. Mitigation measures that will be employed by permittees

There are a number of measures that are considered "good practice" and that are commonly followed by qualified, experienced personnel to minimize the potential risks associated with various of the above procedures. Consistent with the issuance criteria requiring personnel authorized to take marine mammals under a permit to have qualifications commensurate with their duties, only qualified, experienced personnel (e.g., veterinarians, biologists, physiologists) with sufficient experience in the specific intrusive techniques would be allowed to perform intrusive procedures including blood sampling, biopsy, tooth pulling, stomach intubation, enemas, fecal loops/culture swabs, administering anesthesia or other drugs, attachment of flipper tags, application of brands, and remote biopsy sampling. As a result, research assistants would not use endangered Steller sea lions in the wild to gain training in intrusive procedures due to the inherent risks to the animals associated with these procedures, even when performed by a qualified, experienced person.

In addition to the standard permit conditions described above, the applicants have stated they will implement the following measures to minimize the potential adverse effects associated with the proposed additional take activities.

For aerial surveys: Survey planes approach from a kilometer or more offshore and without banking, which is believed to reduces the incidence of hauled out animals entering the water prior to the survey photographs, because the animals would only be within hearing range of the plane for 1-2 minutes.

For capture and restraint: To avoid respiratory distress, ischemia (restricted blood flow), or nerve damage, it is considered important that animals be properly positioned, i.e. ventrally recumbent, during anesthesia (Dierauf 1990). Respiration and pCO_2 are monitored and oxygen administered, as needed to avoid prolonged breath holding during gas anesthesia, which can result in cardiac hypoxia (lack of oxygen to the heart muscle). Qualified personnel (i.e., experienced veterinarians, biologists or other highly trained personnel) are prepared to control or assist ventilations when using Valium, isoflurane, or Tiletamine. The animal's body temperature is closely monitored and steps taken to avoid hypo- and hyperthermia (e.g. cooling with water or covering to keep warm, as necessary). In addition, any animal showing signs of distress while being handled are released immediately and closely monitored. Some of the personnel listed as co-investigators on the permits have extensive experience in sedating and intubating Steller sea lions and/or other pinnipeds in the field. An emergency kit with equipment and supplies for responding to complications or emergencies would be readily available. Drug doses are calculated on the basis of the researcher's best estimate of an animal's lean body mass and metabolic rate. As required by the permits, these procedures would performed or directly supervised by qualified personnel.

To reduce the risk of unintentional injection of drugs by projectile syringe (darts) into blubber, intravenously, or into vital organs, the length of the needle used is appropriate for the size of the animal and its blubber thickness. In addition, care is taken in darting animals to avoid accidental drownings of animals that either flee into the water prior to induction or slump into pools of water at induction.

For intrusive sampling procedures (i.e., blood collection, biopsy, tooth pulling, fecal loops/culture swabs, enemas, stomach intubation, BIA): To the maximum extent practical, the animal is restrained on a smooth surface. An attending veterinarian(s) or other qualified personnel are present during these procedure to monitor the physiologic state of each animal (e.g., by monitoring respiratory rate and character, heart rate, body temperature, and behavioral response to handling and sampling procedures). Animals that are physically restrained but continue to struggle or show signs of stress are released immediately to minimize the risk that continued stress would lead to capture myopathy. The volume of blood taken from individual animals would not exceed 10 ml blood per kg body mass, either as a single blood draw or over the course of several days. Sterile, disposable needles, biopsy punches, etc., are used to minimize the risk of infection and cross-contamination. Where disposable equipment is not available (i.e., enema and stomach tubes, flipper punch, dental elevators) liquid chemical sterilants are used with adequate contact times (as indicated on the product label) to affect proper sterilization, and instruments are rinsed with sterile water or saline before use on animals. Care is taken to avoid contact of equipment disinfectants with an animal's skin, and disinfectant agents are changed periodically to avoid growth of resistant strains of microorganisms. Only experienced, qualified personnel (veterinarians, biologists) who know how to properly pass a stomach tube to avoid introduction of liquid into the trachea.would attempt this procedure. Because proper cold sterilization takes some time, researchers would bring an adequate number of stomach tubes to ensure all tubes are properly sterilized between animals, or that there is one tube per animal. The applicant states that the tubes would be washed, disinfected, rinsed, and shaken or spun dry between animals.

For flipper tagging: It is common for researchers to take care to avoid placing the tag so low as to have the animal walking on it or so high as to have it irritating the animal's flank area (Dierauf 1990).

For hot-branding: The application for Permit No. 358-1564-01 states that pups that are "very young or in poor physical condition (e.g. under 20kg) will not be branded." The NMML (Permit No. 782-1532) states they mark all pups present, even clinically ill pups, to avoid biasing their data.[1] It is worth noting that Steller sea lions are the largest member of the otariid family, and newborn Steller sea lion pups weigh 15-20 kg. Both applicants use isoflurane gas during branding, both as a temporary anesthetic and to ensure that animals lie still for optimal brand quality.

For attachment of scientific instruments: When epoxy hardener is mixed with resin catalyst, heat is generated, and the mix can cause thermal burns. Therefore, care is used in adjusting the proportions of epoxy hardener and resin catalyst to prevent a "hot" mix and the minimum practical amount of epoxy is used to prevent burning the animal. The weight and dimensions of the instrument package relative to the animal's size and mass, and duration of attachment, are important considerations in choosing a tag. Tag size and placement are selected that will not interfere significantly with an animal's ability to forage or conduct other vital functions.

For behavioral/demographic observations and remote monitoring: To minimize the potential for disturbance caused by the placement of observers on rookeries and haulouts or for set-up and maintenance of remote monitoring stations, researchers either access the locations concurrent with other research activities, or from points or by means that would not disturb sea lions (e.g.

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[1] T. Loughlin (NMML), personal communication during conference call between NMFS and NMML on July 26, 2001.

approaching from the other side of the island, where no animals are hauled out) to the maximum extent practicable.

For remote blubber biopsy: The applicants for File No. 1016-1651 do not have previous experience with this technique and state that they are conducting further development of it by testing equipment on pinniped carcasses to ensure appropriate penetration of the darts. The applicants also state they are practicing shooting at stationary targets (i.e., carcasses) to ensure accuracy, and no Steller sea lions would be biopsied until the researcher's accuracy with the rifle and crossbow is within 20 cm of the target 95% of the time. Based on the recommendations of a veterinarian, the applicants state they will take the following measures to minimize the potential adverse effects of this procedure: maintain a sharp biopsy edge; use dart tips only once between sharpening; sterilize instruments by soaking in a cold sterile solution (e.g., Cetylcide) for at least 15 minutes; rinsing instruments with sterile water immediately prior to use; targeting the shoulder and back of the sea lions to reduce the risk of the dart penetrating deeper than the blubber layer.

3. Additional Mitigation Recommendations

Given the significant increase in the number of permit holders, research projects, and takes of threatened and endangered Steller sea lions, the Permits, Conservation and Education Division, in consultation with the Marine Mammal Commission, would require the following additional measures to ensure that the activities of all permit holders are coordinated to minimize the potential for unnecessarily duplicative research and unnecessary harassment of Steller sea lions.

Coordination of field work and monitoring of effects: At least one month in advance of any field trip/season, permit holders will be required to submit to the Permits, Conservation and Education Division and the Chief of the Protected Resources Division of the Alaska Regional Office, a detailed description of their intended field sites and/or survey routes. The Permits Division and the Alaska Regional Office will maintain a matrix of these field trips and survey routes for all permit holders and coordinate with permit holders to ensure that any overlap is not unnecessarily duplicative. The Permits Division will coordinate and facilitate sharing of data and samples between permit holders, as appropriate, to ensure that harassment and takes of Steller sea lions is minimized among all permit holders. Permit holders will be required to report any research-related mortality or serious injury to the Permits Division and Alaska Region as soon as is practicable given communications in field situations. The Permits Division and Alaska Region will facilitate distribution of these reports among permit holders to ensure that (1) research-related mortalities do not exceed 20 animals per year in the western stock and (2) permit holders can consult with each other as quickly as possible to determine where and how research activities need to be modified, subject to approval by the Director, Office of Protected Resources, to ensure further research-related mortalities are minimized and do not exceed a total of 51 sea lions per year for the eastern and western populations combined.

The Recovery Plan for Steller Sea Lions recommends preparing guidelines and regulations to control potentially disruptive activities, including disturbance that may be caused by vessels, aircraft, and researchers on the ground. Accordingly, the NMFS would work with veterinarians, biologists, and physiologists to develop a handbook of "good practices" that incorporates all the items necessary for safe handling of pinnipeds, and require that all permit holders, as a condition of the permit, be required to follow these practices. Many of the measures listed as mitigation in this document are simply "good practice" and are already followed by responsible, experienced researchers. However, the NMFS feels it appropriate to codify these "good practices" , which would also apply to other marine mammal research permits, to ensure uniformity in efforts to minimize the potential for adverse effects of research on marine mammals.

The Recovery Plan also recommends documenting the effects of disturbance caused by human activities that might contribute to the population decline, and suggests they be evaluated in relation to population trends of Steller sea lion management units. In addition, the panels for the peer-review workshops convened in 1997 and 1999 to evaluate the research done on Steller sea lions recommended development of a strategic plan (to be peer reviewed before and after its implementation) and study designs to "integrate the various research projects into a cohesive approach for determining what factors are affecting sea lion populations and their potential recovery." The panels also recommended coordination of the research activities to ensure consistency in collection and analysis of data. The panelists were also concerned that some research did not appear associated with anything that would affect survival probability, and that there appeared to be a lack of integration of the various research programs and disciplines, such that it was not clear how the studies fit together. It is therefore recommended that a panel of independent experts in vertebrate biology, ecology, and management be convened to assist in the development and review of a strategic plan and guidelines or protocols for research, with approved techniques for a variety of intrusive procedures, aerial surveys and pup counts, as well as a protocol for evaluating the effects of research on Steller sea lions. This panel would also be involved, where practicable, in reviewing the results of permitted research activities as documented in the annual reports submitted by permit holders to the Service. In the interim, researchers will be required to provide a more detailed and qualitative description of observed responses of sea lions to the surveys and intrusive procedures in their annual permit reports, to allow NMFS to better assess the effects.

Additional Mitigation for Ground counts: As rookeries and haulout sites may be chosen based, in part, on their proximity to prey resources, it is especially important to minimize the potential for adverse effects at these sites, particularly during the lactation period when pups are most vulnerable. Because the Permits Division feels it is important to limit the effects of disturbance on a given rookery within a single breeding season, as well as to limit the effects of chronic disturbance during a critical life-history stage over time, permit holders will be required to submit to the Permits Division and Alaska Region a proposed field and survey schedule by March of each year of the permit, including the specific rookeries that would be visited, the approximate dates (to be confirmed at least one month prior to the start of field work) of the research, and the specific research activities that would be conducted (including types of samples to be collected). The Permits Division and Alaska Region will maintain a matrix of these field dates and locations and coordinate with all permit holders to ensure that (1) any overlap is not unnecessarily duplicative, (2) collection of samples and data are coordinated among permit holders, as appropriate, to ensure that harassment and takes of Steller sea lions is minimized among all permit holders, and (3) individual rookeries are not disturbed more than once per year during the time when the majority of pups are less than weeks old.

Researchers would be encouraged to develop alternative methods for counting pups that do not involve intentional displacement of adults from the rookery (e.g., use of developing photographic technologies). Researchers would be required to conduct pre- and post-activity monitoring and to maintain and provide reports with qualitative and quantitative records of the response of animals to disturbance. Regarding observations of reactions to disturbance, all researchers working with Steller sea lions should develop and use a standardized set of criteria by which reactions are monitored and measured to assist NMFS in evaluating the effects of this activity.

Minimizing cumulative impats on individual sea lions: Pups less than four months old would not be subjected to muscle biopsy, BIA, injection of Evans blue dye, injection of deuterated water, enemas or stomach intubation. No sea lions would be given both an enema and subjected to stomach intubation. No sea lion would be both flipper-tagged and hot-branded unless permit holders submit justification for the need to both permanently and temporarily mark the same animal.

Cumulative Effects

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 this biological opinion. 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 ESA.

NMFS has no information on future State, tribal, local, or private actions in the action area that would not be subject to section 7 consultation. Therefore, cumulative effects have not been considered in this biological opinion.

Integration and Synthesis of Effects

Studies of natural populations generally have unpredictable effects on the populations that are being studied. Research always poses a risk of killing or serious injuring wild animals while they are captured and restrained. Intrusive research, such as muscle and blubber biopsies, hot-branding, or use of stomach tubes to collect stomach contents, increase the risk of infection for animals. The annual reports from more than a decade of study suggest that the adverse effects of research activities have not affected either Steller sea lion population or any particular rookeries or haulouts, although individual animals have been adversely affected or killed. For example, in 1998, 48,000 Steller sea lions were disturbed by these investigations, 384 pups were captured, tagged, and branded, but no mortalities were reported. In 1997, 31,150 Steller sea lions were approached by these researchers, 14,550 were disturbed, 137 were captured, and 121 were tagged, but there were no known mortalities. The results of the studies conducted in 1996 followed a similar pattern, although there was 1 mortality (which equates to 0.002% of the animals approached or 0.007% of the animals disturbed). In 1995, 7,500 Steller sea lions were disturbed, but there were no mortalities.

The aerial surveys could effectively disturb every animal in both the eastern and western populations of Steller sea lions (see Table 1) several times throughout the year. Unfortunately, research activities conducted on Steller sea lions for more than two decades have not collected or reported detailed information on the responses of the sea lions to the various procedures that would make it possible to assess the individual and collective effects of these research activities on the population ecology of Steller sea lions. Since animals may die from infection caused by intrusive research days to weeks after a procedure (for example, deaths from capture myopathy can occur 7 to 14 days or more following a capture event), we would need information from longer-term monitoring to properly assess the effects of these research activities on Steller sea lions. For example, in their 2000 annual report for Permit No. 782-1532, NMML reports takes from over 274 rookery and haulout sites in Alaska, but behavioral observations following research activities occurred on only 2 sites: at one site the period of observation was only 35 days, at the other site, observations were conducted "ancillary to" seabird research from early June through mid-August. In the absence of adequate monitoring, these deaths would not be noticed.

Animals experience pain in response to specific kinds of stimuli including trauma, heat, and corrosive chemicals. Because there is survival value in appearing not to experience pain, be damaged, or incapacitated in any way, it is not appropriate to assume a procedure is not painful to the animal simply because it does not appear to react. In addition, marine mammals do not typically exhibit symptoms of disease until very late in the disease process, possibly because to appear weak or sick would make them more susceptible to predation. Instead, a disease process is usually fairly advanced before overt symptoms are evident. This means that not only might researchers be unlikely to observe injuries or infections resulting from research that may affect an animal's survival if they do not conduct adequate post-activity monitoring, they may not be able to tell from a cursory exam that an animal selected for handling is already ill in a way that would predispose them to adverse reactions to research activities.

The total number of accidental mortalities per year that would be authorized under all permits is not likely, in the absence of other sources of mortality, to contribute significantly to the decline or failure to recover of threatened or endangered Steller sea lions, assuming they would be distributed among both populations, both sexes, and all age classes. However, the potential sub-lethal affects associated with disturbance are also of concern. These sub-lethal effects include research activities that: (1) disrupt one or more behavioral patterns that are essential to an individual animal's life history or to the animal's contribution to a population, or both; and (2) have the potential for injuries that may manifest themselves as an animal that fails to feed successfully, breed successfully (which can result from feeding failure), or complete its life history because of changes in its behavioral patterns. Injury to an individual animal could be injurious to a population because the individual's breeding success will have been reduced.

The most commonly observed response of pinnipeds to disturbance is avoidance, where the animals move away from the source of the disturbance. It has commonly been assumed that animals are not affected, or only minimally affected, if they do not move away when human activities are occurring in close proximity. However, a recent study suggests that an animal's behavioral response to disturbance is also a function of a variety of factors including the quality of the site currently occupied, the distance to and quality of other suitable sites, the relative risk of predation or density of competitors in different sites, and the investment that an individual has made in a site (e.g., in establishing territory or gaining dominance status) (Gill et al. 2001). As a result, animals with no suitable habitat nearby may be forced to remain despite disturbance, and regardless of the consequences for their survival or reproductive success. Disturbance can result in stress that leads to a variety of neurochemical and hormonal changes with physiological consequences including suppression of the immune system and increased susceptibility to viral and bacterial diseases (Fair and Becker 2000). Disturbance can also result in increased agonistic behaviors that can result in injuries or death, and can lead to stress, which has been shown to decrease reproductive success or survival in a variety of mammals and invertebrates (Neuman 1999). It is not certain whether even short periods of physical exertion, as when disturbance results in increased vigilance, avoidance/escape, or agonistic behaviors, may have significant impacts on an individual's energy budget.

The research that has been conducted thus far has been assumed to have negligible short- and long-term effects on Steller sea lions populations, but that assumption has not been the subject of its own study. The best available information suggests that there is the potential for adverse physical and behavioral effects on individual Steller sea lions from the research activities that will result from the proposed permits. The proposed research activities are expected to result in the accidental death of approximately 50 threatened or endangered Steller sea lions over the next five years, although data available on the longer-term effects of some of the research activities suggest that this number may underestimate the number of Steller sea lions that are likely to die from the effects of the proposed research activities.

As a result, the cumulative effects on the populations, especially with respect to adverse effects on the annual rates of recruitment or survival, are not known. There is a large amount of disturbance associated with some of the research activities, particularly ground counts and pup branding. This disturbance would be considered significant if it adversely affected the reproduction, numbers, or distribution of the eastern or western populations of Steller sea lions in a manner or to a degree that affected the sea lion's likelihood of surviving and recovering in the wild. These adverse effects could manifest themselves in a variety of ways: reductions in the reproductive success of individual sea lions or specific sea lion rookeries caused by continued disturbance, increasing the age at which sea lions start reproducing or decreasing the length of their reproductive life, increasing the interval between reproductive activity (Steller sea lions generally reproduce each year, activities that caused them to reproduce every other year would have a significant, negative effect on their population ecology), or increase the variance associated with their reproductive success. Reductions in numbers could manifest itself through reduced annual survival of specific ages (or all ages), alteration of the age structure of the sea lion populations, or increased variance associated with their annual survival.

By killing about 10 Steller sea lions each year, the proposed permits would reduce the numbers of Steller sea lions. The extent to which the activities that would disturb various sea lion rookeries and haulouts would increase sea lions mortalities or reduce the reproduction, numbers, or distribution of Steller sea lions remains unknown without additional study of the long-term effects of these activities on the sea lions. However, based on the limited information available on the short- and long-term effects of these activities on Steller sea lions, we must conclude that such population-level adverse effects are not likely. There has been no evidence that the research conducted over the past several years has resulted in population-level impacts that would have accelerated the rate of population decline.

Conclusion

After reviewing the current status of the endangered western population of Steller sea lions, the threatened eastern population of Steller sea lions, the environmental baseline for the action area, the effects of the proposed research program, and the cumulative effects, it is NMFS' biological opinion that the research program, as proposed, is not likely to jeopardize the continued existence of the endangered western population of Steller sea lions or the threatened eastern population of Steller sea lions. Critical habitat for this species has been designated for listed Steller sea lions, however, the proposed action is not expected to affect that area and no destruction or adverse modification of that critical habitat is anticipated.

Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the ESA 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 NMFS 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 by FWS 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.

NMFS is not including an incidental take statement that exempts take incidental to the proposed permits from the section 9 prohibitions. The proposed section 10(a)(1)(A) permits exempt any purposeful or incidental take associated with the proposed research from the section 9 prohibitions; since that take will already be exempt, an additional exemption through an incidental take statement is unnecessary.

Conservation Recommendations

Section 7 (a)(1) of the ESA 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 designed to minimize or avoid adverse effects of proposed actions on listed species or critical habitat that has been designated for them, help implement recovery plans or recovery actions, or to develop information that would effect better management decisions in the future.

This biological opinion concluded that the proposed actions are not likely to jeopardize the continued existence of the threatened eastern population of Steller sea lions or the endangered western population of Steller sea lions.

1. To minimize impacts of pup counts, NMFS should condition the proposed permits so that researchers:

   a. will not survey until the end of the pupping season (late June or later), after mother-pup bonds are well established;

   b. will minimize the time that they are occupying the beach ($\leq$ 2 hours for counting, $\leq$ 5 hours if capturing 50 pups for measuring and weighing); and

   c. will use biologists experienced in herding to slowly move the adults out of the way, and experienced counters to complete the surveys as quickly as possible.

2. To minimize the potential negative impacts of pup handling activities, NMFS should condition the proposed permits so that the researchers should:

   a. process pups in small groups (10-20), allow animals to rest before handling, and animals showing signs of distress must be released; and

   b. restrain pups by hand, without using either a restraint board or drugs and minimize handling time.

In order to be exempt from the prohibitions of section 9 of the ESA, NMFS must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary:

1. NMFS should condition the proposed permit so that survey aircraft should be flown at slow speeds (100-150 kts), at an altitude of 150-200 m, and close offshore (500 m).

2. NMFS should condition the proposed permits so that, when investigators are conducting behavioral and demographic observation and remote monitoring stations, they should monitor and observe sea lions from viewpoints that do not harass animals.

3. In the event that a female dies or is seriously injured as a result of the activities, the orphaned pup(s) should be provided for humanely (i.e., salvaged [placed in a Stranding facility for eventual release], or if salvage is not possible, euthanized). Pups humanely euthanized should count against the total number of animals authorized for accidental mortalities.

4. NMFS should condition the proposed permits to require permit holders to exercise caution when approaching all pinnipeds, particularly mother/pup pairs, and to terminate efforts to approach and handle a particular animal or mother/pup pair if there is any evidence that the activity(ies) may be life threatening or interfering with the animals' vital functions.

5. NMFS should condition the proposed permits to require the permit holders to coordinate research authorized herein with other researchers conducting the same or similar studies on the same species and in the same locations

6. Annual Report - Each year that the permit is valid, NMFS should require permittees to submit an annual report by December 31, describing the specific activities that have been conducted. At a minimum, the annual report should include:

    a. *in tabular form*, the: species, activities, numbers of animals, age class/gender, numbers of times each activity was performed on each animal, and specific locations of takes.

    b. *in narrative form*:

        i. A reiteration of the objectives and how the results of the research pertain to or further these research goals.

        ii. A description of the animals' reactions to the activities.

        iii. An indication as to when or if any results have been published or otherwise disseminated during the year.

        iv. A description of the activities planned for the forthcoming year, and steps that have been or will be taken to coordinate the research activities with that of other researchers.

7. Final Report - Permittees should submit final reports within 120 days after completing their research. These reports should include:

    a. A reiteration of the objectives and a summary of the results of the research and how they pertain to or further the research goals stated in the permit application;

    b. An indication, to the extent possible, of where and when the research results will be published; and

    c. A final table similar to the ones provided in the Annual Reports, summarizing *ALL* takes for the entire permit.

8. All reports, and any papers or publications resulting from the research authorized by the

proposed permit should be submitted to the Chief, Permits Division, Office of Protected Resources, NMFS, 1315 East-West Hwy., Suite 13705, Silver Spring, MD 20910.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or critical habitat that has been designated for them, NMFS request notification of the implementation of any conservation recommendations.

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Reinitiation Notice

This concludes formal consultation on NMFS' proposal to issue research permits to the National Marine Mammal Laboratory and others pursuant to the provisions of section 10 of the Endangered Species Act and Marine Mammal Protection Act. 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, section 7 consultation must be reinitiated immediately.

Literature Cited

Ashmole, N.P. 1963. The regulation of numbers of tropical oceanic birds. Ibis 103: 458-473.

Alaska Sea Grant. 1993. Is it food? Addressing marine mammal and seabird declines. Alaska Sea Grant; Fairbanks, Alaska.

Alverson, D.L. 1992. A review of commercial fisheries and the Steller sea lion (*Eumetopias jubatus*): The conflict arena. Reviews in Aquatic Science 6:203-256.

Anderson, P.J., J.E. Blackburn, and B.A. Johnson. 1997. Declines of forage species in the Gulf of Alaska, 1972-1995, as an indicator of regime shift. Proceedings of the Forage Fishes in the Marine Ecosystems Symposium. Alaska Sea Grant College Program, pp. 531-544.

Anderson, P.J. and J.F. Piatt. 1999. Community reorganization in the Gulf of Alaska following ocean climate regime shift. Marine Ecol. Progr. Series 189: 117-123.

Barlow, K. E., I. L. Boyd, J. P. Croxall, K. Reid, I. J. Staniland, and A. S. Brierley. 2002. Are penguins and seals in competition for Antarctic krill at South Georgia? Marine Biology 140:205-213.

Bickham, J.W., J.C. Patton, and T.R. Loughlin. 1996. High variability for control-region sequences in a marine mammal--implications for conservation and biogeography of Steller sea lion (*Eumetopias jubatus*). Journal of Mammalogy 77:95-108.

Bjørge, A., T. Bekkby, V. Bakkestuen, and E. Framstad. 2002. Interactions between harbour seals, *Phoca vitulina*, and fisheries in complex coastal waters explored by combined Geographic Information System (GIS) and energetics modelling. ICES Journal of Marine Science **59**:29-42.

Braham, H. W., R. D. Everitt, and D. J. Rugh. 1980. Northern sea lion population decline in the eastern Aleutian Islands. Journal of Wildlife Management 44:25-33.

Calkins, D., and E. Goodwin. 1988. Investigations of the decline of Steller sea lions in the Gulf of Alaska. Unpublished contract report to the National Marine Fisheries Service, National Marine Mammal Laboratory, April 1, 1988. [Available from the Alaska Department of Fish and Game, 333 Raspberry Rd, Anchorage, AK 99518]

Calkins, D.G., and K.W. Pitcher. 1982. Population assessment, ecology and trophic relationships of Steller sea lions in the Gulf of Alaska. U.S. Dep. of Commer., NOAA. OCSEAP Final Report 19 (1983), pp. 445-546.

Chumbley, K., J. Sease, M. Strick, and R. Towell. 1997. Field Steller sea lions (*Eumetopias jubatus*) at Marmot Island, Alaska, 1979 through 1994. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-77, 99 pp.

Ferrero, R. C., and L. W. Fritz. 2002. Steller sea lion research and coordination: a brief history and summary of recent progress. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, Washington.

Fraser, A. J., J. R. Sargent, J. C. Gamble, and D. D. Seaton. 1989. Formation and transfer of fatty acids in an enclosed marine food chain comprising phytoplankton, zooplankton, and herring (*Clupea harengus* L.) larvae. Marine Chemistry 27: 1-18.

Furness, R.W. 1984. Seabird-fisheries relationships in the northeast Atlantic and North Sea. Pages 162-169. In: D.N. Nettleship, G.A. Sanger, and P.F. Springer (eds.) Marine birds: their feeding ecology and commercial fisheries relationships. Canadian Wildlife Service; Ottawa, Canada.

Furness, R. W., and T. R. Birkhead. 1984. Seabird colony distributions suggest competition for food supplies during the breeding season. Nature:655-656.

Gemmell, N.J. and P. Majluf. 1997. Projectile biopsy sampling of fur seals. Marine Mammal Science 13:512-516.

Gerber, L. R., and G. R. VanBlaricom. 2001. Implications of three viability models for the conservation status of the western population of Steller sea lions (Eumetopias jubatus). Biological Conservation 102:261-269.

Goñi, R. 1998. Ecosystem effects of marine fisheries: an overview. Ocean and Coastal Management 40:17-44.

Grahl-Nielsen, O. and O. Mjaavatten. 1991. Dietary influence on fatty acid composition of blubber fat of seals as determined by biopsy: a multivariate approach. Marine Biology 110: 59-64.

Harwood, J., and J. P. Croxall. 1988. The assessment of competition between seals and commercial fisheries in the North Sea and the Antarctic. Marine Mammal Science 4:13-33.

Heath, R.B., D. Calkins, D. McAllister, W. Taylor, and T. Spraker. 1996. Telazol and isoflurane field anesthesia in free-ranging Steller's sea lions (*Eumetopias jubatus*). Journal of Zoo and Wildlife Medicine 27:35-43.

Heath, R.B., R. DeLong, V. Jameson, D. Bradley, and T. Spraker. 1997. Isoflurane anesthesia in free ranging sea lion pups. Journal of Wildlife Diseases 33:206-210.

Hobson, K.A., and W.A. Montevecchi. 1991. Stable isotopic determinations of trophic relationships in great auks. Oecologia 87:528-531.

Hobson, K.A., J.L. Sease, R.L. Merrick, and J.F. Piatt. 1997. Investigating trophic relationships of pinnipeds in Alaska and Washington using stable isotope ratios of nitrogen and carbon. Marine Mammal Science 13:114-132.

Hobson, K.A., and J.L Sease. 1998. Stable isotope analyses of tooth annuli reveal temporal dietary records: an example using Steller sea lions. Marine Mammal Science 14:116-129.

Innis, S. M., and H. V. Kuhnlein. 1987. The fatty acid composition of northern Canadian marine and terrestrial mammals. Acta Med. Scad. 222:105-109.

Iverson, S. 1995. Principles of fatty acid signature analysis and its use in studying foraging ecology and diets of marine mammals. ICES/NAFO Symposium, Role of Marine Mammals in the Ecosystem, Halifax, Canada

Iverson, S. J., K. J. Frost, and L. F. Lowry. 1997. Fatty acid signatures reveal fine scale structure of foraging distribution of harbor seals and their prey in Prince William Sound, Alaska. Marine Ecology Progress Series 151:255-271.

Jennings, S., and M. Kaiser. 1998. The effects of fishing on marine ecosystems. Advances in Marine Biology 34:201-352.

Loughlin, T.R. 1997. Using the phylogeographic method to identify Steller sea lion stocks. Pages 159-171 *in* A.E. Dizon, S.J. Chivers, and W.F. Perrin (editors), Molecular genetics of marine mammals. Society of Marine Mammalogy, Special Publication No. 3.

Loughlin, T.R., L. Consiglieri, R.L. DeLong, and A.T. Actor. 1983. Incidental catch of marine mammals by foreign fishing vessels, 1978-1981. Marine Fisheries Review 45:44-49.

Loughlin, T.R., and R. Nelson. 1986. Incidental mortality of northern sea lions in Shelikof Strait, Alaska. Marine Mammal Science 2:14-33.

Loughlin, T.R., A.S. Perlov, and V.A. Vladimirov. 1992. Range-Wide Survey and Estimation of Total Abundance of Steller Sea Lions in 1989. Marine Mammal Science 8:220-239.

Loughlin, T.R., M.A. Perez, R.L. Merrick. 1987. *Eumetopias jubatus*. Mammalian Species 283:1-7.

Mate, B.R. 1973. Population kinetics and related ecology of the northern sea lion, *Eumetopias jubatus*, and the California sea lion, Zalophus californianus, along the Oregon Coast. Ph.D. dissertation, University of Oregon.

Merrick, R.L. and T.R. Loughlin. 1997. Foraging behavior of adult female and young-of-the-year Steller sea lions in Alaskan waters. Canadian Journal of Zoology 75(5):776-786.

Merrick, R.L., M.K. Chumbley, and G.V. Byrd. 1997. Diet diversity of Steller sea lions

(*Eumetopias jubatus*) and their population decline in Alaska: a potential relationship. Canadian Journal of Fisheries and Aquatic Sciences 54:1342-1348.

Merrick, R. L., T. R. Loughlin, G. A. Antonelis, and R. Hill. 1994. Use of satellite-linked telemetry to study Steller sea lion and northern fur seal foraging. Polar Research 13: 105-114.

Merrick, R. L., T. R. Loughlin, and D. G. Calkins. 1987. Decline in abundance of the northern sea lion, *Eumetopias jubatus*, in Alaska, 1956-86. Fishery Bulletin U.S. 85:351-365.

Merrick, R. L., T. R. Loughlin, and D. G. Calkins. 1996. Hot-branding: a technique for long-term marking of pinnipeds. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, NMFS-AFSC-68.

Merrick, R., P. Gearin, S. Osmek, and D. Withrow. 1988. Field studies of northern sea lions at Ugamak Island, Alaska during the 1985 and 1986 breeding seasons. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, NOAA Technical Memorandum NMFS F/NWC-143, 60 p.

National Marine Fisheries Service (NMFS). 1992. Recovery plan for the Steller sea lion (*Eumetopias jubatus*). Prepared by the Steller Sea Lion Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland, 92 p.

National Marine Fisheries Service (NMFS). 1995. Status review of the United States Steller sea lion (*Eumetopias jubatus*) population. Prepared by the National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, Washington, 45 pp.

Oro, D., and R. W. Furness. 2002. Influences of food availability and predation on survival of kittiwakes. Ecology 83:2516-2529.

Osterhaus, A.D.M.E., and E.J. Vedder. 1988. Identification of virus causing recent seal deaths. Nature 350:20.

Perez, M. A. and T. R. Loughlin. 1991. Incidental catch of marine mammals by foreign and joint venture trawl vessels in the U. S. EEZ of the North Pacific, 1973-88. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, NOAA Technical Report NMFS-104, 57 p.

Pitcher, K.W., and D.G. Calkins. 1981. Reproductive biology of Steller sea lions in the Gulf of Alaska. Journal of Mammalogy 62:599-605.

Porter, B. 1997. Winter ecology of Steller sea lions (*Eumetopias jubatus*) in Alaska. M.S. dissertation, University of British Columbia, 84 pp.

Rea, L., M. Castellini, B. Fadely, and T.R. Loughlin. 1998. Health status of young Alaska Steller sea lion pups (*Eumetopias jubatus*) as indicated by blood chemistry and hematology. Comp. Biochem. Physiol. 120:617-623.

Ream, R.R., J.D. Baker and R.T. Towell. 1999. Bogoslof Island studies, 1997. Pages 81-92 *in* E. H. Sinclair and B.W. Robson, editors. Fur seal investigations, 1997. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, NOAA Technical Memorandum NMFS-AFSC-106.

Repenning, C.A. 1976. Adaptive evolution of sea lions and walruses. Syst. Zool. 25:375-390.

Sargent, J. R., R. J. Parkes, I. Mueller-Harvey, and R. J. Henderson. 1988. Lipid biomarkers in marine ecology, p. 119-138. *In* M. A. Sleigh, ed. Microbes in the sea. Ellis Horwood, Ltd. Chichester, U.K.

Sease, J.L., J.M. Strick, R.M. Merrick, and J.P. Lewis. 1999. Aerial and land-based surveys of Steller sea lions (*Eumetopias jubatus*) in Alaska, June and July 1996. U.S. Dep. Commer., NOAA Technical Memorandum NMFS-AFSC-99, 43 pp.

Sease, J.L., and T.R. Loughlin. 1999. Aerial and land-based surveys of Steller sea lions (*Eumetopias jubatus*) in Alaska, June and July 1997 and 19986. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-100, 61 pp.

Sease, J. L., R. F. Brown, V. N. Burkanov, D. G. Calkins, P. F. Olesiuk, and A. E. York. In Press. Range-wide survey of Steller sea lions in 1994. J. Wildl. Manage.

Smith, S. J., S. J. Iverson, and W. D. Bowen. 1997. Analysis of fatty acid signatures using classification trees: a new tool for investigating the foraging ecology of seals. Canadian Journal Fishery and Aquatic Sciences 54:1377-1386.

Spaulding, G.C. 1964. Comparative feeding habits of the fur seal, sea lion, and harbour seal on the British Columbia coast. Fisheries Research Board of Canada, Bulletin No. 146.

Strick, J.M., L.W. Fritz, and J.P. Lewis. 1997. Aerial and ship based surveys of Steller sea lions (*Eumetopias jubatus*) in Southeast Alaska, the Gulf of Alaska, and Aleutian Islands during June and July 1994. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-71, 55 pp.

Tasker, M. l., C. J. Campbuysen, J. Cooper, S. Gatrthe, W. Montevecchi, and S. Blaber. 2000. The impacts of fishing on marine birds. ICES Journal of Marine Science 57:531-547.

Taylor, B. L. 1995. The reliability of using population viability analysis of risk classification of species. Conservation Biology **9**:551-558.

Thorsteinson, F.V., and C.J. Lensink. 1962. Biological observations of Steller sea lions taken during an experimental harvest. Journal of Wildlife Management 26:353-359.

Varanasi, U., J.E. Stein, W.L. Reichert, K.L. Tilbury, M.M. Krahn, and S.Chan. 1992. Chlorinated and aromatic hydrocarbons in bottom sediments, fish and marine mammals in U.S. coastal waters: laboratory and field studies of metabolism and accumulation. *In* C.H. Walker and D.R. Livingstone (eds.), Persistent Pollutants in Marine Ecosystems.

Wynne, K. 1990. Marine mammal interactions with the salmon drift gillnet fishery on the Copper River Delta, Alaska, 1988 and 1989. Sea Grant Technical Report No. 90-05. University of Alaska, Fairbanks.

Wynne, K.M., D. Hicks, and N. Munro. 1992. 1991 Marine mammal observer program for the salmon driftnet fishery of Prince William Sound Alaska. Annual Report NMFS/NOAA Contract 50ABNF000036. NMFS Alaska Region, Office of Marine Mammals, P.O. Box 21668, Juneau, Alaska, 99802.

Yodzis, P. 2001. Must top predators be culled for the sake of fisheries? Trends in Ecology & Evolution 16:78-84.

York, A.E. 1994. The population dynamics of northern sea lions, 1975-1985. Marine Mammal Science 10:38-51.

Zenteno-Savin, T., M.E. Castellini, L.D. Rea and B.S. Fadely. 1997. Plasma haptoglobin levels in threatened Alaskan pinniped populations. Journal of Wildlife Diseases 33(1):64-71.