Northern Spotted Owl

Five-Year Review: Summary and Evaluation

U.S. Fish and Wildlife Service
Portland, Oregon

November 2004

5-YEAR REVIEW
Species reviewed: Northern Spotted Owl (*Strix occidentalis caurina*)
Date completed: November 15, 2004

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METHODOLOGY USED TO COMPLETE THIS 5-YEAR REVIEW

In response to a settlement agreement with the American Forest Resources Council et al., the U.S. Fish and Wildlife Service (Service, USFWS) initiated a 5-year review of the northern spotted owl (*Strix occidentalis caurina*) in January 2003. The Service solicited information through two Federal Register notices (April and July, 2003, 68 FR 19569 to 19571 and 44093 to 44094) and direct meetings with affected land management agencies and interested publics.

In September, 2003, the Service contracted with Sustainable Ecosystems Institute (SEI) to produce a report on the status of the northern spotted owl, summarizing and evaluating new information available since its listing, and any new understanding of information that existed at the time of listing. The Service provided all available materials and any preliminary summary drafts from previous work on the 5-year review to SEI.

SEI assembled a panel of scientists with expertise in different academic backgrounds relevant to the status review. These experts read the materials that were available or that were developed during the process, and participated in four public meetings and several panel meetings convened by SEI. During their deliberations, they evaluated the strengths and weaknesses of the various data, hypotheses, and opinions. The SEI panel was supported by a staff of scientists who developed materials for their use. In addition, other scientists helped with particular topics where their expertise was useful (see SEI 2004, Chapter 1 for details of SEI's process). The SEI panel produced a report titled "Scientific Evaluation of the Status of the Northern Spotted Owl." This report provided the primary biological basis for the conclusions of the 5-year review.

The SEI panel used all available information in developing the report, but distinguished between peer-reviewed information and other information. The SEI panel made judgments on scientific quality of information (simple observations, or personal communications were weighted less heavily than rigorous data collection) and critically examined the use of statistical methods, including whether there was adequate statistical power to reject the hypothesis. Throughout the review, the SEI panel attempted to consider alternative hypotheses and the degree to which available information supported various explanations and/or predictions. The SEI panel also evaluated data quality, relative risk, and uncertainty, both collectively in the majority opinion presented in each chapter and individually in their responses to a questionnaire. The questionnaire (Chapter 10 in SEI 2004) was intended to provide detailed information about the individual opinions of panelists regarding these issues. The SEI report was extensively reviewed, including peer review during and following drafting.

Following the completion of a draft SEI report, the Service initiated steps to complete its regulatory requirements for a 5-yr review under section 4(c) of the Endangered Species Act (ESA). Throughout the 5-year review process, the Service sought to answer three questions:

1) Is the northern spotted owl a valid subspecies under the ESA?
2) Is there new information about the threats or population status of the northern spotted owl?
3) If so, does the new information suggest that a change in listing status may be warranted?

To answer the first question, the Service convened a panel of six managers, representing three field offices and the Regional Office to participate in the first Workshop on Taxonomy and Range of the northern spotted owl. Three geneticists were present to answer questions from the panel. The panel's charge was to fully explore and discuss genetic issues relevant to the question of subspecies validity. Prior to the meeting the panelists were provided with copies of the draft SEI report (SEI 2004) Chapter 3 "Assessment of the Subspecies and Genetics"; Barrowclough et al. 1999; Haig et al. 2001; and Haig et al. in press. The panel's conclusions were summarized and provided for use in the second and final Decision Support Workshop for Managers (all documents from both panels are contained in the Service's administrative record for the 5-yr review).

The panel convened for this second workshop consisted of seven Service managers who met for a 1.5 day, facilitated session in late August, 2004. These managers had access to a range of background materials which included the draft SEI report, a brief Service document describing regulatory mechanisms and changes in these mechanisms since the listing, and the original 1990 listing rule. In a series of guided discussion and exercises, the managers explored biological risk information, including uncertainty, and clarified their assumptions about key terms in the ESA. This helped the managers compare the new biological information against their understanding of the statutory requirements to assess whether a change in listing status was potentially warranted.

GENERAL INFORMATION

FR Notice announcing initiation of this review:

April 21, 2003. 5-Year Review of the Marbled Murrelet and Northern Spotted Owl. 68 FR 19569-19571.

July 25, 2003. Second Information Request for the 5-year Reviews of the Marbled Murrelet and the Northern Spotted Owl. 68 FR 44093-44094.

Lead Region: Pacific Region
Barry Mulder, (503) 872-2805

Lead Field Office: Not Applicable

Name of Reviewer(s): Robin Bown, Danielle Chi, Karl Halupka,

Cooperating Field Office(s):

Arcata Fish and Wildlife Office, Arcata, CA
Central Washington Field Office, Wenatchee, WA
Klamath Falls Fish and Wildlife Office, Klamath Falls, OR
Oregon Fish and Wildlife Office, Portland OR.
Red Bluff Fish and Wildlife Office. Red Bluff, CA
Roseburg Field Office, Roseburg, OR
Western Washington Fish and Wildlife Office, Lacey, WA
Yreka Fish and Wildlife Office, Yreka, CA

Cooperating Region(s): None. The northern spotted owl occurs only within Region 1.

BACKGROUND

Species Existing Recovery Priority Number: 3C

Most recent Species Status as reported in the Biennial Recovery Report to Congress:

Species Status: D
Recovery Achieved: 1

Listing History

Original Listing: June 26, 1990. 55 FR 26114-26194. Determination of Threatened Status for the Northern Spotted Owl. Listing of the subspecies throughout its entire range (California, Washington, Oregon, and British Columbia). Subspecies listed.

Associated Actions:

January 15, 1992. 57 FR 1796-1838. Determination of Critical Habitat for the Northern Spotted Owl.

Review History:

Fish and Wildlife Service reviews

The Northern Spotted Owl, A Status Review. January, 1982. The review concluded that the species did not meet the definition of threatened or endangered at that time.

The Northern Spotted Owl Status Review. December 14, 1987. Finding on northern spotted owl petition. December 23, 1987. This finding concluded that the northern spotted owl was not warranted for listing throughout its range.

The Northern Spotted Owl Status Review Supplement 1989. April 21, 1989. Revised finding on the northern spotted owl listing petition. April 25, 1989. This finding concluded that listing the northern spotted owl as a threatened species throughout its entire range was warranted. The subspecies was proposed for listing on June 23, 1989.

1990 Status Review. Northern Spotted Owl, *Strix occidentalis caurina*. April 30, 1990. The status review team recommended that the northern spotted owl be listed as threatened throughout its range. This review resulted in the final listing on June 26, 1990.

Northern Spotted Owl Final Draft Recovery Plan. December 1992. This plan was not finalized.

90-day Finding on a Petition to Remove the Northern Spotted Owl in California from the List of Threatened and Endangered Species. August 31, 1994. The Service found that the petition did not present substantial information indicating the northern spotted owl should be delisted in California.

90-day Finding on a Petition to Delist the Northern Spotted Owl from the List of Threatened and Endangered Species. February 3, 2000. The Service found that the petitioner did not present substantial scientific or commercial information indicating that the delisting of the northern spotted owl may be warranted.

Other reviews

A conservation strategy for the Northern Spotted Owl: a report of the interagency scientific committee to address conservation of the Northern Spotted Owl. 1990. Thomas, Jack Ward; Eric D. Forsman, Joseph B. Lint, E. Charles Meslow, Barry R. Noon and Jared Verner. USDA-Forest Service, USDI-Bureau of Land Management, USDI-Fish and Wildlife Service and USDI-National Park Service, Portland, Oregon. U.S. Government Printing Office 791- 171/20026, Washington, D.C. 427 pp. + maps. An interagency status review of the northern spotted owl that provided the basis for the FEMAT report and the Northwest Forest Plan.

Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Management Assessment Team. U.S. Department of Agriculture, U.S. Department of the Interior, U.S. Department of Commerce, and the Environmental Protection Agency. 1993. Forest Service, Fish and Wildlife Service, National Marine Fisheries Service, National Park Service, Bureau of Land Management, Environmental Protection Agency. Interagency SEIS Team, Portland, Oregon. 1004 pp. This assessment included a detailed section on the northern spotted owl, and provided the basis for the development of the Northwest Forest Plan.

Existing Recovery Plan or Outline:

Final Draft Recovery Plan for the Northern Spotted Owl. December 1992. The recovery plan has not been finalized.

Reference Point Documents:

Determination of Threatened Status for the Northern Spotted Owl. 55 FR 26114-26194. June 26, 1990.

REVIEW ANALYSIS

Page numbers for the status review (SEI 2004) referenced in sections 2 through 10 below reflect the hard copy version of the report, and may vary slightly from the website version, particularly in Chapter 8.

1. Application of the 1996 Distinct Population Segment (DPS) Policy to DPS-listings made prior to enactment of the policy. *Not applicable. Not listed as a DPS.*

2. New Information: Improved Analyses. Have any improved analytic methods resulted in relevant new information? *YES*

The following describe new analytical methods. The implications of these analyses to the northern spotted owl are described in Section 3.

Genetics

In 1990, genetic analysis of the northern spotted owl was restricted to examination of allozymes via gel electrophoresis and specific staining. Several new analyses have been employed in the field of spotted owl genetics and taxonomy since 1990: mitochondrial DNA, Randomly Amplified Polymorphic DNA (RAPD) markers, microsatellites, and Amplified Fragment Length Polymorphism (AFLP) analyses. Details of these new methods can be found in the SEI report Chapter 3 (pgs. 3-10 to 3-19).

Mitochondrial DNA (mtDNA) – Two published studies (Barrowclough et al. 1999; Haig et al. In Press a) and a study in progress (Chi et al. unpublished) have used mitochondrial DNA as a marker to examine genetic variability within and across spotted owl subspecies. The mitochondrial DNA control region was amplified using a Polymerase Chain Reaction (PCR) and sequenced using an automated sequencer. Each unique sequence constitutes a separate haplotype, referred to as such because it represents only one half of the parental contribution, that which is inherited maternally. The number and distribution of separate haplotypes, and the apparent relationships among them based on the number and type of nucleotide substitutions were evaluated within and across different sampled populations to provide information on genetic diversity, taxonomic relationships, and possible evolutionary processes. Mitochondrial DNA makes a useful marker for population studies because it evolves at a faster rate than nuclear genes, and therefore provides more variation for analysis. However, because mitochondrial DNA is maternally inherited, it only tracks population processes through female lineages and is not necessarily representative of the entire organism's genome (SEI 2004 pg. 3-12).

RAPD – One published study (Haig et al. 2001) has used RAPDs to examine genetic variability within and across spotted owl subspecies. This analysis involved using PCR and small primers to amplify random pieces of DNA. The patterns in band/fragment presence and absence produced RAPD genotypes that are examined within and across populations for the purposes of identifying genetic variability, taxonomic relationships, and evolutionary processes. RAPD analysis is intended to target nuclear genes which have lower mutation rates, and thus take longer to exhibit variation. Further, the origins of RAPDs are often unknown in the absence of cloning and sequencing of the genes. In spite of these caveats, RAPD analysis can "indicate variable populations, and when interpreted carefully, can identify interesting populations for further study." (SEI 2004, pg. 3-16).

Microsatellite Loci – One short published paper (Thode et al. 2002) and one study in progress (Henke et al. unpublished) have used microsatellite loci as markers for looking at variation within and across spotted owl subspecies. Microsatellites are nuclear DNA segments consisting of tandem repeats of two to eight bases that appear in sets of a couple to several hundred repeats. Variation is assessed by evaluating the size of the amplified fragments. "These markers have several advantages: they are fast evolving, usually autosomally inherited (ie. they are rarely sex linked), relatively easy to score, have many alleles at each locus, and tend to be useful for diagnosis at the subspecies level. Microsatellites are often used to infer patterns of nuclear gene flow and geographic subdivision in order to compliment mitochondrial studies, and are additionally useful for analyses of parentage, genetic census, and other fine-resolution issues." (SEI 2004, pg. 3-18).

AFLP – One study (Haig et al. 2004) has employed AFLP analysis for the purpose of identifying hybrids resulting from northern spotted owl/barred owl (*Strix varia*) pairings. Restriction enzyme digestion is applied to DNA resulting in fragments that vary in length. These fragments are then amplified through PCR using pre-selective primers, separated through gel electrophoresis, and stained to reveal patterns of band/fragment presence or absence, producing genotypes that can be examined within and across taxonomic units. AFLP analysis is similar in principle to RAPD analysis, but applies PCR using a known primer to fragments that are created through restriction enzyme digestion.

Habitat Tracking

The Service maintains a range-wide database (the Northern Spotted Owl Consultation Effects Tracker) on its intranet that tracks changes to suitable northern spotted owl habitat and incidental take of northern spotted owls, as documented through section 7 consultation. This database contains quantitative estimates of acres of habitat removed and downgraded (i.e., changed function) as a result of Federal projects. These estimates are coded to facilitate aggregation at various spatial scales (e.g., state, physiographic province, administrative unit) which allows examination of the distribution of effects at these levels. However, the data are not yet geospatially referenced or tied to any geographic information system.

The database was created in 2001 and accounts for habitat effects resulting from agency actions since the adoption of the Northwest Forest Plan in 1994. The Northwest Forest Plan baseline has been incorporated into the Consultation Effects Tracker Database as a reference for habitat condition in 1994. The database is updated continuously by the Service as consultations are completed and provides an up-to-date compilation of all management effects to suitable northern spotted owl habitat documented through consultation.

Demography

Demographic analyses on northern spotted owls use a sample of color-banded individuals to estimate fecundity, survival, and annual rate of population change.

The overall analytical framework used at the time of listing is still being used in recent analyses (developing a set of *a priori* models, using maximum likelihood methods to fit the models to the data, and using information theoretic methods to select among competing models). However, important refinements in estimating apparent survival and finite rate of population change from mark-recapture data (Franklin et al. 1996, Franklin et al. 1999, Anthony et al. 2004, Franklin et al. 2004) have been incorporated in the most recent (January 2004 workshop) demographic analyses. In addition to analyzing data separately for each study site, recent analyses also incorporate meta-analyses in which data from all study sites are pooled and analyzed simultaneously. The number of study areas has increased from 2 in 1990, to 14 analyzed in the most recent demography workshop.

Changes in methods to estimate apparent survival include eliminating estimates for juveniles, because these estimates were confounded by emigration (Burnham et al. 1996, Forsman et al. 2002, Anthony et al. 2004), and including examination of two factors (covariates) that may influence survival. The covariates that were investigated during the January 2004 workshop were: (1) reproductive success the previous year (testing for a cost of reproduction) and (2) the proportion of northern spotted owl territories where barred owls were detected each year (testing for competitive or predatory effects of barred owls). The barred owl covariate was included as an exploratory variable to determine if effects were detectable at a coarse scale, recognizing that impacts of barred owls were more likely to occur at the scale of individual territories. Results of this exploratory analysis are preliminary. Details of these new analyses are described in Anthony et al. (2004).

The most substantive change in methods for estimating annual rate of population change (λ) was switching from use of Leslie projection matrix methods (λ_{PM}, which were used at the time of listing and in subsequent demography workshops in 1993 and 1998) to a newly developed method, referred to as the reparamaterized Jolly-Seber method (λ_{RJS}; Pradel 1996). This new method was used as an exploratory analysis in the 1998 demography workshop (Franklin et al. 1999) and in analysis of California spotted owl (*Strix occidentalis occidentalis*) demography (Franklin et al. 2004). The λ_{RJS} method provides a more reliable estimate of population change. A primary reason it gives better estimates is that it does not incorporate estimates of survival and emigration of juvenile owls, which are known to be unreliable and are a part of λ_{PM} estimates. Other advantages of the λ_{RJS} method are that it: (1) directly estimates λ from capture-recapture data which provides a better accounting of gains and losses to the population, (2) reflects annual variability in rates of population change, and (3) yields estimates that are interpreted as a rate of change in the number of territorial owls on the study area – a clear and unambiguous interpretation of population trend [increasing ($\lambda > 1$), decreasing ($\lambda < 1$), or stable ($\lambda = 1$)]. Details regarding the rationale for switching from λ_{PM} to λ_{RJS} and methods of calculation are provided in Anthony et al. (2004).

Another new development in northern spotted owl demographic analyses is an attempt to improve interpretation of annual rates of change as they aggregate through time. Reported estimates of λ_{RJS} for study areas or in meta-analyses are the average across all study years of estimates of the annual rate of population change in the number of owls ($\lambda_{(t)}$). The estimates of $\lambda_{(t)}$ that were < 1.0 represented a decrease in the number of owls; however, subsequent values of $\lambda_{(t)} > 1.0$ for these populations did not indicate that the population had increased to its original numbers. They merely indicated that numbers had increased relative to the number of owls the preceding year. Consequently, a cyclic pattern in $\lambda_{(t)}$ can exist that ultimately results in losses or gains in the number of owls (Anthony et al. 2004). Realized population change (Δ_t), the new analytical development, represents the trend in numbers over the entire period of study for each study area. This approach estimates the proportional change in the population over the time period of λ estimates, and is calculated as a product of annual estimates of realized changes (Anthony et al. 2004). For example, if annual estimates of realized changes for 1993, 1994, and 1995 on a study area were 0.9, 1.2, and 0.7, then the aggregate realized change, Δ_t, for 1996 would be computed as $(0.9)(1.2)(0.7) = 0.756$. This realized population change value indicates that the population going into 1996 was 75.6 percent of the size of the starting population in 1993 (Anthony et al. 2004). This approach allows for estimating changes in population size without doing a direct census. Strength of evidence for realized population change was evaluated using 95 percent confidence intervals calculated using complex methods described in Anthony et al. (2004).

Changes incorporated in demographic analyses have been well received by experts most familiar with the strengths and weaknesses of these methods (Ecological Society of America peer reviews of Anthony et al. 2004).

3. New Information: Biology and Habitat

3. A. Is there relevant new information regarding the species' abundance, demographic features (e.g. age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), demographic trends, or population trends (e.g. increasing, decreasing, stable)? *YES*

Abundance and Density

The 1990 listing document did not include a range-wide population estimate, but did state that about 90 percent of the roughly 2,000 known breeding pairs of northern spotted owls were located on Federally-managed lands (55 FR 26114) and 3,000 to 4,000 pairs were suspected (Thomas et al. 1990). Range-wide estimates since then have not improved substantially – they are still limited to known individuals from localized surveys. Gutierrez et al. (1995) stated there were more than 8,000 known owls based on extensive surveys from 1987 through 1992 on public and private lands. The northern spotted owl population in British Columbia, Canada, based on data from 2002, may be fewer than 33 breeding pairs; fewer than 100 breeding pairs were estimated to be present in 1991 (Zimmerman et al. 2004). Rather than attempt imprecise estimates of range-wide abundance, monitoring has focused on gaining precise estimates of demographic rates on study areas as indicators of abundance trends.

With respect to population densities, the 1990 northern spotted owl listing document stated: "Population densities and numbers are lowest in northern Washington, southern British Columbia, and the eastern portion of its range in California. Few pairs have been located in British Columbia; all have been located near the United States border. Few owls (pairs or singles) are presently found in the Coast Ranges in southwestern Washington or in the northwestern Oregon Coast Ranges (north from the southern portion of the Siuslaw National Forest). The population also decreases in density toward its southern extreme along the Coast Range in Marin, Napa, and Sonoma counties, California and the Mendocino National Forest" (55 FR 26114, pg. 26115).

Relevant new information about density comes mostly from the southern part of the range (i.e., California) and indicates that crude population densities of the northern spotted owls in redwood/Douglas-fir forests of California are higher than other sampled areas within the range. The new, relatively high density estimates reported in Marin County and in other areas along the coast of northern California are contrary to the pattern described in the listing document (SEI 2004, pg. 8-4 and Table 1 of Chapter 8).

Demographic Features and Trends

In 1990, population trends of the northern spotted owl were based on demographic data collected from two study areas: the Willow Creek Study area in California, and the

Roseburg study area in Oregon. Estimation of demographic parameters (e.g., fecundity, survival, and finite rate of annual population change) for populations in these two study areas indicated that resident birds were not reproducing sufficiently to be self-sustaining, and that these populations were sharply declining (55 FR 26114, pgs. 26184-26186). Since listing, a number of new study areas, distributed throughout much of the geographic range of the northern spotted owl, have been added to this demographic analysis for the purposes of evaluating the status and trends of the species. These study areas encompass from 11 to 12 percent of the owl's geographic range, include various land ownerships and management strategies, and span a relatively large number of years. Results of these studies are believed to be representative of most populations of northern spotted owls on Federal lands in Washington, Oregon and California (Anthony et al. 2004). Study sites and analytical procedures (see question 2 above) have varied through time. Workshops to analyze the combined data from all study sites occurred in 1993, 1998, and 2004. At all workshops since listing, data were analyzed separately for individual study areas, as well as simultaneously across study areas (meta-analysis). Analyses are cumulative, however, so later analyses include all data from earlier analyses and supercede earlier analyses (SEI 2004, pg. 8-8). Consequently, we will focus here on the results of the most recent workshop (January 2004) as reported in Anthony et al. (2004).

<u>Fecundity/Reproductive output</u> – Reproductive output was defined as the annual number of young fledging (leaving the nest) per territorial female (Forsman 1983, Franklin et al. 1996). Fecundity was defined as the number of *female* young fledged per territorial female. A 1:1 sex ratio of juvenile owls was assumed; annual per-territory fecundity was therefore one-half of reproductive output.

Age is a primary factor that affects fecundity. Adult females greater than 2 years old had the highest fecundity (0.372 $\pm$ 0.029 SE). Fecundity of the few 2-year old and 1-year old females that attempted to breed was appreciably lower (Anthony et al. 2004). The highest adult female fecundity (> 0.40) was found in the Eastern Cascades of Washington and northern Oregon, the Klamath region of Oregon, and in Marin County in the California Coast Range (Anthony et al. 2004). Lowest fecundity (< 0.30) occurred in the western Cascades of Washington, the Oregon Coast Range, and the Hoopa study area in the Coastal province of California. Reproductive output shows substantial variability both temporally within a study area and geographically among study areas.

The pattern of alternating good and bad years for reproduction, the so-called "even-odd effect," was observed on most study areas, but the pattern appears to be breaking down in recent years (since 1999) (SEI 2004, pg. 8-10). Time trends in reproductive output for individual study areas, either positive or negative, are weak (Table 1; SEI 2004, pg. 8-10). Time trends in fecundity were not supported by meta-analyses (Anthony et al. 2004).

<u>Survival</u> – Survival estimates are based on over 32,000 initial captures and recaptures. Over time, each banded owl in a study area accumulates a capture history based on

whether an owl was observed each year. Analytical methods allow for simultaneous estimation of both recapture and survival probabilities (SEI 2004, pg. 8-7).

Apparent survival rates were generally higher for older owls. Adult apparent survival rates were > 0.85 for most study areas (Anthony et al. 2004). Survival rates varied by study area and were lowest on the Wenatchee study area (eastern Cascades, Washington), followed by Warm Springs (eastern Cascades, Oregon), Marin (coastal California, females only), and Rainier (western Cascades, Washington; Anthony et al. 2004). Meta-analysis revealed regional differences in northern spotted owl apparent survival rates, with highest rates in Oregon Douglas-fir regions and lowest rates in the Washington mixed conifer region (Anthony et al. 2004). High (most estimates > 0.80) and relatively consistent recapture probabilities as documented by Anthony et al. reduce potential bias in estimation of survival rates (Anthony et al. 2004).

Survival rates declined over time on 5 of the 14 study areas: 4 study areas in Washington and 1 study area in the Klamath province of northwest California (Table 1; Anthony et al. 2004). Declines over time were most evident in Washington (Anthony et al. 2004). In Oregon, there were no time trends in apparent survival for four of six study areas, and remaining areas had weak non-linear trends. In California, two study areas showed no trend, one showed a slight decline, and one showed a significant linear decline as described above. Meta-analyses confirmed that the major downward trends in survival are taking place in the mixed-conifer and Douglas-fir regions of Washington (Anthony et al. 2004).

The mean number of young produced in a given year for each study area was analyzed as a predictor of apparent survival during the following year (Anthony et al. 2004). Survival was negatively associated with prior reproduction, but this effect was primarily attributable to study areas at northern latitudes and higher elevations, particularly the Douglas-fir and mixed-conifer regions of Washington and the Douglas-fir zone of the Oregon Cascades (Anthony et al. 2004). This effect was minimal for study areas in California and the mixed-conifer and coastal Douglas-fir regions in Oregon (Anthony et al. 2004). Negative correlation between annual survival and productivity suggests there is a cost of reproduction, which is consistent with many studies of other birds, and the geographic pattern of this correlation suggests winter weather patterns may be the ultimate factor driving the relationship (Anthony et al. 2004).

There was little evidence that land ownership was an important predictor of apparent survival rates in the meta-analyses (Anthony et al. 2004) though the interspersion of land ownership on the study areas confounds this analysis.

<u>Annual rate of population change (λ)</u> – The methods used to estimate this parameter are described in Question 2 in the section dealing with demography. Estimated λ_{RJS} ranged from 0.896 to 1.005 and was < 1 on 12 of 13 study areas (Table 1 and Figure 1; Anthony et al. 2004;). In 4 of these 12, evidence for decline was strong (i.e., 95 percent confidence intervals for λ were < 1) (the Wenatchee and Cle Elum study areas in the eastern cascades of Washington, Warm Springs study area in the Eastern Cascades of

Table 1. Summary of trends in demographic parameters for northern spotted owls from 14 study areas in Washington, Oregon, and California, 1985 to 2003 (modified from Table 21 in Anthony et al. 2004).

Study Area	Primary Land Ownership [a]	Fecundity	Apparent Survival	λ_{RJS}	Realized Population Change [b]
Washington					
Wenatchee (WEN)	Private, USFS, & NPS	Stable	Declining	0.917	Declining
Cle Elum (CLE)	USFS	Declining[c]	Declining? [d]	0.938	Declining
Rainier (RAI)	USFS, NPS & private	Stable	Declining	0.896	Declining
Olympic (OLY)	NPS & USFS	Stable	Declining	0.956	Declining
Oregon					
Coast Ranges (COA)	USFS & BLM	Declining? [c]	Stable	0.968	Declining
H. J. Andrews (HJA)	USFS	Stable? [e]	Stable	0.978	Declining
Warm Springs (WSR)	Tribal	Stable	Stable	0.908	Declining
Tyee (TYE)	BLM & private	Increasing	Stable	1.005	Stationary
Klamath (KLA)	BLM & private	Stable	Stable	0.997	Stationary
South Cascades (CAS)	USFS & BLM	Declining	Stable	0.974	Stationary
California					
NW California (NWC)	USFS	Declining	Declining	0.985	Declining? [f]
Hoopa (HUP)	Tribal	Increasing	Stable	0.980	Stationary
Simpson (SIM)	Private	Declining [c]	Stable	0.970	Declining
Marin (MAR)	NPS	Stable	Stable	NA [g]	NA [g]

[a] Acronyms indicate U.S. Forest Service (USFS), Bureau of Land Management (BLM), and U.S. National Park Service (NPS).
[b] Trend based on estimates of realized population change (Δ_t).
[c] Best model included age and even-odd year effects, but a competing model had a negative time effect on productivity.
[d] Variable among years, but with a declining trend.
[e] Decreasing in early years, increasing in the last 5 years, but stable overall.
[f] Gradual declines in fecundity and apparent survival, plus estimates of realized population change suggest a decline in the last 8 years.
[g] Sample too small to estimate λ.

Oregon, and Simpson in Coastal California). Evidence for decline was good (i.e., 95 percent confidence intervals barely included 1.0) for Rainier and Olympic Peninsula, Washington, and the Oregon Coast Range and H.J. Andrews study areas in Oregon (Figure 1; Anthony et al. 2004). In Washington, the declines appear to be steeper during the last decade (Anthony et al. 2004). Populations appeared to be stationary on five study areas in southern Oregon and California (Tyee, Klamath, South Cascades, Northwest California, and Hoopa) (Table 1 and Figure 1; Anthony et al. 2004).

Estimates of λ_{RJS} were precise for most study areas, but wide confidence intervals for the Rainier and Olympic study areas prevented detection of a difference from λ_{RJS} = 1.0, despite point estimates suggesting a decline of about 40 percent (Figure 1; Anthony et al. 2004).

"Two meta-analyses of λ_{RJS} were completed, one for all 13 study areas combined and one for eight study areas that were part of the Effectiveness Monitoring Program of the Northwest Forest Plan (Lint et al. 1999). The mean λ_{RJS} for all study areas was 0.963 (SE = 0.009), and for the eight monitoring study areas was 0.976 (SE = 0.007), indicating average annual population declines of 3.7 % for all study areas and 2.4 % for the monitoring study areas, neither of which were different from a stationary population based on the 95 % confidence intervals." (SEI 2004, pg. 8-13).

Realized population change analysis (see Section 2 for description) provided evidence that populations on 8 of 13 study areas declined during the study (Table 1). Four study areas showed substantial declines, where estimated current populations were only 40 to 60 percent of initial populations (three in Washington and one in the northern Cascades of Oregon) (Anthony et al. 2004). The duration of these studies ranged from 14 years for the Cle Elum study area, to 11 years for the Rainier and Warm Springs study areas. On the four remaining study areas with declining realized population change, the remaining population in 2002 was 70 to 80 percent of the initial population, during a similar time frame of study (Anthony et al. 2004).

In British Columbia, analysis of survey results indicated that northern spotted owl territory occupancy declined by about 7.2 percent annually, resulting in a 49 percent decline between 1992 and 2001 (Blackburn and Harestad 2002 as cited in SEI 2004, pg. 8-15). Including data from 2002, the decline becomes 67 percent from 1992 to 2002 at an average rate of 10.4 percent annually (Zimmerman et al. 2004).

"One pattern in the results from the meta-analysis is quite clear. The populations studied in Washington are performing less well than those in Oregon and California. All four Washington populations are in decline, with an ongoing decrease in survival rates that means the rate of decline is increasing… Essentially similar results are known for the population further north, in Canada." (SEI 2004, pg. 8-24). Demographic performance of northern spotted owl populations in Oregon was better than in Washington, but a gradient was apparent of stable or increasing trends in the south to declining trends in the north (Figure 1). Demographic trends in California were stable to slightly decreasing (Anthony et al. 2004).

Territorial occupancy rates

Annual progress reports for many of the northern spotted owl demography study areas include information about trends in territory occupancy (number of territories occupied as compared to the total number of territories surveyed). This information potentially provides another means for evaluating trends in abundance. Interpretation of occupancy information, however, is confounded by the need to correct for both owl movements and the probability of detecting owls if they are present (R. Anthony and E. Forsman, pers. comm.). Although territory occupancy rates for some study areas reflect trends estimated by realized population change, occupancy data do not currently provide a reliable,

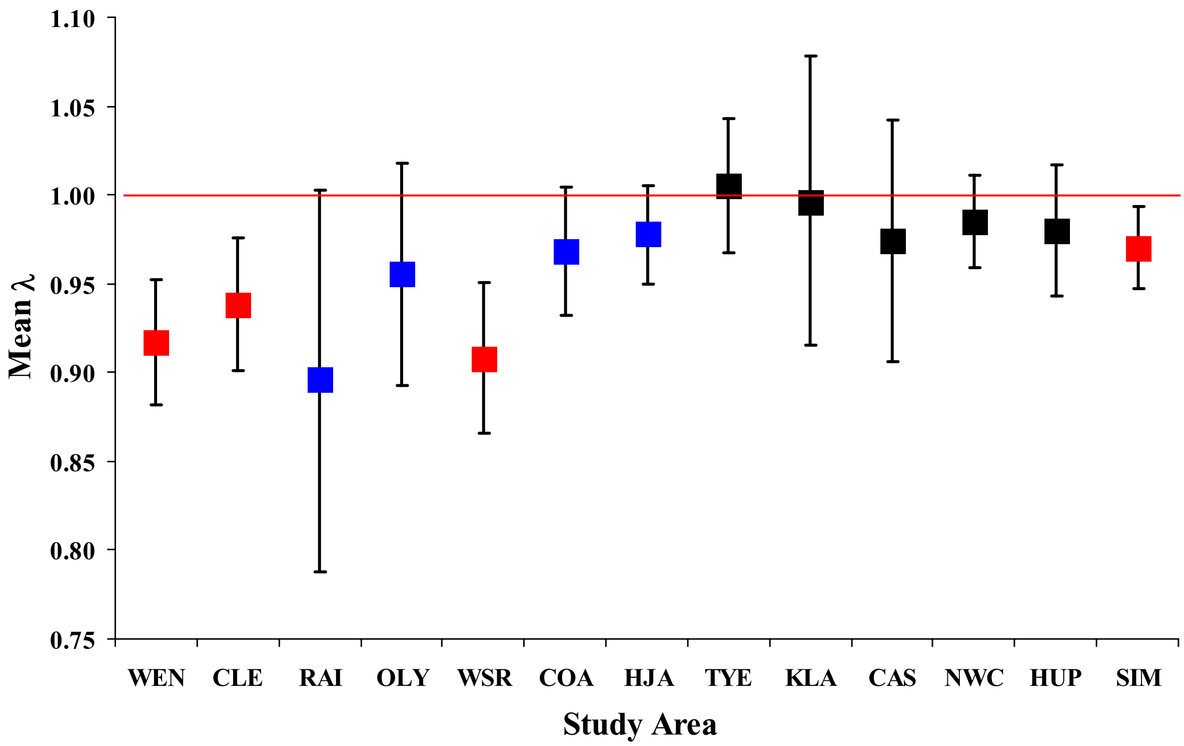

Figure 1. Estimates of mean λ_{RJS} from random effects models based on $\Phi(t)\ p(t)\ \lambda(t)$, with 95 percent confidence intervals for northern spotted owls on 13 study areas in Washington (WEN, CLE, RAI, OLY), Oregon (WSR, COA, HJA, TYE, KLA, CAS), and California (NWC, HUP, SIM). See Table 1 for definition of study area acronyms). (Modified from Figure 7 in Anthony et al. 2004,).

independent estimate of population trends. New methods for improving territory-specific estimates of detection probability may improve our ability to interpret occupancy information in the future, but this work is ongoing and not currently available (R. Anthony and E. Forsman, pers. comm.).

Dispersal

Both natal and breeding dispersal are processes that affect population trends. Natal dispersal is the movement of an owl from its territory of birth to a new territory where it may potentially breed. Breeding dispersal is the movement of a territorial, non-juvenile owl between territories where it may potentially breed. Since 1990, expanded and more comprehensive analysis of radio-marked owls in Oregon and Washington (Forsman et al.

2002) and expanded analysis of re-observed color-banded birds across the species range (Forsman et al. 2002, Diller and Hibbard 1996) have provided new information about both types of dispersal by northern spotted owls.

The distribution of natal dispersal distances measured was skewed towards shorter distances with median dispersal distance of females (24.5 km for banded and 22.9 km for radio-marked owls) greater than that of males (14.6 km for banded and 13.5 km for radio-marked owls). Only 8.9 percent of juveniles dispersed > 50 km (range 0.6 – 111.2 km (Forsman et al. 2002). These new measures of natal dispersal distance confirm the information available in 1990. Results of Diller and Hibbard (1996) suggested that dispersal distances of northern spotted owls in California may be slightly shorter than those found by Forsman et al. (2002) in Washington and Oregon, but this result may be an artefact of comparing medians to means of skewed distributions.

In general, owls did not disperse across the Willamette, Umpqua nor Rogue Valleys of Oregon, but did disperse between the Coast Range and Cascade Mountains through forested foothills between the non-forested valleys (Forsman et al. 2002).

An average of 6 percent of banded, non-juvenile owls exhibited breeding dispersal annually. Probability of breeding dispersal was greater for females, younger owls, owls without mates in the previous year and owls that lost their mates from the previous year through death or divorce (Forsman et al. 2002). Of radio-marked owls that were alive, 44 percent of females and 22 percent of males were paired at 1 year of age, and 77 percent of females and 68 percent of males were paired at 2 years of age. Among owls banded as juveniles, 9 percent were first reobserved as territorial individuals at ≥ 5 years of age (Forsman et al. 2002).

Demographic Trends – Mechanisms

"The cause(s) of Northern Spotted Owl population declines from 1990 to 2003 are poorly understood. Hypothesized reasons for decline include displacement of Spotted Owls by barred owls, loss of habitat to wildfire, loss of habitat to logging on state, private and tribal lands, forest defoliation due to insects, and advancing forest succession toward climax fir communities in the absence of fire (Anthony et al. 2004, L. Irwin, pers. comm)." (SEI 2004, pg. 8-13). Meta-analyses of northern spotted owl demographic rates have not included habitat, weather, or prey covariates. Studies conducted on individual study areas have demonstrated relationships between habitat amount and configuration, weather, and prey, and one or more demographic rates (e.g., Anthony et al. 2002 a and b, Olson et al. in press, Rosenberg et al. 2003, Wagner et al. 1996, Zabel et al. 1996). Inferences from these studies cannot be extrapolated beyond the location where the research was conducted. "In the Klamath Province, California, there appeared to be a trade-off between the benefits to northern spotted owl survival conferred by interior older forest and benefits to reproduction conferred by less interior older forest and more convoluted edge between the two habitat categories (Franklin et al. 2000). Survival was also negatively associated with precipitation and positively associated with temperature during the early nesting period, and reproduction was negatively associated with precipitation during the late nesting period. In addition, owls in territories of higher habitat quality had greater survival during inclement weather than those in poorer quality habitat. Franklin et al. (2000) suggested that habitat quality may determine the magnitude of λ and recruitment may determine variation around λ. Similar analyses on three study areas in Oregon revealed varying results, with one study in the Oregon Coast Range revealing that a mixture of older forests with younger forests and nonforested areas appeared to benefit owl life history traits." (SEI 2004, pg. 8-39).

Analysis of barred owl effects on demographic performance of northern spotted owls was done on an exploratory basis during the January 2004 demography workshop. The covariate used to estimate the effects of barred owls was a coarse-scaled, year-specific variable that lacked the specificity to individual territories that may be necessary to fully evaluate effects of barred owls (Anthony et al. 2004). Overall, results provide some evidence that barred owls may be having a negative effect on northern spotted owl survival in the northern part of the northern spotted owl's range (Anthony et al. 2004). Many field biologists are of the opinion that barred owls are having more of an effect on territory occupancy by northern spotted owls than fecundity or survival (Anthony et al. 2004).

Models of northern spotted owl population dynamics have been consistent in recommending large patches of habitat to support self-sustaining local populations connected by frequent dispersal events (SEI 2004, Appendix 10, pg. 3-48). Early models used in design of the Northwest Forest Plan are now recognized as being overly simplistic, but subsequent efforts (Hof and Raphael 1997, Akcakaya and Raphael 1998) have not improved understanding of factors that drive northern spotted owl population dynamics or put owls at risk (SEI 2004, Appendix 10, pg. 8-53).

Demographic parameters for the northern spotted owl are generally comparable to those seen in other subspecies of spotted owl (Seamans et al. 1999, Franklin et al. 2004) and for other owl species feeding on non-cyclic prey (SEI 2004, pg. 8-3). Results of demographic analyses for all subspecies of spotted owls indicate this species has evolved a life-history strategy that combines low and temporally variable juvenile survival, high and relatively consistent adult survival, and high annual variability in fecundity. High adult survival rates allow individuals to retain territories and persist through periods of less favorable environmental conditions to reproduce when conditions permit (Anthony et al. 2004). This "bet hedging" strategy results from selection that favors adult survival at the expense of present fecundity when recruitment of offspring is unpredictable from year to year (Stearns 1976, Franklin et al. 2000).

3. B. Is there relevant new information regarding the species' genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.)? *YES*

Intra- and Inter-specific Gene Flow

Recent genetic studies (Barrowclough 1999, Haig et al. 2001, Haig et al. in press, Chi et al. unpublished, Henke et al. unpublished) suggest that there is some degree of genetic introgression between the northern spotted owl and the California spotted owl in the

Klamath region, where contact between these two subspecies is most likely (see SEI 2004, pgs. 3-21 to 3-22 for more detailed discussion). Although such introgression could result from temporary movements or dispersal of individuals across geographic subspecies boundaries, genetic 'hybridization' between the northern spotted owl and the California spotted owl is a reasonable and likely explanation for the data evaluated thus far (SEI 2004, pg. 3-16). Because the primary evidence of introgression is based on mitochondrial DNA, which represents genetic contribution of the female only, the degree to which the entire genome includes genetic material typical of both subspecies is unknown. The following aspects regarding this introgression also remain unclear: a) the extent of historical mixing; b) whether current gene flow is increasing, decreasing, non-existent, or constant; c) the directionality of mixing; d) whether the contact zone represents a stable zone of limited genetic mixing, as found for some other avian and non-avian species; and e) the impact genetic mixing may have on the fitness of 'hybrids' and each subspecies (SEI 2004, pgs. 3-22 to 3-23). However, based on both the data and the unknowns "the current low level and restricted range of introgression does not negate the subspecies status of the geographically defined taxa" (SEI 2004, pg. 3-20). Further, this assertion was also supported by participants of a Service workshop held to consider the implications of new information on spotted owl genetics relevant to taxonomy and geographic range.

Interspecific gene flow between the northern spotted owl and the barred owl has been documented based on a combination of observational data [vocalizations or morphology (Hamer et al. 1994, Kelly et al. 2003)] and genetic markers [mitochondrial DNA and AFLPs (Barrowclough 1999, Haig et al. 2004)]. Over 50 cases of interspecific hybridization were documented from 1984 to 1999 (see SEI 2004 for comprehensive list of citations). Most northern spotted owl/barred owl hybrids resulted from a pairing of a male northern spotted owl and a female barred owl or female hybrids (Kelly et al. 2003, Kelly and Forsman 2004, Haig et al. 2004). Backcrosses are also known to occur, but are difficult to identify, suggesting that the degree of genetic introgression likely extends beyond those 50 cases unless later generation backcrosses are less viable (SEI 2004, pgs. 7-32 to 7-33). At this time, the incidence of hybridization between these congeneric species is thought to be relatively low based on the small number of documented cases in comparison to the amount of data examined (Kelly and Forsman 2004).

Genetic Variation

Mitochondrial control region variability (Barrowclough et al. 1999; Haig et al. in press, Chi et al. unpublished), and microsatellite variation (Henke et al. unpublished) in northern spotted owls is typical of that found in other birds. Further, Henke et al. (unpublished) found no significant deviations from Hardy-Weinberg expectations in two northern spotted owl populations in California based on microsatellite data. In contrast, Haig et al. (2001) found remarkably low RAPD variation, particularly given the number of primer sets surveyed. However, the basis behind the apparent discrepancy in the findings of the mitochondrial and microsatellite studies, and the RAPD study is not yet understood (SEI 2004, pg. 3-25).

Genetic analyses corroborate expectations based on field observations. Field studies have documented mating between close relatives (usually parent with offspring) in the northern spotted owl (Carlson et al. 1998, Forsman et al. 2002). However, such pairings appear rare, possibly due to the relatively long natal dispersal distances exhibited by juvenile owls (SEI 2004, pg. 3-25), such that genetic problems associated with inbreeding would not be anticipated.

In general, most genetic markers examined from northern spotted owl populations sampled in Washington, Oregon, and California provided no indication of reduced genetic variation and past bottlenecks (Barrowclough 1999, Haig et al. in press, Henke et al. unpublished). For northern spotted owls in Canada, however, there is some question as to the potential genetic consequences of current population dynamics, in particular, small population size (SEI 2004, Chapter 3). In Canada, the breeding population is estimated to be less than 33 pairs and annual population decline may be as high as 35 percent (Harestad 2004). "With this level of annual decline and with such small population sizes, it is possible (but not necessarily the case) that these populations may be more adversely affected by issues related to small population sizes including inbreeding depression, genetic isolation, and reduced genetic diversity…" (SEI 2004, pg. 3-27).

The listing document stated, "Genetic problems (such as inbreeding) have not yet been considered a problem with spotted owls." (pg. 26191). New information generally confirms that assertion, but low and persistently declining populations in some locations may be at increased risk of loss of genetic diversity.

3. C. Is there relevant new information regarding taxonomic classification or changes in nomenclature? *YES*

Since 1990, there is new information on northern spotted owl morphology, behavior, and genetics that is relevant to the taxonomic classification of the northern spotted owl. This new information corroborates our understanding of northern spotted owl taxonomy in 1990.

Morphology

Qualitative accounts indicate that the northern spotted owl differs in appearance from the California spotted owl (Pyle 1997; Gutiérrez et al. 1995). Quantitative analyses of morphological characters differentiate the Mexican spotted owl (*Strix occidentalis lucida*) from the northern and California subspecies (Barrowclough 1990). Significant morphological differences between the northern spotted owl and the California spotted owl have not been identified, although clinal patterns in plumage have been identified (Barrowclough 1990, SEI 2004, pgs. 3-9 to 3-10).

Behavior

A study of the northern spotted owl four-note location calls (Van Gelder 2003) evaluated various correlates of song variation and found that the model that best explained variation in northern spotted owl calls was a model inferring that all three subspecies are distinct. (SEI 2004, pg. 3-10).

Genetics
"Most nuclear genetic markers (allozymes and RAPDs) have shown remarkably low levels of variation, but some of this variation has been effective at distinguishing the [Mexican spotted owl] from the other two subspecies, and at showing some distinctions between the [northern spotted owl] and [California spotted owl] (Barrowclough and Gutiérrez 1990; Haig et al. 2001). These studies also document some hybridization at or near the contact zone of [northern spotted owl] and [California spotted owl]. A recent study using six microsatellite loci provides evidence of significant differentiation between the [California spotted owl] and [northern spotted owl] (Henke et al. unpublished), and again, some evidence for greater similarity of the subspecies closer to the area where they may come into contact." (SEI 2004, pg. 3-19).

"Three recent studies using mitochondrial DNA sequence (Barrowclough et al. 1999, and Haig et al. in press, Chi et al. unpublished) show a genetic distinction between individuals classified by range or morphology as Northern Spotted Owl and California Spotted Owl birds. Furthermore, both datasets with Mexican Spotted Owl included suggest that California Spotted Owl individuals are more closely related to Mexican Spotted Owl than either is to the Northern Spotted Owl." (SEI 2004, pg. 3-19). However, each study did also detect a small degree of haplotype mixing, mostly near the border of the California Spotted Owl and Northern Spotted Owl." (SEI 2004, pg. 3-15).

Synthesis
A comprehensive scientific review of new information relevant to northern spotted owl taxonomy (SEI 2004, Chapter 3) concluded that the subspecies designation for the northern spotted owl is well supported. Further, although "mitochondrial and nuclear genetic studies document some gene flow near the contact zone of Northern Spotted Owl and California Spotted Owl subspecies, the current low level and restricted range of introgression does not negate the subspecies status of the geographically defined taxa." (SEI 2004, pg. 3-19).

A panel of geneticists and Service managers was convened on August 11, 2004, for a one-day workshop (Workshop on Taxonomy and Range) to examine the scientific information reviewed by SEI (2004, Chapter 3). This panel concluded that the northern spotted owl is a valid subspecies, and thus a listable entity, under the Endangered Species Act. This panel also determined that the new information did not support changing the existing range boundaries of the northern spotted owl at this time.

> **3. D. Is there relevant new information regarding the species' spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range, etc.)?** *YES*

Limited new information is available regarding change in distribution of the northern spotted owl within its historic range. Ongoing surveys of northern spotted owls in British

Columbia, Canada, indicate that the population has declined from about 100 pairs in 1990 to about 30 pairs in 2002 (Zimmerman et al. 2004). Although northern spotted owls continue to occupy most of their historic range in British Columbia, they are more sparsely distributed with more pronounced gaps within this range (Zimmerman et al. 2004). Gutierrez et al. (1995) displayed a range map which indicates range contraction at the northwest extent of the species' range in British Columbia, but the text of this document states that the "Historical distribution [is] presumed the same as current distribution…"

On the Olympic Peninsula and in the Western Cascades of Washington, studies of interactions between northern spotted owls and barred owls suggest that northern spotted owls are being progressively displaced from low elevation forests and remaining northern spotted owls are found upslope (S. Gremel, pers. comm., Pearson and Livezey 2003).

Continuing surveys since the time of listing have confirmed that populations of northern spotted owls in southwest Washington and on the northwest coast of Oregon persist at very low numbers (SEI 2004, pg. 8-26) (e.g., about 13 pairs and 16 singles in southwest Washington; V. Harke, pers. comm. 2004).

Genetic analyses of mitochondrial DNA indicate a low percentage of mitochondrial haplotype mixing between northern and California spotted owls near to the geographical boundary of the two subspecies in northern California and southern Oregon (SEI 2004, pg. 3-3). Northern spotted owl mitochondrial haplotypes have been found within the geographic range of the California spotted owl in the Sierra Nevada (G. Barrowclough, pers. comm., SEI 2004, pg. 3-22). As mitochondrial DNA only track maternal lineages and genetic contributions, the degree to which the entire genome consists of genetic material representative of both subspecies is unknown. Further, current data do not allow interpretation of the history, directionality, and eventual outcome of mixing between spotted owl subspecies. A panel of Service managers and Federal geneticists convened for a workshop (Workshop on Taxonomy and Range) to evaluate the implications of the new information on spotted owl genetics to taxonomy and range, considered the data collected from the apparent 'mixing' zone of the two subspecies and the unknowns surrounding this data and concluded that little can be said on its relevance to the current range of the northern spotted owl at this time.

Development of the metapopulation concept (reviewed in Gutiérrez and Harrison 1996) is an important theoretical advance regarding the interpretation of population dynamics that has occurred largely since the northern spotted owl was listed. "Metapopulations are subdivided populations, with demographically significant exchange between them, meaning that migration or dispersal among populations leads to the stabilization of local population fluctuations, the prevention of local extinctions (the "rescue effect"), the colonization of new habitats or habitats made vacant by local extinctions, or all three. When a species shows metapopulation structure in this sense, the important implication is that its viability is highly sensitive to landscape structure (that is, the distribution of habitat in space and time)." (Gutiérrez and Harrison 1996).

In most areas of the northern spotted owl range, the species was probably originally distributed continually, but is now functionally a metapopulation as a consequence of habitat loss." (SEI 2004, pg. 8-5). In models of northern spotted owl populations, risks of extinction were primarily dependent on the numbers, sizes, and spacing of habitat patches and the interaction of these variables with demography and dispersal (Gutiérrez and Harrison 1996).

Some new information on genetics and dispersal provides insights into the potential isolation of northern spotted owl populations (c.f. SEI 2004, pg. 8-26). Studies of genetic variation in RAPDs (Haig et al. 2001) and mitochondrial DNA (Haig et al. in press) both provided opportunities to estimate rates of gene flow among owl populations. RAPD analysis found evidence of geographical structure in the limited variation detected, especially among breeding regions, suggesting low levels of gene flow (Haig et al. 2001). In contrast, mitochondrial DNA analysis found that gene flow may be occurring among northern spotted owl populations at a level adequate to prevent the deleterious effects associated with inbreeding and loss of genetic variation, even in populations considered most likely to be demographically isolated, such as the Olympic Peninsula population in Washington (Haig et al. in press). Estimates of gene flow based on both techniques are most valuable in a comparative sense only (Haig et al. in press); neither is the preferred technique for evaluating recent levels of gene flow. Thus, new genetic information provides contradictory results that suggest additional work of rates of gene flow is needed (SEI 2004, pg. 3-25).

The most extensive analysis of northern spotted owl dispersal, based on radio-marked juveniles and adults as well as banding records, found that: (1) occasional long-distance dispersal occurred and (2) although owls did not cross large unforested valleys (e.g., the Willamette and Rogue valleys), dispersal occurred around these valleys via forested foothills (Forsman et al. 2002). This dispersal study was conducted in locations in Oregon and Washington that did not provide a good opportunity to investigate dispersal across other putative barriers mentioned in the listing document such as the Columbia River or fragmented habitats in the California Coast province.

3. E. Is there relevant new information addressing habitat or ecosystem conditions (e.g. amount, distribution, and suitability of the habitat or ecosystem)? *YES*

Qualitative and Quantitative Vegetation Characteristics of Northern Spotted Owl Habitat

"In general, studies completed by 1990 showed that Northern Spotted Owls consistently used old-growth forests, forests of mixed mature and old-growth, or, especially in the Redwood region, mature forest with structural characteristics similar to old-growth stands, for foraging, roosting and nesting in proportions greater than expected based on availability." (SEI 2004, pg. 5-3). Since 1990, numerous studies of northern spotted owl habitat relationships have been conducted, that essentially substantiate our understanding in 1990. (For a more comprehensive review of new information on habitat association, see SEI 2004, Chapter 5)

Studies examining the stand conditions within northern spotted owl home ranges and core areas have yielded consistent results in almost every province sampled. Areas surrounding owl sites consisted of a higher proportion of mature and old growth forest in comparison to random locations (SEI 2004, pg. 5-22). These differences tend to diminish as distance from the owl core area increases (Hunter et al. 1995, Ripple et al. 1997, Meyer et al. 1998, Swindle et al. 1999, Perkins 2000). The one exception to this observation comes from Irwin (in press) in the Eastern Cascades of Washington which documented more mature and old-growth forest (> 64 cm dbh) in random locations than owl locations and more smaller forest (20-64 cm dbh) in owl locations than random locations. "Irwin (in press) hypothesized that development of dense understories of shade tolerant trees 13-19 cm dbh, which resulted from fire suppression since 1910, may have led to abandonment of 45 owl territories in mesic forests of their study area." (SEI 2004, pg. 5-6).

Additional patterns and key findings of research conducted on northern spotted owl habitat relationships since 1990 are as follows:

- Higher reproductive rates were noted in northern spotted owls inhabiting interior Douglas-fir and mixed grand fir forests, in comparison to western hemlock forest types in the Washington Cascades (Hicks et al. 2003, Irwin et al. 2004).
- Northern spotted owl sites characterized by a higher proportion of mature and old-growth forest in the surrounding landscape experience higher reproductive rates in some areas [e.g., Oregon Klamath Province (Ripple 1997, Thrailkill et al. 1998), California Redwood Zone (Thome et al. 1999)].
- In the Oregon and California Klamath zones, northern spotted owl occupancy and reproductive success appears positively associated with forest heterogeneity (SEI 2004, pgs. 5-11 and 5-23, and see Zabel et al. 2003, Franklin et al. 2000).

Prey

The basic understanding of the relationship between northern spotted owls and their prey expressed in the listing document was generally confirmed by SEI review of recent studies of northern spotted owl prey and foraging ecology (SEI 2004, Chapter 4). There were two noteworthy new insights from recent studies.

Rosenberg et al. (2001, 2003) found a positive correlation between northern spotted owl reproductive success and abundance of deer mice (*Peromyscus maniculatus*) (about 2 percent of the northern spotted owl's prey biomass). Possible explanations for this association include: (1) deer mouse abundance may provide a critical level of nutrients or energy required for owl reproduction, (2) high deer mouse density may stimulate owl courtship and breeding, and (3) northern spotted owls and deer mice may respond similarly to weather patterns (Rosenberg et al. 2003).

Another new development since listing is a growing body of work suggesting that in some circumstances habitat heterogeneity benefits northern spotted owl demographic responses (e.g., Meyer et al. 1998, Anthony et al. 2000, Anthony et al. 2002 a and b, Franklin et al. 2000, Franklin and Gutierrez 2002). In the Klamath Province of

California, there was a positive relationship between habitat heterogeneity and northern spotted owl demographic responses (Franklin et al. 2000, Franklin and Gutierrez 2002). The positive relationship between habitat edge and northern spotted owl reproductive success in the Klamath Province of California may reflect availability of dusky-footed woodrats (*Neotoma fuscipes*) (Ward et al. 1998), which are found in high densities in early seral or ecotonal habitats (Sakai and Noon 1993, 1997), as well as in older forests (Carey et al. 1999, Raphael 1988). However, even where northern flying squirrels (*Glaucomys sabrinus*) are the dominant prey, some habitat heterogeneity may provide access to a wider range of potential prey species, such as bushy-tailed woodrats (*Neotoma cinerea*), pikas (*Ochotona princeps*), and snowshoe hares (*Lepus americanus*) that occupy edge habitats (SEI 2004, pg. 4-22).

Habitat Trends and Distribution

Historic Old Growth/Mature Forest Levels and Rates of Loss – Recent estimates of historic levels (i.e., pre-logging) of old growth and mature forest in the Pacific Northwest (Rasmussen and Ripple 1998, Teensma et al. 1991, Booth 1991) approach initial calculations reported in 1990 (see SEI 2004, pgs. 6-10, 6-11, for more discussion). In 1990 the Service estimated that northern spotted owl habitat had declined anywhere from 60 percent to as much as 88 percent since the early 1800s (55 FR 26114). This loss was concentrated mostly at lower elevations and in the Coast Ranges, attributed primarily to timber harvest and land conversion activities, and to a lesser degree to natural perturbations (1990 listing document). Although a new compilation of surveys of forest resources from the 1930s has recently been completed (Harrington 2003), interpreting the results of these historic surveys in terms of what areas constituted habitat for northern spotted owls has not been possible.

Current Rates of Habitat Loss – In 1990, current rates of habitat loss due to timber harvest ranged from 1 to 1.5 percent per year on National Forests in California and in Oregon and Washington, respectively; current and anticipated future rates of habitat loss on BLM lands in Oregon at that time were projected to eliminate all available habitat on non-protected BLM lands (except the Medford District), within 26 years (USFWS 1990).

Since 1990, there have been only a few efforts that have produced indices or more direct estimates of habitat change or trends. A recent study (Cohen 2002) reported on landscape-level changes in forest cover across the Pacific Northwest using remote sensing technology (SEI 2004, pg. 6-11). "There was a steep decline in harvest rates between the late 1980s and the early 1990s on State and Federal and private industrial forest lands." (SEI 2004, pg. 6-11). Not all forested land is suitable habitat for northern spotted owls, so area of timber harvest does not equate to area of northern spotted owl habitat removed. Although these estimates of harvest rates do not translate directly to changes in northern spotted owl habitat, they do provide some insight into harvest trends since 1980 (SEI 2004, pg. 6-11).

The northern spotted owl habitat trend analysis conducted by the Service (USFWS 2004a) indicated an overall decline of approximately 2.11 percent in the amount of suitable habitat on Federal lands due to range-wide management activities from 1994 to 2003 (Table 2). The Northwest Forest Plan incorporated an expected loss of northern spotted owl habitat due to management activities of 2.5 percent per decade (USDA and USDI 1994, pg. 46). The majority of management-related habitat loss was in Oregon, which contributes over 75 percent of habitat removed range-wide (121,735 acres). In particular, the Oregon Klamath Mountains province has experienced a 6.8 percent reduction in habitat since 1994 (53,468 acres), an average annual rate of 0.76 percent (Table 2). The California Cascades province, with a 5.77 percent reduction (5,091 acres) in habitat (0.64 average annual decline), is the only other location that shows a relatively high rate during the 9 years of record. Because this province has a smaller habitat baseline, it contributes less to the range-wide rate. Habitat additions to the Federal land base were not considered a change in habitat condition and thus were not included in the baseline or in calculations of habitat trends.

Table 2. Summary of habitat acres and percent change in northern spotted owl habitat on Federal lands due to management activities from 1994 to 2003 (SEI 2004).

Physiographic Province	Forest Plan Baseline	Management Changes (acres)	Percent Change	Average Annual Rate of Change
Olympic Peninsula	560,217	-87	-0.02	-0.002
WA Eastern Cascades	706,849	-5,024	-0.71	-0.08
WA Western Cascades	1,112,480	-11,139	-1.00	-0.11
Western Lowlands	0	0	0	0
OR Coast Range	516,577	-3,278	-0.63	-0.07
OR Klamath Mt.	786,298	-53,468	-6.80	-0.76
OR Cascades East	443,659	-13,867	-3.13	-0.35
OR Cascades West	2,045,763	-51,122	-2.50	-0.28
Willamette Valley	5,658	0	0	0
CA Coast	51,494	-250	-0.49	-0.05
CA Cascades	88,237	-5,091	-5.77	-0.64
CA Klamath	1,079,866	-12,673	-1.17	-0.13
Regional totals	7,397,098	-155,999	-2.11	-0.23

There are no direct rangewide estimates of habitat amounts or rates of loss on non-federal lands at this time. Cohen et al. (2002) reported that the harvest rates on private industrial lands were consistently about twice the average rate of harvest on public land from the early 1970s through the mid-1990s. “In the late 1980s and early 1990s the harvest rate was estimated at 2.4 percent per year for private industrial land. An increase in private non-industrial lands owner's harvest rates started in the 1970s when the rate was 0.2 percent per year and continued to increase to the early 1990s when the rate was similar to that of the private industrial lands." (SEI 2004, pg. 6-11). Again, these estimates can only be used to infer rates of forest removal on Federal and non-Federal lands, which may or may not translate into the same comparisons with respect to habitat loss. They may also provide some insight into the potential differences in the rates of habitat loss on different land ownerships (SEI 2004, pg 6-11).

The Service has approved 16 habitat conservation plans that address management of northern spotted owls on nonfederal lands (representing about 10 percent of the non-federal forest lands in the spotted owl's range). Habitat conservation plans are designed to offset harmful effects the proposed activity might have on the spotted owl. The HCP process allows resource use to proceed while promoting owl conservation. Some of these plans contain estimates of owl habitat, however, each utilizes different definitions or surrogates for habitat that are not comparable. In addition, reporting requirements vary widely, and do not provide information to determine rates of habitat removal.

Current Rates of Habitat Loss Due to Natural Events – Habitat loss due to natural events totaled 224,041 acres, which equated to a 3.03 percent decline in available habitat range-wide from 1994 to 2003 (USFWS 2004a). Most natural loss of habitat resulted from wildfires (75 percent of natural event losses), followed by insect and disease (25 percent). Very little loss from windthrow was reported (Table 3). Seventy different fires ranging from 6 to 113,667 acres of estimated habitat loss contributed to total loss due to natural disturbance. Only 14 fires of 70 resulted in loss of suitable nesting/roosting habitat exceeding 1,000 acres. In general, the Oregon Klamath Mountains province suffered the highest loss of habitat from natural events, all due to wildfire. Ninety-six percent of habitat loss in this province can be attributed to the Biscuit fire, that burned approximately 113,667 acres of habitat on three different administrative units in the Rogue River basin in 2002 (See Appendix 7 in USFWS 2004a). Information on loss of northern spotted owl habitat due to natural disturbances on non-Federal lands was not available.

Habitat development – As with habitat loss, development of suitable habitat contributes to overall trends in habitat availability and distribution across time. Estimates of late-successional habitat development were calculated at the regional scale using a modeled projection approach (USDA et al. 1993, USFWS 2004a). This approach estimated 600,000 acres of ingrowth per decade on Federal lands, representing about an eight percent decadal increase in forest over 80 years of age on Federal lands relative to the Northwest Forest Plan baseline. Habitat development would not be expected to be evenly distributed across the range of the northern spotted owl, though the lack of spatial information in the analysis prevents us from describing the distribution.

In reality, projecting the transition of a forests age and size classes to different levels of habitat function requires extensive field verification. SEI (2004, pg. 6-29) recognized that the accuracy of such estimates are approximations to be used on range-wide scales and that given the uncertainty about the rate of complex forest structure development in the 80+ year-old stands, habitat development was likely overestimated, although the extent can not be determined (SEI 2004, pg. 6-30).

Table 3. Federal habitat lost due to natural disturbance events from 1994 to 2002 (acres).

Physiographic Provinces	Fire	Wind	Insect and disease	Provincial total	Percent change	Annual rate of change
Olympic Peninsula	-299			-299	-0.05	-0.01
WA Eastern Cascades	-5,754			-5,754	-0.81	-0.09
WA Western Cascades			-250	-250	-0.02	-0.002
Western Lowlands				0	0	0
OR Coast Range	-66			-66	-0.01	0
OR Klamath Mountains	-117,622			-117,622	-14.96	-1.66
OR Cascades East	-4,008		-55,000	-59,008	13.30	-1.48
OR Cascades West	-24,583			-24,583	-1.20	-0.13
Willamette Valley				0	0	0
CA Coast	-100			-100	-0.19	-0.02
CA Cascades				0	0	0
CA Klamath	-15,869	-100	-390	-16,359	-1.51	-0.17
Regional total	-168,301	-100	-55,640	-224,041	-3.03	-0.34

In the 1990 listing document, discussion pertinent to development of northern spotted owl habitat was limited, focusing almost exclusively on the extent to which current rates of habitat removal/loss could be offset by habitat development over time: “Although more suitable habitat is likely to develop with time, it does not seem probable that recruitment of suitable habitat will significantly offset currently anticipated losses resulting from timber harvesting and natural events such as fire and wind storms (Thomas et al. 1990).” (page 26151). Given the general nature of this statement, we were unable to quantitatively compare anticipated rates of habitat development at the time of listing to those estimated now.

<u>Comparison of current rates of habitat loss due to management to those in 1990 -</u> Average annual rates of harvests for northern spotted owl habitat on Federal lands have declined substantially since 1990 (Table 4). Harvest rates on the National Forests in Oregon and Washington dropped from 1.5 percent per year (64,000 acres) at the time of listing to an average of 0.21 percent per year from 1994 to 2003 (10,341 acres). Harvest rates for northern spotted owl habitat on National Forests in California dropped from 0.6

percent per year (calculated at approximately 4,700 acres) to an average of 0.14 percent per year (1,653 acres). Harvest rates for northern spotted owl habitat on BLM lands in Oregon dropped from three percent per year (22,000 acres) in 1990 to 0.52 percent per year (4,911 acres) in 2003 (Table 4).

Table 4. Comparison of Federal habitat trends presented in the final listing document to recent trends of habitat change due to Federal management activities. Values represent acres, with average annual percentage in parentheses.

	Final Listing Document[1]		5-year Review
Management agency and state	Pre-listing period (about 1981 to 1990)[2]	Anticipated rates (about 1991 to 2000)[3]	Calculated rates[4] (1994 to 2003)
FS in WA and OR	64,000 (1.5)	39,400 (1)	10,341 (0.21)
FS in CA	Not reported[5]	4,700 (0.6)	1,653 (0.14)
BLM in OR	22,000 (3)	23,400 (3)	4,911 (0.52)
Total		67,500 (1)	16,905 (0.24)

1 Habitat change values were presented in the listing document in units of acres per year, rather than as a percentage of total available habitat per year. We converted these values to annual percentage rates by dividing by the habitat amount in the Forest Plan baseline for each management agency and geographic group and multiplying by 100 (annual percentage rates in parentheses, indicating negative changes).

2 Reported in the listing document as observed trends from 1981-1990.

3 Estimated in the listing document as trends expected in the next decade (1991-2001).

4 Annual acreage totals calculated as the sum of effects from 1994 to 2003 divided by 9 years of record. Annual percentage rates calculated as described above.

5 The listing document references a rate of 12,000 acres of habitat loss per year in California, but it was unclear what time period this rate represented. Consequently, we did not include it here.

Sudden Oak Death – "Sudden Oak Death (SOD) is a forest disease caused by the fungus-like pathogen, *Phytopthora ramorum* that was recently introduced from Europe. At the present time [Sudden Oak Death] is found in natural stands from Monterey to Humboldt Counties, California, and has reached epidemic proportions in oak and tanoak forests along approximately 300 km of the central and northern California coast (Rizzo et al. 2002). It has also been found near Brookings, Oregon, killing tanoak and causing dieback of closely associated wild rhododendron and evergreen huckleberry (Goheen et al. 2002). It has been found in several different forest types and at elevations from sea level to over 800 m. [Sudden Oak Death] is continuing to spread." (Exerpted from SEI 2004, pg. 6-46).

"Sudden Oak Death (SOD) has the potential to be locally important in some parts for the range of the Northern Spotted Owl. [Sudden Oak Death] infects many important tree species within the range of the [northern spotted owl] including Douglas-fir, coast redwood, tanoak, Pacific madrone, Canyon live oak, and California black oak." (SEI

2004, pg. 6-26). Significant mortality of these tree species, or of Douglas-fir and coast redwood, in which effects are currently unknown, would be expected to significantly modify northern spotted owl habitat structure (SEI 2004, pg. 6-26). Although such effects to northern spotted owl habitat have not yet been documented, there exits a potential for future habitat loss due to Sudden Oak Death.

3. F. Is there relevant new information addressing disease, predation, or competition? *YES*

Disease

West Nile virus is a new disease that could affect northern spotted owls. West Nile virus is an arbovirus that is primarily transmitted by mosquito vectors and avian species are the primary hosts. West Nile virus appears to have arrived in the United States in 1999. Over 150 birds native to North America have been infected with West Nile virus (Bernard and Kramer 2001, Komar et al. 2001, Komar et al. 2003, Marra et al. 2004). One captive northern spotted owl in Ontario, Canada, is known to have contracted West Nile virus and died. Although scattered cases have been reported in the Pacific Northwest, West Nile virus has not emerged within the native range of the northern spotted owl. Health officials expect eventual emergence throughout California, Oregon, and Washington (SEI 2004, pg. 8-33). Many mosquito species capable of transmitting the virus are present throughout the Pacific Northwest. Modeling to predict where West Nile virus is likely to affect California wildlife suggests that populations of northern spotted owls in the coastal mountains of northwestern California are at greatest risk of exposure (Boyce et al. 2004). We are not aware of similar modeling for Oregon and Washington.

While birds are the key reservoir hosts of West Nile virus, mammalian prey may also play a role in spreading West Nile virus among predators, like northern spotted owls. Owls and other predators of mice can contract the disease by eating infected prey (Garmendia et al. 2000, Komar et al. 2001). Recent tests of tree squirrels (which includes flying squirrels) from Los Angeles County, California, found over 70 percent were positive for West Nile virus (R. Carney, pers. comm. 2004). Flying squirrels are a primary prey item for northern spotted owls.

Susceptibility to infection and mortality rates of infected individuals vary among bird species, even within groups (SEI 2004, pg. 8-35). Owls appear to be quite susceptible. For example, breeding screech owls (*Megascops asio*) in Ohio experienced 100 percent mortality (T. Grubb, pers. comm.). Barred owls, in contrast, showed lower susceptibility (B. Hunter, pers. comm.) Some level of innate resistance may occur (Fitzgerald et al. 2003), which could explain observations in several species of markedly lower mortality in the second year of exposure to West Nile virus (Caffrey and Peterson 2003). Wild birds also develop resistance to West Nile virus through immune responses (Deubel et al. 2001). The effects of West Nile virus on bird populations at a regional scale have not been large, even for susceptible species (Caffrey and Peterson 2003), perhaps due to the short-term and patchy distribution of mortality (K. McGowan, pers. comm.) or annual changes in vector abundance and distribution.

Although we know that northern spotted owls are susceptible to West Nile virus, the degree to which this disease will affect owl populations range-wide remains unclear due to a number of uncertainties. These uncertainties include: (1) how uniformly the disease will spread throughout the range of the northern spotted owl; (2) the most likely vector of spread to northern spotted owls (e.g., directly, or through prey species); (3) what proportion of northern spotted owls infected with West Nile virus will suffer mortality; and (4) whether northern spotted owls will develop resistance to the West Nile virus (SEI 2004, pg. 8-36).

Little new information is available about diseases other than West Nile virus (Gutierrez et al. 1995). A case of spirochetosis (Thomas et al. 2002), and incidence of ectoparasites (Young et al. 1993, Hunter et al. 1994, and Morishita et al. 2001), and endoparasites (Hoberg et al. 1993) have been reported since listing. The prevalence of infection with these agents and the population consequences are unknown. Necropsies of 48 juvenile and adult owls that were recovered during a telemetry study of dispersal found that at least 32 (67 percent) were infected with blood parasites or intestinal parasites, or had evidence of disease (Forsman et al. 2002). Infections with multiple species of hemoparasites and intestinal parasites were common and one owl had avian cholera (Forsman et al. 2002). Although starvation or predation appeared to be the ultimate cause of death in most cases, parasites or disease may have been a predisposing factor (Forsman et al. 2002). This new information affirms similar suggestions (Hunter et al. 1987, Gutiérrez 1989, Hoberg et al. 1989) made before the northern spotted owl was listed.

For more detailed information about West Nile virus and other diseases, see SEI 2004, pgs. 8-32 to 8-38 and 2-9 to 2-10. References here are as cited in these pages of SEI 2004.

Predation
New information about predation generally confirms the range of potential predators on northern spotted owls that was suspected at the time of listing. Likewise, the effects of these predators on northern spotted owl populations remain nearly as uncertain now as they were in 1990. Although predation on northern spotted owls occurs and may be numerically important as a cause of death, there are no studies addressing whether predation occurs at levels that affect northern spotted owl population trends. The majority of observations of predation are incidental to other studies. Indirect evidence from demography studies (e.g., Forsman et al. 1996) and lack of avoidance responses by northern spotted owls following experimental playback of great horned owl (*Bubo virginianus*) calls (Crozier et al. in press), suggest that predation is not a major influence on population dynamics or behavior. In their responses to the questionnaire about uncertainty and risk, no SEI panelists felt that predation was an important risk factor for northern spotted owls. At this point, a strong effect of predation is best regarded as an untested hypothesis which, while possible, lacks any empirical support, and is not favored by circumstantial evidence (SEI 2004, pgs. 8-28 to 31).

Forest fragmentation was mentioned in the 1990 final listing rule (55 FR 26114) as a possible factor contributing to increased risk of predation. Given the general lack of concern regarding predation effects, and the absence of any corroborating evidence, there appears to be no reasonable basis for regarding an effect of fragmentation on predation levels as a primary or significant effect on northern spotted owl populations. Absent new information, the indirect effect of fragmentation through predation remains an untested hypothesis (SEI 2004, pgs. 8-30 to 31 and 11-8 to 9).

Competition

The recent invasion of the barred owl into the Pacific Northwest introduces a new potential competitor for the northern spotted owl. Although historically restricted to eastern North America (Rignall 1973, Mazur and James 2000), the barred owl has rapidly expanded its range westward since the early 1900s (see SEI 2004 Chapter 7 for chronology of invasion and comprehensive list of references). By 1990, barred owls were found throughout the majority of the range of the northern spotted owl, and were thought to exist primarily as scattered pairs and individuals, except in the northern Washington Cascades and British Columbia, where detection rates approached those of northern spotted owls (USFWS 1990).

In 1990, information on the habitat use and biology of barred owls in the Pacific Northwest, as well as potential mechanisms of competition with northern spotted owls, was limited to a few studies (e.g., Allen 1985, Hamer 1988, Hamer et al. 1989) and anecdotal reports. In general, barred owls were thought to: (1) utilize a broader range of habitat types (including landscapes fragmented by timber harvest) and prey species, (2) have smaller home ranges, and (3) be more aggressive than northern spotted owls during interspecific encounters. Based on the understanding at the time, barred owls were considered a likely competitor that had the potential to adversely affect northern spotted owl populations (USFWS 1990).

<u>Range Expansion and Population Increase of the Barred Owl since 1990</u> – Since 1990, the barred owl has expanded its range south into Marin County, California and the central Sierra Nevada, such that it is now roughly coincident with the range of the northern spotted owl (SEI 2004, pg. 7-13). Further, notwithstanding the likely bias in survey methods towards underestimating actual barred owl numbers (SEI 2004, pg. 7-16), Barred owl populations appear to be increasing throughout the Pacific Northwest, particularly in Washington and Oregon (Zabel et al. 1996, Dark et al. 1998, Wiedemeier and Horton 2000, Kelly et al. 2003, Pearson and Livezey 2003, Anthony et al. 2004). For example, "in southwestern Oregon, the Bureau of Land Management Coos Bay District reported barred owl sites increased from one known site in 1990 to 40 sites in 2001, despite greatly reduced survey efforts between 1995 and 2001; by 2002 barred owls were approximately one-third as common as northern spotted owls (J. Guetterman pers. comm.)." (SEI 2004, pg. 7-17). "Kelly et al. (2003) estimated there were 706 barred owl territories in Oregon based on 2,468 detections of barred owls. More importantly, these territories were spread over most of western Oregon and the forested regions of northeastern Oregon." (SEI 2004, pg. 7-18). Barred owl numbers now may exceed northern spotted owl numbers in the northern Washington Cascades (Kuntz and

Christopherson 1996) and British Columbia (Dunbar et al. 1991) and appear to be approaching northern spotted owl numbers in several other areas [e.g., Redwood National and State Parks in California (Schmidt 2003)].

There are a few locations where exceptions to this trend of increasing barred owl presence have been noted. In southern British Columbia, barred owls were more common than northern spotted owls by the mid 1980s, but then decreased in numbers between 1992 and 2001, a trend also noted in northern spotted owls (Blackburn and Harestad 2002). On the Yakama Reservation in Washington, barred owls numbers increased dramatically throughout the 1990s, but appeared then to stabilize or decline after 1998 (King 2003). Not including the Redwood National and State Parks, barred owl numbers in California still appear relatively low, particularly on industrial forest lands (SEI 2004, pg 7-18). However, in spite of these exceptions, barred owl populations in the Pacific Northwest appear to be self-sustaining, based on current density estimates and apparent distribution (SEI 2004, pg. 7-16).

Habitat Use by Barred Owls in the Pacific Northwest – Although barred owls were initially thought to be more closely associated with early successional forests than northern spotted owls (Hamer et al. 1989, Iverson 1993), recent studies indicate they are found in mature and old-growth forests as well (Pearson and Livezey 2003, Schmidt 2003), including the same habitat types used by northern spotted owls (i.e., Douglas-fir, mixed conifer, and coastal redwood) (SEI 2004, pgs. 7-19 to 7-23).

Within Douglas-fir/mixed conifer forest types, some studies found that, in contrast to northern spotted owls, barred owls were more frequently located along low elevation valley bottoms near riparian habitats or at higher elevations characterized by higher annual rainfall (Herter and Hicks 2000, Blackburn and Harestad 2002, Pearson and Livezey 2003). However, other studies have reported complete elevational overlap (Kuntz and Christopherson 1996, Iverson 1993, George and Lechleitner 1999) and have documented barred owls in xeric, upland sites as well moister habitats. Invasion by the barred owl may be characterized by initial colonization of watercourses and riparian areas, followed later by expansion into drier habitats (Gremel 2000) where conditions remain suitable (SEI 2004, pg. 7-23). These studies suggest that barred owls are capable of utilizing a broader range of habitat types relative to northern spotted owls (SEI 2004, pg. 7-20).

Empirical comparison of northern spotted owl and barred owl food habits in the Pacific Northwest essentially is restricted to one study (Hamer et al. 2001). This study indicated that, where sympatric, barred owl diets overlapped strongly (>75 percent) with northern spotted owl diets. However, barred owl diets were also more diverse than northern spotted owl diets, including species associated with riparian and other moist habitats, as well as those considered more terrestrial and diurnal in their habitats. Further, barred owl diets were more evenly distributed across prey species, and were more diverse (Hamer 2001).

Breeding Biology – "Barred Owls have a larger range of clutch sizes than Northern Spotted Owls (1-5 vs. 1-3; Gutiérrez et al. 1995, Mazur and James 2000). However, it is not clear that they produce more young on average than Spotted Owls (i.e., are more productive than Spotted Owls in the Pacific Northwest)… Like Spotted Owls, Barred Owl reproductive activity appears to be quite variable from year to year (Mazur and James 2000)." (SEI 2004, pg. 7-18).

Competitive Dynamics Between Barred Owls and Northern Spotted Owls – New information on encounters between barred owls and northern spotted owls comes primarily from anecdotal reports – as in 1990 – which corroborate our initial observations that barred owls react more aggressively towards northern spotted owls than the reverse (SEI 2004, pg. 7-25). There are also a few instances of barred owl aggression and predation on northern spotted owls (Leskiw and Gutiérrez 1998, Johnston 2002). Although more experimental approaches are needed to more definitively characterize barred owl/northern spotted owl interactions, the information collected to date indicates that encounters between these two species tend to be agonistic in nature, and that the outcome is unlikely to favor the northern spotted owl (SEI 2004, pg. 7-25). Given this relationship, barred owls may be able to displace or preempt northern spotted owls from territories (SEI 2004, pg. 7-25). Further, use of more diverse habitat types and prey, may confer some competitive advantage to barred owls over northern spotted owls with respect to reproductive output (SEI 2004, pg. 7-26).

Evidence that competition between barred owls and northern spotted owls may be adversely affecting the latter species is largely indirect, based primarily on retrospective examination of long-term data collected on northern spotted owls. Correlations between local northern spotted owl declines and barred owl increases have been noted in the northern Washington Cascades (Kuntz and Christopherson 1996, Herter and Hicks 2000, Pearson and Livezey 2003), on the Olympic peninsula (Wiedemeier and Horton 2000, Gremel 2000, 2002), in the southern Oregon Cascades [e.g., Crater Lake National Park (Johnston 2002)], and in the coastal redwood zone in California [e.g., Redwood National and State Parks (Schmidt 2003)]. "These changes are correlative and do not prove causality; however, a logical and reasonable interpretation, given the potential and known extent to which the two species share habitat and food resources, and interact behaviorally, is that one change is probably causing (or at least interacting among causes) the other change." (SEI 2004, pg. 7-27).

Kelly et al. (2003) examined the effect of barred owls on territory occupancy by northern spotted owls at demography study areas in Washington and Oregon. They found that northern spotted owl occupancy was significantly lower in northern spotted owl territories where barred owls were detected within 0.8 km (0.5 mi) of the northern spotted owl territory center than in northern spotted owl territories where no barred owls were detected. Kelly et al. (2003) also found that in northern spotted owl territories where barred owls were detected, northern spotted owl occupancy was significantly lower ($P < 0.001$) after barred owls were detected within 0.8 km of the territory center; occupancy was "only marginally lower" ($P = 0.06$) if barred owls were located more than 0.8 km from northern spotted owl territory centers. In the Roseburg study area, 46 percent of northern spotted owls moved more than 0.8 km, and 39 percent of northern spotted owls were not relocated again in at least 2 years after barred owls were detected within 0.8 km of the territory center. Observations provided by Gremel (2000) from the Olympic National Park are consistent with those of Kelly et al. (2003); he documented significant displacement of northern spotted owls following barred owl detections "coupled with elevational changes of northern spotted owl sites on the east side of the Park." (SEI 2004, pg. 7-29). Pearson and Livezey (2003 reported similar findings on the Gifford Pinchot National Forest where unoccupied northern spotted owl sites were characterized by significantly more barred owl sites within 0.8-km, 1.6-km, and 2.9-km from the territory center than in occupied northern spotted owl sites.

At three study areas in Washington, investigators have found relatively high numbers of territories that were previously occupied by northern spotted owls that are now apparently not occupied by either spotted or barred owls (e.g., 49 of 107 territories, 46 percent, in the Cascades; Herter and Hicks 2000). Given that habitat is still present in these vacant territories, some factor may be reducing habitat suitability or local abundance of both species. For example, weather conditions could cause prolonged declines in abundance of both species (Franklin et al. 2000). Because northern spotted owls have been anecdotally reported to give fewer vocalizations when barred owls are present, it is possible that these putatively vacant territories are still occupied by northern spotted owls that do not respond to surveys. Likewise, survey protocols for northern spotted owls are believed to under-detect barred owls. Thus, some proportion of seemingly vacant territories may be an artifact of reduced detection probability of the survey protocol. Nonetheless, presence of vacant territories suggests that factors other than barred owl invasion alone are contributing to declines in northern spotted owl abundance and territorial occupancy (SEI 2004, pgs. 7-31 and 35).

Demographic studies of northern spotted owls have recently attempted to incorporate barred owls as a possible factor in population trends. During the Demographic Workshop in January 2004, the proportion of northern spotted owl territories where barred owls were detected each year was used as a covariate to test for competitive or predatory effects of barred owls. This barred owl covariate was included as an exploratory variable to determine if effects were detectable at the scale of a demographic study area, recognizing that impacts of barred owls were more likely to occur at the scale of individual territories (Anthony et al. 2004). Fecundity of northern spotted owls appears to be affected little by the presence of barred owls, although the Wenatchee and Olympic demographic study areas showed possible effects (Anthony et al. 2004). Barred owls had a negative effect on northern spotted owl survival on the Wenatchee and Olympic study areas and possibly an effect on the Cle Elum study area (Anthony et al. 2004). Iverson (2004) also reported little effect of barred owl presence on northern spotted owl reproduction although his results could have been influenced by small sample size. Olson et al. (in press) found a significant (but weak) negative effect of barred owl presence on northern spotted owl reproductive output but not on survival at the Roseburg study area (SEI 2004, pg. 7-36 to 7-37).

Regarding interactions between barred and northern spotted owls, the uncertainties associated with methods, analyses, and possible confounding factors (e.g., effects of past habitat loss, weather) warrant caution in interpretation of the patterns emerging from the data and information collected to date (SEI 2004, pgs. 7-39 to 7-40). Further, data are currently lacking that would allow accurate prediction of how barred owls will affect northern spotted owls in southern, more xeric, portion of the range (i.e., California and Oregon Klamath regions). In spite of these uncertainties, the preponderance of the evidence gathered thus far is consistent with the hypothesis that barred owls are playing some role in northern spotted owl population decline, particularly in Washington and portions of Oregon and the northern coast of California (SEI 2004, pgs. 7-41 to 7-42 and 11-8).

SEI (2004, pgs. 7-9 to 7-12) compared the size differences between barred owls and northern spotted owls in the Pacific Northwest to size ratios of coexisting species of *Strix* owl species, including that of the Mexican spotted owl and the barred owl in the southwest U.S. and Mexico. This analysis was conducted to explore the potential for eventual coexistence of or niche partitioning by barred owls and northern spotted owls based primarily on differences in mass. Results of this analysis indicated that the difference in size between the northern spotted owl and the barred owl in the Pacific Northwest was only 17.5 percent, lower than ratios calculated for all other assemblages examined. The SEI panel concluded that this difference may be too slight to permit "coexistence by dint of size and size-related ecology alone." (SEI 2004, pg. 7-12).

3.G. Is there any other relevant new biological information (e.g., ecological community dynamics, symbiotic interactions)? *YES*

Since 1990, considerable new information has been developed about many aspects of the biology of the northern spotted owl. Some of this information is not included in this template because the Service found it was not relevant to determining the appropriate listing category for the owl. SEI (2004) provided a complete review of new information.

4. New Information: Management

4. A. Is there relevant new information regarding regulatory mechanisms? *YES*

Since the listing of the northern spotted owl in 1990, there have been only minor changes to Federal laws, changes to Canadian laws, and changes to State laws and regulations that might affect management or protection of the species.

Federal Lands and Regulations

There have been no significant changes to U.S. Federal laws or regulations that would affect the northern spotted owl since its listing in 1990 (USFWS 2004b).

Canadian Laws and Regulations

The northern spotted owl was listed throughout its range, including that portion within British Columbia, Canada. There have been significant changes to Canadian Federal laws since the listing of the northern spotted owl under the U.S. Endangered Species Act (including the Canadian population).

The northern spotted owl was listed as endangered by the Committee on the Status of Endangered Wildlife in Canada in 1986. Under the Canadian Species at Risk Act, whose provisions took effect June 1, 2004, the northern spotted owl is protected from killing and harassment, and its nests are protected from damage or destruction. The Canadian Spotted Owl Recovery Team (established in 1990) developed an options report in 1994 for the Cabinet. This report prompted development of a Spotted Owl Management Plan with an estimated 60 percent chance of stabilizing the northern spotted owl in Canada. In 2002, the B.C. Ministry of Water, Land, and Air Protection released an assessment which suggested that this plan was insufficient and suggested that extirpation could occur within 5 to 10 years. A new recovery team has been established and is currently working on a new recovery plan (Zimmerman et al. 2004).

The Canadian population of the northern spotted owl is very small (less than 33 pairs), isolated, and in decline (10.9 percent from 1992 to 2002, 35 percent from 2001 to 2002). The Canadian population has reached the point where it is now vulnerable to stochastic demographic events that could cause further declines and perhaps extirpation, and conditions are not likely to improve in the short term (SEI 2004, pgs. 3-26 to 3-27). Given the extremely low populations and steep decline of the northern spotted owl in Canada, the lag period required needed for regrowth of habitat, and the threats from invasive species, it is too early to determine if the current management approach will allow the northern spotted owl to persist in Canada.

State Lands and Regulations

Washington State Laws and Regulations – The northern spotted owl was listed as a state endangered species in March 1993, based primarily on loss of suitable habitat. The State Threatened and Endangered Species Act prohibits direct taking (killing), but contains no specific habitat protection provisions.

The Washington State Forest Practices Regulations apply to 7 million acres of private forest within the range of the northern spotted owl in Washington. The State Forest Practices Board adopted new rules in 1995, developed around the principle that habitat protection and recovery of the northern spotted owl is focused on Federal lands. The rules established 10 large Spotted Owl Special Emphasis Areas (2 million acres) adjacent to Federal lands designed to provide demographic support and linkage corridors (dispersal) between Federal lands. Depending on the focus of the specific Spotted Owl Special Emphasis Area, forest management should be aimed at maintaining the viability of the owl(s) associated with each northern spotted owl site center, providing demographic support, or providing dispersal habitat. Outside of Spotted Owl Special Emphasis Areas, 70 acres of the highest quality suitable northern spotted owl habitat surrounding a northern spotted owl site center should be maintained during the nesting season, but may be harvested after the season is over. These regulations are currently undergoing review and revision.

Oregon State Laws and Regulations**:** The northern spotted owl was listed as a state threatened species in Oregon in1988. Northern spotted owl protection under the Oregon Threatened and Endangered Species Rules is limited to the prohibition of direct take (kill), transportation and possession of listed species on all ownerships.

Provisions for the northern spotted owl were added to the Oregon Forest Practices Act rules in 1991. The rules require maintenance of a 70-acre core area where northern spotted owls are known to occur in, or immediately adjacent to, a proposed timber sale unit. However the rules do not require pre-project surveys, and thus many sites are undoubtedly missed. To avoid disturbing nesting northern spotted owls, a seasonal operating restriction for forest practices activities exists within one-quarter mile of a known nest site between March 1 and September 30 of each year. These rules are unlikely to provide long-term support for stable northern spotted owl sites on their own as the 70 acre core is not large enough to maintain owls in the absence of other adjacent habitat.

California State Laws and Regulations **–** The northern spotted owl is designated a bird species of special concern in California. The California Forest Practice Rules provide that no timber harvest plan can be approved if it is likely to result in take of federally-listed species, unless the take is authorized. In 1990, concurrent with the Federal listing of the northern spotted owl, the Forest Practices Rules were amended to establish protections that would avoid taking of northern spotted owls. Forest Practices Rules require pre-project surveys for northern spotted owls within a distance of 0.7 mile from proposed harvest boundaries and the retention of specified amounts of habitat near spotted owl activity centers and within radii within 500 feet, 1,000 feet, 0.7 mile, and 1.3 miles around the activity centers. To our knowledge, no timber harvest plans have been implemented since 1990 that were anticipated to result in take of a northern spotted owl.

4. B. Is there relevant new information regarding implementation of conservation measures (e.g. Habitat Conservation Plans, Safe Harbor Agreements, Experimental Populations, management plans, etc.) that benefit the species? *YES*

Since the listing of the northern spotted owl in 1990 there have been significant changes in Federal land management and the development of 16 habitat conservation plans.

Federal Land Management Plans

The vast majority of Federal lands within the range of the northern spotted owl are managed by the Forest Service and BLM under individual land management plans as amended by the Northwest Forest Plan which specifically provides for conservation of the northern spotted owl.

Federal Land Management prior to 1990

In 1990, 63 percent of National Forest Lands within the range of the northern spotted owl were subject to timber harvest. Northern spotted owl management was based on a network of forest-wide individual protected owl sites (Spotted Owl Habitat Areas) in conjunction with existing suitable habitat in parks, wilderness, and other reserved areas. By the end of 1989 there were 644 Spotted Owl Habitat Areas on the 17 National Forests containing northern spotted owls (55 FR 26114, pg. 26188).

In 1990, BLM land in Oregon had an average cutting rate of 23,400 acres per year, an estimated 3 percent annual loss of owl habitat. This was anticipated to eliminate all northern spotted owl habitat on non-protected BLM lands in 12 (Eugene District) to 52 (Medford District) years. Timber harvesting was restricted in 109 northern spotted owl agreement areas under a cooperative agreement through 1990 (55 FR 26114, pg. 26189).

Federal Land Management since 1990 - The Northwest Forest Plan
The Northwest Forest Plan represented a substantial change in management direction and approach for northern spotted owl habitat on Federal lands from strategies in place at the time of listing. The Northwest Forest Plan was designed to provide for late-successional and old-growth species, including the northern spotted owl, by providing large blocks of habitat over time that would support clusters of northern spotted owls that have a high probability of long-term persistence and conditions to allow for dispersal between these blocks.

The Northwest Forest Plan was approved and implemented through amendment of individual National Forest and BLM land management plans in 1994. This plan guides management of the vast majority of Federal lands within the range of the northern spotted owl, primarily through the standards and guidelines of various land use allocations. Five land use allocations (covering approximately 15.4 million acres or 63 percent of the Federal lands) likely contribute to development and maintenance of clusters of reproductively successful northern spotted owls. These reserve allocations include Late-Successional Reserves, Managed Late-Successional Areas, Congressionally Reserved Areas, Reserve Pair Areas, and some Adaptive Management Areas. The remaining allocations, including Administratively Withdrawn Areas, Riparian Reserves, Matrix, Connectivity Blocks, and some Adaptive Management Areas contribute in various ways to connectivity between the large reserve areas. In some cases, forest conditions on these connectivity allocations may aggregate into landscapes capable of supporting resident northern spotted owls. The location and duration of such conditions is unknown (USFWS 2004b).

As a result of this plan, harvest levels of northern spotted owl habitat on Federal lands have dropped from an anticipated annual rate of approximately 1 percent at the time of listing to 0.24 percent since plan implementation (USDI 2004). Based on ongoing implementation monitoring, we have high confidence that the Northwest Forest Plan is being implemented as described in the record of decision. From 2001 to 2003, implementation monitoring identified a 98 to 99 percent compliance with the standards and guidelines for the projects reviewed (REO 2004, Implementation Monitoring Report, on REO website). Monitoring for effectiveness of the plan requires a longer time period. The Northwest Forest Plan is a long term conservation strategy, and the 10 years of implementation is too short to determine ultimate effectiveness of elements of the strategy. However, many of the scientific principles of the Northwest Forest Plan have been confirmed or validated in the decade since adoption (SEI 2004. Chapter 9).

Incidental Take Permits and associated Habitat Conservation Plans.
The development of habitat conservation plans is driven by the listing of the species and the desire of a landowner or manager to get an incidental take permit. Each habitat conservation plan is developed by the landowner to meet their specific needs, land condition, and mitigation potential, making each habitat conservation plan unique and difficult to summarize or compare.

There are 16 current or completed incidental take permits issued for northern spotted owls, 8 in Washington, 4 in Oregon, and 4 in California (see Table 5). They range in size from 40 acres to over 1.6 million acres, though not all acres are included in the mitigation for northern spotted owls. In total, the habitat conservation plans cover approximately 2.9 million of the 32 million acres of non-federal forest lands in the range of the northern spotted owl. Most habitat conservation plans are of fairly long duration, though they range from only 5 years (Boise Cascade) to 100 years (West Fork Timber). One habitat conservation plan (Scofield) has a permanent deed restriction. The first incidental take permit was issued in 1992, but most were issued after 1995.

While each habitat conservation plan is unique, there are several general approaches to mitigation of incidental take, including: 1) reserves of various sizes, some associated with adjacent Federal reserves; 2) forest harvest that maintains or develops suitable habitat; 3) forest management that maintains or develops dispersal habitat; and 4) deferral of harvest near specific sites. Individual habitat conservation plans may employ one or more of these mitigation measures, as described below (USFWS 2004b). Similarly the conservation objectives of individual plans vary from specified numbers of breeding owls, with specified levels of reproductive success, to management objectives for nesting/roosting/foraging habitat or dispersal habitat (SEI 2004, pg. 9-19).

Monitoring and reporting requirements vary widely among habitat conservation plans in relation to the level of take and type of mitigation applied. Many have limited monitoring requirements, but some habitat conservation plan monitoring plans include detailed monitoring of owl reproductive success, forest condition for specific habitat objectives, levels of habitat modifications, or level of management activity. Most monitoring has some annual reporting, while others have 5-year reporting (SEI 2004, pg. 9-19). As many habitat conservation plans include novel or new approaches to management for northern spotted owls and require long time periods to realize conservation values (e.g. habitat development over decades), it is difficult to evaluate the success of implementation or the effectiveness of the mitigation over the short time period since these habitat conservation plans were implemented.

The majority of scientific principles applied in habitat conservation plans remain valid, though untested due to the short duration of habitat conservation plan implementation. In addition, some habitat conservation plans are designed to compliment or coordinate with the Federal forest management of the Northwest Forest Plan, providing additional support

Table 5. Current habitat conservation plans on nonfederal lands, area covered, and summary of mitigation to offset harmful effects of the proposed activities for northern spotted owls.

HCP	Total Acreage	Owl Mitigation Approach
Washington DNR	1,632,000 acres	NRF and Dispersal designated areas managed to provide demographic and dispersal support to Federal lands managed for northern spotted owls.
Plum Creek	169,117 acres initially, now 124,650 acres	Manage to provide nesting and foraging habitat to complement the surrounding and interspersed Federal habitats.
Murray Pacific (West Fork)	53,527 acres	Develop and maintain dispersal habitat.
Port Blakely	7,486 acres, now 11,334	Provide some dispersal habitat and may support the current two owls at end of permit
Scofield Corp	40 acres	One-time partial harvest of marginal habitat, deed restriction on remaining timber
Boise Cascade	620	Small area salvage logging
City of Tacoma	14,900 acres	Manage to maintain and develop late-successional forest in 75 percent of area
Cedar River (Seattle)	90,546 acres	Most land in reserves, allow habitat development, and limited disturbance
Elliott State Forest	93,000 acres	Reserve areas, managed long-rotation harvest basins providing late-successional habitat, dispersal habitat on remaining areas
Millicoma Tree Farm	209,000 acres	Manage to speed development of dispersal condition between Federal Late-successional Reserves, maintain landscape condition over time.
Coast Range Conifers	109 acres	Completed, no longer active.
City of The Dalles	1,432 acres	Manage according to Northwest Forest Plan standards
Simpson	383,100 plus 74,000 acres (acquired 1998)	Reserves, harvest practices resulting in increase in oldest 46+ age class over time.
Regli Estate	480 acres	Maintain foraging habitat around known owls above take thresholds.
Terra Springs	76 acres	Deed restriction on a portion of the covered area, maintain and develop suitable habitat.
Pacific Lumber	211,700 acres	Harvest restrictions near specific sites, net gain of habitat in the long term, maintain a minimum number of sites at a minimum occupancy reproductive level. Public acquisition of Headwaters Reserve.

for the Northwest Forest Plan approach. Some landowners are also carrying out significant monitoring and research (SEI 2004, pg. 9-21).

4.C Is there relevant new information regarding overutilization for commercial, recreational, scientific or educational purposes? *NO*

5. New Information: Threats

5. A. Is there relevant new information regarding the magnitude or imminence of previously identified threats to the species? *YES*

Curtailment of Habitat or Range

In the 1990 listing rule, the Service identified historic loss of habitat, continuing loss of habitat to timber harvest, habitat fragmentation, isolation of populations, and declining population trends as habitat-related threats (55 FR 26114, pgs. 26175 to 26186). New information suggests reductions in the magnitude of each of these threats (SEI 2004, Chapters 6, 10, and 11).

The SEI panel concluded that **past habitat loss** is a current threat due to potential lag effects and synergistic interactions with other factors, though it is probably having a reduced effect now as compared to 1990 (SEI 2004, Chapters 10 and 11). The Service expects this effect to continue to decline over time. This threat has decreased slightly since the listing.

Continuing habitat loss due to timber harvest, particularly on Federal lands where information is available to determine rates, has declined relative to expectations in 1990. The anticipated average annual harvest rates on Federal lands since the implementation of the Northwest Forest Plan have dropped from 1 percent to 0.24 percent (SEI 2004, Chapter 6). The SEI report concluded that the threat posed by current and ongoing timber harvest on Federal lands has been greatly reduced, primarily because of the Northwest Forest Plan (SEI 2004, Chapters 10 and 11). Consequently, the magnitude of this threat has been substantially reduced since the time of listing.

The 1990 listing rule identified **fragmentation** of a large portion of the old-growth and mature habitat as a result of timber harvest as a threat to the northern spotted owl (55 FR 26114, pg. 26191). The SEI report concluded that while forest fragmentation has contributed to poor demographic performance in parts of the range (e.g., northern areas), recent studies indicate that habitat heterogeneity and the presence of ecotones within owl home ranges may impart positive effects through prey availability in some portions of the southern range. When considering both survival and reproduction, northern spotted owls appeared to benefit from a mixture of older forest and other cover types in the California Klamath province and the Oregon Coast Range, whereas composition of stand ages was not a good predictor of reproductive output in two studies in the Oregon Cascades. In these areas, forest fragmentation is not equivalent to habitat fragmentation (Franklin et al. 2002, SEI 2004, pgs 5-9 to 5-12). These findings should not be extended to other areas of the subspecies' range, particularly where primary prey species prefer late-successional forests (e.g., northern flying squirrels) (SEI 2004, Chapters 5 and 8). Habitat fragmentation is the aggregate of effects of historic habitat loss, continuing habitat loss due to uncharacteristic wildfire, and continuing timber harvest, albeit at reduced levels. Habitat fragmentation remains a threat in the northern part of the range, with little change in magnitude. The threat of forest fragmentation is reduced in the southern portions of the range.

At the time of listing, **population isolation** due to habitat loss and forest fragmentation or the presence of other barriers to dispersal (e.g., Columbia River corridor) was discussed as a potential risk to the northern spotted owl, particularly in the Olympic Peninsula, Washington and Oregon Cascades, and the Shasta/Modoc area in northern California (55 FR 26114, pg. 26182). New information that directly addresses population isolation of northern spotted owls is lacking (SEI 2004, pg. 8-26). However, demographic analyses provide indirect evidence that population isolation may still be a concern in some areas. Rapidly declining owl populations have been documented in Washington and northern Oregon (Anthony et al. 2004) and British Columbia (Zimmerman et al. 2004), which eventually could contribute to demographic isolation (SEI chapter 8). Poor demographic performance may also be a consequence of demographic isolation. Because of the reduced owl populations in the northern portion of the range, the SEI panel (2004, pgs. 3-26 to 3-27) concluded that these populations were at an increased risk for demographic stochasticity. Thus, population isolation appears to still be a threat, although evidence from some genetic analyses (Haig et al. in press) and expanded studies of dispersal (Forsman et al. 2002,) suggest that risk of isolation for most populations is less than indicated in the listing document.

In 1990, evidence of **declining populations** was available from demographic analyses of only two study areas, Willow Creek in California and Roseburg in southern Oregon. Populations at these sites were declining at approximately 5 and 14 percent, respectively. Ongoing work at these and other sites has resulted in a more robust demographic analysis. Based on the latest analysis of 14 study areas, populations are generally declining in Washington and northern Oregon (Anthony et al. 2004). Data indicate that the decline has been accelerating in Washington over the last decade, perhaps due to declines in adult survival. In southern Oregon and California, most populations were either slightly declining, stable, or slightly increasing (SEI 2004, Chapter 8). Populations in Canada have declined at an average annual rate of 10.9 percent in the last decade, 35 percent in the last year alone. This information shows current population trends appear better in the southern portion of the range, but large and increasing rates of decline increase the level of threat faced by populations in the north, especially in Washington and Canada.

Disease and Predation

The 1990 listing rule identified **predation** on juvenile northern spotted owls by great horned owls, exacerbated by forest fragmentation that could bring these species in closer contact, as an issue of concern, but of unknown effect on northern spotted owl populations. SEI noted that there is little evidence that predation is having an effect on northern spotted owl population dynamics (SEI Chapter 8). However, indirect evidence from demography studies such as high adult survival rates in the presence of great horned owls (e.g., Forsman et al. 1996) and lack of avoidance responses by northern spotted owls following experimental playback of great horned owl calls (Crozier et al. in press), suggest that predation is not a major influence on population dynamics. At this time, available evidence suggests that predation is not as substantive a threat to northern spotted owl populations as it was considered in 1990, but evidence about this threat is still circumstantial. This has resulted in an apparent decrease in concern for the effect of predation on northern spotted owl populations.

Regulatory Mechanisms
The 1990 listing rule concluded that current State regulations and policies did not provide adequate protection for northern spotted owls. Less than 1 percent of the non-federal lands provided long-term protection for northern spotted owls (55 FR 26114, pg. 26187). There have been major improvements in the forest practices laws and regulations in Washington and California, though it is too early to judge the long-term effectiveness of these regulations in supporting northern spotted owls (USFWS 2004b).

The 1990 listing rule noted that rate of harvest on Federal lands, the limited amount of permanently-reserved habitat, and northern spotted owl management based on a network of individual protected owl sites (55 FR 26114, pg. 26188) did not provide adequate protection for the northern spotted owl. These management practices, if continued, would result in an estimated 60 percent decline in remaining northern spotted owl habitat and this amount of habitat might not be sufficient to ensure long-term viability of the northern spotted owl. The Northwest Forest Plan was adopted in 1994, and significantly altered management of Federal lands. The substantial increase in reserved areas and associated reduced harvest (approximately 1 percent per year to 0.24 percent per year) has substantially reduced this threat to northern spotted owls. However, the plan allows some loss of habitat and assumed some unspecified level of continued decline in northern spotted owls. The SEI panel noted that many, but not all of the scientific building-blocks of the Northwest Forest Plan have been confirmed or validated in the decade since adoption, though one major limitation appears to be the inability of a reserve strategy to deal with invasive species. Reserves provide no protection against viruses, fungi or invasive owls. Climate change is an additional threat to northern spotted owls that was not explicitly addressed in the Northwest Forest Plan and, more generally, is not readily addressed by a reserve-based conservation strategy. Neither of these issues reduces the important contribution of the Northwest Forest Plan to northern spotted owl conservation (SEI 2004, Chapter 9).

Other Factors
The 1990 listing rule expressed considerable concern about potential competition from **barred owls**, though the long term effects of competition were unknown. The SEI panel considered barred owls a current and future threat to northern spotted owls, though there was a difference of opinion on the conclusiveness of some evidence suggesting barred owls displace northern spotted owls and the mechanism for the apparent effects (SEI 2004, Chapters 7, 10 and 11). Our understanding of this threat has improved, raising it from an issue of concern to a primary threat of greater imminence.

The 1990 listing rule also raised concerns about potential **hybridization between barred owls and northern spotted owls**. SEI noted that, while hybridization does occur occasionally, it has not materialized as a significant problem and is not considered a major threat. In one study, 47 hybrids were identified out of over of 9,000 observed northern spotted owls (Kelley and Forsman 2004). There is concern that, if local northern spotted owl populations reach very low levels, hybridization may increase and exacerbate problems; however, hybridization with barred owls is not considered a threat at this time.

The 1990 listing rule identified **extrinsic factors such as fire, wind, and volcanic eruption** as potential sources of habitat loss which could affect species persistence probabilities. The rate of aggregate habitat loss from natural disturbance was unknown in 1990. The SEI panel noted that habitat loss due to these factors continues, and that the risk of loss to fire, in particular, has increased since 1990 as a result of past fire suppression and build up of fuels in some areas (SEI 2004, Chapters 9 and 11). A total of 2.3 percent of Federal northern spotted owl habitat was lost to fire over a 10-year period, most in the Biscuit Fire in southwest Oregon (SEI 2004, Chapters 6). Forest fire was identified as a major source of loss in drier, fire-prone areas of the owl's range (e.g., eastern Cascades, Klamath Province). Losses to other events such as windthrow and insect infestations were generally not considered significant threats (SEI 2004, Chapter 11). This new information suggests that the threat posed to the northern spotted owl due to habitat loss from particular extrinsic factors, particularly wildfire, has increased since 1990 (SEI 2004, Chapters 10 and 11).

The 1990 listing rule indicated that reduced rates of reproductive success and survival resulting from **loss of genetic variability**, perhaps due to inbreeding, were not considered a threat at that time. The SEI panel concluded that genetic effects from small population size are unlikely to be important at this time, but may increase in the future in areas with small local populations (e.g., Canada) (SEI 2004, Chapters 3 and 11). The SEI report did note that reduced populations in the northern part of the range could increase the risk of stochastic impacts on demographic processes, in part based on the demographic meta-analysis showing high rates of decline over the past decade (SEI 2004, Chapter 11). However, some new information from surveys of genetic variation suggest gene flow may be occurring among northern spotted owl populations sufficient to prevent the deleterious effects associated with inbreeding and loss of genetic variation (Haig et al. in press). Thus, loss of genetic variability and other small population effects are not considered a current threat.

5. B. Is there relevant new information regarding new threats to the species? *YES*

Curtailment of Habitat or Range

The risk of **range curtailment** has increased in imminence in British Columbia, Canada. Rapid and steep population declines in recent years have resulted in a total breeding population of about 30 pairs. This small population is at greater risk of extirpation due to stochastic events (SEI 2004, Chapters 3 and 11).

Sudden Oak death represents a future threat to northern spotted owl habitat, though not a present or immediate threat. It poses a threat of uncertain proportions because of its potential impact on forest tree dynamics and alteration of key habitat components (e.g., hardwood trees) in the southern portion of the range (SEI 2004, Chapter 11).

Disease and Predation
While the SEI panel did not identify disease as a current major threat, they expressed considerable concern about the imminent arrival of **West Nile virus**. The SEI panel was unanimous in regarding this as a potential threat in the future, as the virus has spread rapidly across the United States, and is now within the range of the northern spotted owl. It is known to be fatal to many species of birds, including northern spotted owls, though susceptibility to infection and mortality rates vary by species. Therefore, we do not know how this virus will ultimately affect northern spotted owl populations (SEI 2004, Chapter 11). This new threat is considered imminent and potentially substantial.

Other Factors
"Recent research suggests that a significant factor in demographic performance may be **interaction among factors** (Chapter 8). While individual factors (such as habitat loss or fragmentation) were previously identified as threats, their relative importance and effect may depend on the interactions (synergisms) between and among factors. Five of eight panel members regarded the results of such interaction as a significant current threat. Unfortunately, at this time, there is little information available to examine such interactions; this would require far more detailed and statistically robust data on the causes of population trends than are currently available. However, limited analysis of such interactions suggests that good quality habitat may buffer the owls against the negative effects of bad weather (Franklin et al. 2000). If interactions such as this one occur at different scales and with different factors, synergistic effects could be very important." (SEI 2004, pg. 11-10).

6. New Information: Application of the DPS policy *Not applicable. Not listed as a DPS.*

7. New Information: Other. Is there any additional, relevant, new information not addressed in questions 3.A. -6.A.? *No*

8. Using Recovery Criteria: *Not Applicable.*

There is no final recovery plan for this species, and therefore no recovery criteria for delisting. The Northwest Forest Plan Record of Decision expected and intended that the management direction and land allocations of the plan would constitute the Federal contribution to the recovery of the northern spotted owl. (USDA and USDI 1994); however, the Northwest Forest Plan does not include any recovery criteria or goals.

9. Synthesis

9. A. Biological Assessment: Given the updated information, particularly information presented in Section 3 (pg 9), summarize the biological status of the species.

The following synthesis summarizes key information provided in the preceding sections of this document, using the information and evaluation provided by SEI. In some cases original reference citations (as cited in SEI 2004) are used to help the reader.

Abundance and Population Trends

As of 1992, there were approximately 8,000 known individuals on private and Federal lands throughout the range of the northern spotted owl though total populations were undoubtedly higher than this estimate (Gutiérrez et al. 1995.) Past and current survey coverage of all suitable northern spotted owl habitat is incomplete. Survey efforts have been sporadic, not systematic and thus survey coverage and effort are insufficient to produce reliable population estimates. Consequently, other indices, such as demographic data, are used to evaluate the current condition of the northern spotted owl population and estimated changes in that condition over time (USFWS 2001). In 1990, demography studies were in their infancy and not enough information was available to reflect rangewide trends. Data from the current demography studies are extensive and provide a strong scientific basis for evaluating trends, thus reducing the need to rely on habitat as a surrogate measure.

Estimated annual population change ($\lambda_{RJS)}$ ranged from 0.896 to 1.005 and was less than 1 on 12 of 13 demographic study areas distributed throughout the range of the northern spotted owl (Table 1 and Figure 1; Anthony et al. 2004). Evidence for decline was strong or good in all four study areas in Washington, in thee of six study areas in Oregon, and one of three study areas in California. Populations appeared to be stationary on five study areas in southern Oregon and California. The meta-analysis of λ_{RJS} for 13 demographic study areas in Washington, Oregon, and California indicated an average annual population decline of 3.7 percent from 1985 to 2003; an average annual population decline of 2.4 percent was calculated for the study areas included in Northwest Forest Plan effectiveness monitoring (Anthony et al. 2004). In British Columbia, northern spotted owl populations have declined 67 percent from 1992 to 2002 at an average rate of 10.4 percent annually (Zimmerman et al. 2004). Four study areas in the United States showed realized population declines over the entire period of study (ranging from 11 to 14 years) that were between 40 and 60 percent. Estimates of rates of decline made in 2004 are lower than those estimated in 1990, but the population decline continues, and declines in Washington study areas appear to be accelerating during the last decade (Anthony et al. 2004).

In general, northern spotted owl populations are exhibiting strong declines in the northern portion of their range in Canada, Washington, and parts of Oregon, while populations in the southern portions of their range are generally stable. Declines in Washington appear to be driven by decreased adult survivorship. Juvenile mortality is known to be relatively high or variable in northern spotted owls from year to year. However, increased adult mortality is a concern for a species like the northern spotted owl that exhibits a "bet hedging" strategy favoring adult survival at the expense of present fecundity when recruitment of offspring is unpredictable from year to year (Stearns 1976, Franklin et al. 2000).

Genetics and Taxonomy

There is genetic evidence of introgression between the northern spotted owl and the California spotted owl in the zone where the two subspecies meet. The nature and degree of genetic introgression, and whether this apparent introgression is primarily the result of current or past events, remain unknown. There is also genetic and observational evidence of mating between barred owls and northern spotted owls. At this time, however, neither introgression with California spotted owls, nor hybridization with barred owls appears to be occurring at a level that would challenge the current taxonomic classification or the persistence of northern spotted owl populations (SEI Chapter 3). Further, northern spotted owls currently do not appear to be experiencing any genetic consequences that might result from small and/or isolated populations (i.e., loss of genetic variation due to inbreeding). Rapidly declining populations could lead to small populations and subsequent genetic consequences in the future (SEI 2004, pgs. 11-13) .

Spatial Distribution

The northern spotted owl continues to be distributed throughout its historic range. However, abundance is very low in British Columbia, southwest Washington, and northwest Oregon, as was the case in 1990. Populations of northern spotted owls may have been nearly continuous in their distribution historically, but now they are functionally metapopulations due to habitat removal (SEI 2004, pg. 8-4).

Habitat Condition and Trends

The status review (SEI 2004, Chapters 5 and 6) reaffirms that northern spotted owls are associated with mature and old-growth forests composed of Douglas-fir, mixed conifer, or redwood. The degree to which northern spotted owls benefit from more homogenous expanses of older forest (as in the northern portion of the range) as opposed to forest heterogeneity (as in the Willow Creek study area) varies from north to south. This variability in habitat association may reflect differences in prey type and availability.

There is currently an estimated 7 million acres of suitable northern spotted owl habitat on Federal lands. Although effects of historic habitat loss are likely still being realized, the current rate of habitat loss on Federal lands due to timber harvest has greatly declined over the past 10 years. Habitat continues to be lost to natural disturbances, like wildfire; this loss will continue and may increase in the future due. There is the potential for habitat loss in the southerly portions of the range due to Sudden Oak Death, although the magnitude of loss is unpredictable at this time. Most recent habitat loss due to both management and natural disturbance has been concentrated in southern Oregon (USFWS 2004a).

Development of northern spotted owl habitat over time is occurring, particularly in reserves. However, quantifying the results of successional processes based on existing methodologies is a speculative endeavor. As much as 600,000 forested acres may have developed the structural characteristics needed to support northern spotted owls in the past 15 years. Although this estimate is comparable to habitat losses that have occurred over that time, it does not offset historic habitat loss incurred throughout the range of the owl prior to 1990. In addition, fuels management projects to help reduce the potential for catastrophic wildfire is expected to have some long-term benefits to maintenance and restoration of owl habitat.

Insufficient information is available from habitat conservation plans, or other sources, to estimate spotted owl habitat quality, quantity, or trends on nonfederal lands. Cohen (2002) reported that harvest rates on private industrial lands were about twice the average rate of harvest on public land from the early 1970s through the mid-1990s

Disease, predation, and competition

While habitat loss due to timber harvest and fire, among other factors, may be important and contributing to declining population trends, the only factor known to be both widespread and increasing in effect is the presence of barred owls (SEI 2004, pg 8-24). Barred owls are now found throughout the range of the northern spotted owl and appear to be increasing in density, especially in the northern part of the spotted owl's range. Barred owls appear to be displacing spotted owls, and spotted owl demographic performance is declining to a greater extent in this area. This is based on circumstantial and correlative evidence, and there may be no single, over-arching explanation for declines of the northern spotted owl in the northern part of the range. In addition to a longer duration of exposure to more dense populations of barred owls, populations in the northern part of the range also may typically experience lower prey density, higher energy expenditures, more critical weather events, and generally lower demographic performance.

Juvenile northern spotted owls experience relatively high mortality rates attributed, in part, to predation. There is no evidence currently to suggest that adult northern spotted owls are particularly vulnerable to predation. Further, northern spotted owl population trends do not appear particularly sensitive to the effects of existing diseases or parasites. However, West Nile virus, a disease new to the western United States and known to cause mortality in northern spotted owls (n=1) (SEI 2004, pg. 8-36), could impact populations in the future depending on the owl's degree of susceptibility and the pattern of disease spread.

9. B. 1. Threats Assessment (5-Factor Analysis): Given the updated information, particularly information presented in Section 4 (pg 36), provide an analysis of the threats to the species in the context of the 5 listing factors.

a) the present or threatened destruction, modification, or curtailment of its habitat or range;

The magnitude and intensity of this threat has diminished considerably since 1990. Implementation of the Northwest Forest Plan on federally-managed lands has reduced the rate of habitat removal to about one-fifth the rate expected at the time of listing. Habitat removal rates on private land are largely unknown and habitat loss from uncharacteristic wildfire may be increasing due to the effects of long-term fire suppression (SEI 2004, pgs. 6-4). New information does not suggest substantive changes in the severity of effects of habitat removal; although silvicultural treatments can accelerate the development of late-successional forest structure, the recovery period from the time habitat is removed until it is again suitable for northern spotted owls spans several decades. Implementation of the Northwest Forest Plan has demonstrated that rate of habitat removal on federally-managed lands can be modified by a management strategy.

Populations of northern spotted owls continue to decline across the range of the species, with the most severe declines occurring in the northern portion of the range (Washington and British Columbia). The recently enacted Species At Risk Act (June 1, 2004) is intended to help prevent extirpation of the northern spotted owl in Canada, but benefits to the owl will only be realized over time. Populations in the southern portion of the range are either slightly declining, stable, or slightly increasing. Although the current estimated rate of decline is less than estimated in 1990 (rangewide), the cumulative result of continued decline over that 14-yr period is estimated to be 40 to 60 percent in some northern study areas. Smaller population size intensifies the threats posed by diseases, competitors, and stochastic events. Populations in northern areas do not yet appear to be exhibiting favorable responses to implementation of the Northwest Forest Plan and other management efforts meant to contribute to the recovery of the northern spotted owl (SEI 2004, pg. 9-9).

b) overutilization for commercial, recreational, scientific or educational purposes;

This continues to be a minor threat, consistent with the 1990 listing decision (SEI 2004, pg. 11-6).

c) disease or predation;

Disease is not a current major threat, but West Nile virus may ultimately affect owl populations and may cause local extirpation (SEI 2004, pg. 11-9). While there is no way to predict the impact of West Nile virus, the virus has spread into the range of the northern spotted owl (USGS 2004), and is known to be fatal to many species of birds, including spotted owls (n=1) (SEI 2004, pg. 8-36). West Nile virus could dramatically change the magnitude and intensity of the threat posed by disease depending on the response of the owl population. Populations of other common species of birds, including owls, that have experienced high mortality rates from West Nile virus infection have rebounded rapidly after the first wave of infection. Whether populations of a rare and sparsely distributed species like the northern spotted owl will respond similarly is unknown.

There is very little available evidence that predation on northern spotted owls is affecting their population dynamics.

d) the inadequacy of existing regulatory mechanisms; and

Regulatory mechanisms have improved significantly since 1990. Implementation of the Northwest Forest Plan on federally-managed lands has greatly increased the amount of reserved lands and substantially reduced the rate of habitat loss (See 9.B.1.a.). The Northwest Forest Plan recognized that it would take several decades of regrowth of forest and development of late-successional or old-growth habitat to begin to see improvements in the conservation of the spotted owl. In addition, in June 2004, the prohibitions in Canada's Species at Risk Act (SARA) took effect, creating an added layer of protection for species at risk in Canada.

There have also been major improvements in the State forest practices laws and regulations in Washington and California (USFWS 2004b). Sixteen current or completed incidental take permits (habitat conservation plans) have been issued for northern spotted owls covering a total of approximately 2.9 million of the 32 million acres of non-federal forest lands in the range of the northern spotted owl. Mitigation for northern spotted owls in each habitat conservation plan varies commensurate with the level of take authorized and will take decades to complete. Most mitigation is associated with habitat protection or management intended to benefit the species. Many of the habitat conservation plans include new approaches to management for northern spotted owls that are expected to provide long-term changes in habitat condition and trends.

Habitat restoration for northern spotted owls will take decades to be realized. As such, it is too early to evaluate the long-term effectiveness of conservation efforts and regulatory changes (Northwest Forest Plan, State regulations, or habitat conservation plans) in conserving northern spotted owls. However, some of the new or potential threats to northern spotted owls (West Nile virus, Sudden Oak Death, barred owls) may not respond to or be affected by habitat management or improvement.

e) other natural or manmade factors affecting its continued existence.

Information on the effects of barred owls on northern spotted owls has increased. Although the preponderance of this information is correlative, the strength of the apparent effect has raised competition with barred owls a primary threat to the future of the spotted owl. Hybridization with barred owls is not currently considered a threat to the northern spotted owl due to a low frequency of occurrence.

Changes in forest fuel-loadings due to fire suppression have increased habitat vulnerability to stand-replacing fire, and habitat loss due to wildfire may be increasing in the drier portions of the northern spotted owl's range. The increased vulnerability is evident through the large habitat areas burned, particularly in the drier provinces over the past 15 years. Consequently, the threat posed to the northern spotted owl due to habitat loss from particular extrinsic factors, particularly wildfire, has increased since 1990 (SEI 2004, Chapters 10 and 11). Statutory and policy changes have recently been made in an attempt to promote and expedite projects to reduce forest fuels which could benefit spotted owl habitat in the long term. The Northwest Forest Plan also provides mechanisms for reducing the risk of uncharacteristic wildfire which are intended to be consistent with efforts to manage spotted owl habitat. Implementation of these efforts should help protect and restore long-term habitat quality for northern spotted owls.

Recent genetic studies indicate that genetic variability in the northern spotted owl is typical of that found in most birds, and is consistent with Hardy-Weinberg expectations. Consequently, genetic problems associated with small, isolated populations do not appear to be present at this time.

9. B. 2. Describe any interactions, additive effects, and/or synergistic effects of these threats.

Franklin et al. (2000) and Franklin (2003 presentation) have drawn attention to significant (synergistic) interactions among factors affecting demography. For instance, inclement weather (e.g. heavy snow, cold and wet springs (SEI 2004, pgs 8-18 and 8-19)) may have different effects on survival and reproduction, depending on territory 'quality'. In high quality habitat, owls may be buffered to an extent from environmental challenges such as bad weather. Individual owls with reduced flight costs, higher prey availability, and better thermal environments (all dependent on territory location) might be expected to both survive and reproduce more successfully. Similarly, prey and habitat are strongly linked factors; both are affected by weather, disturbance dynamics, and forest management among other factors (reviewed in SEI 2004, Chapter 4), and may be expected to influence owl demography in a complex manner.

Other important interactions include the effects of landscape pattern. Spatial relationships of different habitat types can have profound influences on prey abundance and availability, and are hypothesized to affect predation and competition. Variation in climate and weather clearly correlate with strong geographic variation in forest structure and composition, habitat associations, prey identity and abundance, and other factors. In all these cases, our *a priori* assumption must be that demographic responses of northern spotted owls will be complex, and are unlikely to be explicable in terms of just one driving factor. Recognition of interactions among multiple factors (often with non-linear relationships) is a feature of the increasingly sophisticated understanding of northern spotted owl demography that continues to develop. (from SEI 2004, pgs. 8-23).

Competition with barred owls and loss of habitat due to Sudden Oak Death are two new factors, additive to habitat loss which, while not threats now, have the potential to be major threats in the future. However, the potential for management to address the additive effects of Sudden Oak Death and barred owls on habitat availability is unknown. Sudden Oak Death may affect habitat suitability by reducing structural complexity and species composition through removal of susceptible plant species such as tanoak. Barred owls use a variety of habitats including those preferred by northern spotted owls. Occupancy of northern spotted owl habitat by larger and more aggressive barred owls may make it entirely or partially unavailable to northern spotted owls, although this potential effect remains an assumption in the absence of more rigorous experimental field study. Given that barred owl populations are rapidly expanding and likely to persist, the duration and severity of the barred owl effect may be greater than habitat removal effects due to management or natural disturbance.

9. C. Conservation Efforts: Given the updated information, particularly information presented in Section 5 (pg 41), summarize the conservation efforts (e.g. Habitat Conservation Plans, Safe Harbor Agreements, Experimental Populations, management plans etc.).

The Northwest Forest Plan represented a substantial increase in northern spotted owl habitat protection. Development of habitat in reserved areas on Federal lands and an associated reduction in habitat loss due to harvest has substantially improved the likelihood of successful conservation of the northern spotted owl. As planned (USDA and USDI 1994), the Northwest Forest Plan provides for the managed reduction of suitable habitat in the matrix, with the associated decline in owls in those land allocations. Although intended to be responsive to stochastic events (such as wildfire), the reserve design of the Northwest Forest Plan did not anticipate factors such as invasive species which may pose a threat to the owl (e.g., West Nile virus, Sudden Oak Death, or barred owls). The combined effects of historic habitat loss and new threats that are not habitat-associated render the Northwest Forest Plan a necessary component of northern spotted owl conservation, but raises questions as to how to address non-habitat factors in such a way to ensure a sufficient strategy for conservation.

Effectiveness monitoring for the Northwest Forest Plan includes demographic studies of northern spotted owls, which indicate populations continue to decline, and as expected rates of decline on lands managed under the Northwest Forest Plan are lower than on lands with other management programs such as habitat conservation plans (Anthony et al. 2004). Effectiveness monitoring modules to assess the status and trends of older forests during the first decade of plan implementation will be completed in 2005.

There have been major improvements in the State forest practices laws and regulations in Washington and California, though it is also too early to judge the long-term effectiveness of these regulations in supporting northern spotted owls (USFWS 2004b). In addition, 16 current or past incidental take permits (habitat conservation plans) have been issued for northern spotted owls covering a total of approximately 2.9 million of the 32 million acres of non-federal forest lands in the range of the northern spotted owl. The mitigation for northern spotted owls in each habitat conservation plan varies commensurate with the level of take authorized. Habitat conservation plans are designed to offset harmful effects the proposed activity might have on the spotted owl, and the process allows resource use to proceed while promoting owl conservation. As many habitat conservation plans include new approaches to management for northern spotted owls that require long periods to realize conservation values (e.g., habitat development over decades), we cannot yet evaluate the effectiveness of the mitigation over the short time period (most less than 10 years) since these habitat conservation plans were implemented. Some habitat conservation plans are designed to complement or coordinate with the Federal Northwest Forest Plan, providing additional support for the Northwest Forest Plan's conservation strategy for northern spotted owls. For example, some plans are designed to provide dispersal between Federal reserve areas or maintain owl habitat in proximity to Federal reserves.

10. Result

10. A. Given your responses to Section 9.A. - 9.C. (pg 46), does the 5-year review indicate that a change in classification may be warranted? *NO*

All previous sections of this document provide the foundation for the summaries and conclusions presented below.

Background

This recommendation is based on the following: a) a comprehensive status review for the northern spotted owl (SEI 2004); and 2) the deliberations of a panel of seven senior managers from Region 1 of the U.S. Fish and Wildlife Service which convened on August 23-24, 2004, for a 2-day workshop (i.e., Decision Support Workshop for Managers) to assess whether a change in listing category for the northern spotted owl may be warranted. For a comprehensive description of this workshop, see "Methodology Used to Complete this 5-year Review" (and the Service's administrative record).

During the Decision Support Workshop for Managers, the participants discussed a variety of biological and regulatory issues relevant to making a recommendation about the proper listing category for the northern spotted owl. Biological topics included: (1) effects of habitat loss, including the lingering effects of historic habitat removal and the risk of future habitat loss due to uncharacteristic wildfire (see sections 3E, 5A, 9A, 9B1a),;(2) results of demographic studies (see sections 2, 3A, 5A, 9A, 9B1a) and degree to which these results were representative of rangewide trends; (3) effects of barred owls on northern spotted owls (see sections 3E, 5A, 9A, 9B1e); and (4) limits on inference and levels of uncertainty surrounding threats described by SEI (2004, Chapter 11). In reviewing the new information on spotted owl genetics documented in SEI (2004, Chapter 3) and discussed in the Workshop on Taxonomy and Range (see sections 3B and 3C), the managers concluded that the northern spotted owl is a valid subspecies under the ESA and that no change in the geographic range of the subspecies is warranted at this time.

Regulatory issues that received the most consideration were: (1) effects of land ownership on northern spotted owl conservation; (2) effectiveness of the Northwest Forest Plan; and (3) the meanings of critical statutory terms included in the definitions of "threatened" and "endangered," namely *likely to become endangered/extinct*, *foreseeable future*, and *all or a significant portion of the range*. In interpreting these statutory terms in the context of the northern spotted owl, the managers' interpretation of "in danger of extinction" emphasized immediacy (e.g., three to five northern spotted owl generations) and intensity of threat sufficient to result in functional or actual extinction in the wild. Managers considered the "foreseeable future" to be from 10 to 50 years in the future.

The managers panel noted that the comprehensive status review (i.e., SEI 2004) described distinct differences in demographic performance (i.e., strongly declining populations in the northern portion of the range) and the nature and intensity of current threats (e.g., barred owl) across the range of the northern spotted owl. This led to a discussion of what geographic area would constitute a significant portion of the range. The managers concluded that British Columbia, Washington, and northern Oregon constituted a significant portion of the range.

Rationale for Recommendation

The Service recommends that the northern spotted owl remain listed under the ESA as "threatened" based the following points:

- The rate of habitat loss on Federal lands has been substantially reduced, and projection models have been used to estimate a potential ingrowth of about 600,000 acres of late-successional habitat some of which will have the structural characteristics to support spotted owls. This change in threat level is a reflection of the effectiveness of the Northwest Forest Plan in addressing what was identified as the paramount threat to the northern spotted owl in 1990. However, habitat loss and modification from harvest continues on both Federal and private lands. In addition, loss of habitat from uncharacteristic wildfires appears to be increasing but efforts are underway to help reduce future fire potential.

- Demographic data collected over 15 years document declining populations across the species range with the most pronounced declines in British Columbia, Washington, and northern Oregon. This area of pronounced decline constitutes approximately 50 percent of the geographic range of the northern spotted owl, supports about 25 percent of all known northern spotted owl activity centers, and contains greater than 25 percent of all northern spotted owl habitat, greater than 90 percent of which is federally-managed. These declines in the Washington and northern Oregon demographic study areas, as well as in Canada, indicate the northern spotted owl meets the definition of a threatened species (likely to become endangered throughout all or a significant portion of its range). However, populations are still relatively numerous over most of the species historic range, suggesting the threat of extinction is not imminent, and the subspecies is not "endangered" even in the northern part of the range where the demographic results are least promising.

- Management of Federal lands under the Northwest Forest Plan provides a major contribution to conservation of the northern spotted owl. A greater proportion of northern spotted owl habitat in Federal ownership was considered a factor that could temper risks to owls due to uncertain management practices on non-federal lands. However, the continued decline of northern spotted owls in the northern portion of the range, despite the presence of a high proportion of habitat on Federal lands, suggests that effects from past habitat loss and modification have not yet responded to habitat protection on Federal lands. In addition, the synergistic effects of past and new threats, such as barred owls, are unknown.

- The nature, magnitude, and extent of barred owl effects on northern spotted owls remain uncertain. Consequently, there was general agreement amongst managers that barred owl effects across the range must be weighted carefully, given uncertainty about how the species interact and potential time-lags in detecting effects. Likewise, the new threats of West Nile virus and Sudden Oak Death were perceived as both potentially severe and imminent, but substantial uncertainty about their effects mediated against placing too much weight on these factors.

In summary, for every risk factor that has declined since listing (e.g., the current rate of habitat loss due to timber harvest, the threat of predation), another factor was identified that counterbalanced risks (e.g., habitat removal due to uncharacteristic wildfires, West Nile virus, barred owls). The net change in loss of habitat is positive, and although spotted owl populations continue to decline, that response was expected. The uncertainty surrounding barred owls, and the new potential disease, fire and sudden oak death threats and their effect on the spotted owl population suggests a net increase in risk since 1990. However, the increase in risk was not considered sufficient to suggest reclassification to endangered at this time. (All documents from the Managers' Decision Support Workshop are contained in the Service's Administrative Record).

10. B. Based on this review, indicate the appropriate Recovery Priority Number for the species. 6 (subspecies, high degree of threat, low recovery potential) C (conflicts with other interests).

The biological and ecological limiting factors for northern spotted owls are fairly well understood compared to those of most other listed species. However, since the initial listing in 1990, there has been a change in our understanding of the threats to the species' persistence. The primary threats identified in 1990, particularly habitat loss due to timber harvest, were fairly well understood and could be alleviated over the long term through changes in management activities. The threats that are currently identified as potentially posing the greatest risk to northern spotted owls (e.g., barred owl competition and West Nile virus infection) are relatively poorly understood, are likely to be pervasive, and will be difficult to alleviate. Currently identified threats stem from invasive competitors and diseases that are already well established and would require intensive management to alleviate, with an uncertain probability of success. Therefore, the recovery priority number for the northern spotted owl has changed from 3C to 6C.

11. Recommendations for Future Actions

High Priority Research Needs

Barred Owl Effects – We need to understand the mechanism(s) through which barred owls are having effects on northern spotted owls. This could be accomplished by using an experimental approach versus the correlational approaches that have been used thus far, and by tailoring the barred owl covariate to better represent barred owl effects in the demographic analyses. Further, more detailed data on behavioral interactions between barred owls and northern spotted owls would shed more light on how barred owls affect northern spotted owls (i.e., interference, resource exploitation, or some combination of the two). This topic was identified as a high priority by managers and scientists as well as by SEI (2004, Chapter 12).

Prey Dynamics – There is a paucity of information on prey population dynamics and habitat associations. For example, we have little understanding of: a) how prey species (e.g., *Peromyscus*) respond to weather variables; b) how prey numbers represent variability in habitat conditions; and c) how prey respond to habitat disturbance (e.g., wildfire, silvicultural treatment, etc.).

Effects of Wildfire – Creation of a more fire-prone landscape resulting from a long history of fire suppression has been identified as an increased threat to the northern spotted owl due to an increased risk of habitat loss. However, information on how northern spotted owls respond to silvicultural treatments like thinning and fuels reduction is still very limited. Thus the question becomes, 'how does risk of habitat loss due to wildfire compare to that of habitat treatment?'. Research that addresses this question may help balance short term effects of forest management against long-term effects to habitat in the absence of management.

Owl Demographic Responses to Habitat Variables – Although a great deal of research has been conducted on northern spotted owl habitat associations, very little has linked northern spotted owl vital rates to particular habitat variables. This information is needed to better understand what aspects of habitat are most important for northern spotted owl survival and reproduction. Again, this was identified as a need by managers, scientists, and SEI (2004, Chapter 12).

Additional Recommendations (identified by SEI 2004 in addition to those described above)

Genetics – More sampling and microsatellite analyses in the zone of contact between the northern and the California subspecies of spotted owls is needed to better understand the level of genetic introgression, the effects of introgression, and the status of introgression. Further, data that could speak to whether loss of genetic diversity may become a future threat where populations are declining should be gathered.

Habitat Trends – A rangewide, spatially explicit habitat map and tracking system must be developed so that changes to habitat, regardless of ownership, can be estimated accurately. Such a system could provide more information on habitat trends on private lands, which is very limited currently. We also need to develop approaches for estimating development of habitat in order to track net habitat availability across the landscape over time. Lastly, we need to determine differential effects of various disturbance regimes on habitat use by owls.

West Nile virus – As the effects of West Nile virus have not yet been realized, we need to continue monitoring the spread of this disease and causes of northern spotted owl mortality where West Nile virus is known to occur.

REFERENCES

12. List all information and data sources used in this review, and provide file locations if these sources will not be filed with the review. Include on this list any experts used and their affiliations and note whether they provided information or if they acted as peer-reviewers, or both.

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The SEI expert panel included:

- Dr. Steven Courtney, SEI Project Lead
- Dr. Richard Bigley, Washington State Department of Natural Resources
- Dr. Martin Cody, University of California, Los Angeles, Department of Biology
- Dr. Jack Dumbacher, California Academy of Sciences, Department of Ornithology & Mammalogy
- Dr. Robert Fleischer, Smithsonian Institution, NMNH - Genetics Program
- Dr. Alan Franklin, Colorado State University
- Dr. Jerry Franklin, University of Washington
- Dr. Rocky Gutierrez, University of Minnesota, Department of Fisheries, Wildlife and Conservation Biology
- Dr. John Marzluff, University of Washington, Division of Ecosystem Sciences College of Forest Resources

The SEI panel was supported by:

- Dr. Jennifer Blakesley, SEI Spotted Owl Biologist
- Dr. Andy Carey, USDA Forest Service, Pacific Northwest Research Station
- Mr. William La Haye, Spotted Owl Biologist
- Mr. David Kennedy, David Evans and Associates Consultant Biologist
- Dr. Barry Noon, Colorado State University, Fisheries and Wildlife Biology Department
- Dr. Craig Moritz, University of California, Berkeley, Department of Integrative Biology
- W. Monahan, University of California at Berkeley, Museum of Vertebrate Zoology
- Ms. Lisa Sztukowski, SEI Project Administrator and Database Manager

USFWS Taxonomy and Range Workshop Experts. These three geneticists assisted the USFWS management panel by reviewing the SEI panel genetics chapter and seminal spotted owl genetics papers. They provided review and discussion of the conclusions of the papers and their relationship to the question of the northern spotted owl's subspecies status and range.

Dr. Don Campton, USFWS, Region 1, Abernathy Fish Technology Center

Dr. Diane Elam, USFWS, Region 1

Dr. Susan Haig, US Geological Survey, Forest and Rangeland Ecosystem Science Center

USFWS Decision Support Workshop Experts. These three scientists were present at the Decision Support Workshop to answer questions on spotted owls, genetics, or forest issues.

Dr. Steven Chambers, USFWS, Region 2, Senior Scientist

Dr. Jeffrey Dunk, USDA Forest Service, Pacific Southwest Research Station and California State University, Humboldt

Dr. Martin Raphael, USDA Forest Service, Pacific Northwest Research Station

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U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW

Northern Spotted Owl (*Strix occidentalis caurina*)

CURRENT CLASSIFICATION : Threatened

5-YEAR REVIEW RESULT:
__XXX__ No Change in Status
________ Endangered to Threatened
________ Threatened to Endangered
________ Delist

APPROPRIATE LISTING/RECLASSIFICATION PRIORITY NUMBER: Not Applicable

REVIEW CONDUCTED BY: Robin Bown, Danielle Chi, and Karl Halupka

Regional Director, Region 1, U.S. Fish and Wildlife Service

Concur D. B. Allen Date 11/15/04

Not concur____________________ Date____________