FINAL SPECIES REPORT
Fisher (*Pekania pennanti*), West Coast Population

U.S. FISH AND WILDLIFE SERVICE (Service)
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INTRODUCTION

The purpose of this species report is to synthesize the best available scientific and commercial information regarding the fisher, throughout the range of its West Coast Distinct Population Segment (DPS) in the United States. This biological report has been prepared to support the review of the species under the Endangered Species Act (Act or ESA) so that we can evaluate whether or not the fisher West Coast DPS continues to warrant listing under the Act.

On October 7, 2014, the U.S. Fish and Wildlife Service (Service) published a proposed rule in the Federal Register to list the West Coast DPS of fisher as threatened (79 FR 60419). Prior to the proposed rule, the Service published a 12-month finding in the Federal Register on April 8, 2004, stating that listing the West Coast DPS of the fisher under the Act was warranted, but precluded by other higher priority listing actions (69 FR 18770). We have annually reviewed this finding and monitored the status of the fisher, as required under 16 U.S.C. 1533(b)(3)(C)(i) and (iii), as reflected in the annual Candidate Notices of Review (CNORs). See the November 21, 2012, Federal Register (77 FR 69994) for the most recent CNOR.

In our proposed rule (79 FR 60419, p. 60426) we described the West Coast DPS of the fisher as: the Cascade Mountains and all areas west to the coast in Oregon and Washington; the North Coast from Mendocino County, California, north to Oregon; east across the Klamath, Siskiyou, Trinity, and Marble Mountains, and across the southern Cascade Mountains; and south through the Sierra Nevada. Not included are the mountainous areas east of the Okanogan River in Washington and the Blue Mountains west to the Ochoco National Forest, in eastern Oregon, because of the naturally occurring geological conditions that isolate them from the western portions of Washington and Oregon. Figure 1 depicts our analysis area for this species report.

Figure 1. Analysis area for west coast population of fishers (*Pekania pennanti*).

ABBREVIATIONS USED

ºC	degrees Celsius
ºF	degrees Fahrenheit
ac	acres
ACEC	Area of Critical Environmental Concern
Act	Endangered Species Act of 1973, as amended
AR	anticoagulant rodenticide
cm	centimeters
BGEPA	Bald and Golden Eagle Protection Act of 1940, as amended
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
CAL FIRE	California Department of Forestry and Fire Protection
CDFW	California Department of Fish and Wildlife (formerly CDFG)
CCAA	Candidate Conservation Agreement with Assurances
CDFG	California Department of Fish and Game (now CDFW)
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CI	confidence interval
CNOR	Candidate Notice of Review
dbh	diameter at breast height
DNA	genetic material
DPS	Distinct Population Segment
ECOS	Environmental Conservation Online System
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act of 1973, as amended
FEMAT	Forest Ecosystem Management Assessment Team
FGAR	first-generation anticoagulant rodenticide
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act of 1947, as amended
FLPMA	Federal Land Policy and Management Act of 1976, as amended
FPA	Z'Berg Nejedly Forest Practice Act of 1973
FPR	Forest Practice Rules
FR	Federal Register
ft	feet
g	grams
GHG	greenhouse gas
GIS	geographic information system
ha	hectares
HCP	Habitat Conservation Plan
in.	inches
INFISH	Inland Native Fish Strategy
IPCC	Intergovernmental Panel on Climate Change
JBLM	Joint-Base Lewis-McChord
kg	kilograms
km	kilometers
km^2	square kilometers

lbs.	pounds
LD50	median lethal dose
LRMP	Land and Resource Management Plan
m	meters
mi	miles
mi^2	square miles
MBTA	Migratory Bird Treaty Act of 1918, as amended
MMMA	marbled murrelet management area
MOA	memorandum of agreement
NEPA	National Environmental Policy Act of 1969, as amended
NFMA	National Forest Management Act of 1976, as amended
NWFP	Northwest Forest Plan
OAR	Oregon Administrative Rules
ODFW	Oregon Department of Fish and Wildlife
ODF	Oregon Department of Forestry
oz.	ounces
PACFISH	Interim management of anadromous fish-producing watersheds on Federal lands in eastern Oregon and Washington, Idaho and portions of California.
PRC	California Public Resources Code
PSQ	probably sales quantity
RCW	Revised Code of Washington
RPF	registered professional forester
RMP	Resource Management Plan
Service	U.S. Fish and Wildlife Service
SGAR	second-generation anticoagulant rodenticide
SNAMP	Sierra Nevada Adaptive Management Project
SNFPA	Sierra Nevada Forest Plan Amendment
SPI	Sierra Pacific Industries
SSFCA	Southern Sierra Fisher Conservation Area
SWAP	State Wildlife Action Plan
SWGP	State Wildlife Grants Program
THP	Timber Harvest Plan
USDA	U.S. Department of Agriculture
USDI	U.S. Department of Interior
USDOJ	U.S. Department of Justice
USDOT FHWA	U.S. Department of Transportation Federal Highway Administration
USFS	U.S. Forest Service
USNRM	U.S. Northern Rocky Mountains
VDGIF	Virginia Department of Game and Inland Fisheries
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources

SPECIES DESCRIPTION

The fisher, as described by Powell (1981, p. 1), is a medium-sized light brown to dark blackish-brown mammal, with the face, neck, and shoulders sometimes being slightly gray. The chest and underside often has irregular white patches. The fisher has a long body with short legs and a long bushy tail. At 3.5 to 5.5 kilograms (kg) (7.7 to 12.1 pounds [lbs.]), male fishers weigh about twice as much as females (1.5 to 2.5 kg [3.3 to 5.5 lbs.]). Males range in length from 90 to 120 centimeters (cm) (35 to 47 inches [in.]), and females range from 75 to 95 cm (29 to 37 in.) in length. Fishers show regional variation in typical body weight. For example, fishers from western North America weigh more in the northern parts of their range than those living in the southern extent of their range (Lofroth *et al.* 2010, p. 10).

Photo Credit: Nick Nichols, National Geographic

TAXONOMY

The fisher (*Pekania pennanti*) is classified in the order Carnivora, family Mustelidae; this family also includes weasels, mink, martens, and otters (Anderson 1994, p. 14). Initially described by Erxleben (p. 470) as *Mustela pennanti* in 1777, taxonomists during the twentieth century placed the fisher in the genus *Martes* (Goldman 1935, pp. 176–177; Powell 1981 pp. 1, 4; Powell 1993, pp. 11–12) but kept the specific epithet *pennanti* (Hagmeier 1959, p. 185). Recent genetic research has led to a reclassification of the fisher into the genus *Pekania* (Koepfli *et al.* 2008, p. 5; Sato *et al.* 2012, p. 755) and shows that fishers are more closely related to the tayra (*Eira barbara*) and the wolverine (*Gulo gulo*) than to other species in the genus *Martes* (Hosoda *et al.* 2000, p.264; Stone and Cook 2002, p. 170; Koepfli *et al.* 2008, p. 5; Sato *et al.* 2009, p. 916; Wolsan and Sato 2010, p. 179; Nyakatura and Bininda-Emonds 2012, p 13; Sato *et al.* 2012, p. 754). The Service adopts this recent name change, which places the fisher in a monotypic genus.

Characteristic of the genus *Pekania* include its large body size compared with *Martes* species and the presence of an external median rootlet on the upper carnassial (fourth) premolar (Anderson 1994, p. 21).

In 1935, Goldman (1935, p. 177) described three subspecies of fisher based on differences in skull dimensions, although he stated they were difficult to distinguish: (1) *Martes pennanti pennanti* in the east and central regions; (2) *M. p. columbiana* in the central and northwestern regions; and (3) *M. p. pacifica* in the Pacific States. A subsequent analysis questioned whether there was a sufficient basis to support recognition of different subspecies based on numerous factors, including the small number of samples available for examination (Hagmeier 1959, p. 193). Regional variation in characteristics used by Goldman to discriminate subspecies appears to be clinal (varying along a geographic gradient), and the use of clinal variations is "exceedingly difficult to categorize subspecies" (Hagmeier 1959, pp. 192–193). Although subspecies taxonomy is often used to reference fisher populations in different regions, and studies of genetic variation show patterns of population subdivision similar to the subspecies (Kyle *et al.* 2001, p. 2345; Drew *et al.* 2003, p. 59), it is not clear whether the subspecies are valid. Additional support for the uncertainty regarding the taxonomic validity of fisher subspecies is provided by Knaus *et al.* (2011, p. 5) who examined the entire mitogenomes of fishers from all three purported subspecies and found no evidence of monophyly. In other words, they did not find evidence to support a genetic tree that places each subspecies on a single branch, with a common ancestor and common descendants for each subspecies, and where all members of each subspecies are genetically distinct from the members of the other subspecies.

New information since Service (2014)

The reclassification of the fisher to the genus Pekania has been accepted by Bradley *et al.* (2014, pp. 4, 6, 13) and added to the Revised Checklist of North American Mammals North of Mexico, 2014.

LIFE HISTORY

Reproduction

Fishers live to be about 10 years of age in the wild and captivity (Arthur *et al.* 1992, p. 404; Powell *et al.* 2003, p. 644) with both sexes reaching maturity their first year but often not becoming effective breeders until 2 years of age (Powell and Zielinski 1994, p. 46; Powell *et al.* 2003, p. 638). Fishers are solitary except females with kits and during the breeding season, which is generally from late February to the middle of May (Wright and Coulter 1967, p. 77; Frost *et al.* 1997, p. 607). The breeding period in California and Oregon begins in late February and lasts through April based on observations of significant changes of fisher movement patterns (reviewed by Lofroth *et al.* 2010, p. 56). Uterine implantation of embryos occurs 10 months after copulation; active gestation is estimated to be 36 days and birth occurs nearly 1 year after copulation (Wright and Coulter 1967, pp. 74, 76; Frost *et al.* 1997, p. 609; Powell *et al.* 2003, p. 639).

The proportion of adult female fishers that den each year in western North America is 0.64 (range = 0.39–1.00) (Lofroth *et al.* 2010, pp. 55–57; Matthews *et al.* 2013, pp. 103–104). Individual fishers may not give birth every year and reproductive rates may change as females age (Weir and Corbould 2008, p. 28). Among fishers who do give birth, the mean litter size for fishers is between one and three kits (litter size range from one to six kits) (Powell 1993, p. 53; Powell *et al.* 2003, pp. 639–640; Sweitzer *et al.* 2015b, p. 10). The average litter size for 19 females during 4 den seasons on the Hoopa study area in Northern California was 1.9 kits (Matthews *et al.* 2013, p. 103). Within the analysis area, females give birth between mid-March and mid-April (Truex *et al.* 1998, p. 36; Aubry and Raley 2006, p. 12; Higley and Matthews 2006, p. 8; Self and Callas 2006, p. 9; Weir and Corbould 2008, p. 78; Spencer *et al.* 2015, p. 12; Sweitzer *et al.* 2015b, p.9). Newborn kits are entirely dependent on the mother and are weaned at about 10 weeks of age (Powell 1993, p. 67). At about 4 months of age, kits are mobile enough to travel with their mothers (Aubry and Raley 2006, p. 13).

Throughout their range, fishers use tree or snag cavities (Paragi *et al.* 1996a, entire; Truex *et al.* 1998, p. ii; Weir 2003, p. 12; Aubry and Raley 2006, p. 16; Higley and Matthews 2006, p. 10; Self and Callas 2006, p. 6; Weir and Corbould 2008, pp. 105–106; Davis 2009, p. 23) to give birth and raise their young (Coulter 1966, p. 81). Kits may be moved to numerous den locations (Arthur and Krohn 1991, p. 382; Paragi *et al.* 1996a, p. 80; Higley and Matthews 2006, p. 7) before they are weaned (Powell 1993, p. 67). Once weaned, the kits stay with the female, utilizing multiple structures (for example, tree cavities, hollow logs, log piles) (Truex *et al.* 1998, p. 35; Aubry and Raley 2006, pp. 7, 16–17; Higley and Matthews 2006, pp. 6–7) within the female's home range until juveniles disperse in the fall or winter following their birth (Aubry and Raley 2006, p. 12; Matthews *et al.* 2009, p. 9). Kits become independent of their mother and develop their own home ranges by 1 year of age (Powell *et al.* 2003, p. 640).

Natural Causes of Mortality

Natural sources of mortality besides predation and disease include interspecific and intraspecific conflict (Lofroth *et al.* 2010, p. 63; Sweitzer *et al.* 2015a, p. 6), drowning (Lewis 2014, p. 67), and starvation. One death attributed to starvation was determined to be caused by old age, since the animal's teeth were worn to the gum line (Aubry and Raley 2006, p.11) while another starved after suffering an infection in its throat from a porcupine quill (Weir and Corbould 2008, p. 24). Among 128 fishers necropsied in California, seven (five percent) died of nutritional deficiencies, although the specific reasons for the nutritional deficiencies were not identified (Gabriel 2013, p. 99; Gabriel 2013b, pers. comm.). These seven fishers included four adults, a juvenile, and two kits recovered from abandoned den sites. For a discussion on other causes of natural mortality, see the *Disease* and *Predation* sections below. For a discussion on anthropomorphic causes of mortality, see the *Trapping and Incidental Capture*, *Research Activities*, *Collision with Vehicles*, and *Exposure to Toxicants* sections below.

New information since Service (2014)

Gabriel *et al.* (2015, entire) investigated the causes of mortality for 167 fishers in California. Their investigations used a combination of gross necropsy, histology, toxicology, and molecular methods. Of the 167 fishers collected from 2007-2014 they had sufficient material to perform necropsies on 123 fishers. They reported the results of their investigations by grouping the causes of mortality into six categories. These categories included predation, natural disease, poisoning, vehicular strike, human-caused (other than vehicular strike), and unknown. This new information did not identify natural causes of mortality other than predation or disease. Further discussion of this new information is included in the *Disease* and *Predation* sections below.

Sweitzer *et al.* (2015a, p. 6) similarly documented four fisher deaths in the southern Sierra Nevada related to starvation or illness from a debilitating injury that prevented foraging. One additional fisher mortality documented during this study resulted from a rattlesnake bite (Sweitzer *et al.* 2015a, p. 6).

Survivorship

Adult female survival has been shown to be the most important single demographic parameter determining fisher population stability (Truex *et al.* 1998, p. 52; Lamberson *et al.* 2000, pp. 6, 9, Spencer *et al.* 2011, p. 794, 798). From 2005 to 2009, Higley and Matthews (2009, pp. 15, 62) documented that adult female survival varied from 58.9 percent to 94.4 percent for all female fishers marked on the Hoopa Valley Reservation in California. On the eastern Klamath study area, Swiers (2013, p. 19) estimated that the annual survival rate of 64 percent did not vary from 2007 to 2011 and did not vary by sex. Truex *et al.* (1998, p. 32) documented an annual survival rate, pooled across years from 1994 to 1996, of 61.2 percent of adult female fishers in the southern Sierra Nevada, 72.9 percent for females in their eastern Klamath study area, and 83.8 percent for females in their North Coast study area. Addressing the population in the southern Sierra Nevada, Truex *et al.* (1998, p. 52) concluded that, “High annual mortality rates raise concerns about the long-term viability of this population.” From spring 2007 to winter 2011, Sweitzer *et al.* (2011) reported adult female survival for two study areas in the southern Sierra Nevada as 72 percent (95 percent confidence interval of 56 percent to 88 percent) in the north and 74 percent (95 percent confidence interval of 60 percent to 87 percent) in the south.

New information since Service (2014)

In the Hoopa study area in the NCSO population Higley *et al.* 2013 analyzed capture-mark-recapture (CMR) data collected from 2004-2005 to 2012-2013 to estimate population size, apparent survival, and lambda using “Closed Captures”, “Recaptures Only”, and “Pradel Models,” respectively in program MARK (White and Burnham 1999). Estimates of female annual survival indicate a stable to slight increase in annual survival while male-only survival was declining during the same time period (Higley *et al.* 2013, p. 100, Figure 27).

The most recent annual monitoring data for fishers reintroduced to the northern Sierra Nevada report monthly survival estimates for females and males during reproduction as 0.97 (95% CI = 0.95–0.99). Outside reproductive time periods, estimated monthly survival rates for both sexes is 0.99 (95% CI = 0.97–1.0). The estimate for annual survival rate for adult fishers, including breeding and non-breeding periods is 0.80 (95% CI = 0.55–0.84) (Powell *et al.* 2014, p. 14) Sweitzer *et al.* (2015b, pp. 784–785) found that “change in fisher survival was more important than fecundity for deterministic population growth.”

A recent study by Sweitzer *et al.* (2015b, p. 779) in the Sierra National Forest reported adult survival rates from fall 2008 to early summer 2013 as 72 percent (95 percent confidence interval of 62 percent to 82 percent). Additionally, Sweitzer *et al.* (2015c, p. 9) reported variation in projected fisher survival rates from this area dependent upon season, sex, and age. In particular, the authors noted lower survival in males and differences between male and female survival based on season Sweitzer *et al.* (2015c, p. 7).

Recruitment

The estimated recruitment rate we used for this analysis is defined as the number of juveniles alive per adult female at the time of juvenile dispersal during the fall of the year. Very little is known about fisher recruitment and often data are derived by piecing together various sources of information (for example, denning rates of adult females, telemetry and capture data, aging data, etc.). In central interior British Columbia, Weir and Corbould (2008, p. 21) estimated that the average fall recruitment rate of juveniles per adult female was 0.58, suggesting very little recruitment of new individuals into that population.

New information since Service (2014)

Matthews *et al.* (2013, p. 104) reported seasonal recruitment rates for fishers. Recruitment rates were: 1.0 juveniles per adult female at weaning (0.51 for female kits and 0.49 for male kits), 0.32 juveniles per adult female after the fall–winter live trapping period (0.28 for females and 0.05 for males), and 0.19 kits per adult female at home range establishment (0.16 for females and 0.02 for males) (Matthews *et al.* 2013, p. 104).

SPACING PATTERNS AND MOVEMENT

Home Range and Territoriality

An animal's home range is the area traversed by the individual in its normal activities of food gathering, mating, and caring for young (Burt 1943, p. 351). Fisher home range size most likely increases with increasing latitude (Lofroth *et al.* 2010, p. 69; Weir *et al.* 2013, p. 121) and with body size (Lindstedt *et al.* 1986, p. 416). The abundance or availability of prey and their vulnerability to predation may play a role in home range size and selection (Powell 1993, p. 173; Powell and Zielinski 1994, p. 57). Only general comparisons of fishers' home range sizes can be made, because studies across the range have been conducted by different methods. Generally, fishers have large home ranges, with male home ranges typically larger than female home ranges. Fisher home ranges vary in size across North America and range from 16 to 122 square kilometers (km^2) (4.7 to 36 square miles (mi^2)) for males, and from 4 to 53 km^2 (1.2 to 15.5 mi^2) for females (reviewed by Powell and Zielinski 1994, p. 58; Lewis and Stinson 1998, pp. 7– 8; Zielinski *et al.* 2004b, p. 652; Sweitzer *et al.* 2015d, p. 90; Weir *et al.* 2013, p. 117). West of the Rocky Mountains in the U.S. and Canada, male home ranges tended to be three times larger than females, averaging 18.8 square kilometers (km^2) (7.3 mi^2) for females and 53.4 km^2 (20.6 mi^2) for males (Lofroth *et al.* 2010, pp. 67–68).

Fishers exhibit territoriality, with little overlap between members of the same sex; in contrast, overlap between opposite sexes is extensive, and the extent of overlap is possibly related to the density of prey (Powell and Zielinski 1994, p. 59). It is not known how fishers maintain territories; it is possible that scent marking plays an important role (Leonard 1986, p. 36; Powell 1993, p. 170). Direct aggression between individuals in the wild has not been observed, although combative behavior has been observed between older littermates and between adult females in captivity (Powell and Zielinski 1994, p. 59).

Fishers are polygynous (Powell 1993, p. 54) with males typically seeking out females in estrus. During the breeding season, male fishers may expand their home ranges as much as 2.4-fold or temporarily abandon their territories by taking long excursions and moving up to 22 km (13.7 mi) within 48 hours to increase their opportunities to mate (Buck 1982, p. 28; Aubry and Raley 2006, p. 13; Arthur *et al.* 1989, p. 677; Jones 1991, pp. 77–78). However, males who maintained their home ranges during the breeding season were more likely to successfully mate than were nonresident males encroaching on an established range (Aubry *et al.* 2004, p. 215). Adult females do not make pronounced breeding season movements, particularly in those years that they are raising kits, and appear to maintain relatively consistent home ranges year-round (Arthur *et al.* 1993, p. 872).

New information since Service (2014)

Home ranges of four male fishers in northeastern British Columbia averaged 210 km^2 (81 mi^2) Weir *et al.* 2013, p. 117). In Weir's British Columbia study area, he concludes that home range size may also be a function of the availability and distribution of particular resources needed for reproduction (Weir *et al.* 2013, pp. 121–122).

Lewis (2014, p. 29) reported mean home ranges of 128.3 km^2 (49.5 mi^2) and 63.5 km^2 (24.5 mi^2) for male and female fishers, respectively, in a reintroduced population in the Olympic Peninsula. The author notes that future research is needed to determine if mean home range sizes become smaller as the population becomes established (Lewis 2014, p. 39).

One study in the southern Sierra Nevada observed extensive overlap of annual home ranges of female fishers, with reduced overlap in core use areas (Sweitzer *et al.* 2015d, pp. 88–89).

Dispersal

Dispersal, the movement of juveniles from their natal home range to establish a breeding territory, is the primary mechanism for the geographic expansion of a population. Long distance dispersal has been documented for fishers with males moving greater distances than females. Arthur *et al.* (1993, p. 872) reported an average maximum dispersal distance of 14.9 km (9.3 mi) and 17.3 km (10.7 mi) for females and males, respectively [range = 7.5 km (4.7 mi) to 22.6 km (14.0 mi) for females and 10.9 km (6.8 mi) to 23.0 km (14.3 mi) for males] in a low density population in Maine with relatively high trapping mortality. In areas such as this, with high trapping mortality, young fishers may not have to disperse as far in order to find unoccupied home ranges (Arthur *et al.* 1993, p. 872). York (1996) reported dispersal distances for juvenile male and female fishers averaging 33 km (20 mi) [range = 10 km (6 mi) to 107 km (66 mi)] for a high-density population in Massachusetts. On the Hoopa Valley Indian Reservation study area, the mean dispersal distance between natal dens and the centroids of newly established subadult home ranges was 4.0 km (2.5 mi) [range = 0.8 km (0.5 mi) to 18.0 km (11.2 mi)] for 7 females and 1.3 km (0.81 mi) for 1 male (Matthews *et al.* 2013, p 104). However, the mean maximum travel distance was greater for males, 8.1 km (5.0 mi) [range = 5.9 km (3.7 mi) to 10.3 km (6.40 mi)], than for females, 6.7 km (4.1 mi) [range = 2.1 km (1.3 mi) to 20.1 km (12.5 mi)] (Matthews *et al.* 2013, p. 104). Notably, only two females dispersed far enough from their natal home ranges to avoid overlapping with their mothers' home ranges (Matthews *et al.* 2013, p 104).

Juveniles dispersing from natal areas are capable of moving long distances and navigating various landscape features such as highways, rivers, and rural communities to establish their own home range (York 1996, p. 47; Weir and Corbould 2008, p. 44). Dispersal characteristics may be influenced by factors such as sex, availability of unoccupied areas, turnover rates of adults, and habitat suitability (Arthur *et al.* 1993, p. 872; York 1996, pp. 48–49; Aubry *et al.* 2004, pp. 205–207; Weir and Corbould 2008, pp. 47–48). Long distance dispersal by juveniles is made at a high cost and is usually not successful. Fifty-five percent of fishers in a British Columbia study died before establishing home ranges, and only 17 percent successfully established a home range (Weir and Corbould 2008, p. 44). Those individuals that traveled longer distances were subject to greater mortality risk (Weir and Corbould 2008, p. 44).

Based on field observation and microsatellite genotype analyses of the fisher population in the southern Cascades, Aubry *et al.* (2004, p. 217) found empirical evidence of male-biased juvenile dispersal and female philopatry (the drive or tendency of an individual to return to, or stay in, its home area) in fishers, which may have a direct bearing on the rate at which fishers can colonize formerly occupied areas within their historical range. Tucker’s (2013, p. 65) use of bi-parentally inherited genetic markers to investigate sex-biased dispersal of southern Sierra Nevada fishers yielded mixed results, but suggested that males disperse more often than do females. Research at the Hoopa study area also supports the theory that fishers have male-biased dispersal and female philopatry (Matthews *et al.* 2013 p. 105).

New information since Service (2014)

Dispersal by juvenile fisher begins during or after their first fall or winter when they are about seven to 10 months old (Aubry and Raley 2006, p. 14; Naney *et al.* 2012, p. 72). Juveniles in the southern Oregon Cascade Range began dispersing at about 10 months old in early February (Aubry and Raley 2006, p. 14). In the southern Sierra Nevada, juvenile dispersal likely begins in March (Sweitzer *et al.* 2015b, p. 5; Sweitzer *et al.* 2015d, pp. 36).

Mean juvenile dispersal distance in the southern Sierra Nevada was 4.89 km (3.04 mi) for females and 8.48 km (5.27 mi) for males (Sweitzer *et al.* 2015d, p. 82). The maximum juvenile dispersal distances for this area were 22.26 km (13.83 mi) for a female and 36.17 km (22.48 mi) for a male (Sweitzer *et al.* 2015d, p. 82). However, Sweitzer *et al.* (2015c, p. 9) did not find that dispersal reduced survival among dispersal-aged fishers in the southern Sierra Nevada.

Food Habits

Fishers are opportunistic predators, primarily of squirrels (*Tamiasciurus*, *Sciurus*, *Glaucomys*, and *Tamias* spp.), mice (*Microtus*, *Clethrionomys*, and *Peromyscus* spp.), snowshoe hares (*Lepus americanus*), and birds (numerous spp.) (reviewed in Powell 1993, pp. 18, 102; reviewed in Lofroth *et al.* 2010, pp. 74–76, 161–163). Fishers may indirectly shape forest plant communities through their influence on the population dynamics of prey species that are important seed predators in western coniferous forests (for example, tree squirrels and other rodents that cache or hoard seeds) (for example, Roemer *et al.* 2009, p. 170). Carrion and plant material (for example, berries) also are consumed (Powell 1993, p. 18). The fisher is one of the few predators that successfully kills and eats porcupines (*Erethizon dorsatum*), (Powell 1993, p. 135).

While snowshoe hares and porcupines are important prey items across much of North American range of fishers, within the analysis area the ranges of these prey species do not extensively overlap the range of the fisher (Powell 1981, p. 3; Bittner and Rongstad 1982, pp. 146–163; Dodge 1982, p. 355; Ellsworth and Reynolds 2006, p. 10). Fishers in the analysis area have a diverse diet with the dominant component in Oregon and California being small and mid-sized mammals (Zielinski *et al.* 1999, entire; Aubry and Raley 2006, pp. 25–27; Golightly *et al.* 2006, entire). Diet studies in California have indicated that fishers prey predominantly on mammals, but their diet also includes birds, insects, and reptiles (Zielinski *et al.* 1999, entire; Golightly *et al.* 2006, entire).

Golightly *et al.* (2006, entire) examined diet and energetic return based on body size, to infer daily energy demands for fishers in the Klamath/North Coast Bioregion. He concluded that an average-weight Douglas squirrel (*Tamiasciurus douglasii*) would supply a female fisher with a 1.6-day supply of energy and a woodrat (*Neotomoa* spp.) could supply 2 days of energy. A fisher would need to find and consume 10 to 26 smaller prey items (for example, mice (*Peromyscus maniculatus*) or western fence lizard, *Sceloporus occidentalis*) per day to meet their energetic needs (Golightly *et al.* 2006, pp. 40–41).

New information since Service (2014)

Fishers in coastal Washington also prey upon mountain beaver (*Aplodontia rufa*) (Lewis 2014, p. 109).

HABITAT ASSOCIATIONS

The occurrence of fishers at regional scales is consistently associated with low- to mid-elevation environments of coniferous and mixed conifer and hardwood forests with abundant physical structure (reviewed by Hagmeier 1956, entire; Arthur *et al.* 1989, pp. 683–684; Banci 1989, p. v; Aubry and Houston 1992, p. 75; Jones and Garton 1994, pp. 377–378; Powell 1994, p. 354; Powell *et al.* 2003, p. 641; Weir and Harestad 2003, p. 74, Raley *et al.* 2012, pp. 238–245). Within the analysis area, current fisher populations inhabit forested areas from sea level to approximately 2,600 meters (m) (8,530 feet [ft]) (Lofroth *et al.* 2010, p. 88; Lewis 2014, p. 98; Sweitzer *et al.* 2015d, pp.59–60). Historically, fishers in the analysis area were distributed in similar elevation ranges as current populations even though they are now considered likely extirpated in many areas of Oregon and Washington (Bailey 1936, pp. 298–299; Aubry and Houston 1992, pp. 69–70, 74–75; Lewis and Stinson 1998, pp. 4–5; Aubry and Lewis 2003, p. 79; 85–86; Lofroth *et al.* 2010, pp. 41–43, 47, and references therein).

Snow conditions and ambient temperatures may affect fisher activity and habitat use. Fishers in eastern parts of the taxon's range may be less active during winter and may avoid areas where deep, soft snow inhibits movement (Leonard 1980, pp. 108–109; Raine 1983, p. 25). Historical and current fisher distributions in California and Washington are consistent with forested areas that receive low or lower relative snowfall (Krohn *et al.* 1997, p. 226; Aubry and Houston 1992, p. 75). Fishers in Ontario, Canada, moved from low-snow areas to high-snow areas during population increases, indicating a possible density-dependent migration to less suitable habitats factored by snow conditions (Carr *et al.* 2007, p. 633). These distribution and activity patterns suggest that the presence of fishers and their populations may be limited by deep snowfall. However, the reaction to snow conditions appears to be variable across the range, with fishers in some locations appearing unaffected by snow conditions or increasing their activity with fresh snowfall (Jones 1991, p. 94; Roy 1991, p. 53; Weir and Corbould 2007, p. 1512). Thus, fishers' reaction to snow may be dependent on a myriad of factors, including, but not limited to: local freeze-thaw cycles, the rapidity of crust formation, snow interception by the forest canopy, lower rates of primary forest productivity, less complex forest structure, and prey availability (Krohn *et al.* 1997, p. 226; Mote *et al.* 2005, p. 44; Weir and Corbould 2007, p. 1512, Raley *et al.* 2012, p. 248–249).

Fishers in the analysis area occur in a wide variety of forest plant communities (Buck *et al.* 1994, pp. 368–370; Klug 1997, p. 32; Self and Kerns 2001, p. 3; Zielinski *et al.* 2004b, pp. 650–651; Aubry and Raley 2006, pp. 3–4). Some of the most productive habitats for fishers are within floristically diverse landscapes that likely provide for a wide variety of prey species (Buskirk and Powell 1994, pp. 285-287). Raley *et al.* (2012, p. 249) hypothesize that it may benefit fishers to include a diversity of available forest conditions within their home ranges to increase their access to a greater diversity and abundance of prey species as long as important habitat features supporting reproduction and thermoregulation are available. In California, fishers occur in a wider array of plant communities (for example, mixed conifer-hardwood forests) than are or would have been available to historical populations to the north in Oregon and Washington where many of these plant communities do not occur. Historically and currently, fishers do not occupy high elevation sub-alpine and alpine environments (Roy 1991, p. 42; Aubry and Lewis 2003, p. 82).

The key aspects and structural components of fisher habitat are best represented in areas that are comprised of forests with diverse successional stages containing a high proportion of mid- and late-successional characteristics (Buskirk and Powell 1994, pp. 286–287; Zielinski *et al.* 2004b, pp. 652–653, 655). Natural forest development is a dynamic continuum that begins with a disturbance event, such as wildfire or windthrow (areas of downed trees due to high winds), that alters major components of the forest, initiating an array of successional stages across the landscape. Over time, the disturbance-affected forest grows and experiences a series of successional stages in vegetation species occurrence and stand structure. Timber harvest can also be considered a disturbance event that, if the harvesting techniques mimic or maintain some of the attributes of natural forest development processes, may also be able to develop late successional characteristics. In the absence of major disturbance (changes in successional stage) over many decades depending on the forest type, the structure and species composition of mature or late-successional forest forests may result. Late successional forests are generally characterized by more diversity of structure and function than younger forest developmental stages and the specific characteristics of structural diversity vary by region, forest type, and local conditions.

To support fishers' successful reproduction and protection from predation, forest structure must provide both natal and maternal den and rest sites (Powell and Zielinski 1994, p. 53). The extent to which late successional forests and forest structure is required to support fishers may depend on scale (Powell *et al.* 2003, p. 641), because fishers select habitat at multiple spatial scales for different activities or behaviors (Powell and Zielinski 1994, p. 54; Weir and Harestad 1997, p. 260; Garner 2013, p. 41; Niblett 2015, p. 10). Female fishers are more selective than males in the use of various forest conditions and structures in order to successfully give birth and rear their kits (Lofroth *et al.* 2010, pp. 91, 101, 106, 115). Landscapes that support the establishment of fisher home ranges provide habitat attributes necessary for resting and denning based at the individual tree and site scales; these landscapes also provide foraging opportunities at forest stand and larger scales that contain an abundance and diversity of prey (Powell 1993, p. 89; Buskirk and Powell 1994, p. 284; Weir and Corbould 2008, p. 103, Raley *et al.* 2012, p. 237). Overall, fishers appear to be more selective in the habitat and structures that provide rest and den sites than the habitat types selected for foraging (Lofroth *et al.* 2010, p. 121).

Throughout their range, fishers are obligate users of tree or snag cavities for dens where they give birth (reviewed by Lofroth *et al.* 2010, p. 119; Coulter 1966, p. 81). Kits may be moved from their natal den to numerous maternal den locations before they are weaned; as a result, a denning female requires multiple den trees per year (Arthur and Krohn 1991, p. 382; Paragi *et al.* 1996a, p. 80; Higley and Matthews 2006, p. 7; Powell 1993, p. 67). Once weaned, the kits stay with the female, and consequently the family unit utilizes multiple structures (for example, tree cavities, hollow logs, and log piles) within the female's home range until juvenile dispersal in the fall or winter (Truex *et al.* 1998, p. 35; Aubry and Raley 2006, p. 7, 12, 16–17; Higley and Matthews 2006, p. 6–7; Matthews *et al.* 2009, p. 9).

Cavities in large-diameter live or dead trees are selected for natal dens and more often for maternal dens than other structures (Powell and Zielinski 1994, pp. 47, 56). Dens are in larger diameter trees because they need to be large enough to provide a cavity with an inside diameter of greater than 30 cm (12 in.) (Weir and Corbould 2008, p. 142; Weir *et al.* 2012, p. 230). Furthermore, female fishers select den trees with very specific dimensions of the cavity entrance (Weir *et al.* 2012, p. 237). All entrances to den cavities in British Columbia ranged from 4.5 to 9.5 cm (1.8 to 3.8 in.) to allow the female fisher access to the cavity, but exclude larger animals such as potential predators or male fishers (Weir *et al.* 2012, p. 237).

Similar to den site selection, fishers select resting sites with characteristics of late successional forests: large diameter trees, coarse downed wood, and singular features of large snags, tree cavities, or deformed trees (Powell and Zielinski 1994, p. 54; Lofroth *et al.* 2010, pp. 101–103, Aubry *et al.* 2013, entire). Live trees, snags, and logs used for resting were, on average, 1.4 to

3.4 times larger in diameter than average available structures (Weir and Harestad 2003, pp. 77–78; Zielinski *et al.* 2004a, p. 475; Purcell *et al.* 2009, p. 2700). When fishers use younger forest types, they select large-diameter trees or snags, if present, that are remnants of a previously existing older forest stage (Jones 1991, p. 92). In addition, similar to den site use, fishers utilize multiple rest sites per day distributed throughout their home range, and rest site selection and use changes daily and seasonally (Lofroth *et al.* 2010, p. 72). The type of site and structure selected may be dictated by weather conditions, proximity to available prey, and potential predators (Lofroth *et al.* 2010, p. 119). Because of all of these factors and selectivity for mature forest type structure, resting and denning sites may be limiting to fisher distribution (Powell and Zielinski 1994, pp. 56–57).

Rest sites may be selected for their insulating or thermoregulatory qualities and for their effectiveness at providing protection from predators (Weir *et al.* 2004, pp. 193–194, Raley *et al.* 2012, pp. 244–245). Raley *et al.* (2012, p. 240) summarizes the "overwhelmingly consistent" characteristics of over 2,260 resting structures selected by fishers throughout western North America, stating:

> Fishers rested primarily in deformed or deteriorating live trees (54–83% of all rest structures identified in individual studies), and secondarily in snags and logs (Weir and Harestad 2003; Zielinski *et al.* 2004b; Aubry and Raley 2006; Purcell *et al.* 2009). The species of trees and logs used for resting appeared to be less important than the presence of cavities, platforms, and other microstructures. In live trees, fishers rested primarily in rust brooms in more northern study areas (Weir and Harestad 2003; Weir and Corbould 2008; Davis 2009) and mistletoe brooms or other platforms elsewhere (e.g., Self and Kerns 2001; Yaeger 2005; Aubry and Raley 2006). In contrast, fishers primarily used cavities when resting in snags (e.g., Self and Kerns 2001; Zielinski *et al.* 2004b; Purcell *et al.* 2009). Fishers used hollow portions of logs or subnivean spaces [formed beneath logs and packed snow] more frequently in regions with cold winters (e.g., Weir and Harestad 2003; Aubry and Raley 2006; Davis 2009) than those with milder winters (e.g., Yaeger 2005; Purcell *et al.* 2009; Thompson *et al.* 2010). These results suggest that fishers use structures associated with subnivean spaces to minimize heat loss during cold weather (Weir *et al.* 2004; Weir and Corbould 2008).

In most cases, cavities in live trees, snags, and down logs used as reproductive dens (natal and maternal) and rest sites are a result of heartwood decay (Weir 1995, p. 137; Aubry and Raley 2006, p. 16; Weir and Corbould 2008, p. 105; Reno *et al.* 2008, p. 19; Davis 2009, pp. 26–27). Fishers do not excavate their own natal or maternal dens; therefore, other factors (such as heartwood decay of trees, excavation by woodpeckers, broken branches, frost, or fire scars) are important in creating cavities and narrow entrance holes (Lofroth *et al.* 2010, p. 112). Depending on tree species and ecological conditions, cavity formation in large trees or snags (for denning and resting) may require over 100 years to develop (Raley *et al.* 2012, pp. 242-244, Weir *et al.* 2012, pp. 234-237). The tree species selected for den and rest sites may vary from region to region based on local influences. In regions where both hardwood and conifers occur, hardwoods are selected more often, even if they are only a minor component of the area (Lofroth *et al.* 2010, p. 115), due to their propensity to develop cavities from structural damage to the tree. Den and rest cavities tend to be in older and larger diameter trees than other available trees in the vicinity, particularly when they are in conifer tree species, where the larger size of these structures is likely related to tree age and the long time periods required for cavities to develop (reviewed by Lofroth *et al.* 2010, pp. 115, 117; Zhao *et al.* 2012, p. 118).

The strongest and most consistent predictor of fisher occurrence in western North America is an association with moderate to dense forest canopy at larger spatial scales (reviewed by Lofroth *et al.* 2010, p. 119, and Raley *et al.* 2012, p. 245; Sweitzer *et al.* 2016, p. 218). This is emphasized by the fishers' avoidance of non-forested habitats with little or no cover (Powell and Zielinski 1994, p. 39; Buskirk and Powell 1994, p. 286) such as open forest, grassland (Powell and Zielinski 1994, p. 55), and wetland habitats (Weir and Corbould 2010, p. 408). An abundance of coarse woody debris, boulders, shrub cover, or subterranean lava tubes sometimes provide suitable overhead cover in non-forested or otherwise open areas for daily movements, seasonal movements by males and juvenile dispersal (Buskirk and Powell, 1994, p. 293; Powell *et al.* 2003, p. 641). In the understory, the physical complexity of coarse woody debris such as downed trees and branches provides a diversity of foraging and resting locations (Buskirk and Powell 1994, p. 295).

Fishers also occupy and reproduce in managed forest landscapes and forest stands not classified as mature or late-successional if those managed forest landscapes provide sufficient amounts of and an adequate distribution of the key habitat and structural components important to fishers (Self and Callas 2006, entire; Reno *et al.* 2008, pp. 9-16; Clayton 2013, pp. 7–8; Garner 2013, p. 41). Younger and mid-seral forests may be suitable for fishers if complex forest structural components such as trees with cavities, large logs, and snags are maintained in numbers fulfilling life history requirements (Lewis and Stinson 1998, p. 34). Studies in British Columbia (Weir and Corbould 2010, p. 406) and California (Klug 1997, pp. 5, 33; Self and Kerns 2001, pp. 7–8, 10; Lindstrand 2006, pp. 50–51) have shown that fishers occur in heavily managed forested landscapes that may contain few stands of mature or late-successional forest. These studies report "a mosaic of seral stages" (Weir and Corbould 2010, p. 406), with "significant older residual components in harvested stands" (Klug 1997, pp. 5–7) or patches of dense-canopy and dead wood habitat elements that most likely provide the structural complexity required by fishers (Klug 1997, p. 42) Lindstrand 2006, pp. 50-51; Clayton 2013, pp. 7–8; Niblett 2015, pp. 9–10).

In addition, forest structure that provides high quality fisher habitat should supply a high diversity and density of prey vulnerable to fisher predation. According to Buskirk and Powell (1994, p. 286), the physical structure of the forest and prey associated with those forest structure types are thought to be the critical features that explain fisher habitat use, rather than specific forest types. In the analysis area, large old trees, a diversity of tree species, and snags provide habitat elements important for populations of northern flying squirrels (*Glaucomys sabrinus*), tree squirrels (*Sciuridae* spp.), and other arboreal rodents (*Arborimu*s spp.) (Carey 1991, entire; Aubry *et al.* 2003, pp. 412–413, 426–429). Additionally brushy understory vegetation provides key habitat for many other important fisher prey species: snowshoe hares (*Lepus americanus*; Hodges 2000, pp. 137–140), brush rabbits (*Sylvilagus bachmani*; Verts and Carraway 1998, p. 133), dusky footed woodrats (*Neotoma fuscipes*; Carey *et al.* 1999a, pp. 67–70, Carey *et al.* 1999b pp. 74–77), and chipmunk species (*Tamais* spp.; Verts and Carraway 1998, pp. 168, 170–171). As stated by Powell (1993, pp. 73, 89, 96–97), the structure and species composition of mature or late-successional forest are probably not as important to fishers as the vegetative and structural aspects that lead to abundant and diverse prey populations and reduced fisher vulnerability to predation.

Abiotic factors have also been considered by some researchers and in some habitat modeling efforts to be important components of assessing habitat suitability and distribution of fishers. In many previous reviews and summaries of fisher habitat, riparian areas and buffers have often been highlighted as one of the key habitat features that improve a landscape's ability to support fishers (Service 2004, p. 18773; USFS and BLM 1994a, pp. J2-54, J2-56–J2-57, J2-79). However, more recent analyses of information across the west indicate that fishers' patterns of use of riparian areas are not consistent among studies (reviewed by Lofroth *et al.* 2010, p. 94). For example, ongoing studies that are investigating denning habits and habitat of female fishers indicate that a substantial number of den sites are located on south and east facing slopes and ridges early in the denning season (Thompson 2013, pers. comm.; Chatel *et al.* 2013, pers. comm.; Clayton 2013, pp. 11, 18–19). The researchers' current hypothesis is that thermoregulation considerations by female fishers and their kits (warmer in the late winter and early spring and cooler in the summer) influences seasonal and regional den and rest site selection, and therefore that the availability of den and rest structures in suitable habitat located in a diverse set of abiotic factors is important (Raley *et al.* 2012, pp. 244–245).

In summary, the physical structure of the forest and prey associated with forest structures are thought to be critical features that explain fisher habitat use (Buskirk and Powell 1994, p. 286), and the composition of individual fisher home ranges is usually a mosaic of different forested environments and successional stages (reviewed by Lofroth *et al.* 2010, p. 94). Further, fishers are opportunistic predators with a relatively general but carnivorous diet, and the vulnerability of prey may be more important to the use of an area for foraging than the abundance of a particular prey species (Powell and Zielinski 1994, p. 54). Fishers will use a variety of successional stages when active, reflecting those of their primary prey (Powell 1993, p. 92; Buskirk and Powell 1994, p. 287, Raley *et al.* 2012, p. 241), but fishers appear to be more often associated with stands containing complex forest structure for resting and denning (Buskirk and Powell 1994, pp. 286–287; Powell and Zielinski 1994, p. 53). Thus, a forested landscape that includes sufficient numbers, diversity, and distribution of structural elements suitable for denning, resting, and prey habitat, with moderate to dense overhead canopy for fishers, may be adequate habitat for occupancy. Currently, there are no data available reporting the fitness of fisher populations located in intensively managed landscapes or landscapes composed mostly of older, less intensively managed forests (Raley *et al.* 2012, pp. 252–253).

New information since Service (2014)

Fishers on the Sequoia National Forest have been documented at slightly higher elevations, up to 2,740 m (9,000 ft) (Spencer *et al.* 2015, p. 7). The majority of the higher elevation detections occurred on the Kern Plateau, which receives less snow than other areas at similar elevations (Spencer *et al.* 2015, p.7).

Zielinski and Schlexer (2015 p. 151) found that rest sites in live trees maintained their condition class and were still available for use 10 years later. They further concluded, "growing trees to large size is also the best way to guarantee a supply of adequately-sized dead structures" (Zielinski and Schlexer 2015 p. 151).

The type of treatment and amount of area treated are also important factors in determining fisher use of managed forests (Clayton 2013, pp. 12–22; Garner 2013, p. 41; Zielinski *et al.* 2013a, p. 825).

Habitat Models

Numerous large scale habitat models have been developed for various regions within the west coast analysis area (Lewis and Hayes 2004, entire; Carroll *et al.* 1999, entire; Carroll 2005, entire; Davis *et al.* 2007, entire; Zielinski *et al.*, 2010, entire; Spencer *et al.* 2008, entire; Spencer *et al.* 2011, entire; Spencer *et al.* 2012, entire) but none provide a seamless habitat suitability depiction for the entire west coast analysis area. We developed a model (hereafter "fisher analysis area habitat model") of potential habitat quality for fishers across the west coast analysis area (Figures 2, 3). We provide an overview of the model details below.

We obtained reports of fisher from more than 5,000 points across the analysis area (Figure 4) and selected points for model development that were verified detections (they had physical evidence to verify fisher identification; see the **Distribution and Abundance** section below) and that occurred after 1970. To ensure the spatial independence necessary for model development, if two or more detections were within 5 km of one another, the most reliable and recent detection was retained, or in case of a tie, by random selection. Our detection selection process resulted in 456 verified fisher detection localities for model development.

The analysis area was subdivided based on eco-regional subsection divisions into six overlapping model regions. We subdivided the analysis area to account for potential differences in habitat conditions due to differing ecological conditions and modeled habitat conditions based on 22 environmental predictors (for example, vegetation, climate, elevation, terrain).We did not consider urban and open water areas as having the potential to provide fisher habitat conditions. Three regions of the analysis area (Washington, the northern two-thirds of Oregon, and the central Sierra Nevada) had at the time insufficient numbers and distribution of fisher detections to calibrate the models.

To portray potential fisher habitat for areas with insufficient verified detection data (Washington, the northern two-thirds of Oregon, and the central Sierra Nevada), we projected modeled habitat from areas with verified detection data onto the adjacent regions with insufficient data. Throughout much of the Cascade Range of Washington and Oregon and parts of the Olympic Peninsula, we developed an expert model to inform potential habitat spatial attributes necessary for this analysis. The modeling resulted in spatial representations of predicted probability of fisher occurrence or potential habitat suitability for each modeling region. We then created three categories of habitat, based on strength of fisher habitat selection in each area populated by fishers. Model values corresponding to habitat preferentially used by fishers were considered to be "high quality"; model values corresponding to habitat avoided by fishers were considered to be "low quality"; and habitat that was neither avoided nor selected was considered to be "intermediate" habitat. In regions where fisher location data were not available to calibrate the

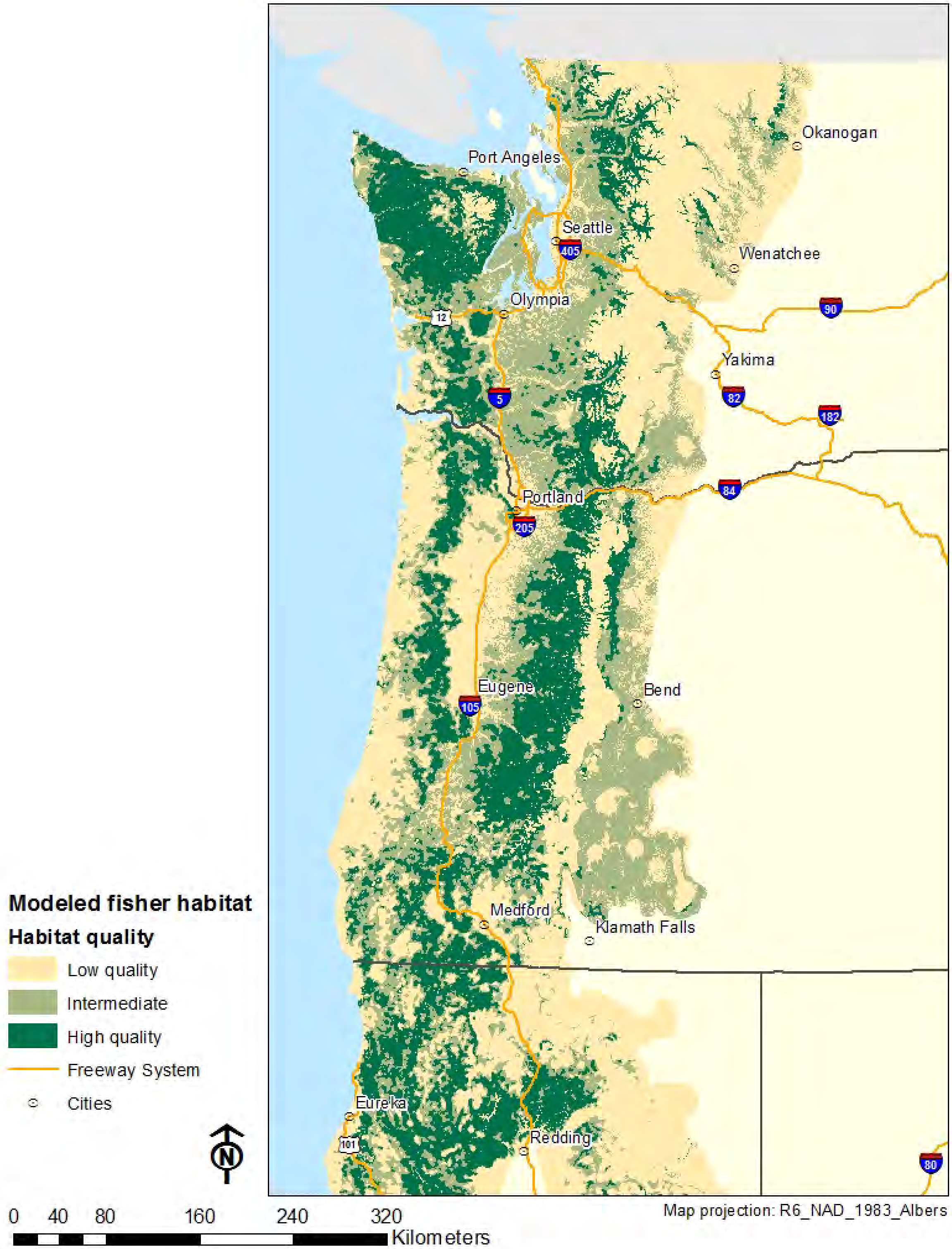

Figure 2. Fisher analysis area habitat model (north half).

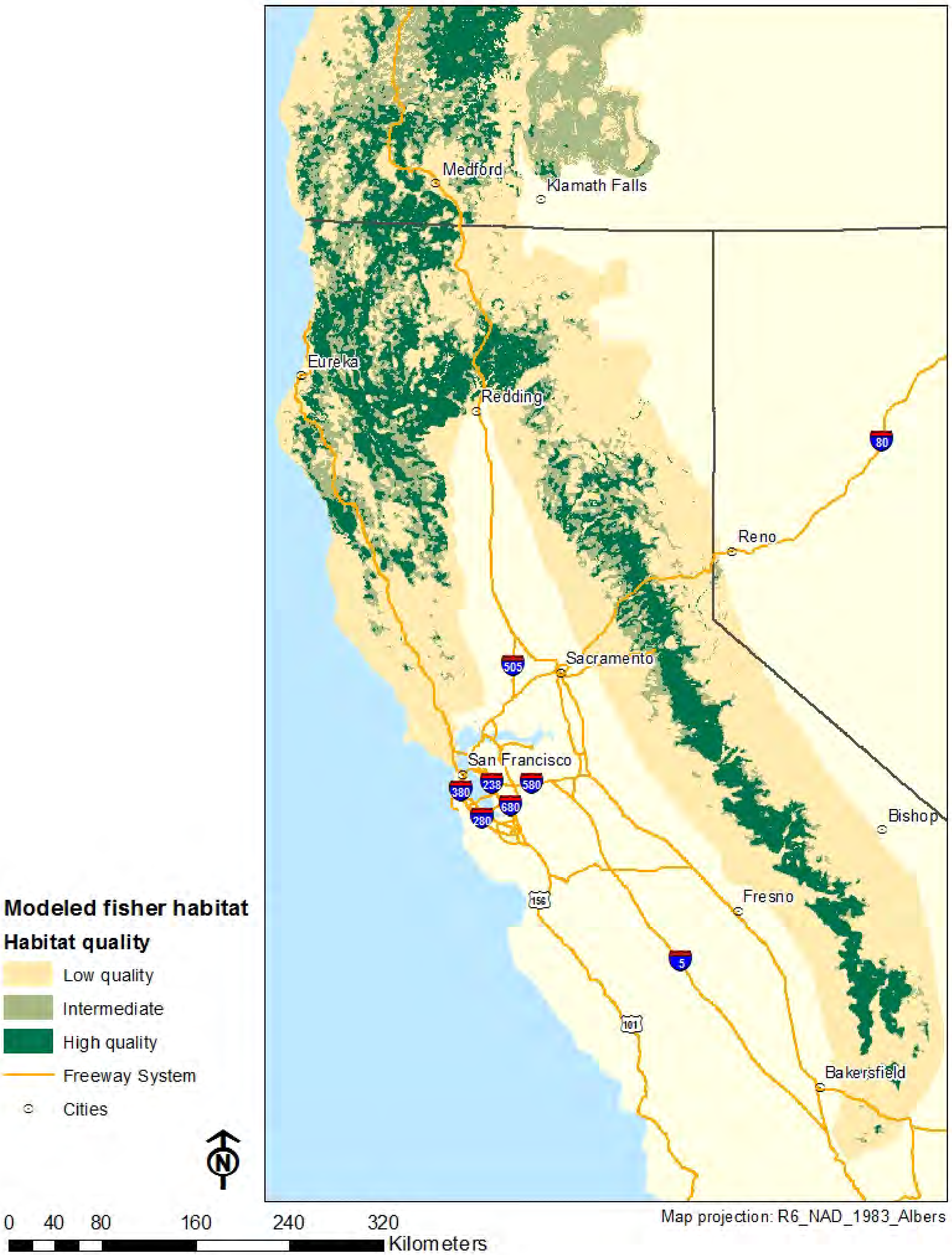

Figure 3. Fisher analysis area habitat model (south half).

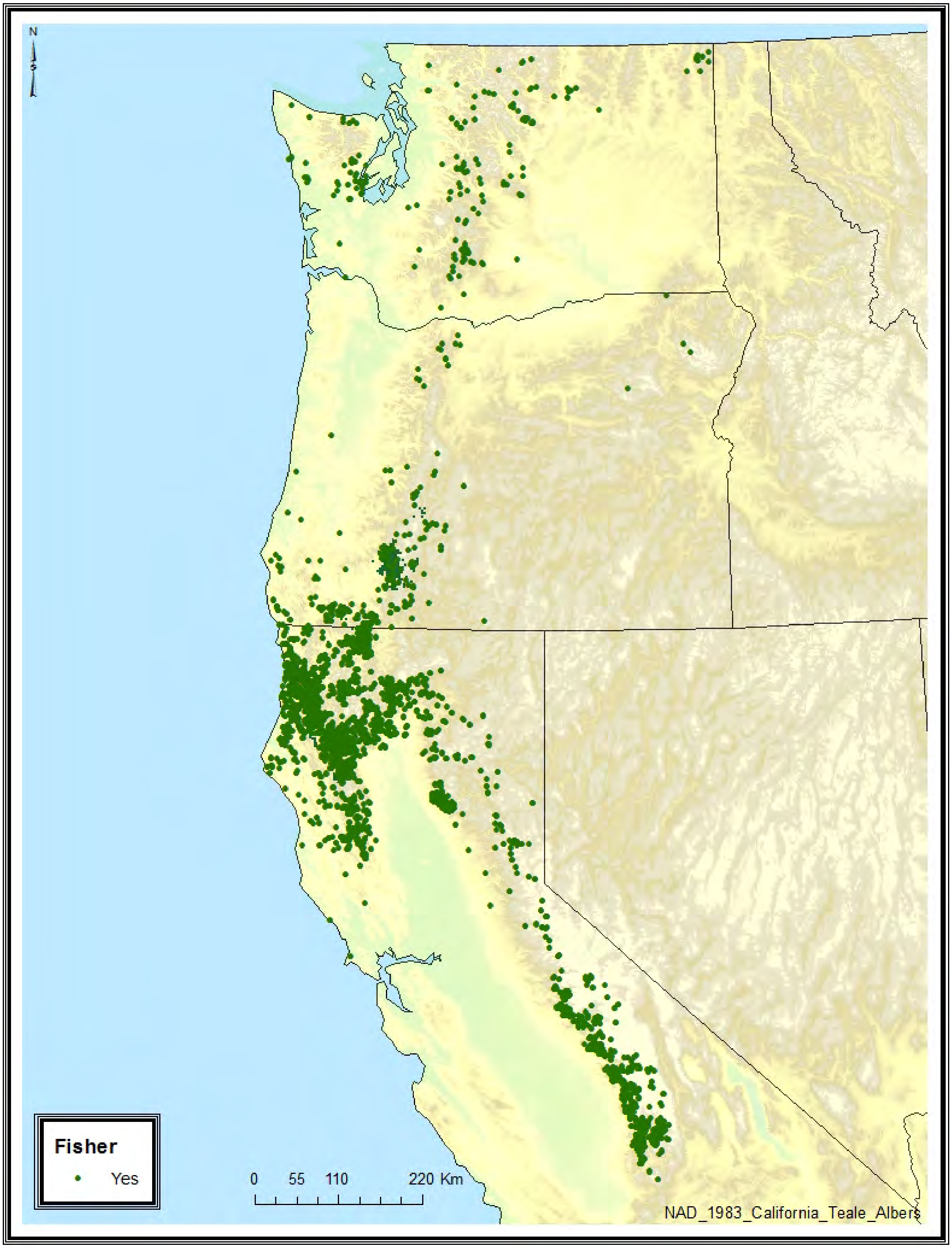

Figure 4. Fisher locality data for the analysis area; reports are from 1896 to 2013. This figure has not been updated since 2013. We are in the process of updating our database with the new data and will use this information to update locality maps in future fisher status reviews.

habitat categories, habitat was categorized to match neighboring regions. Note that the "low quality" category may include non-habitat as well as areas with some habitat value, but that fishers use infrequently relative to their availability on the landscape. Although our final model predicts the probability of detection, we assume that areas with a higher probability of detection fulfill a greater number or quality of life-requisite needs for fishers and may therefore be used as an index of relative habitat suitability.

New information since Service (2014)

Additional information on the fisher analysis area habitat model is provided in Appendix C of this document.

DISTRIBUTION AND ABUNDANCE

Prehistorical and Historical Distribution across the Range of the Species

Fishers are found only in North America (Anderson 1994, pp. 22–23). The earliest dated occurrence of the genus *Pekania* comes from fossil beds in north-central Oregon and indicates that ancestors of present-day fishers were in North America by at least 7.05 million years ago (Samuels and Cavin 2013, pp. 451–452). Fishers appear in the Pleistocene fossil record approximately 30,000 years ago in the eastern United States throughout the Appalachian Mountains, south to Georgia, Alabama, and Arkansas, and west to Ohio and Missouri (Anderson 1994, p. 18). No fossil evidence of a fisher range expansion to the north or west exists until the middle Holocene (4,000 to 8,000 years ago) in southern Wisconsin, and only within the past 4,000 years is there evidence that present-day fishers inhabited northwestern North America (Graham and Graham 1994, pp. 46, 58). Although there is limited fossil evidence available from central Canada, fishers' expansion westward and northward likely coincided with glacier retreat and the subsequent development of the boreal spruce forests (Graham and Graham 1994, p. 58). Fossil remains of fisher in the northwest occur in paleontological and archeological sites in British Columbia, Washington, and Oregon dating from 4,270 years before present (Graham and Graham 1994, pp. 50–55).

Our present understanding of the historical (before European settlement) distribution of fishers is based on the accounts of natural historians of the early twentieth century and general assumptions of what constitutes fisher habitat. The presumed fisher range prior to European settlement of North America (circa 1600) was throughout the boreal forests across North America in Canada from approximately 60 degrees north latitude, extending south to the Great Lakes area and also along the Appalachian, Rocky, and Pacific Coast Mountains (Figure 5) in the United States (Hagmeier 1956, entire; Hall 1981, pp. 985–987; Powell 1981, pp. 1–2; Douglas and Strickland 1987, p. 513; Gibilisco 1994, p. 60; Lewis *et al.* 2012a, p. 9). The distribution of fishers has been described by numerous authors who delineate different distribution boundaries depending on the evidence used for occurrences.

The presumed presence of fishers has been drawn along the lines of forest distribution, and the species has been consistently described as an associate of boreal forest in Canada, mixed deciduous-evergreen forests in eastern North America, and coniferous forest ecosystems in the west (Lofroth *et al.* 2010, p. 39). For this reason, range maps of historical distribution typically portray large areas of continuous occurrence, although it is likely that the suitability of habitat to support fishers within the portrayed range varied over time and spatial scales, subject to climatic variation, large-scale disturbances, and other ecological factors (Gibilisco 1994, p. 70; Graham and Graham 1994, pp. 57–58). Fishers do not occur in all forested habitats today, and evidence would indicate they did not occupy all forest types in the past (Graham and Graham 1994, p. 58). Likewise, recent genetic investigations point to the lack of a ubiquitous presence of fishers across the landscape. Tucker *et al.* (2012, entire) identified an apparent break in the distribution and a range reduction along the length of the Sierra Nevada, which they estimated occurred prior to the influence of European settlement.

Unregulated trapping, predator-control efforts, habitat loss and fragmentation, and climatic changes in eastern North America likely contributed to a reduction in range and distribution of fishers in the late 1800s and early 1900s. As a result, the extent of the range contracted in all Canadian Provinces except the Northwest Territory and Yukon Territories (Lewis *et al.* 2012a, p. 11) and only remnant populations remained in the United States in Maine, Minnesota, New Hampshire, New York, and the Pacific States (Powell and Zielinski 1994, p. 41). At its most contracted state in the early 1900s, Lewis *et al.* (2012a, p. 6) estimated that fishers occupied approximately 43 percent of their historical range before European settlement.

Current Distribution Outside of the Analysis Area

Since the 1950s, fishers have recovered in some of the central (Minnesota, Wisconsin) and eastern (New England) portions of their historical range in the United States as a result of trapping closures, habitat regrowth, and reintroductions (Brander and Brooks 1973, pp. 53–54; Powell 1993, p. 80; Gibilisco 1994, p. 61; Lewis and Stinson 1998, p. 3; Proulx *et al.* 2004, pp. 55–57; Lewis *et al.* 2012a, p. 11). Fisher distribution is expanding into Virginia from West Virginia in the Appalachian Mountains, but it is unclear whether they are establishing breeding populations (VDGIF 2012, p. 1).

Presently, fishers are found in all Canadian provinces and territories except Newfoundland, Labrador, and Prince Edward Island (Proulx *et al.* 2004, p. 55, Lewis *et al.* 2012a, p. 11) (Figure 5). The fisher range in Quebec, Ontario, and eastern Manitoba is contiguous with currently occupied areas in New England, northern Atlantic states, Minnesota, Wisconsin, and the Upper Peninsula of Michigan in the United States (Proulx *et al.* 2004, pp. 55–57; Lewis *et al.* 2012a, p. 11). In Saskatchewan and Alberta, fishers are found primarily north of 52 degrees and 54 degrees north latitude, respectively, and are not connected to breeding populations of fishers in the United States (Proulx *et al.* 2004, p. 58; Lewis *et al.* 2012a, p. 11). Fishers occupy low- to mid-elevation forested areas throughout British Columbia, but are rare or absent from the coast and from the southern region of the province for at least 200 km (125 mi) to the border with the United States (Weir *et al.* 2003, p. 25; Weir and Lara Almuedo 2010, p. 36). Eighty-eight fishers were legally harvested from the South Thompson Similkameen area of south-central British Columbia, bordering north-central Washington, between 1928 and 2007; and of these only 13 were harvested since 1985 (Lofroth *et al.* 2010, p. 48). This region is south of the established fisher population distribution in the province (Weir and Lara Almuedo 2010, p. 36); therefore,

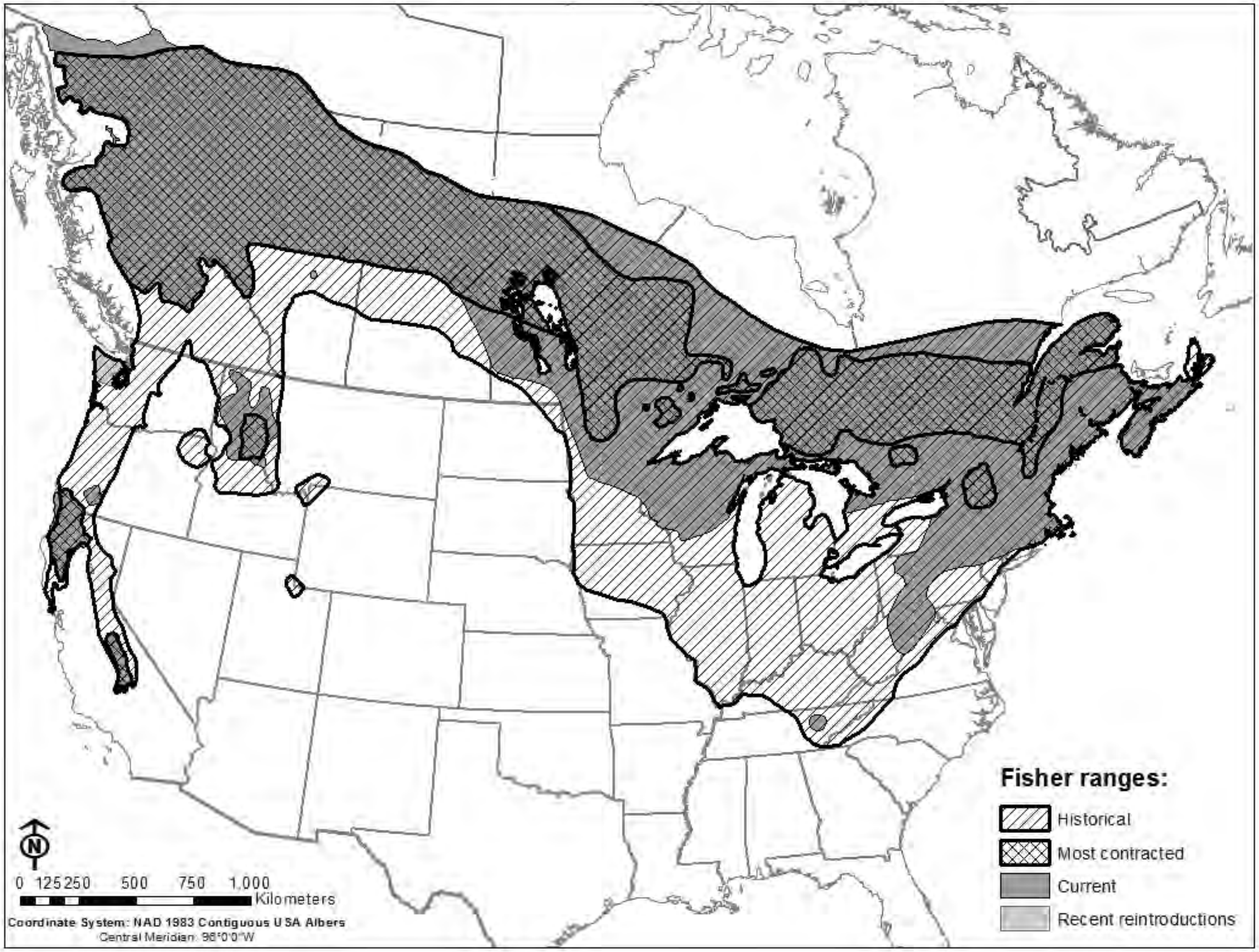

Figure 5. The fisher's historical, most-contracted, and current ranges. (Adapted from Lewis *et al.* 2012a, Figure 8.)

the significance of the trapping data in this region is not clear without more specific location information. These harvest data could indicate that individuals were captured at the periphery of larger, established populations, that there is a low-density population in south-central British Columbia, or that individuals represent transient or extralimital (outside an established population area) records. Contemporary fisher distribution in U.S. Northern Rocky Mountains of western Montana and Idaho covers an area similar to that depicted in the historical distribution synthesized by Gibilisco in 1994 (p. 64). The historical and contemporary distribution of fishers in the U.S. Northern Rocky Mountains is described in detail in our 12-month finding for the Northern Rocky Mountain DPS (76 FR 38504, June 30, 2011) including forested areas of western Montana and north-central to northern Idaho.

Distribution within the Analysis Area

At the beginning of the twentieth century in the Pacific States and Provinces, the fisher's range and distribution were described as "broadly distributed," but "generally rare" (Lofroth *et al.* 2010, p. 39). Hagmeier (1956, p. 152) reported fishers to be "common throughout most of the forested regions" of British Columbia, apparently supporting a regular fur harvest across 90 percent of the province (Rand 1944, p. 79). In Washington, fishers historically occurred throughout densely forested areas both east and west of the Cascade Crest, on the Olympic Peninsula, and probably in southwestern and northeastern Washington (Dalquest 1948, pp. 187–189; Aubry and Houston 1992, pp. 69–70; Lewis and Stinson 1998, pp. 4–5). In Oregon, Bailey (1936, pp. 298–299) reports fishers occurred in the boreal forest zones of the Cascade Range from Washington to California, west to the coniferous coastal forests and cool humid Coast Ranges; this report also extends their range to the northeastern portion of the state near the Washington and Idaho borders. In the forested, higher mountain masses of California, Grinnell *et al.* (1937, pp. 214–215) describe fishers as ranging from the Oregon border southward through the Coast Range to Lake and Marin Counties, east through the Klamath Mountains to Mount Shasta, and south throughout the main Sierra Nevada to Greenhorn Mountain in northern Kern County. Recent genetic research (Knaus *et al.* 2011, p. 11; Tucker *et al.* 2012, entire) contradicts the Grinnell *et al.* (1937, p. 216) assumption that there was a continuous population from Mt. Shasta through to the southern Sierra Nevada.

To describe the current distribution of fishers in the analysis area, we used various sources of information. We compiled fisher locality data from published and unpublished literature (Zielinski *et al.* 1995, entire; 1997a, entire; 1997b, entire; 2000, entire; 2005, entire; 2010, entire; Zielinski and Stauffer 1996, entire; Slauson and Zielinski 2007, p. 19; Beyer and Golightly 1996, p. 18; Dark 1997, p. 31; Carroll *et al.* 1999, p. 1347; Zielinski *et al.* 2000, p. 28; Zielinski *et al.* 2010, pp. 41,47; Slauson and Zielinski 2001, p. 12; Hamm *et al.* 2003, p. 203; Slauson *et al.* 2003, pp. 20–21; Farber and Criss 2006, p. 11; Thompson 2008, entire; Lindstrand 2006, p. 49, 2010, p. 18; Spencer *et al.*2008, p. 44; Spencer *et al.*2011, entire), and telemetry research studies conducted between 1977 and 2013 (Buck *et al.* 1979, p. 171; Self and Kerns 2001, p. 24; Zielinski *et al.* 2004b, p. 652; Yaeger 2005, p. 4; 2008; Self and Callas 2006, p. 10; Thompson *et al.* 2010, entire; Clayton 2011, pers. comm.; Sweitzer and Barrett 2010, entire); submissions from the public during the information collection period; and information from individual fisher researchers, private companies, and agency databases, including entries to the U.S. Department of Agriculture Forest Service (USFS)'s *Forest Carnivore Surveys in the Pacific States* database.

The *Forest Carnivore Surveys in the Pacific States* database provided an archive and retrieval system for data from standardized forest carnivore surveys conducted in the Pacific states, regardless of their success or failure to detect target species. Figure 4 depicts locality information from reports of the species in the analysis area from 1896 through 2013

In compiling the location information to describe the fisher's current distribution, we considered the biology of this cryptic species and the differing amount and type of information associated with each locality point. Like most forest mesocarnivores, fishers are difficult to detect. They also are wide ranging animals with males making regular long distance movements, particularly during the breeding season (Leonard 1986, p. 41; Arthur *et al.* 1989, p. 678) and when dispersing (York 1996, p. 49; Aubry and Raley 2006, p. 14; Weir and Corbould 2008, p. 47; Matthews *et al.* 2013, p. 105; Sweitzer *et al.* 2015d, p. 82). Such movements can make it difficult to distinguish with certainty between occurrence records that represent established populations in suitable habitats and records that represent short-term occupancy or exploratory movements without the potential for establishment of home ranges, reproduction, or populations.

Determining that an area is unoccupied by fishers is also difficult. Fishers within the analysis area tend to live in remote locations where they are seldom encountered, documented, or studied. They naturally occur at low population densities and are rarely and unpredictably encountered where they do occur. They are territorial and require expansive areas of forested habitat for each individual, meaning large areas may be occupied by just a few individuals, thus reducing their likelihood of detection. In addition, many mobile species are difficult to detect in the wild because of morphological features (such as camouflaged appearance) or elusive behavioral characteristics (such as nocturnal activity) (Peterson and Bayley 2004, pp. 173, 175). While positive fisher detections, using techniques such as sooted track plates and remotely triggered cameras, are conclusive, non-detections (inferred absence) are based on detection probability, which in turn is strongly influenced by survey effort. Slauson *et al.* (2009, p. 35) recommend using caution when interpreting the results of previous surveys because the use of inconsistent survey protocols has resulted in varying survey effort. Slauson *et al.* (2009, p. 35) recommend a minimum effort of at least 200 functional days for summer season surveys, and a minimum of 60 functional days of survey effort per sample unit during non-summer surveys to achieve a probability of detection greater than 95 percent. Surveys below these thresholds may be insufficient to conclude that fishers are absent.

Due to the challenge associated with survey efforts in relatively remote and inaccessible areas, as well as the lack of sufficient resources, we often lack adequate information to definitively determine whether fishers occupy an area or not. It is also difficult to precisely determine their current range or estimate past trends in range contraction or expansion. Assumptions about whether an area is occupied or unoccupied must be based on limited information, which can also be interpreted in several ways. Therefore, we used multiple lines of evidence to determine where fisher populations occurred in the past and where they presently occur.

Lines of Evidence for Past and Current Distributions of Fishers

As we stated previously, our present understanding of the historical distribution of fishers is based on the accounts of natural historians of the early twentieth century and their general assumptions of what constitutes fisher habitat. These historical efforts did not typically have the rigorous standards imposed on today's information. With the passage of environmental legislation in the 1970s, such as the National Environmental Policy Act of 1970 and ESA, scientifically defensible information about the status of wildlife has become increasingly required to support management decisions. The development of rigorous non-invasive survey methods for carnivores such as sooted track plates and remotely triggered cameras became prevalent in the mid-1990s. In 1995, Zielinski *et al.* (1995, entire) published a manual that described protocols for detecting forest carnivores. This manual allowed for a standardization of surveys and provided a means for comparison between verified records of detections of various forest carnivores, including the fisher.

Verifiable records are records supported by physical evidence such as museum specimens, harvested pelts, DNA samples, sooted track plate impressions, and diagnostic photographs. Documented records are those based on accounts of fisher being killed or captured. Use of only verifiable and documented records avoids mistakes of misidentification often made in eyewitness accounts of visual encounters of unrestrained animals in the wild. Visual-encounter records often represent the majority of occurrence records for elusive forest carnivores, and they are subject to inherently high rates of misidentification of the species involved, including fishers (McKelvey *et al.* 2008, pp. 551–552). Visual-encounter records of a fisher itself, or its sign, by the general public or untrained observer may be found in agency databases; however, correct identification of fisher or its sign can be difficult by an untrained observer. Thus, these unverified records or anecdotal reports need to be viewed cautiously (Aubry and Lewis 2003, p. 81; Vinkey 2003, p. 59; McKelvey *et al.* 2008, p. 551). Other animals that are similar in appearance and share similar habitats, such as the American marten (*Martes americana*), mink (*Mustela vison*), or domestic cat (*Felis catus*), may be mistaken for fishers (Aubry and Lewis 2003, p. 82; Lofroth *et al.* 2010, p.11; Kays 2011, p. 1). Animal signs, such as snow tracks, can be significantly altered by environmental conditions, and difficult to identify (Vinkey 2003, p. 59). On natural substrates, fisher tracks can be confused with those of the more common American marten.

We assigned a numerical reliability rating (following Aubry and Lewis 2003, p. 81) to each fisher occurrence record as follows:

1) Specimens, photographs, video footage, or sooted track-plate impressions (records of high reliability that are associated with physical evidence);
2) Reports of fishers captured and released by trappers or treed by hunters using dogs (records of high reliability that are not associated with physical evidence);
3) Visual observations from experienced observers or from individuals who provided detailed descriptions that supported their identification (records of moderate reliability);
4) Observations of tracks by experienced individuals (records of moderate reliability);
5) Visual observations of fishers by individuals of unknown qualifications or that lacked detailed descriptions (records of low reliability); and
6) Observations of any kind with inadequate or questionable description or locality data (unreliable records).

The development and use of rigorous survey methods to collect data on fisher began approximately 20 years ago, just prior to the publication of Zielinski *et al.*'s (1995, entire) survey protocol manual; therefore, we have chosen 1993 as the beginning of the contemporary period. We evaluated all records with reliability ratings 1 through 6 for insight into past population distribution (prior to 1993). We consider reliability ratings 1 and 2 as the best available information on fisher locations. Because the use of unreliable records to support distribution and population extent has led to overestimation of current ranges (Aubry and Lewis 2003, p. 86; McKelvey *et al.* 2008, p. 551), we used only the most reliable and verified data from 1993 to 2013 in our analysis of the current distribution of fisher populations in the analysis area. A 20-year timeframe provides for the most recent evaluation of contemporary fisher distribution because of the substantial efforts made over the last 20 years to assess the status of fisher and other forest carnivores in the analysis area using opportunistic surveys and systematic grids of baited track and camera stations (Figure 6). We base the contemporary (1993 to 2015) distribution of fisher populations on verifiable or documented records of physical evidence such as animals captured for scientific study, genetic analysis of biological samples, and photographs or track plate impressions (reliability ratings 1 and 2; Figure 7). Note that Figures 6 and 7 do not reflect additional surveys, or detections with reliability ratings 1 and 2 we received as a result of public comment.

Past (1896 to 1993) and Current Distribution within the Analysis Area

All locality data prior to 1993 demonstrates a distribution that generally conforms to the presumed historical distribution (Figure 8). A map showing the dataset constrained to reliability codes 1 through 4 from 1953 to 1993 suggests fishers still occurred at various locations on the landscape throughout their historical distribution (Figure 9). However, in much of the analysis area, especially in Washington and northern Oregon, the scarcity of reports suggests that fishers were quite rare during these decades. For the period prior to 1993, the most reliable data from these areas come from reports of incidental capture of fishers. There have been few fishers captured in Washington in recent decades (1 each in 1969, 1971, 1987, 1990, and 1992) (Lewis and Stinson, 1998, pp. 23, 53). Three of these fishers were captured incidental to bobcat, marten, and coyote trapping efforts since 1985, in approximately 2.4 million trap-nights, which in part led Lewis and Stinson (1998, p. 23) to conclude, "The fisher is rare in Washington. Infrequent sighting reports and incidental captures indicate that a small number may still be present. However, despite extensive surveys, the Department has been unable to confirm the existence of a population in the state," and "We believe that remaining fishers in Washington are unlikely to represent a viable population, and without recovery activities, the species is likely to be extirpated from the state" (Lewis and Stinson 1998, p. 36). However, the Washington Department of Fish and Wildlife (WDFW) clarified during the open comment period that they are concerned with the conclusions that could be made from the fisher records in Washington in recent decades. Specifically, they pointed out that three of those recent detections were escapees from a wildlife park and a fisher that had been reintroduced in Montana, and that they consider the 1969 fisher record to be the last verified record of a native fisher in Washington (WDFW 2015).

In the same time period in Oregon, few incidental captures were reported and all either appeared to be associated with the Southern Oregon Cascades Reintroduced Population (see below), or occurred to the south of this reintroduced population (Robart 1982, pp. 8–9). Fisher locations in northern Oregon are therefore exclusively derived from the less reliable visual sightings and unverified track locations.

Throughout the Coast Ranges of Oregon and Washington and the Cascades north of the reintroduced Southern Oregon Cascades Population, infrequent verified detections, all prior to 1993, suggest the species has been reduced to scattered individuals or remote isolated populations. Based on the available verified detection data, two native populations of fishers were identified in the southern portion of the analysis area: one in the southern Sierra Nevada (Southern Sierra Nevada Population) and the other in northern California and southwestern Oregon (Northern California-Southwestern Oregon Population) (Figure 7; Table 1). Reports resulting from systematic surveys suggested that fishers appeared to occupy less than half of the range in California than they did in the early 1900s (Zielinski *et al.* 1995, p. 108; Zielinski *et al.* 2005, p. 1394; CDFW 2015, p. 23), based on the assumption that the two populations had until recently been connected. However, Tucker *et al.* (2012, p. 3) estimated that the two populations have been separated for more than 1,000 years. The new information provided in Tucker *et al.* (2012, entire) makes drawing conclusions about the extent of the loss of historical range within California difficult.

New information since Service (2014)

In preparation of their fisher status review, California Department of Fish and Wildlife (CDFW 2015) staff reviewed historical records and reported anecdotal evidence concerning the presence of fishers in the northern and central Sierra Nevada. Records collected came from naturalists' reports, CDFW trapping records, and USFS reports (CDFW 2015, pp.17-21). The approach used by CDFW to describe the historical distribution of fishers in California is consistent with our previous approach. We consider these records that rely on both naturalists' reports and trapping records to constitute reliability ratings of 2 or 3 and therefore indicate fisher presence in the northern and central Sierra Nevada at least until the 1920s.

Tucker *et al.* (2014) reexamined genetic data for fishers in the Southern Sierra Nevada (SSN) population. This reanalysis of genetic data was inconclusive relative to whether or not genetic data could be used to indicate an expansion of the SSN population northward. However, a summary of recent survey data was provided. The summarized survey information states that surveys conducted in the 1990s resulted in few detections of fishers in the north genetic group of the SSN population (1 to 2 fishers depending on study area). Current surveys in the north genetic group that are designed to collect genetic data on individuals are detecting 25–44 fishers depending on study area (Tucker *et al.* 2014, p. 131). Reliability ratings for the data collected for this analysis are considered to be highly reliable (reliability rating 1).

Figures 6- 9 have not been updated. We received additional locality data during public and peer review comment periods and the public hearing for our proposed listing rule. Location data we received was categorized with reliability ratings of 1 through 5. Information with reliability ratings of 1 do not include new location data beyond the current population boundaries with the exception of detections in the Southern Oregon Cascades and the southern Cascades of California (see the **Current Distribution of Reintroduced Populations** section below). We

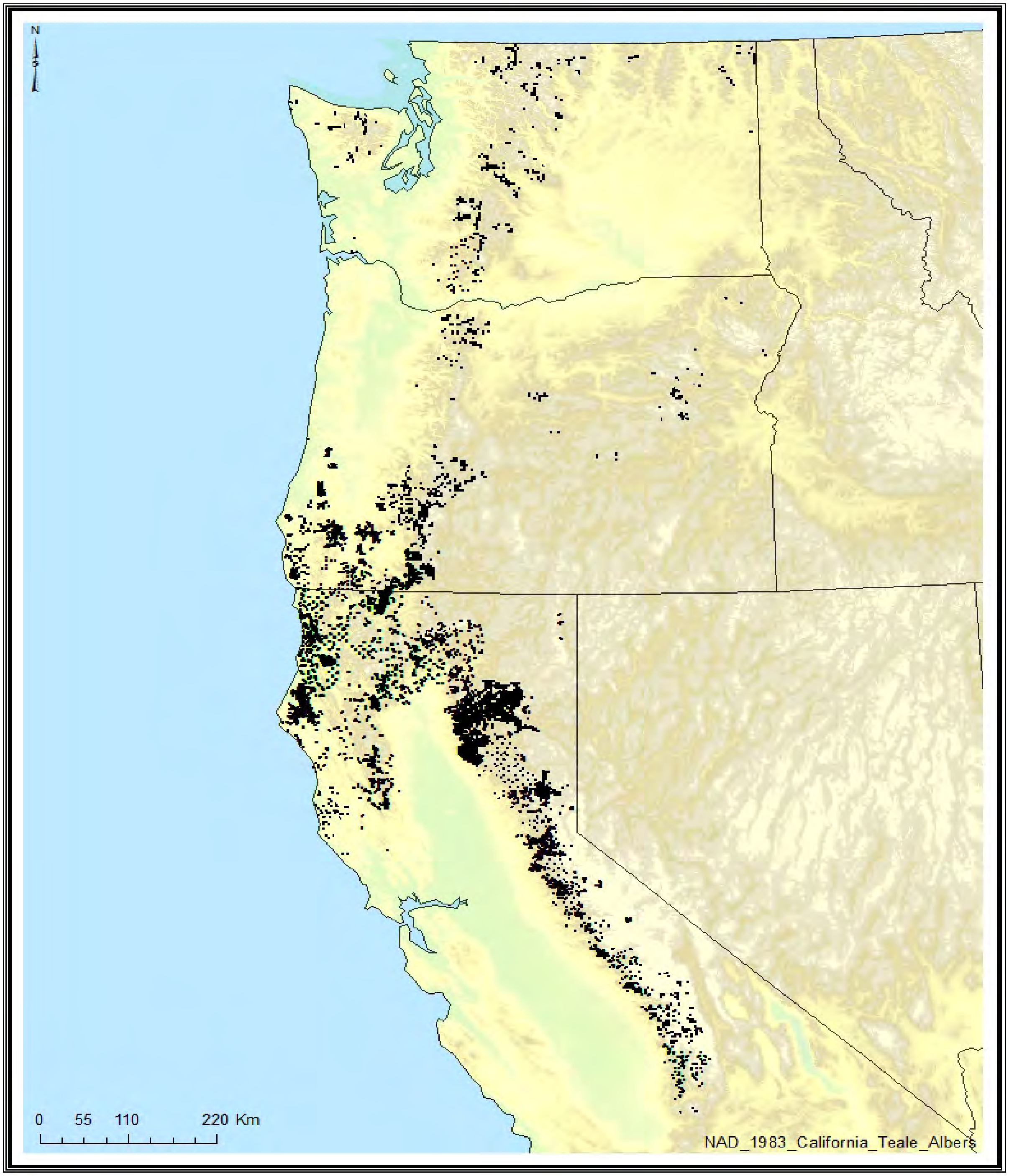

Figure 6. Opportunistic and systematic surveys (with both positive and negative results), fisher trapping efforts for research, and other verifiable records (for example, fisher telemetry data) from 1993–2013. Figure has not been updated. We are in the process of updating our database with the new data and will use this information to update locality maps in future fisher status reviews.

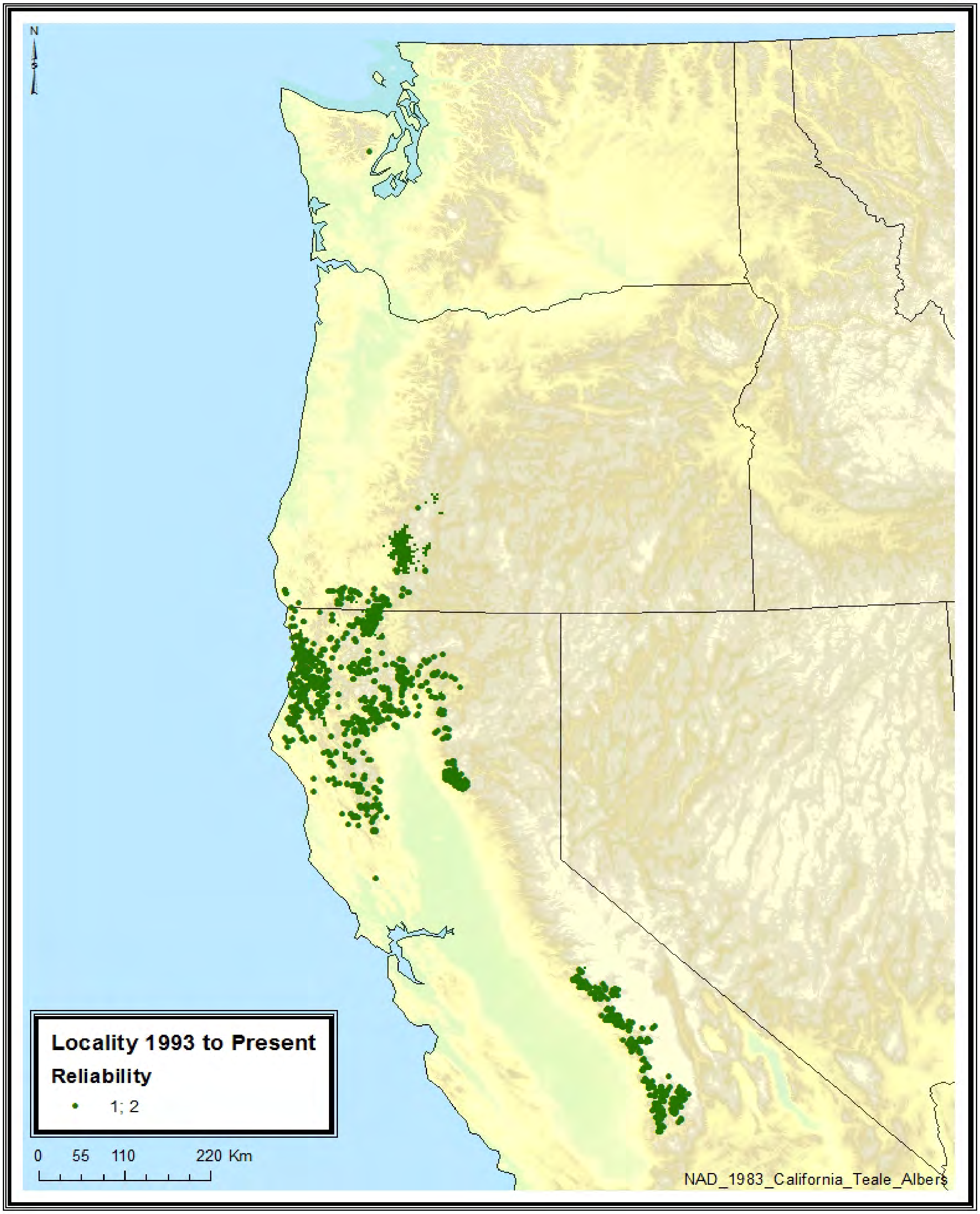

Figure 7. Locality records 1993 to 2013 for reliability ratings 1 and 2. Please note that the ONP population here is represented by a single dot, and this representation is based on the information we received from WA Department of Fish and Wildlife. Figure has not been updated. We are in the process of updating our database with the new data and will use this information to update locality maps in future fisher status reviews.

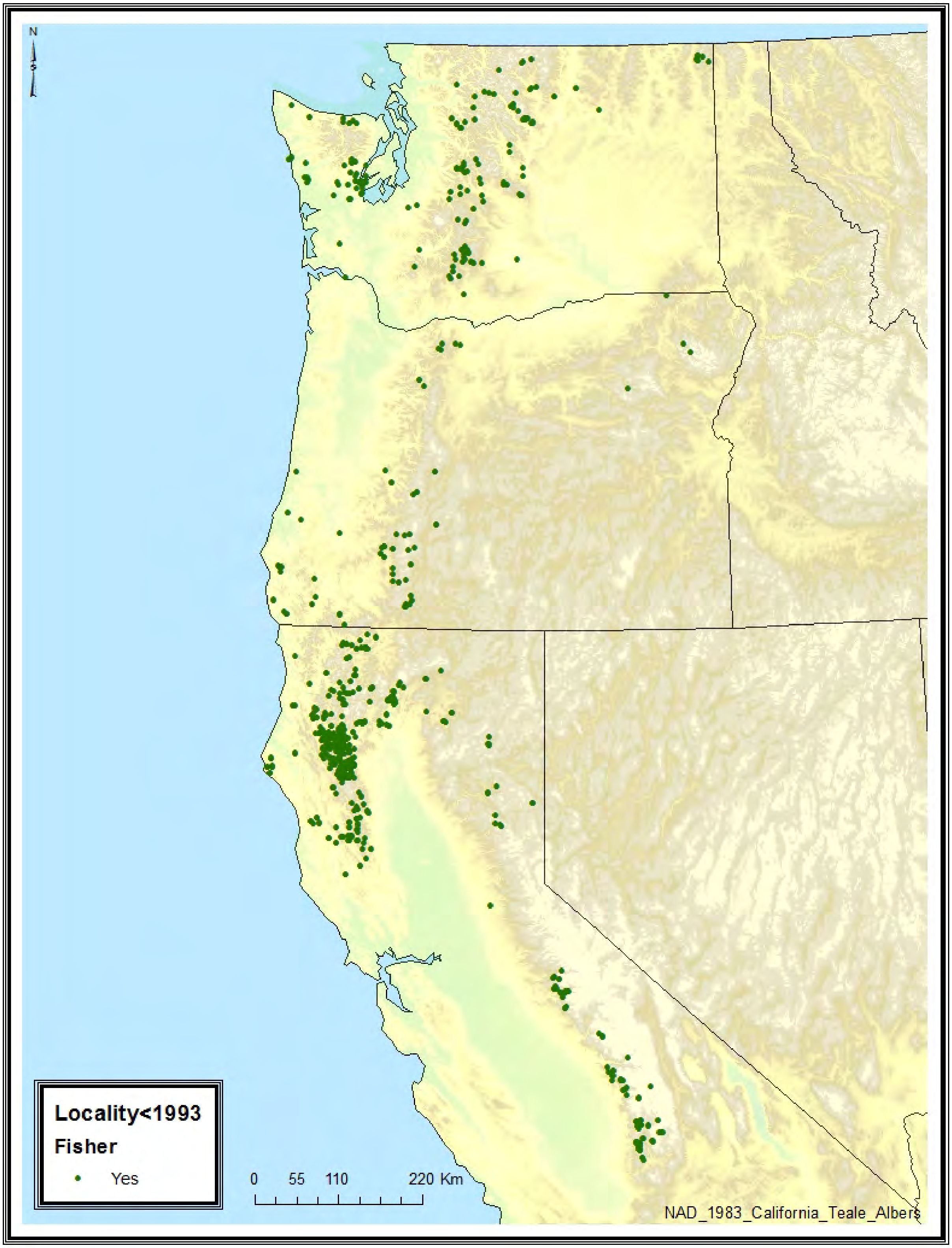

Figure 8. All records prior to 1993. This map displays records with reliability ratings 1 through 6. Here we have presented fisher detections locations with all reliability ratings (1-6) to illustrate the probable historical distribution of fishers.

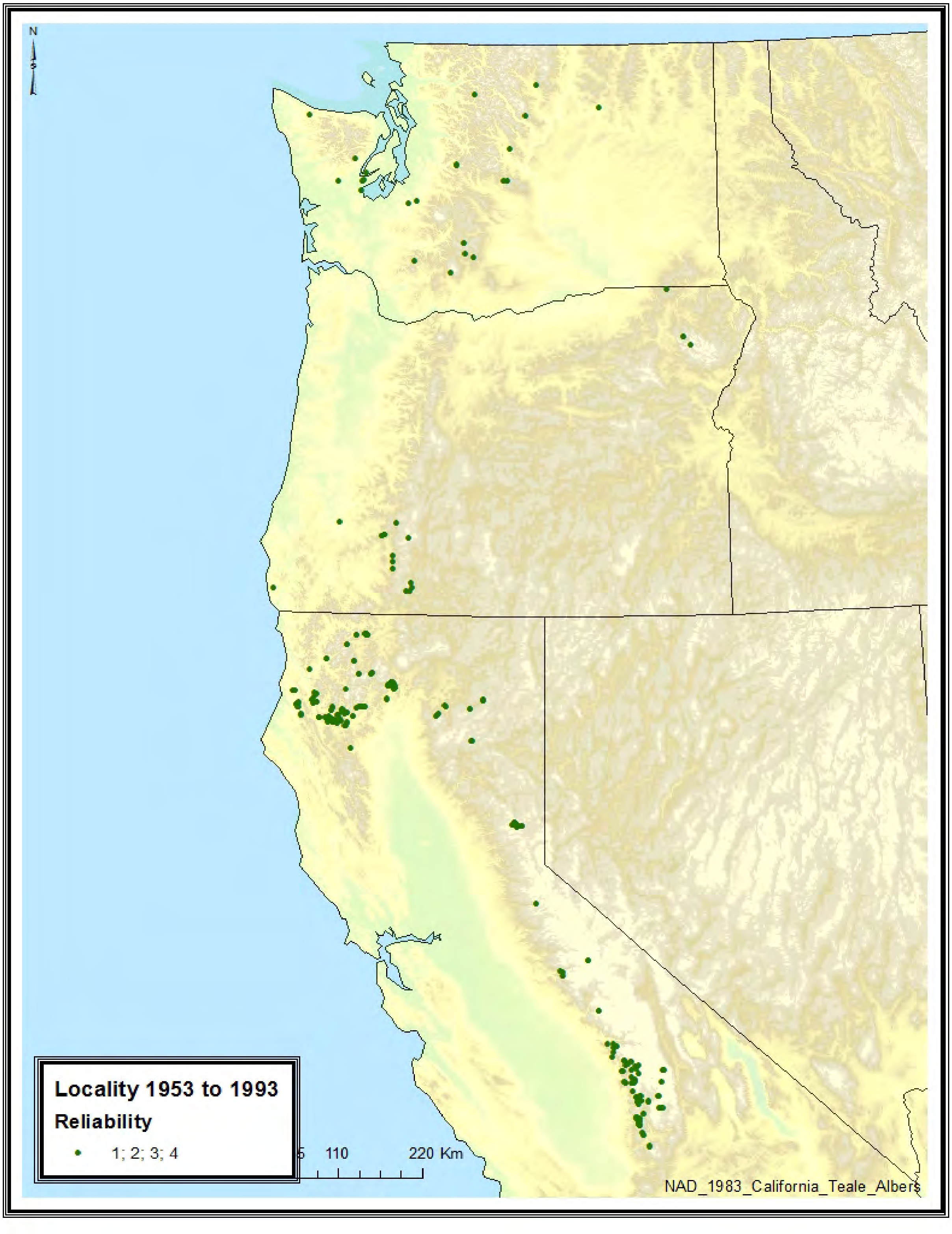

Figure 9. Fisher records 1953 to 1993 with reliability ratings 1 to 4. These detections are presented to illustrate that fishers still occurred at various locations throughout their historical distribution. Reliability ratings of 5 and 6 are not depicted due to their low reliability.

recently obtained data from ORBIC (2015) of fishers in the central and northern Oregon Coast Range, either pre-1993 records or more recent non-verifiable records. As part of that same data set, we obtained a record of a fisher skull (reliability rating 1) found southwest of Roseburg, Oregon, in Douglas County. We are in the process of updating our database with the new data and will use this information to update locality maps in future fisher status reviews.

Three reintroduction efforts have resulted in repeated detections of fishers: one in the northern Sierra Nevada (Northern Sierra Nevada Reintroduced Population), one in the southern Oregon Cascade Range (Southern Oregon Cascades Reintroduced Population), and one on the Olympic Peninsula of Washington (Olympic Peninsula Reintroduced Population). The Southern Oregon Cascade Population is separated from the next known populations to the north in British Columbia by more than 800 km (500 mi) and from the Olympic Peninsula by over 400 km (250 mi). As discussed in the **Current Distribution of Reintroduced Populations** section below, the reintroduced Southern Oregon Cascades Population is well established but the other two reintroduced populations are very new and their long-term stability is not yet certain. It is encouraging to note from ongoing monitoring efforts that fishers are persisting and reproducing after the last year of fisher releases on the Olympic Peninsula (4 years) and in the northern Sierra Nevada (3 years).

Table 1. Population occurrences and estimates of current range extent.

Population	State	Native / Reintroduced	Range Extent (km^2)	Percent of Analysis Area
Olympic Peninsula	Washington	Reintroduced	11,000	3%
Southern Oregon Cascades	Oregon	Reintroduced	5,000	1%
Northern California-Southwestern Oregon	California and Oregon	Native	40,000	11%
Northern Sierra Nevada	California	Reintroduced	2,000	1%
Southern Sierra Nevada	California	Native	12,700	4%
Analysis Area			353,956	100%

New Information

Between December 2015 and February 2016, 23 fishers were released into the southern Washington Cascades. These fishers were released as the first stage of the reintroduction effort being implemented by WDFW, which ultimately plans to release a total of 160 fishers between two recovery zones in the Washington Cascades.

Current Distribution of Populations (1993 to Present)

A scarcity of verifiable sightings in Washington, northern Oregon, and central Oregon suggests that these populations appear to be likely extirpated, except on the Olympic Peninsula where they have been recently reintroduced (see the **Current Distribution of Reintroduced Populations** section below). However, we cannot be sure that a lack of detections in Washington and much of Oregon indicates the species is entirely absent. In Washington, cumulative years of trapping, fisher and other carnivore survey efforts, and review of fisher sighting reliability information led Lewis and Stinson (1998, p. 36) to conclude, "The fisher is rare in Washington. Infrequent sighting reports and incidental captures indicate that a small number may still be present. However, despite extensive surveys, the Department has been unable to confirm the existence of a population in the state." In addition to the survey efforts in Washington mentioned above, there are large areas in coastal Oregon and Washington and in the central Oregon Cascades where surveys have not been conducted, and survey efforts are relatively sparse in the Cascades of Washington and northern Oregon (Figure 6) (Oregon Department of Fish and Wildlife (ODFW) 2015 pers. comm.). Although functioning populations like those we see in southern Oregon and California appear not to be present, it is possible, particularly in unsurveyed areas, that an isolated remnant population could be overlooked (Hudgens and Garcelon 2013, pp. 2-4, 9-10). WDFW's current assessment of fisher presence in Washington is that they consider the 1969 fisher record to be the last verified record of a native fisher in Washington (WDFW 2015) until reintroductions began in 2008. The Service considers populations in Washington to be likely extirpated other than in reintroduction areas.

For example, in the U.S. Northern Rocky Mountains (USNRM), fishers were thought to be extirpated by 1930 from Montana and Idaho, as they were in other parts of the United States (Newby and McDougal 1964, p. 487; Weckwerth and Wright 1968, p. 977). Several reintroductions were initiated by Montana and Idaho Departments of Fish and Game, resulting in the release of 188 fishers originating from central British Columbia, Minnesota, and Wisconsin between 1959 and 1991 in north-central Idaho and northwestern and west-central Montana (Weckwerth and Wright 1968, p. 979; reviewed by Vinkey 2003, p. 55; Roy 1991, p. 18; Heinemeyer 1993, p. i). Subsequent to these reintroductions, genetic analyses revealed a remnant native population of fishers in the USNRM that survived the presumed extirpation thought to have occurred early in the twentieth century (Vinkey *et al.* 2006, p. 269; Schwartz 2007, p. 924). Fishers in the USNRM today reflect a unique genetic legacy and identity from this remnant native population combined with the genetic contributions from fishers introduced from British Columbia and the Midwest.

Northern California-Southwestern Oregon (NCSO)

The NCSO population includes the original native fisher population in northern California and southern Oregon, the Southern Oregon Cascades (SOC) and Northern Sierra Nevada (NSN) Reintroduced Populations.

The fishers in the Southern Oregon Cascades are descendants of fishers that were introduced from British Columbia and Minnesota in 1961 and from 1977 to 1981 (Aubry and Lewis 2003, pp. 82–85, 87; Drew *et al.* 2003, p. 57, 59). This population occurs in portions of Douglas, Jackson, and Klamath Counties with verified detections from near Lemolo Lake in the north to Hyatt Reservoir in the south. Information on the current distribution of this population on the western boundary of Crater Lake National Park is from data collected during a 6-year telemetry effort (Aubry and Raley 2006, p. 5). On the eastern extent of the range of this population, we have trail camera photographs documenting fisher use of the western shore of Upper Klamath Lake. The Southern Oregon Cascades Population appears to be persisting without additional augmentations.

Fishers in the Southern Oregon Cascades are relatively close (within 40 km (25 mi)) to the Northern California-Southwestern Oregon Population, but are separated by a relatively narrow band of forested habitat and the heavily traveled Interstate 5. No genetic exchange has been documented (Aubry *et al.* 2004 p. 214; Drew *et al.* 2003, p. 59; Wisely *et al.* 2004, p. 646; Farber *et al.* 2010, p. 12) between these populations. However, one male fisher from the Northern California-Southwestern Oregon Population was detected east of Interstate 5, approximately 30 km (19 mi) south of the Southern Oregon Cascades Population in 2012 (Pilgrim and Schwartz 2012, pp. 4-5).

The NCSO population occurs in the Klamath Mountains of southwestern Oregon in Josephine, Jackson, and Curry Counties in Oregon and extends south into California through the Klamath Mountains and Coast Ranges of Del Norte, Siskiyou, Humboldt, Trinity, western Tehama, northeastern Mendocino, western Glenn, northern Lake, and western Colusa Counties and in the Cascade Range of southern Siskiyou and Shasta Counties. Surveys conducted in 2011 and 2012 at the eastern edge of this population in eastern Shasta County detected fishers where prior surveys conducted in 2003 did not. It is unclear if these recent detections represent an expansion front or are just wide ranging or dispersing males. At the southwestern edge of this population in southern Lake County, a photograph of a fisher over 60 km (37 mi) south of any previous reports was taken by a remote camera in March 2013. We have no other survey efforts occurring in this vicinity, so it is unknown whether this single detection represents an established population or represents a wide-ranging male during the breeding season.

In California, fishers were into the northern Sierra Nevada from 2009-2011. The introduction was as a cooperative venture between the Service, the California Department of Fish and Wildlife (CDFW), and Sierra Pacific Industries (SPI). Two of the 11 objectives of this reintroduction were to implement an experimental design and monitoring effort to assist with determining and describing mortality, movement patterns, and habitat use of released fishers on private industrial timberlands and to return fishers to their historical range in the northern Sierra Nevada (Service 2008, pp. 2-3). Forty fishers (16 males and 24 females) were relocated from northwestern California to the northern Sierra Nevada in the vicinity of Butte, Plumas, and Tehama Counties (Callas and Figura 2008, entire). Project plans call for monitoring these fishers for 7 years to determine the extent of their distribution into the northern portion of the Sierra Nevada (Callas and Figura 2008, p. 65). The success of this introduction will not be known for several years. Before this introduction, the Southern Sierra Nevada population was separated from the Northern California-Southwestern Oregon Population by approximately 400 km (250 mi) (Zielinski *et al.* 1995, pp. 107–108; 2005, p. 1394). With the reintroduction, this distance has been reduced to approximately 280 km (175 mi).

<u>New information since Service (2014)</u>

The NCSO population of fishers is the largest of the fisher populations and is located in Curry, Douglas, Josephine, Jackson, Klamath, and Lane counties in southern Oregon and in Butte, Del Norte, Humboldt, Lake, Mendocino, Plumas, Shasta Siskiyou, Tehama, and Trinity counties in northern California. In our proposed rule, we considered that the NCSO and SOC populations may be connected by dispersing fishers.

Recent surveys conducted in the southern Oregon Cascades, Jackson County, have detected two individuals with genetic haplotypes consistent with the NCSO population. One male fisher and one female fisher from the NCSO population were detected east of Interstate 5, approximately 30 km (19 mi) south of the SOC population in 2012 and approximately 56 km (35 mi) east of Interstate 5 in 2014, respectively (Pilgrim and Schwartz 2012, pp. 4–5; Pilgrim and Schwartz 2015, entire). This recent detection of a male and a female fisher is where individuals from the SOC population were also found, indicating that these populations may be in the initial stages of convergence (Pilgrim and Schwartz 2014, entire; 2015, entire).

Until the reintroduction of fishers as part of the Sierra Pacific Industries (SPI) Stirling Management Unit Candidate Conservation Agreement with Assurances (CCAA), the southern boundary of the NCSO fisher population was Shasta County, California. Ongoing monitoring of these reintroduced fishers indicates that they are reproducing and have expanded their occupancy northward into the surrounding forested areas beyond the original footprint of the reintroduction. The distance between the NSN and original NCSO population is now approximately 40 km (25 mi) which is within the dispersal distance potential of male fishers. Unlike the SOC reintroduced fishers, NSN fishers are the same genetic haplotypes as those in NCSO, thus we will be unable to confirm when successful reproduction has occurred between the original and reintroduced fishers. Based on the new information submitted since the proposed rule we now consider that the NCSO fisher population includes areas formerly identified as being the SOC and NSN reintroduced populations.

Southern Sierra Nevada

The current extent of occurrence of the Southern Sierra Nevada Population in California includes portions of Mariposa, Madera, Fresno, Tulare, and Kern Counties. While historically the population extended farther north, today the northern limit is the Merced River in Yosemite National Park in Mariposa County. The southern limit is the forested lands overlooking the Kern River Canyon, while the eastern limit is the high elevation, granite-dominated mountains, and the western limit is the low elevation extent of mixed conifer forest. This population currently occupies the west slope of the southern Sierra Nevada from the Merced River drainage in Yosemite National Park, south through the Greenhorn Mountains at the southern extent of the Sierra Nevada.

Current Distribution of Reintroduced Populations

Lewis *et al.* (2012b, entire) reviewed data from 38 translocations of fishers in North America. Their analysis also included population modeling and field data from actual reintroduction efforts to provide insight into what factors influence the success or failure of efforts to restore fisher populations. Their results and management recommendations for influencing success of reintroductions include efforts that are slightly female biased, adult biased, release 60 or more fishers, and utilize source populations close to release sties. Based only on the parameter of total number of fishers released, large releases such as the Olympic Peninsula reintroduction (>80 fishers) have a predicted index of success of 80% while those that release fewer than 60 fishers are predicted to have less than a 50% success rate (Lewis *et al.* 2012b, pg. 7). Overall, the success rate for fisher reintroductions in North America is 77 percent which is twice the probability of success documented in western North America (Lewis *et al.* 2012b, pg. 10).

Olympic Peninsula

The Washington Department of Fish and Wildlife (WDFW), in cooperation with the Olympic National Park, United States Geological Survey, and others, began to reintroduce fishers onto Park Service lands on the Olympic Peninsula in Washington in January 2008 (Lewis and Happe 2008, p. 7). These reintroductions were complete at the end of 2010 with a total of 90 fishers (40 males and 50 females) relocated from British Columbia to Olympic National Park (Lewis *et al.* 2011, p. 4). These fishers will be monitored for a number of years to determine both the extent of their distribution and success in establishing a population of fishers on the Olympic Peninsula. The success of this introduced Olympic Peninsula population will not be known for several years.

Southern Oregon Cascades

New information since Service (2014)

See the *Northern California-Southwestern Oregon (NCSO)* section above, which includes the original native fisher population and the Southern Oregon Cascades (SOC) and Northern Sierra Nevada (NSN) Reintroduced Populations

Northern Sierra Nevada

New information since Service (2014)

See the *Northern California-Southwestern Oregon (NCSO)* section above, which includes the original native fisher population and the Southern Oregon Cascades (SOC) and Northern Sierra Nevada (NSN) Reintroduced Populations

Washington Cascades

The WDFW began a fisher reintroduction project in the South Cascades of Washington State on December 3, 2015. Since February 10, 2016, 23 fishers have been released from the Cispus Learning Center along the Cispus River. This project is the second phase of WDFW's efforts to recover fishers in Washington according to the Washington Fisher Recovery Plan (Hayes and Lewis 2006, p. 39). The reintroduction plan (Lewis 2013, p. v) calls for a total of 160 fishers to be released into the Cascade Mountains at a rate of 40 per year for four years (two years in the South Cascades, two years in the North Cascades). The source population for the fishers (British Columbia) is the same as for the Olympic Peninsula reintroduction. The WDFW Fisher Recovery Plan (Hayes and Lewis 2006, p. vii) has the goal of establishing multiple self-sustaining populations of fishers in Washington. We are not referring to this group of fisher individuals in the South Cascades as a population at this time because they have not yet had the opportunity to successfully interbreed. These animals are not physically or demographically connected to any other populations of fishers.

Population Status

Estimates of fisher abundance and vital rates are difficult to obtain and often based on harvest records, trapper questionnaires, and tracking information (Douglas and Strickland 1987, p. 522), and recent information is limited. Habitat modeling and behavioral or other natural history characteristics (for example, home range sizes) also are used to estimate population sizes over a geographic area (Lofroth 2004, pp. 19–20; Lofroth *et al.* 2010, p. 50). Fisher densities over areas of suitable habitat have been reported, but there are no total or comprehensive population sizes for the fisher in the eastern United States or Canada. In the western range, fisher population size has been estimated using habitat models and home range size estimates. Habitat-based methods likely overestimate population sizes because some apparently suitable habitat may not be occupied. A combination of habitat modeling, protocol surveys, and occupancy modeling can improve habitat-based population estimates.

Based on trapping records from the 1920s, Grinnell *et al.* (1937, p. 227) provided an estimate of 1 fisher per 259 km^2 (100 mi^2), equating to 300 fishers in California. The Grinnell *et al.* population estimate for California is incorrect by modern standards due to the lack of a significant sample size, survey bias, and inadequate knowledge of the historical baseline, although they employed accepted methodologies at the time they conducted their research.

Despite the lack of precise empirical data on fisher numbers in the analysis area, the reduction in the range of the fisher on the west coast, as indicated by the lack of detections or sightings over much of its historical range, and apparent isolation from the main body of the species range (Drew *et al.* 2003, p. 59; Wisely *et al.* 2004, p. 646; Knaus *et al.* 2011, p. 11; Lewis *et al.* 2012a, p. 11; Tucker *et al.* 2014, pp. 132-133), reveal that the extant fisher populations are reduced in size relative to our understanding of their historical distribution.

Northern California-Southwestern Oregon

As described above, the NCSO population includes the original native fisher population in northern California and southern Oregon, the Southern Oregon Cascades (SOC), and the Northern Sierra Nevada (NSN) Reintroduced Populations.

No published population or density estimates are available for the entire NCSO Population. There are density estimates for several individual study areas (Zielinski *et al.* 2004b, p. 654; Thompson 2008, entire; Matthews *et al.* 2011, entire; Swiers 2013, entire; Table 2). These studies, with population density estimates varying by two orders of magnitude from 18 to 52 animals per 100 km^2, show how difficult it is to extrapolate to an overall population estimate.

In studies that have measured fisher populations over time, some have observed stable densities and others have recorded substantial changes. Using genetic mark-recapture techniques, Swiers (2013, pp. 19-20) estimated a stable annual population ranging from 29 to 35 from 2007 to 2011 on the 510 square kilometers (km^2) (197 square miles [mi^2]) Eastern Klamath Study Area in northern Siskiyou County, California, and southern Jackson County, Oregon, with an estimated population growth rate of 1.06 (95% confidence interval [CI] 0.97–1.15). Using mark-recapture techniques, Matthews *et al.* (2011, p. 72) reported a decline in population density estimates from 52 (95 percent CI = 43–64) fishers per 100 km^2 (38.6 mi^2) in 1998, to 14 (95 percent CI = 13–16) fishers per 100 km^2 (38.6 mi^2) in 2005 on the Hoopa Valley Indian Reservation in the Klamath Mountain Range (eastern Humboldt County, California). The authors speculated that this 73 percent decline may have been a result of increased predator densities, disease, decreased prey availability due to changes in prey habitat, or some combination of these (Matthews *et al.* 2011, pp. 72–73). Higley and Matthews (2009, p. 22) reported that the 2005 Hoopa study may have begun when the local population was rebounding from an unknown devastating effect, but a population growth rate of 1.03-1.12 (95% CIs span 1; Higley and Matthews 2009, p. 66) and shift in age structure since then indicate the population is showing signs of stability or increase. It remains unclear, however, if this was a localized decrease in what may have been temporarily a very dense population in 1998 on the Hoopa Reservation, or something occurring over a larger geographic area. While using different techniques, fisher surveys on adjacent land owned by industrial timber landowner, Green Diamond Resource Company (Humboldt County, California), did not detect declines over a similar time period, suggesting that the declines seen in the Hoopa study may have been localized (Thompson 2008, p. 23).

It should be noted that both the Hoopa and Eastern Klamath study area population growth rate estimates within this population have 95 percent confidence intervals spanning 1, which indicates a declining population if less than 1 and a stable to slightly increasing population if equal to 1 or greater. These growth rates were measured in study areas where fishers were abundant enough to generate adequate sample sizes for statistical analysis. Other studies in the NCSO population had insufficient data, were not designed to estimate population growth rates, or were not conducted over a long enough time period to assess population parameter. Given the small portion of the NCSO population sampled by the two study areas (0.62% of the entire area, 1.08% of modeled intermediate and high probability fisher habitat), it is difficult to determine whether the NCSO population as a whole is increasing, decreasing, or stable.

There have been several approaches used to estimate NCSO population size. One unpublished study, by Self *et al.* (2008, pp. 3–5), used fisher density estimates derived from a variety of study areas within the NCSO population, and calculated that 4,018 fishers might be present in the population. However, this is likely a large overestimate, because the analysis assumes that habitat is occupied at the same densities as observed within the study areas, which may not be representative of fisher density throughout the area occupied by the population. A preliminary analysis based on spatially explicit habitat and population models, with parameters chosen to best match actual fisher occupancy and breeding (Matthews 2013, pers. comm.), suggests an equilibrium population size of approximately 2,790 to 3,990 individuals (Spencer 2014, pers. comm.; Rustigian-Romsos 2013, pers. comm.). However, there is no information on whether or not the current population is near its equilibrium size. Tucker *et al.* (2012, pp. 7, 9–10) used genetic data to calculate an effective population size of 129, which corresponds to an actual population size between 258 and 2,850. This number could be influenced by small population sizes over a number of past generations, likely including the time period when fisher trapping was legal (Tucker 2013, pers. comm.). Based on these various approaches, the NCSO population estimates range from a population size of 258 to 4,018.

Additional insight into the status of the NCSO population comes from occupancy modeling and from protocol surveys located both inside and outside the study areas listed above. A positive survey indicates that fishers were present at the survey location, but a negative survey can result either from the absence of fishers or from a failure to detect fishers that were present. Occupancy modeling is a method to correct for these false-negative survey results. The California Department of Fish and Wildlife surveyed 86 sites, each consisting of 2 stations separated by 1.6 km, within forested lands of the Klamath and California Coast Ranges. They observed fishers at approximately 41 percent of these sites (Furnas 2014, pers. comm.). Using occupancy modeling, Furnas (2014, pers. comm.) estimated that fishers were present at 65 percent (90 percent CI 53–79 percent) of the survey sites.

We mapped our database of fisher surveys (Figure 6) onto a hexagonal, 1,000-ha grid depicting hypothetical fisher home ranges within the area occupied by the NCSO population (Figure 10). There were 1,274 hexagons that contained at least one survey location between 2003 and 2013; 34 percent of these hexagons contained at least one positive survey, whereas 66 percent included only negative surveys. Within high-value modeled habitat, the percentage of hexagons with at least one positive survey was higher, 47 percent. If we assume a detection probability of 60 percent, we estimate that fishers may have been present within approximately 56 percent of all surveyed hexagons and within 78 percent of hexagons with high habitat value. Fisher detection probabilities are affected by latitude, season, type of survey, and survey effort (Furnas 2014, pers. comm.; Slauson *et al.* 2009, entire), but given reported fisher detection probabilities (reviewed by Slauson *et al.* 2009, pp. 15-19), we believe that 60 percent detection probability is a conservative estimate that does not place undue confidence in the accuracy of negative results. An assumption of higher detection probabilities would lend greater credibility to negative survey results and would therefore lead us to estimate that fishers occupied less of the available habitat.

These analyses indicate that a significant amount of high quality habitat remains unoccupied within the current boundaries of the NCSO population. There are several potential explanations for this. It is possible that relatively low survival rates, such as those observed on the Eastern Klamath Study Area (Swiers 2013, p. 19), are preventing this population from fully occupying the available habitat, much less expanding northward into Oregon. Unoccupied areas identified as high quality habitat by the habitat model may contain sources of mortality not identified by the model, such as high disease or predation rates, or the presence of anticoagulant rodenticides at nearby marijuana plantations. Alternatively, although the model identifies high quality habitat distributed through much of the area occupied by this population, some areas of good habitat are separated from others by roads, rivers, areas of low quality habitat, or other filters. These filters can impede connectivity within the population, which may depress occupancy rates, although interconnected fisher populations occur in spite of perceived filters such as roads, rivers, and landscape features (Swiers 2013, p. 13; Tucker *et al.* 2013, p. 12). Preliminary habitat-based population models suggest that the configuration of habitat affects population numbers in this region, and that some areas with high quality habitat may remain unoccupied even at equilibrium population sizes, probably due to restricted connectivity between these locations and the main body of the population (Rustigian-Romsos 2013, pers. comm.). Furthermore, since fishers' life histories are strongly influenced by adult survival, it may take longer time periods of stable conditions or environments for population growth and recovery of fisher populations into areas of higher quality habitat (Buskirk *et al.* 2012, p. 91).

Table 2. Density estimates.

Location	Density (N per 100 km^2 [38.6 mi^2])	Source
British Columbia, Canada (outside analysis area)		
British Columbia, high quality habitat	1.0-1.54	Weir 2003, p. 20
Central British Columbia, industrial forest, 1996-2000	0.88 ± 0.11 to 1.12 ± 0.21	Weir and Corbould 2006, p. 124
Northern California-Southwestern Oregon		
Green Diamond Resource Company, Humboldt County, California, 2002-2003	7 males 11 females	Thompson 2008, p. 23
North Coast Study Area, Six Rivers and Shasta-Trinity National Forests, Humboldt and Trinity Counties, California	5	Zielinski *et al.* 2004b, p. 654
Eastern Klamath Study Area, Siskiyou County , California and Jackson County, Oregon, 2007-2011	5.7-6.9	Swiers 2013, p. 19
Hoopa Valley Indian Reservation, Klamath Mountains, Humboldt County, California, 2005	14	Matthews *et al.* 2011, p. 72
Hoopa Valley Indian Reservation, Klamath Mountains, Humboldt County, California, 1998	52	Matthews *et al.* 2011, p. 72
Southern Sierra Nevada		
Sequoia National Forest, Tulare County, California	8 females	Zielinski *et al.* 2004a, p. 654
Sierra National Forest, Fresno County, California, 2002, camera trapping study	13.4 (95% CI: 7.6-24.2)	Jordan 2007, p. 25
Sierra National Forest, Fresno County, California, 2003, camera trapping study	9.5 (95% CI: 5.6-17.0)	Jordan 2007, p. 25
Sierra National Forest, Fresno County, California, 2004, camera trapping study	10.0 (95% CI: 6.7-14.4)	Jordan 2007, p. 25
New Information: Sierra National Forest, Fresno County, California, 2008-2012, camera and mark recapture study	7.2-9.7	Sweitzer *et al.* 2015d, p. 78

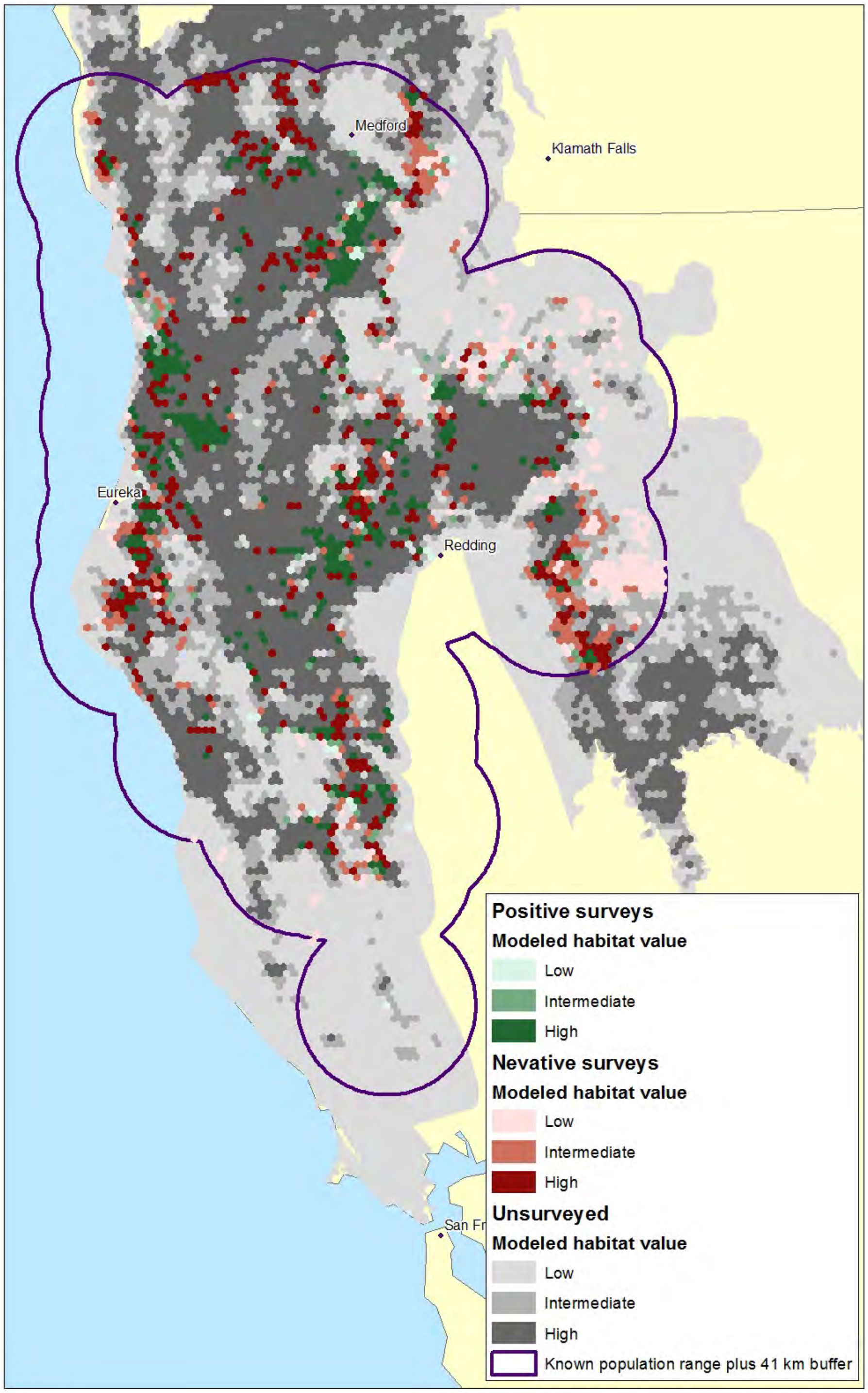

Figure 10. Hypothetical 1000-ha fisher home ranges that contain positive survey results since 2003 (green); that were surveyed since 2003 but contain only negative survey sites (red and pink); or that were not surveyed between 2003 and 2013 (gray). The purple outline buffers all positive detections of native animals (not including animals within the Northern Sierra Nevada or Southern Oregon Cascades Reintroduced Populations), by 41 km to represent a maximum likely dispersal distance.

New Information

In the southern Oregon Cascades, a fisher was detected on the Willamette National Forest in Lane County, just north of the county line, along the Middle Fork of the Willamette River on January 27, 2014. This is the first verifiable contemporary detection of fishers on the Willamette National Forest. However, Aubry and Raley (2006, p. 5) had a juvenile male disperse about 55 km (34 mi) to the northeast to the Big Marsh area on the Deschutes National Forest, which would be east of and across the Cascade crest from the Willamette National Forest sighting, indicating the Willamette sighting may be a potential disperser from the known Southern Oregon Cascades population.

Fisher observations from Crater Lake National Park (Park) include data from 1990, and 2013 through 2015 and are not limited to the Southern Oregon Cascades study area (S. Mohren 2016, pers. comm.). In 1990, the USFS located a radio-collared fisher near the panhandle in the southern portion of the Park. Observations from 2013 include an incidental sighting and observations of tracks southwest and north of the lake, respectively. Fishers were also detected at one camera location in the northeast portion of the Park in 2014 and at three camera stations in the southern portion of Park in 2015. A report of fisher observations east of the lake from 2015 lacks verification; however, the Park will place a camera station in the area in 2016 as part of its ongoing monitoring for carnivores.

The Klamath and Chiloquin Ranger Districts of the Fremont-Winema National Forest (FWNF) conducted surveys for fishers in 2012, 2013, and 2015 (Albert 2014, entire; Albert 2015, entire) within and outside of the Southern Oregon Cascades study area. The FWNF deployed baited camera stations and observed four fishers on the Klamath Ranger District in 2013; however, the FWNF was not successful in obtaining hair samples at these locations to further identify individuals or determine genetic descent. Surveys in 2015 detected fisher at two bait stations on the Klamath Ranger District; results from hair samples are pending. In addition to the camera bait station detections, two dead fishers were collected from the Klamath Ranger district in 2013 and 2015. Surveys will continue on the Chiloquin Ranger District in 2016.

In October 2015, the Klamath Falls Recreation Area (KFRA) and the Ashland Recreation Area, Medford BLM initiated a fisher telemetry project in partnership with USFS Pacific Northwest Research Station and Oregon State University. Five fishers (three female and two male) were collared using a combination of GPS and VHF radio collars. That project, in conjunction with baited camera and hair snare surveys, is currently ongoing and fieldwork is planned to be completed in 2016.

There are not enough data available from the Southern Oregon Cascades to determine population trends. Recent detections of fisher in areas where they were not previously recorded (for example, northern and eastern portions of Crater Lake National Park and portions of the Lakeview and Medford BLM study areas) may or may not represent an expansion of this population. However, based on the current survey efforts along with multiple unsolicited sightings of fisher in the past few years on KFRA where fisher were previously known to be absent, fisher appear to be expanding into the KFRA (S. Hayner 2016, pers. comm.).

In the California portion of NCSO, a recent 2015 estimate of 632–1,165 fishers was based on data collected by California Department of Fish and Wildlife (CDFW) as part of a mesocarnivore monitoring program in northern California (Furnas *et al.* 2015, pers. comm.). It is important to note that the sampling area for the CDFW study excluded southwest Oregon and the coastal redwood of California; thus, this estimate is not representative of the entire area within the NCSO population.

Population trend information for the approximately 45,000 km^2 (17,375 mi^2) NCSO population is based on two long-term studies. The NCSO population represents approximately 12 percent of the West Coast DPS and includes the area in both the SOC and NSN reintroduced fisher populations:

- The Hoopa study area is approximately 145 mi^2 (370 km^2) in size and represents the more mesic portion of the NCSO population area; fisher studies have been ongoing since 1996. The population trend from 2005–2012 indicates a lambda (population growth rate) of 0.992 (C.I. 0.883–1.100) with a higher lambda rate for females (1.038 [C.I. 0.881–1.196]) than for males (0.912 [C.I. 0.777-1.047]) (Higley et al. 2014, p. 102, Higley 2015, pers. comm.). Demographic parameters are showing a decrease in annual male fisher survival. A lambda of approximately 1.0 indicates a stable overall population trend.

- The Eastern Klamath Study Area is approximately 510 km^2 (200 mi^2) in size and represents the more xeric portion of the NCSO population area. Monitoring has been conducted since 2006. Estimates for lambda from 2006–2013 are 1.06 (C.I. 0.97–1.15) (Powell et al. 2014, p. 23). This lambda of approximately 1.0 indicates a current stable population within the study area.

- Fishers in the NSN portion of NCSO population stem from a 2009 to 2012 translocation of 40 fishers from Humboldt, Siskiyou, and Trinity counties, California to the SPI Stirling Management Unit in Butte, Plumas, and Tehama counties, California. Ongoing monitoring of fishers that were reintroduced has confirmed that fishers born on site have established home ranges and have successfully reproduced. Trapping efforts in the fall of 2015 as part of ongoing monitoring of the reintroduced population indicates that a minimum of 49 fishers (34 females, 15 males) were alive, nine more individuals than were originally introduced.

Southern Sierra Nevada

Several approaches have been taken to understanding the population status of the Southern Sierra Nevada (SSN) population. Density estimates are available from three study sites (Zielinski *et al.* 2004b, p. 654; Jordan 2007, pp. 12–44; Sweitzer *et al.* 2015d, p. 78; see also Table 2). There has been one preliminary population viability analysis, with parameters based on expert opinion (Lamberson *et al.* 2000, entire), and another spatially explicit population model based on a combination of empirical data and expert opinion (Spencer *et al.* 2011, entire). One monitoring program has enabled researchers to measure trends in occupancy within the SSN population over a period of eight years (Zielinski *et al.* 2013b, entire). By all estimates, the isolated SSN population is small.

For the purpose of modeling population viability, Lamberson *et al.* (2000, p. 2) used expert opinion to estimate a population size between 100 and 500 individuals in the SSN population. They then used a deterministic, Leslie stage-based matrix model to gauge risk of extinction for the SSN population of fisher and found that the population has a very high likelihood of extinction given reasonable assumptions with respect to demographic parameters (2000, pp. 10, 16). For an initial population of 200, when all demographic parameters are low, extinction is predicted to occur in about 15 years, and when all demographic parameters are at medium levels, extinction is predicted to occur in about 45 years (Lamberson *et al.* 2000, pp. 18–20). When all demographic parameters are at their highest levels, the population increases regardless of whether the initial population is 50, 100, or 200 animals. It is important to note that the authors chose demographic parameters to represent a biologically realistic range of values based on literature reviews and preliminary data (Lamberson *et al.* 2000, p. 6), rather than through robust demographic measurements of the population they were modeling. Therefore, it is not clear which, if any, of their parameter levels best represents the demography of the population. In light of more recent empirical studies, the true demographic parameters likely fall in between the medium and high parameter levels, and the population growth rate on the Sierra Nevada Adaptive Management Project study area is estimated to be 1.1 (95 percent CI 1.04–1.19), which indicates a stable or slightly increasing population (Sweitzer 2013a, pers. comm.; Sweitzer 2013b, pers. comm.). The authors note that population growth rates for a study area, where fishers are abundant enough to generate adequate sample sizes for research, may not be representative of the entire population.

Spencer *et al.* (2011, entire) created a spatially explicit population model that combined an empirically derived fisher probability-of-occurrence model with demographic parameters derived from literature review and expert opinion. Based on the modeled number of female home ranges that could be supported by the available habitat, they concluded that the carrying capacity of the currently occupied areas was approximately 125–250 adults (Spencer *et al.* 2011, p. 788), and that the population was probably less than 300 adult fishers (Spencer *et al.* 2011, p. 801). They also extrapolated the density estimates measured by Jordan (2007, p. 25; see Table 2 above) to arrive at a figure of 276–359 fishers (Spencer *et al.* 2011, p. 802), including juveniles and subadults, in this population. However, as discussed above for the NCSO population, this type of extrapolation is likely to result in an overestimate of the true population. Spencer *et al.* (2011, p. 797) further concluded that a 10–20 percent reduction in survivorship from the parameters used in their initial model would interfere with population expansion.

In 2002, USFS initiated a regional monitoring program to track occupancy trends of fishers in the SSN population. A power analysis for the program (Zielinski and Mori 2001, entire) determined a sampling design that targeted an 80 percent probability of detecting a 20 percent decline in occupancy in the population over a 10-year period. The sampling scheme was not designed to detect increases in occupancy (Zielinski *et al.* 2013b, p. 3). After 8 years of monitoring, Zielinski *et al.* (2013, entire) used occupancy modeling techniques, not available at the time of the original program design, to investigate occupancy, persistence rates, and trend in occupancy. They found no trend or statistically significant variations in occupancy during the 8-year period of the program (Zielinski *et al.* 2013b, p. 8) and concluded the SSN population was not decreasing. Subsets of their study area varied in occupancy rates and persistence, with the southwestern portion of their study area the most densely occupied, but none showed a significant trend (Zielinski *et al.* 2013b, p. 11). However, the annual target sampling size (288 units/year) was unattainable, due to logistical and financial constraints, and the average sample size was instead 139.5 units/year (Tucker 2013, p. 82). As a result of this smaller sample size and shorter duration, the results of this study must be considered inconclusive. Recreating the sampling scheme of this monitoring program and using the implemented average annual sample size at the Sierra Nevada Carnivore Monitoring Program, Tucker (2013, pp. 80–97) investigated the link between occupancy and abundance, showing that a 43 percent decline in abundance over an 8-year period only resulted in a 23 percent decline in occupancy reported. This estimate was derived using a spatially explicit simulation approach with an assumed initial population size of n=300, as the relationship between occupancy and abundance varies depending on population density; the same simulation using an initial population size of n=150 would yield a slightly greater decline in occupancy (Tucker 2015, pers. comm.). This effort demonstrates the complexities in determining population trend and identifies important cautions in extrapolating the conclusion of no trend in occupancy to a conclusion of no trend in abundance over 8-years of monitoring of the SSN population.

<u>New information since Service (2014)</u>

A recent study of radio collared fishers monitored from 2008 through 2014 in the SSN population showed the survival rate (calculated using demographic parameters) of adult males, but not females, is lower than other populations in the DPS, and estimates a lambda of 0.97 (C.I. 0.79–1.16) (Sweitzer *et al.* 2015a, pp. 781–783; Sweitzer *et al.* 2015b, p. 10). A more recent analysis from this study (Sweizter *et al.* 2015d, p. 77), however, suggests a lower population growth rate of 0.90 (95 percent C.I. 0.71–1.12) from 2008 to 2014; however, the population growth rate was at 1.0 or above for the period from 2010 to 2014 (Sweitzer *et al.* 2015d, p. 77). Population growth in the SSN population area is thus estimated to trend less than 1.0; the authors suggest the population is not in persistent decline, however, but is offset by periods of stability or growth (Sweitzer *et al.* 2015a, p. 784).

Reintroduced Populations

Translocations, the intentional transport and release of animals to augment, reestablish, or introduce a population, have been used in attempts to recover extirpated or depleted populations of many species. Recovery efforts throughout much of the fisher's North American range have relied heavily on translocations, and the fisher has proven to be one of the most successfully reintroduced carnivores (Powell 1993, pp. 80–85, Breitenmoser *et al.* 2001, p. 242; Lewis *et al.* 2012a, p. 9). Translocations, however, are not always successful (Breitenmoser *et al.* 2001, p. 242) and many fisher translocations in eastern and western North America failed to reestablish populations (Powell 1993, p. 84; Aubry and Lewis 2003, pp. 82–85; Lewis 2006, pp. 28–29). Lewis and Hayes (2004, pp. 4–5) report at least 31 fisher reintroductions attempted throughout their range in the U.S. and Canada from 1947 to 2003 with 21 (68 percent) considered successful (fishers persisted more than10 years following first release), 7 considered failures (22 percent), 2 were not evaluated (6 percent), and 1 is ongoing. Reintroductions have been more successful in eastern states and provinces (79 percent) than in western states and provinces (58 percent) (Lewis and Hayes 2004, p. 5). Within the Analysis Area, six separate translocations have been attempted during the last 53 years (Aubry and Lewis 2003, p. 82; Lewis *et al.* 2012a, p. 8). Two of these reintroduction efforts were unsuccessful, one resulted in an established population (Southern Oregon Cascades), and the three most recent reintroductions (Olympic Peninsula and Northern Sierra Nevada) have not reported that they have met their criteria for success.

During the 1950s, the USFS and Weyerhaeuser Corporation asked the Oregon State Game Commission to reintroduce fishers to Oregon as a means of controlling porcupine populations (Aubry and Lewis 2003, p. 82). In 1961, two attempts were made to reintroduce fishers to Oregon, involving a total of 24 fishers translocated in 1961 from British Columbia. Of these 24, 11 were released near Klamath Falls in the southeastern Cascade Range, and 13 near La Grande in the Wallowa Mountains (Aubry and Lewis 2003, p. 82; Lewis and Hayes 2004, p. 7). The lack of observations or incidental captures of fishers after the 1961 releases suggested that the translocations were unsuccessful, and that additional releases would be required to reestablish fishers and reduce porcupine damage (Aubry and Lewis 2003, pp. 82–86).

Olympic Peninsula

From 2008 to 2010, 90 fishers were translocated from central British Columbia to the Olympic Peninsula. By monitoring translocated fishers with radio-telemetry, project researchers evaluated post-release survival, home range establishment, reproduction, and resource selection of founding individuals. Initial findings indicate that survival was highly variable among release years (Lewis *et al.* 2012b, pp. 5–8; Lewis 2014, p. 63). Project researchers confirmed reproduction seven times from 2009 to 2011 (Lewis *et al.* 2012b, pp. 9–10).

Wilderness constraints provide logistical difficulties for researchers, which lead to additional uncertainties about the current status of reintroduced fishers in the Olympic Peninsula. A second monitoring phase consisting of non-invasive surveys of fisher distribution and relative abundance was initiated in the summer of 2013 and will help determine whether a self-sustaining population of fishers has been established in the Olympic Peninsula. In early 2013, biologists from many agencies and Tribes began a 4-year investigation of the success of the Olympic Fisher Restoration Project (Happe 2013a, pers. comm.). By late October of 2013, the project partners had detected fishers at 12 percent of sampling units, and there were indications of survival of translocated individuals (photos of radio-collared individuals) and of reproduction (for example, one road-killed female was lactating and had four placental scars) (Happe 2013b, pers. comm.).

<u>New information since Service (2014)</u>

In 2013 and 2014, the monitoring team detected fishers in 14 of 132 areas sampled, including six of the founding fishers and seven new recruits to the population (Happe *et al.* 2014, pp. 13–14; Happe *et al.* 2015, pp. 10–12). Sixteen fishers were also detected with non-project cameras, by trapping, and as carcasses (Happe *et al.* 2014, p. 16; Happe *et al.* 2015, pp.14-15). These fishers will continue to be monitored for a number of years to determine both the extent of their distribution and success in establishing a population of fishers on the Olympic Peninsula. Preliminary results showing wide distribution and documentation of reproduction are encouraging, but the success of this reintroduced population will not be known for several years.

The Olympic Peninsula population occurs in three percent of the analysis area, and has not been observed to have spread beyond the Peninsula. This population is not physically or demographically connected to any other population of fishers. Population size estimates and trend information are not known at this time.

Southern Oregon Cascades

From 1977 to 1981, 24 fishers from British Columbia (n=11) and Minnesota (n=13) were released west of Crater Lake in the southern Oregon Cascades (Aubry and Lewis 2003, p. 84). An ecological study from 1995 to 2002 (Aubry and Raley 2006, entire) indicated fisher presence in the vicinity of these releases still occurred. Subsequent work (Drew *et al.* 2003, p. 57; Wisely *et al.* 2004, p. 646) found that these fishers exhibited genetic traits in common with British Columbia and Minnesota fishers, but did not exhibit traits consistent with native Oregon or California fishers (Aubry *et al.* 2004, pp. 211–215).

Although this population was reestablished >30 years ago, and is about 40 km (25 mi) from the native Northern California-Southwestern Oregon Population, no genetic exchange between the 2 populations has been documented (Aubry *et al.* 2004, p. 214; Drew *et al.* 2003, p. 59; Wisely *et al.* 2004, p. 646; Farber *et al.* 2010, p. 12). Fishers in the Cascade Range of Oregon may be geographically isolated from those in southwestern Oregon because of ecological (extensive areas of open grassland and oak savannahs) and anthropogenic (Interstate 5 corridor, urban, and agricultural development) barriers in the intervening area (Aubry and Lewis 2003, pp. 86-87; Aubry *et al.* 2004, p. 204). One male fisher from the NCSO population was detected in the vicinity of the southern extent of the Southern Oregon Cascades reintroduced Population (Stephens 2012, pers. comm.; Pilgrim and Schwartz 2012, pp. 4-5). Therefore, it is possible the Southern Oregon Cascades Reintroduced and NCSO populations may have become interconnected by dispersing fishers.

There are no reliable estimates of population size. Based on verifiable occurrence records since the 1977–1981 reintroductions, it appears that this population has not expanded its range much beyond a relatively small area (Aubry and Lewis 2003, p. 85) of about 2,500 km^2 (~950 mi^2; Aubry and Raley 2006, p. 3). A winter 2012-2013 survey effort on the Fremont-Winema National Forest, just south of the Crater Lake National Park boundary, failed to find fishers (Albert 2013, p. 1; Ackerman 2013, pers. comm.), but trail camera photographs captured in late 2013 indicate that this population of fishers persists (Broyles 2013, pers. comm.).

<u>New information since Service (2014)</u>

See New Information in the *Northern California-Southwestern Oregon (NCSO)* section above, which includes the original native fisher population and the Southern Oregon Cascades (SOC) and Northern Sierra Nevada (NSN) Reintroduced Populations

Northern Sierra Nevada

From late 2009 through late 2011, 40 fishers were released into the northern Sierra Nevada and

southern Cascade Mountains of California. All animals were equipped with radio telemetry and monitored for survival, reproduction, dispersal, and home range development (Powell *et al.* 2013, p. 2). The released fishers experienced high survival during both the initial post-release period (4 months) and for up to 2 years after release (Powell *et al.* 2013, p. 2). Released fishers produced kits in all three springs since translocation (Powell *et al.* 2013, p. 18).
A trapping effort conducted in the fall of 2013 determined that at minimum, 28 fishers were known to be alive within the study area (total fishers captured as well as non-captured, telemetered fishers) (Swiers 2013, pers. comm.). Population estimates from the 2013 trapping effort had not yet been calculated as of this reporting, but a fall 2012 trapping effort returned a minimum population size of 37 and population estimates averaging 33 fishers (95 percent CI 22–44) across all model types used (Powell *et al.* 2013, p. 13). Note that this value (33) is less than the known minimum population size for fall of 2012, and the confidence interval suggests that the population in the fall of 2012 was slightly larger than in the fall of 2011, when it was estimated to include between 18 and 40 fishers (Powell *et al.* 2013, p. 13).

New information since Service (2014)

See New Information in the *Northern California-Southwestern Oregon (NCSO)* section above, which includes the original native fisher population and the Southern Oregon Cascades (SOC) and Northern Sierra Nevada (NSN) Reintroduced Populations

Reintroduction Summary

The Southern Oregon Cascades Reintroduced Population has persisted for over 30 years, despite estimates of a small population size. Various agency survey efforts over the past five years have resulted in verified sightings, including both photographs and DNA evidence, north, south, and east of the Aubry and Raley (2006, entire) study area. These recent agency surveys, while not systematic in design, do indicate evidence of potential population expansion.

For both the Olympic Peninsula Reintroduced Population, Washington Cascades Reintroduction area, and the Northern Sierra Nevada Reintroduced Population, it is too early to determine if the populations will persist. Current indications are encouraging, but it will take time to determine population trend and stability of these three new reintroductions.

REVIEW OF STRESSORS

In the following section, we will review and evaluate potential stressors that may be affecting fishers in the analysis area based on past, current and future impacts. Our approach draws upon methodologies put forth by NatureServe (Master *et al.* 2012, entire) and the fisher threat assessment conducted by Naney *et al.* (2012, entire), and we adopt various terms and descriptions that assist our analysis. When information is available, we may describe impacts according to geographic areas (for example, we use 8 of the 11 geographic areas as described by Naney *et al.* (2012, pp. 13–14) within the analysis area based on differences in biophysical environment, human modifications to those environments, current fisher distribution, and political jurisdiction (Table 3; Figure 11)). The NCSO population occurs in the Western Oregon Cascades, Eastern Oregon Cascades, Northern California-Southwestern Oregon and Sierra

Nevada subregions. The SSN population occurs in the Sierra Nevada subregion and the reintroduced ONP population is present in Coastal Washington. The recent reintroduction of fishers in the Cascades of Washington occurs in the Western Washington Cascades sub region.

Definition of Terms

Stressors

Stressors are the activities or processes that are causing or may cause in the future the destruction, degradation, or impairment of west coast fisher populations or their habitat. In some instances, these stressors could be resulting in residual impacts as a result of past activities. Stressors are primarily related to human activities, but can be natural events and act on fishers at various scales and intensities throughout the analysis area. Stressors may be observed, inferred, or projected to occur in the near term.

Classification of Stressors

Timing (immediacy) of the Stressor

The timing (immediacy) of each stressor was assessed independently based upon the nature of the stressor and time period that we can be reasonably certain the stressor is acting on fisher populations or their habitats. In general, we considered that the trajectories of the stressors acting on fisher populations within the analysis area could be reasonably anticipated over the next 40 years. This is the period of time over which we concluded we can reasonably rely on predictions about the future in making determinations about the future conservation status of fisher, as described below.

Stressors that directly cause mortalities were assessed in terms of their contribution to annual mortality rates. Without performing an additional population viability analysis, we could not precisely determine the effects of each stressor on total population numbers over the next 40 years. However, annual mortality rates allow us to compare the effects of the stressor with changes in mortality examined hypothetically in previous population models (Lamberson *et al.* 2000, entire; Spencer *et al.* 2011, entire). We also addressed the likely trend of each stressor over the next 40 years to evaluate whether the impacts of the stressor were likely to increase, decrease, or remain the same in the future.

Table 3. Analysis area sub-regions.

Analysis Area Sub-Region	State/ Province	Geographic Description	Populations	Proportion Federal	Proportion Non-Federal
Coastal WA	Washington	Canadian border south to the Columbia River and west of Interstate 5 but excluding the Puget Trough. Includes the west and east sides of the Olympic Mountains.	*The Olympic Peninsula Reintroduced Population (ONP) occurs in a portion of this sub-region.	0.38	0.62
Western WA Cascades	Washington	West side of the Cascade Range from the Canadian border south to the Columbia River and east of Interstate 5, but excluding the Puget Trough.	*Cascade Fisher reintroduction site occurs in a portion of this sub-region?	0.66	0.34
Eastern WA Cascades	Washington	East side of the Cascade Range from the Canadian border south to the Columbia River.		0.66	0.34
Coastal OR	Oregon	West of Interstate 5 from the Columbia River south to about the main stem of the Rogue River but excluding the Willamette Valley.		0.25	0.75
Western OR Cascades	Oregon	West side of the Cascade Range from the Columbia River south to the Upper Rogue River drainage basin (about Crater Lake National Park) and east of Interstate 5, excluding the Willamette Valley	* The NCSO Population occurs in a portion of this sub-region.	0.76	0.24
Eastern OR Cascades	Oregon	East side of the Cascade Range in Oregon.	*The NCSO Native Population occurs in a portion of this sub-region.	0.70	0.30
Northern California-Southwestern Oregon	Oregon / California	In Oregon, from about the Rogue River south to the California border and west of Interstate 5 to the coast. In California, the southern Cascade Range to Lassen County, west to the coast and south into Lake County.	*The NCSO Population occurs throughout this sub-region.	0.49	0.51
Sierra Nevada	California	From the southern end of the Cascade Range in California (Lassen County) to the southern extent of the Sierra Nevada.	*The NCSO Population occurs in northern portion of this sub-region. *The SSN Population occurs in the southern portion of this sub-region.	0.57	0.43

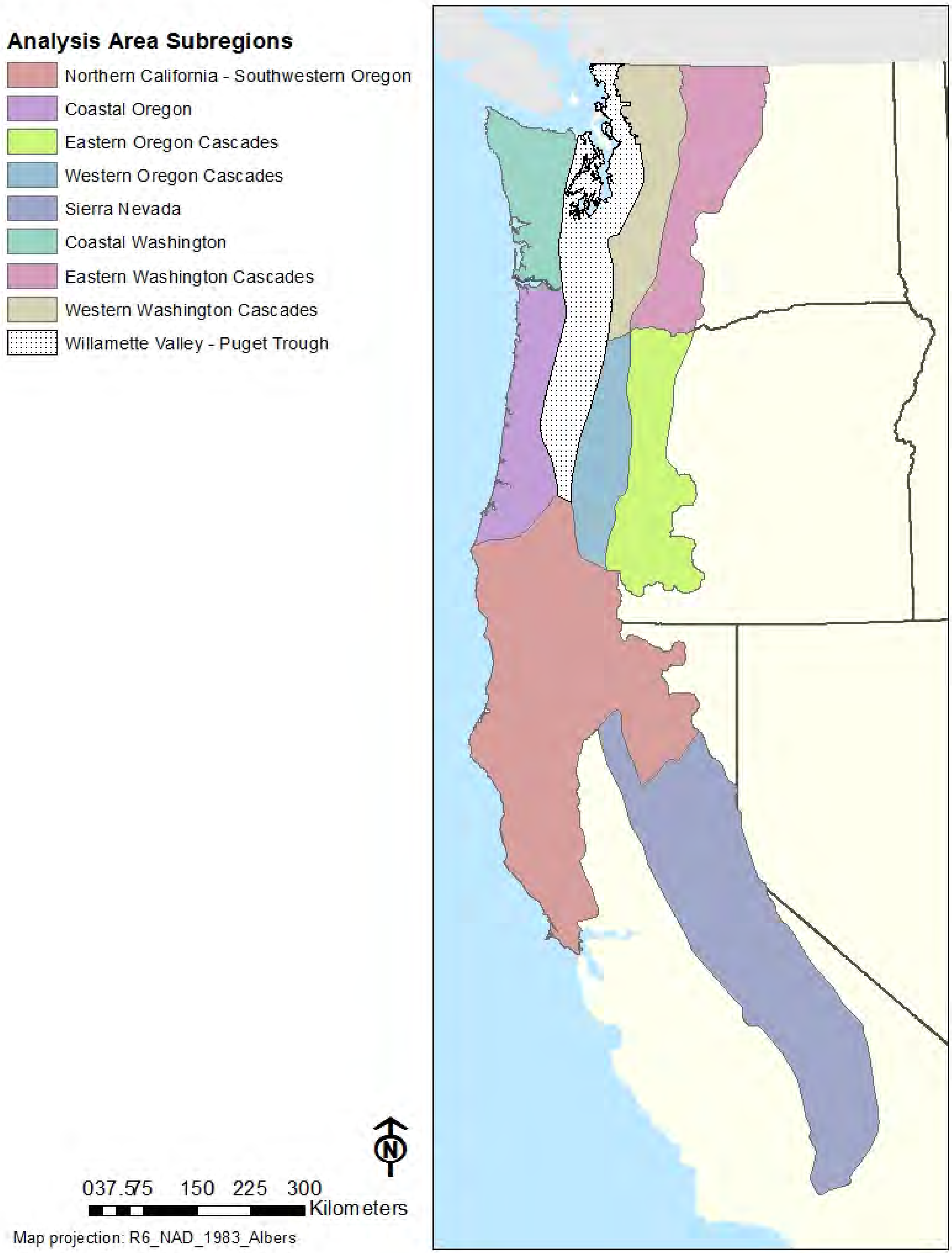

Figure 11. Graphical representation of analysis area sub-regions used to evaluate potential stressors.

Stressors that affect fisher habitat may often have a more persistent effect than stressors that cause direct mortality. When habitat is lost, it may take many decades to return. Therefore, even though habitat loss has an immediate impact on fisher populations, its effects are also expected to continue in the future, possibly for many decades until trees become large and old enough to generate the structures needed for fisher denning and resting. Land management regimes are also planned on a multi-decade timescale. For example, most USFS Land and Resource Management Plans were developed between 1983 and 1993 (USFS 2012, p. 21164); under California Forest Practice Rules, one avenue for private land management relies on Sustained Yield Plans, which project timber production over a 100-year timeframe (CAL FIRE 2013a, pp. 14, 218–223). In general, however, we found that most management plans project actions out over a period of several decades. Climate change is underway, but its effects are likely to be long lasting and moreover are likely to accelerate at some point in the future. Climate change models show considerable agreement until mid-century, but diverge thereafter depending partly on assumptions about whether greenhouse gas emissions are curtailed or continue to increase.

Timing (immediacy) Categories:

Past/Historical—only in the past and unlikely to return, or no direct effect.

Ongoing—continuing (a stressor now).

Future—expected to occur in the short-term future, such as over the next 40 years.

Long-term future—in the future beyond the next 40 years. The effects of some ongoing stressors may be projected for the late 21st century, which is outside of the future time period as defined above; therefore, we report them as the long-term future effects. For climate change, we also reviewed information over the next 100 years.

Magnitude of a Stressor's Impact

In addition to identifying the timing of the impact, we considered the scope and magnitude of those impacts. The scope of an impact is based on the proportion of suitable habitat within a known population area (such as ONP, SOC, NCSO, NSN, or SSN) or the proportion of those populations that can reasonably be expected to be affected by a stressor based on the best available information. The magnitude of impact refers to the estimated risk level or degree of decline that a stressor may cause to one or more of the populations, or by the amount of suitable habitat that may be lost, degraded, or fragmented based on the best available information.

For each stressor, we summarized the best available scientific information relating to its potential direct and indirect impacts on the West Coast DPS of fisher. If significant information gaps existed, resulting in high levels of uncertainty in determining the scope and magnitude of impact for particular stressors, we used our best professional judgment. We used three impact level classes—low, medium, and high—to represent the likely impact of stressors to the fisher in the West Coast DPS. We defined the impact level classes as follows:

Low-level impact: Stressor is impacting individual fishers within the West Coast DPS currently or in the future, or stressor is resulting in a minor amount of habitat impacts currently or in the future.

Medium-level impact: Stressor is impacting fishers within the West Coast DPS at the population level (one or more of the five populations) currently or in the future, or stressor is resulting in more serious impacts to fisher habitat at the population level (as compared to a low-level impact) currently or in the future.

High-level impact: Stressor is significantly impacting the West Coast DPS of fishers at the rangewide level currently or in the future, or stressor is causing significant impacts to fisher suitable habitat at the rangewide level currently or in the future.

Stressors Related To Habitat Loss and Fragmentation

Introduction

Habitat components important to a fisher's use of stands and the landscape can be identified broadly as structural elements (for example, snags, down wood, live trees with cavities, and mistletoe brooms), overstory cover (dominant, co-dominant, and intermediate trees), understory cover (vertical and horizontal diversity), and vegetation diversity (floristic species) (Lofroth *et al.* 2010, pp. 119–121). The reduction in, or losses of, these components are outcomes of natural disturbance events (for example, wildfire, forest insects, and disease) and various vegetation management activities (for example, timber harvest, silvicultural practices, herbicide application, and fuel reduction techniques). Depending on the scale, intensity, and distribution of disturbance events (for example, if the areas of disturbance are larger or more extensive than the natural pattern and scale of disturbance), then overall ability of the landscape to support fishers and to restore or connect fisher populations may be diminished (Agee 1991, p. 33; 69 FR 18770, April 8, 2004, entire; Powell and Zielinski 1994, p. 64; Franklin *et al.* 2002, pp. 7–10, 20–21; Weir and Corbould 2008, pp. 127, 161–162; Wisdom and Bate 2008, pp. 2091–2092; Naney *et al.* 2012, entire).

The loss of and reduction in the availability and distribution of structural elements and the processes that create them (for example, mistletoe, heart rot fungi, age-related decadence, primary cavity excavators) can negatively affect fisher reproduction and energy budgets (Lofroth *et al.* 2010, pp. 123–130, Naney *et al.* 2012, p. 22). Furthermore, in many of the ecosystems in the analysis area, these structural elements are important habitat components for fisher prey (Aubry *et al.* 1991, pp. 292–294; Carey and Johnson 1995, pp. 347–349; Bowman *et al.* 2000, p. 123). Timber harvest and silvicultural techniques such as regeneration harvest; selective harvest of insect damaged and diseased trees; and thinning to promote vigorous stands of trees often removes the largest trees or focuses on the removal of older, diseased, or decadent trees. This furthers results in the removal and/or limitation of future recruitment of rest and den trees. In addition, application of herbicides to reduce competition for conifers can remove the shrub and hardwood layer that provides understory cover, structural complexity, and a valuable mast crop for fisher prey, and over the long term removes hardwoods that would provide future fisher den and rest sites. Fuels reduction and fire suppression techniques that focus on the removal or salvage of snags and fire damaged trees may similarly diminish the distribution, abundance, and recruitment of den and rest sites across the landscape (Naney *et al.* 2012, pp. 29–37).

Wimberly and Ohmann's (2004, p. 643) analysis of forest trends in the Oregon Coast Range found that land ownership historically had the greatest influence on changes in forest structure between 1936 and 1996, with State and Federal ownership retaining more large-conifer structure than private lands. Loss of forest and change in forest structure was primarily due to timber harvest, with fires accounting for a small portion of the loss (Wimberly and Ohmann 2004, pp. 643–644). Between 1972 and 1995, timber clearcut harvest rates in all stand types were nearly three times higher on private land (1.7 percent of private land per year) than public land (0.6 percent of public land per year), with the Coast Range dominated by private industrial ownership and having the greatest amount of timber harvest as compared to the adjacent Klamath Mountain and Western Cascades Provinces (Cohen *et al.* 2002, pp. 122, 124, 128).

Past loss and fragmentation of fisher habitat may contribute to the decline of fisher populations (Aubry and Lewis 2003, p.82). Fragmentation occurs when there is a change in habitat configuration (Sauder and Rachlow 2014, p. 75). Fragmentation can be caused by several anthropogenic factors (for example, vegetation management, conversion to agriculture, residential construction, and highways) and natural sources, such as large rivers, mountain ridgelines, and valley deserts or grasslands between forested areas (Green *et al.* 2008, pp. 19, 27, 29; Naney *et al.* 2012, p. 15). Anthropogenic factors causing fragmentation may compound habitat loss by isolating patches of suitable habitat within area of unsuitable or less suitable habitat, within which fishers may not be able to establish home ranges, forage (by affecting prey species composition, abundance, and availability), find suitable rest and den sites, or simply travel through (Buskirk and Powell 1994, p. 288; Hayes and Lewis 2006, p. 34; Weir and Corbould 2008, p. 148). Fragmentation can also increase energetic costs to fishers, which may result in nutritional stress that can reduce animal condition, ultimately affecting survival, reproduction, and recruitment (Lehmkuhl and Ruggiero 1991, pp. 35–44). Predation risk may be increased due to the need to travel through low suitability habitat (for example, lack of cover or rest sites) or additional travel time needed to circumnavigate unsuitable habitat (Weir and Corbould 2008, p. 31). This may be exacerbated by an increased abundance of predators associated with fragmented and early-seral habitats (Lehmkuhl and Ruggiero 1991, pp. 38–39). Fragmentation from timber harvest or fire (depending on harvest method, fire intensity, and site potential) ranges in time from one fisher lifetime (about 10 years) after low-intensity disturbances in forested systems that regenerate quickly (for example, three to five years in coastal California; Klug 1997, p. 39), to more than 80 years in the in the drier areas of California and southern Oregon (Agee 1991, p. 32; Franklin and Spies 1991, p. 108).

Timber harvest and other vegetation management treatments are expected to continue on private, state, tribal, and Federal lands. Some forms of vegetation management may not exert a significant negative effect on forest structure and stand conditions important to fishers. For example, vegetation management that implements thinning with the goal of maintaining or enhancing late-successional characteristics or increases structural and species diversity in young stands may provide or improve fisher habitat. In other cases, some vegetation management activities may actually increase prey abundance and diversity, possibly benefitting fishers (Carey and Wilson, 2001 pp. 1019-1029; Waldien 2005, pp. 25-35; Klenner and Sullivan 2009, pp. 1081-1083). Although there is no published work explicitly testing and evaluating the direct effects of vegetation management or fuel treatments on fishers, various studies indicate that management to reduce fire risk or restore ecological resilience may be consistent with maintaining landscapes that support fishers in both the short and long term, provided that treatments retain appropriate habitat structures, composition, and configuration (Spencer *et al.* 2008, entire; Scheller *et al.* 2011, entire; Thompson *et al.* 2011, entire; Truex and Zielinski 2013, entire; Zielinski 2013, pp. 17-20; Zielinski *et al.* 2013a, p. 825; Clayton 2013, entire; Garner 2013, pp. 29, 41–43; Niblett *et al.* 2015, pp. 9–10; Sweitzer *et al.* 2016, p. 219).

New information since Service (2014):
Recent literature is increasing our understanding of how fishers might use managed landscapes and of the attributes of those areas that fisher may be selecting for or against. For example, researchers are documenting fishers in managed landscapes composed of multiple seral stages with legacy structures and varying degrees of forest openings and connectivity (Niblett *et al.* 2015, p. 11; Sauder and Rachlow 2015, p. 54). The scale of analysis (for example, landscape, home range, den site, etc.) and the degree of “edge” (two adjacent habitat types) is an important consideration when assessing the suitability of managed stands as fisher habitat (Aubry and Raley 2006, p. 15; Niblett *et al.* 2015, p. 11; Sauder and Rachlow 2014, p. 80; Sauder and Rachlow 2015, pp. 52-54; Sweitzer *et al.* 2016, p. 220). Zielinski *et al.* (2013, p. 825) also found that the rate at which treatments occur is extremely important in understanding fisher tolerance to vegetation treatments.

Below, we address stressors that affect the forest vegetation types most readily used by fishers and most likely to contain the habitat components fishers rely upon. Large-scale loss of important habitat components resulted from previous forest management practices that began in the 1800s and ended in the early 1990s. Although forest management practices have changed, effects to habitat still occur due to wildfire, climate change, current forest management, human development, and construction of linear features such as roads and power lines. All of these changes in habitat may affect the landscape’s overall ability to support fishers and may also fragment habitat, limiting fisher movement and dispersal. In both the historical and current analysis of stressors related to habitat, we address each stressor individually for the convenience of describing its potential effects to fishers and fisher populations, but these stressors act together, both additively and synergistically, to affect the species.

Historical loss of late-successional forest from past activities and disturbances

Within the analysis area, late-successional forest is associated with important fisher habitat elements. In the west, the habitat components most often associated with smaller scales of fisher habitat (for example, large diameter trees, live trees with cavities, complex cover and floristic species) are represented more frequently in late-successional forests and many studies indicate that fishers select for late-successional forests and select against early-successional forests (Rosenberg and Raphael 1986, pp. 269–271; Jones and Garton 1994, pp.382–383; Zielinski *et al.* 2004b, pp. 654–655; Matthews *et al.* 2008, p. 49; Weir and Corbould 2008, pp. 124–125). Although fisher home ranges comprise a range of seral stages, they often include high proportions of mid- to late-seral stage forests (Raley *et al.* 2012, p 248). Consequently, many fisher researchers have suggested that the magnitude and intensity of past timber harvest is one of the primary causes for fisher declines across the United States (Douglas and Strickland 1987, p. 512; Powell 1993, pp. 77–80, 84; Powell and Zielinski 1994, p. 41), and this has been offered as one of the main reasons fishers have not recovered in Washington, Oregon, and portions of California as compared to the northeastern United States (Aubry and Houston 1992, p. 75; Powell 1993, p. 80; Powell and Zielinski 1994, pp. 39, 64; Lewis and Stinson 1998, p. 27; Truex *et al.* 1998, p. 59).

Sharp declines in late-successional forests in Washington, Oregon, and California began with the harvest of these forests in the 1800s (55 FR 26114, June 26, 1990; McKelvey and Johnston 1992, pp. 225–232; Bolsinger and Waddell 1993, p. 2; FEMAT 1993, pp. 6–8; Franklin and Fites-Kaufmann 1996, p. 648; Beardsley *et al.* 1999, p. 21). Late successional forests comprised about 50 percent of forests in Washington, Oregon, and California in the 1930s and 1940s, but by 1992 they comprised less than 20 percent (4,168,269 hectares [ha]) (10.3 million acres [ac]) of those forests (Bolsinger and Waddell 1993, p. 2). Franklin and Spies (1986, p. 80) estimated that 6 million ha (15 million ac) of late successional forest existed west of the Cascade Range in Washington and Oregon in the 1800s. Most of the forest (perhaps 80 percent) probably occurred in relatively large contiguous areas (greater than 405 ha [1,000 ac]) (Bolsinger and Waddell 1993, p. 2). In western Washington and Oregon, modern estimates suggest that 82–87 percent of the late successional forests present at the time of settlement have now been logged (Booth 1991, p. 1).

The conversion of low-elevation forests in western Washington to tree plantations and non-forest uses removed a large portion of potential fisher habitat west of the Cascades (Lewis and Hayes 2004, p. 4). During the last 50 years, the structure, composition, and landscape of much of western Washington's commercial timberlands have significantly changed because of intensive timber harvesting activities (Lewis and Hayes 2004, p. 4). Most of the remaining younger low and mid-elevation forest has reduced amounts of large live trees, snags, and coarse woody material, and is not likely to be able to sustain fisher populations (Lewis and Stinson 1998, p. 27; Lewis and Hayes 2004, p. 4).

In northwestern California, the pattern of timber harvest has historically differed from harvest patterns in Washington and Oregon (Franklin and Fites-Kaufmann 1996, p. 630). Rosenberg and Raphael (1986, p. 272) emphasize that the fragmentation of northwestern California Douglas-fir (*Pseudotsuga menziesii)* forests is relatively recent in comparison with forests of other regions (redwoods of California and Douglas-fir forests of Washington and Oregon), and that the true long-term responses of species to the break-up of their habitat cannot yet be discerned.

In the Sierra Nevada of California, Franklin and Fites-Kaufmann (1996, p. 648) found that forests with high late successional and old-growth structural rankings are now uncommon (14 percent of mapped area). Late successional forests of mixed conifer are a particularly poorly represented forest type as a result of past timber harvesting, and key structural features such as large-diameter trees, snags, and logs, are generally at low levels (Franklin and Fites-Kaufmann 1996, p. 648). This loss of structurally complex forests has likely played a significant role in both the loss of fishers from the central and northern Sierra Nevada, as well as the fishers' failure to recolonize these areas (USFS 2000, p. 5).

Although there has been a dramatic loss of older forests through much of the 20th century, since 1990, timber harvest has sharply declined throughout the historical west coast fisher range. Total volume of timber harvested in California in 2010 was 73 and 74 percent below what it was in 1988 and 1972, respectively. Timber harvested from Sierra Nevada national forests in 2010 was 86 percent lower than that harvested in 1988. Though much of the decline in timber harvest has been the result of declines on federal lands, harvests from private lands has also dropped (Charnley and Long 2014, pp. 631–632). Federal timber harvest volume in Oregon has dropped by over 90 percent since the late 1980s, with harvest from other ownerships also declining 20 percent (Gale *et al.* 2012, pp. 4, 10, 11). Although the Oregon data include forests outside of the fisher analysis area, about 80–90 percent of the timber harvest volume in Oregon occurs in the western part of the state (Gale *et al.* 2012, p. 17), which is where the majority of Oregon's fisher analysis area occurs. Similar declines have occurred in Washington, including western Washington where the majority of the fisher analysis area is, with declines of timber volume on private lands since the late 1900s and dramatic declines on Federal lands similar to Oregon and California (WDNR 2016, entire). Kennedy *et al.* (2012, entire) measured amounts of disturbed forest area within the Northwest Forest Plan (NWFP) area between 1985 and 2008, and similarly found a substantial decline in the magnitude of disturbance on federal lands, coinciding with NWFP implementation (Kennedy *et al.* 2012, p. 128). In summary, harvest volume levels that resulted in the widespread loss and fragmentation of historical fisher habitat have declined across ownerships over the past two decades, but most dramatically on Federal lands (47 percent of the west coast fisher analysis area). Declining levels of timber harvest volume can be a reflection of declining tree size being harvested, a decline in actual numbers of acres of fisher habitat being harvested, or both.

1.0 Wildfire, Emergency Fire Suppression Actions, and Post-Fire Management Actions

<u>1.1 Wildfire</u>

Definitions

The analysis area encompasses regions subject to several different fire regimes; that is, each region experiences wildfires of differing sizes, frequencies, and severities. Within a region, different land cover types also burn with varying frequency and severity. These fire regimes are affected by naturally occurring climate and vegetation conditions as well as by human management decisions.

Fire severity has often been described in categories as high, mixed, or low severity. Low-severity fire burns at ground level and does not kill most overstory trees, although it may consume understory vegetation and downed woody debris (Jain *et al.* 2012, p. 47). High severity fire, also called stand-replacing fire, kills all or nearly all vegetation within a stand and may extend across a landscape (Jain *et al.* 2012, p. 47). Mixed-severity fires are characteristic of many western forests, and are a highly complex disturbance regime that produces unique patch dynamics and ecosystem responses. Characteristics of mixed-severity fire include widely varying fire intervals and combinations of surface, torching, and crown fire behavior both within and between fires, resulting in intermixed patches of live and dead understory and overstory vegetation (Halofsky *et al.* 2011, pp. 1–2). Mixed-severity fires can result in intricately mixed patches of vegetation of varied age at a relatively fine scale, resulting from the variations in fire frequency and severity as well as species responses to this variation (Halofsky *et al.* 2011, p. 13).

Fire frequency is generally expressed in terms of the fire return interval, or average time between fires at the same location), or fire rotation interval (the time required before every part of a given area would be expected to burn at least once). Historical fire return intervals in the analysis area vary from 6–9 years in some areas of northern California to 1,000 years or more for some forest types in western Washington (Agee 1993, pp. 228–231; Stuart and Stephens 2006, pp. 159–161; Lofroth *et al.* 2010, pp. 22–23). In general, the forests of western Washington and northwestern Oregon have burned infrequently, with a fire return interval of 200 years or more, but when they have burned, the fire was most often stand-replacing (Agee 1991, p. 32; Lofroth *et al.* 2010, pp. 22–23). In much of the Eastern Cascades, Klamath bioregion, and Sierra Nevada, historical fire return intervals prior to the era of fire suppression were typically in the range of 11–35 years, and fires were most often low or mixed-severity (Lofroth *et al.* 2010, pp. 22–23; Sensenig *et al.* 2013, p. 105). In the current era of fire suppression, the average fire return interval has lengthened dramatically in regions and forest types that historically had short fire return intervals (Skinner *et al.* 2006, p. 178).

<u>New information since Service (2014)</u>

Specific to high-severity fire, historical high severity fire rotations in California's Sierra Nevada are estimated at 281 years in the north and 354 years in the south (Baker 2014, p. 18). In the Sierra Nevada, Baker (2014, p. 25) suggests that high severity fires were historically relatively extensive, and may have covered from 31 percent (southern Sierra Nevada) to 39 percent (northern Sierra Nevada) of the area, but mixed-severity fires were the dominant fire class in these forests (from 48 percent in the north to 43 percent in the south).

Effects of fire on fisher habitat elements

Fires can cause reductions to or removal of important elements of fisher habitat, including vegetative diversity, over-story canopy cover, understory cover, and key structural elements (large hollow trees, large down logs, large live trees). Fire can also can create or maintain some structural elements used by fishers; in other words, the consequences of fire for fisher habitat are complex and not subject to generalization. Low-severity fire may reduce some habitat elements, such as understory cover, while increasing others, such as vegetative diversity, and both remove and create dead wood elements such as snags and down wood. High-severity fire is more likely to remove forest cover from large blocks of habitat and potentially result in loss of habitat.

<u>New information since Service (2014)</u>

Mixed-severity fire may contribute to the regeneration of the hardwood component of mixed conifer forest used by fishers (Cocking *et al.* 2014, entire). Fishers may benefit from the increases in the abundance of mammalian prey species following mixed-severity fire (for example, Hanson 2013, p. 27; Ganey *et al.* 2014, p. 47). Such habitat may therefore serve as favorable foraging habitat for fishers if situated in proximity to sufficient areas of habitat that provide adequate denning and resting structures.

Low-severity fires decrease the density, diversity, and abundance of understory vegetation, at least over the short term. These understory reductions may diminish prey habitat quality and quantity, decrease prey abundance and availability, or remove cover for effective foraging, although abundance of some prey species may increase (Lehmkuhl *et al.* 2006, pp. 596–597; Monroe and Converse 2006, pp. 237–238; Fontaine and Kennedy 2012, p. 1553). The recovery of understory, however, especially on productive sites, can occur within one fisher lifetime (Naney *et al.* 2012, p. 6). In addition, low severity fires can be critical in the creation or maintenance of reproductive habitat for fishers, as fire scars enhance the formation of cavities that serve as denning sites (Weir *et al.* 2012, pp. 237–238). When evaluated using a fisher habitat model derived from fisher location data, sites recently treated with prescribed burning showed similar foraging habitat value to sites that were not burned (Truex and Zielinski 2013, p. 90). Some low-severity fires may eliminate large downed wood (Innes *et al.* 2006, p. 3184), or reduce canopy cover enough to diminish the value of the stand as resting habitat (Truex and Zielinski 2013, p. 90). In forest types subject to frequent fires that remove woody structures near the ground, fishers are closely associated with riparian areas (Powell *et al.* 2003, p. 641), which do not burn as often.

Resting and denning sites are likely to be lost as a result of stand-replacing fires. Mixed- and high-severity fires can reduce or destroy key biological legacies and other structural habitat elements, like large snags or large downed wood. These elements, which are already uncommon in some areas, are used as resting and denning structures for fishers. Typically, decades are required for these elements to develop, and it may take more than a century to develop large, hollow trees that are suitable for reproductive dens (Naney *et al.* 2012, p. 7). Therefore, the loss of these elements could render habitat unsuitable as resting or denning habitat for a century or more.

<u>New information since Service (2014)</u>

Habitat may be degraded or lost in the short-term by fire; fires can promote the development of fisher habitat in certain portions of the analysis area, particularly those regions characterized by mixed oak-conifer forests (Cocking *et al.* 2014, entire; but also see Collins and Roller 2013, p. 1810). In Sierra mixed-conifer forests, a historical fire regime characterized by mixed-severity fires, with high severity fires occurring at moderate to long intervals, is believed to have produced the heterogeneous forests with abundant, dense, late-successional habitat characteristics favored by fishers (Baker 2014; Cocking *et al.* 2014; Hanson 2013).

Forests characterized by highly variable natural disturbances, such as mixed-severity fire regimes, are relatively resilient to recurrent severe fire, and severe, short interval fires did not result in loss of species richness, including hardwood and conifer species (Shatford *et al.* 2007, pp. 144–145; Donato *et al.* 2009, p. 142; Halofsky *et al.* 2011, p. 14; Baker 2014, p. 26; Cocking *et al.* 2014, pp. 94, 102–104). Mixed-severity fires promote vigorous regeneration of mixed conifer forest and that such regeneration is not precluded by native shrub cover that may initially recolonize following fire. In the Sierra Nevada, Baker (2014, pp. 14, 24) found that historical mixed-conifer forests were dominated by relatively younger and smaller trees. Large trees were still a key feature of these forests, but were not numerically dominant in the forest assemblage.

Collins and Roller (2013, p. 1810) suggest that in some areas, management intervention in the form of the replanting of conifers may be required to ensure the return of mixed-conifer forests following stand-replacing fire.

When overstory canopy is markedly reduced, as in mixed- or moderate-severity fires, important microclimate characteristics are altered (for example, increased temperature or reduced shelter from wind and precipitation). Additionally, conflicts with other species or conspecifics may increase due to the open stand structure and absence of rest sites. Landscapes with reduced canopy cover may provide decreased protection from predation, raise the energy costs of traveling between foraging sites, and provide unfavorable microclimate and decreased abundance or vulnerability of preferred prey species (Lofroth *et al.* 2010, p. 85). Once overstory is removed, it may take many decades to reestablish (Naney *et al.* 2012, p. 2)

When stand-replacing fire removes canopy cover altogether, and at a large enough scale, habitat is likely rendered unsuitable for fishers, as these early successional stands may lack canopy cover and the structural elements for rest and den sites required by fishers (Jones and Garton 1994, pp. 380–382; Weir and Harestad 1997, pp. 257–258; Weir and Corbould 2008, p. 2). If large-scale loss of canopy occurs due to large stand replacing fires, the number of fisher home ranges is reduced. Fragmentation due to fire may lead to increased energy expenditures and could ultimately affect survival, reproduction, and recruitment of fishers (Naney *et al.* 2012, p. 7). Predation risk may increase due to the lack of cover and the relatively high abundance of predators in fragmented landscapes (Naney *et al.* 2012, p. 7–8). Large enough areas of early seral vegetation after fire may present a temporary barrier to dispersing fishers, thereby reducing connectivity within and between populations.

Some fires may lead to vegetation type conversion from forest to shrublands, which may permanently change landscape permeability for fishers (Naney *et al.* 2012, p. 7; Collins and Roller 2013, p. 1801). In areas dominated by mixed-severity fire regimes, past fire history can play a significant role in shaping future fire behavior, and vegetation types that are either relatively vulnerable or resistant to stand-replacing fire can result in a self-reinforcing dynamic (Perry *et al.* 2011, pp. 703, 715). However, fire regimes derive from complex interactions among vegetation, climate, topography, and other biotic and abiotic factors that vary over space and time. As Perry *et al.* (2011, p. 709) notes, the mixed severity fire dynamic is too complex to be neatly pigeonholed. The research of Perry *et al.* (2011, pp. 707, 709) suggests that if the fire return interval is sufficiently short, the high-severity fire in the shrublands may erode the forested patches, eventually causing conversion of the entire landscape to shrublands. Conversion of forested areas to shrubland may present a long-term barrier to dispersing fishers, causing populations to become fragmented or preventing migration between populations.

Fisher use of burned landscapes

Fishers evolved in forests that were subject to wildfire, leading Powell and Zielinski (1994, p. 64) to hypothesize that management regimes mimicking small stand-replacing fires will not harm fisher populations, as long as enough late-successional conifer forest remains available nearby. In Ontario, fishers were described as being practically absent from logged and burned areas (de Vos 1951, p. 500), but were occasionally observed in burned areas, particularly during the breeding season (de Vos 1952, pp. 12-13). However, large stand-replacing fires in Wisconsin and Michigan are believed to have played a role in the extirpation of fishers in that region (Williams *et al.* 2007, p. 1). Fishers' ability to use burned landscapes likely depends on the size and severity of the fire, as well as pre- and post-fire vegetation conditions.

New information since Service (2014)

Relatively few studies have been conducted on the degree to which fishers use post-fire landscapes. In the southern Sierra Nevada, Hanson (2013, entire) observed fisher scat within areas that had experienced mixed severity fire 10–12 years previously, in areas where the fires had caused over 50 percent tree mortality. Fishers may use previously burned forests for foraging, in response to an increase in small mammal prey (Hanson 2013, p. 27). Potential benefits to fishers were found when such fires occur in unlogged mature/old forest with moderate to high pre-fire canopy cover and high structural complexity. Hanson (2013, p. 28) suggests that mixed-severity and even high severity fire is not at odds with fisher conservation in this area.

Sweitzer *et al.* (2016, p. 221) found no negative association between local colonization or persistence of fishers and fire, and also observed a female fisher denning within a patch of forest burned by a low severity fire four years earlier. Similar to other findings, these researchers also suggest that 5–10 years of succession in forests disturbed by fire produces conditions suitable for fisher prey species (Sweitzer *et al.* 2016, p. 222). Overall, they conclude their research does not identify a consistent negative effect of fire on fisher habitat use, but additional research is needed before concluding that fire is not damaging foraging and denning habitats used by fishers in the southern Sierra Nevada (Sweitzer *et al.* 2016, p. 222).

Surveys following the Fountain Fire, which burned 64,000 acres in Shasta County, California in 1992, suggest fisher use of burned area following high severity fire and salvage logging, followed by replanting. Observations of fishers at bait stations in February and March 2015, 15 years after replanting ended, revealed four fisher detections inside the fire perimeter, two detections adjacent to the fire perimeter, and two within riparian leave (buffer) areas approximately a mile inside the fire perimeter. The authors concluded that fishers are making use of previously burned, even-aged regenerating stands, at least for dispersal and foraging (Engstrom 2015, pers. comm.).

Martens are close relatives of fishers and have similar habitat requirements (Purcell *et al.* 2012, pp. 47–50), so studies on martens' post-fire habitat use provide the best indication of fishers' post-fire habitat use, given the scarcity of studies on fishers. In the Northwest Territory, 21 years after a large, high-severity fire, martens used forested areas in preference to burned areas, though both were included in home ranges (Latour *et al.* 1994, entire). Compared with other northern marten populations, this population used abnormally large home ranges, suggesting that the burned areas provided suboptimal habitat (Latour *et al.* 1994, p. 353). In contrast, trappers in Alaska reported that martens reached high densities in burned areas 3–10 years post-fire, and believed that marten abundance was related to small mammal abundance within the burned area (Stephenson 1984, pp. 2–19). Recently burned areas may provide habitat that does not support reproduction but is adequate for dispersing juvenile martens; for example, in Alaska, young martens dispersed through but did not reproduce or establish home ranges in a study area consisting mostly of burned areas 7 and 26 years post-fire (Paragi *et al.* 1996b, entire). This latter observation appears to be consistent with the scant data available for fishers.

Spotted owls (*Strix occidentalis* spp.) use many of the same habitat elements and forest conditions as fishers (for example, forest stands with older forest structure such as snags, hollow trees and down logs); therefore, research on spotted owl use of post-fire landscapes may provide clues for potential fisher response. Some studies have suggested that there is little or no change in occupancy by spotted owls after fires, especially those burned at low to moderate severity but also sometimes including high severity burns (Bond *et al.* 2002, pp. 1025–1026; Keane *et al.* 2010, pp. 11–12; Roberts *et al.* 2011, p. 616; Lee *et al.* 2012, pp. 798–800). Other studies have documented reductions in occupancy due to high severity fire (Gaines *et al.* 1997, p. 126; Jenness *et al.* 2004; p. 769; Clark 2007, pp. 40–45; Keane *et al.* 2010, pp. 11–12). Telemetry studies indicate that spotted owls use recently burned habitat for foraging and sometimes even nest in areas burned at low or moderate severity (Bond *et al.* 2009, pp. 1120–1122; Clark 2007, pp. 99–116), although they may shift their core nesting and foraging areas away from burned areas (King *et al.* 1998, p. 3, Clark 2007, pp. 40–41). Unfortunately, all of these studies are of short duration post-fire or their results are confounded by salvage logging or the effects of past timber harvest (for example, Clark *et al.* 2013, p. 686; see the Post-Fire Management Activities section below). It is possible that due to high site fidelity, spotted owls may occupy areas that are not otherwise suitable to meet all of their life requirements and that they occupy these areas despite a reduction in fitness (Clark 2007, p. 41; Clark *et al.* 2011, pp. 43–44). In contrast to spotted owls' site fidelity, fishers travel widely in their home ranges and rarely reuse resting structures (Zielinski *et al.* 2004a, pp. 481–482; Lofroth *et al.* 2010, pp. 57, 72). Female fishers with dens show stronger site fidelity, but still may use five or more den sites throughout a season (Paragi *et al.* 1996a, p. 80). This characteristic may make fishers more resilient to fire. However, because they are less vagile (able to disperse) than spotted owls, fishers may be more sensitive to barriers to dispersal created by large patches of stand replacing fire.

1.2 Emergency Fire Suppression Activities

Some fire suppression activities may affect fisher habitat. These include backburning (intentional burning to control the progression of wildfire), construction of fuel breaks (removal of all flammable material down to mineral soil), and removal of snags or other large trees. Some fire suppression activities occur on a relatively small spatial scale, while others occur over much larger areas. In regard to emergency suppression, Backer *et al.* (2004, p. 937) state: "[t]he ecological impacts of fire-suppression activities can be significant and may surpass the impacts of the fire itself."

Backburning has effects similar to those of wildfire, but in some cases, backburning may produce patches of high severity fire even when the wildfire itself is burning at low and moderate severity (Backer *et al.* 2004, p. 944). Wide fuel breaks may remove long, linear strips of fisher habitat. There have been isolated cases of widespread large tree removal for fire personnel safety. Fire suppression techniques that focus on the removal of snags may diminish the distribution, abundance, and recruitment of fisher den and rest sites across the landscape (Naney *et al.* 2012, pp. 29–37). In addition, exotic plants and animals, both terrestrial and aquatic, may be transferred from site to site within fires and across large geographic areas when crews travel from one state to another (Backer *et al.* 2004, p. 940), which may have indirect effects on vegetation and prey communities in the post-fire landscape.

1.3 Post-Fire Management Activities

Salvage logging (harvest of dead or soon to be dead trees with commercial value) occurs on the vast majority of private timberlands in the analysis area, and also occurs on Federal lands. Smaller fires are also salvage logged, but the number of these operations is difficult to estimate. This type of harvest can lead to increased erosion and sedimentation; damage to soils and nutrient-cycling processes; removal of snags and live trees; decreased regeneration of trees; shortened duration of early-successional ecosystems; increased spread of weeds from vehicles; damage to recolonizing vegetation; reduction in hiding-cover and downed woody material for fisher prey; increased short-term and medium-term fire risk; and alterations of patterns of landscape heterogeneity (Service 2011, p. III-48). Moreover, these activities reduce the ecosystem benefit of disturbance from fire in diversifying and rejuvenating landscapes (Lindenmayer *et al.* 2004, p. 1303). The recent threat assessment for fishers also acknowledged that modification of forest structure from fire was greater when followed by post-fire salvage logging (Naney *et al.*, 2012, page 31). Establishment of conifer plantations after salvage logging has been linked to higher severity in future fires (Perry *et al.* 2011, p. 709). As there are so few studies of fisher use of burned landscapes, it is difficult to separate out the effect of post-fire salvage logging from the effects of fire. We do have indications that fishers are able to use some salvage logged post-fire landscapes a decade or more post-fire at least for foraging or dispersal (see *Fisher use of burned landscapes* above).

Hazard tree reduction projects post-fire also have the potential to reduce large live trees and snags that pose a threat to human safety and also may be suitable for fisher den or rest sites in a post fire landscape. Some form of hazard tree treatment occurs after the vast majority of fires unless they occur in wilderness areas. Areas with especially dense road networks or near wildland urban interface are the most heavily impacted. There are no data specific to the potential effects on fisher from such operations.

1.4 Fuels Reduction Treatments

New information since Service (2014)

There have been few studies of the effects to fishers from mechanical thinning of forests as a means of reducing the risk of severe wildfire. Garner (2013, entire) reported that fishers may tolerate fuels reduction treatments provided they focus on the reduction of surface and ladder fuels, and care is taken to maintain both canopy cover and sufficient abundance of forest structures, such as large diameter defective and standing dead trees, most likely to provide suitable rest and den sites. Fisher home ranges included larger proportions of treated areas than are found on the landscape as a whole, but when selecting microsites within their home ranges, fishers tended to avoid using sites within 200 meters of a mechanically thinned area (Garner 2013, p. ii).

The results of Sweitzer *et al.* (2016, entire) suggest some similar effects. These researchers report a modest reduction in local habitat use by fishers after disturbance from restorative fuel reduction (Sweitzer *et al.* 2016, p. 218). Fishers did not completely cease to use those areas, however; the resulting persistence rate was 0.67, and a female was observed denning in such an area (Sweitzer *et al.* 2016, p. 219). They suggested fishers may have shifted to foraging in adjacent forest habitat with less disturbance on a temporary basis, and most likely would resume using areas that had undergone restorative fuel reduction within a few years (Sweitzer *et al.* 2016, p. 220). This study also found fishers using previously burned areas, including areas that had been subjected to managed burns (see *Fisher use of burned landscapes*, above).

1.5 Stressors Related to Wildfire in Each of the Analysis Area Sub-regions

Sierra Nevada

There is evidence of increasing fire severity in yellow pine-mixed conifer forests (Miller and Safford 2012, p. 46; but see Mallek *et al.* 2013, p. 15), which comprise the majority of fisher habitat in the Sierra Nevada. This finding has been challenged by Hanson and Odion (2015), but other studies also report that fires in low and mid-elevation forests in the Sierra Nevada and southern Cascades are burning at higher severities at present as opposed to historically (Mallek *et al.* 2013, p. 1; see also Safford *et al.* 2015, entire). Mallek *et al.* (2013 and references therein, p. 17) suggest that large and severe fires in the absence of strategic forest management approaches could reduce habitat quality and population size for fishers in the southern Sierra Nevada. Because fisher habitat in this region occurs in a narrow band running north to south, fires burning at high severity within fisher habitat have the potential to disrupt north-south connectivity of habitat within the Sierra Nevada (Figures 14 and 15).

The estimate given in Appendix C (Tables 25a and 25b) shows the amount of habitat likely to be lost to fire, but does not estimate the effects of the population fragmentation that would result if connectivity is lost between the northern and southern ends of the area occupied by the SSN population of fishers. If habitat connectivity is lost to the north of the area currently used by the SSN population, this loss could prevent the population from expanding (see the Examples: 2013 Fire Season section below). In addition, if forests burned at high severity in this region are replaced by chaparral or grasslands (see above, and Climate Change section), such a change would represent a permanent loss of habitat. Low- or mixed-severity fire, on the other hand, may play an integral role in maintaining mixed conifer-hardwood forest suitable for fisher (Shatford *et al.* 2007, pp. 144–145; Donato *et al.* 2009, p. 142; Halofsky *et al.* 2011, p. 14; Baker 2014, p. 26; Cocking *et al.* 2014, pp. 94, 102–104).

Northern California – Southwestern Oregon

The fire regime in Northern California and Southwestern Oregon is historically extremely variable, as is the forest composition within this region. In forests with a large hardwood or redwood component, post-fire stump sprouting may speed the recovery of fisher habitat (Skinner *et al.* 2006, p. 184; Skinner and Taylor 2006, p. 210; Stuart and Stephens 2006, pp. 159–160). However, fisher habitat is highly fragmented in many parts of this sub-region (see Figure 2), and temporary losses of habitat may impede dispersal and increase fragmentation of the resident fisher population (Rustigian-Romsos 2013, pers. comm.).

Western Oregon Cascades

Most of the Western Oregon Cascades have a historical fire return interval of 25–200 years, and some higher elevation areas as well as the northernmost portion of the sub-region have fire return intervals longer than 200 years. Most of the Western Oregon Cascades contain large blocks of contiguous habitat.

Eastern Oregon Cascades

As in the Sierra Nevada and Coastal Oregon, high quality habitat in this region occurs mainly in a narrow band, with a few scattered outlying fragments of high quality habitat. Fires burning through this band of habitat have the potential to decrease habitat connectivity.

Coastal Oregon

The historical fire-return interval in in Coastal Oregon is relatively long, greater than 200 years. Historically, most fires here have burned at high intensity. Fisher habitat in Coastal Oregon occurs in a narrow strip, similar to the band of fisher habitat in Sierra Nevada, but is more fragmented. Severe fires that remove fisher habitat in Coastal Oregon have the potential to further disrupt habitat connectivity.

Western Washington Cascades

The Western Washington Cascades historically experienced fire even less frequently than Coastal Oregon or Washington, and as in those areas, fires were most often high-severity stand-replacing fires. The total area burned in this region is projected to increase over the long-term, though this extent will still be relatively small compared with the area burned in other sub-regions (Littell *et al.* 2010, pp. 14–15). High quality fisher habitat is relatively sparse and fragmented in this sub-region (see Figure 2).

Eastern Washington Cascades

Our habitat model for the Eastern Washington Cascades (see Figure 2) and Lewis and Hayes (2004, p. 20) shows that little high quality habitat available is in this sub-region and that the intermediate habitat is fragmented. High-severity fire occurring in this sub-region is likely to further reduce habitat availability and connectivity.

Coastal Washington

The southern portion of the Coastal Washington sub-region is very similar to Coastal Oregon in both fire regime and the spatial arrangement of fisher habitat. The Olympic peninsula has more diversity in fire regimes, and in a recent threat assessment, some fisher experts rated the threat of wildfire as a greater concern in Coastal Washington (Naney *et al.* 2012, pp. 24–25). However, there is a larger block of contiguous fisher habitat on the Olympic peninsula, and habitat connectivity is unlikely to be problematic there unless fires become extremely large, severe, and widespread in the future.

Examples: 2013 Fire Season

During the 2013 fire season, at least 25 fires of 2 km^2 (500 ac) or greater burned at least partly within high-quality or intermediate fisher habitat within the analysis area. The majority of the fires were in the Sierra Nevada and in the NCSO areas, but several fires also burned in the Eastern Oregon Cascades and Eastern Washington Cascades, and one fire complex (including at least two fires) burned habitat in the Western Oregon Cascades near the boundary with the NCSO sub-region. Fire perimeters (USDI GS 2013) are shown in Figure 13, and areas burned within high-quality and intermediate habitat are shown in Table 4. The figure and calculations for the table used fire perimeters current as of September 11, 2013.

The Rim Fire is particularly noteworthy both for its large size and for its location, which was just to the north of the current range of the SSN population (Figure 14). The Rim Fire perimeter covered approximately 655 km^2 (253 mi^2) of high-quality fisher habitat and 114 km^2 (44 mi^2) of intermediate habitat. The amount of fisher habitat burned in the Rim Fire is greater than the amount of fisher habitat burned in the entire Sierra Nevada sub-region during 2008, the year with the most extensive fires in the Sierra Nevada, when 564 km^2 (218 mi^2) of high quality and 187 km^2 (72 mi^2) of intermediate habitat burned. If the fire burned at mainly low severity within fisher habitat, the effects may be minimal. However, if the fire burned large patches at high severity, the habitat currently occupied by the SSN population may be disconnected from habitat to the north. The population may thus be unable to expand northward or to shift its range northward as many species are expected to do in response to climate change. The effect of the Rim Fire on fisher habitat requires further analysis when all fisher habitat relative to post-fire data are available.

A fire need not be as large as the Rim Fire to disrupt habitat connectivity in the Sierra Nevada if it burns at high severity in a location with already limited habitat connectivity (Figure 15). As an example, the location of the Aspen Fire highlights this possibility, as it occurred at the north end of a narrow isthmus connecting two larger blocks of high quality habitat. Because both the size and severity of fire may be increasing within fisher habitat in the Sierra Nevada, this risk is likely to increase in the future.

In the other regions, the amount of fisher habitat burned during the 2013 fire season is consistent with the amount burned during fire seasons between 1984 and 2011. In each sub-region where fires burned during 2013, the area of fisher habitat burned fell between the median and the maximum area burned per year between 1984 and 2011. Coastal Washington, Coastal Oregon, and the Western Washington Cascades did not have any major fires within fisher habitat during 2013, as was also the case during most years between 1984 and 2011.

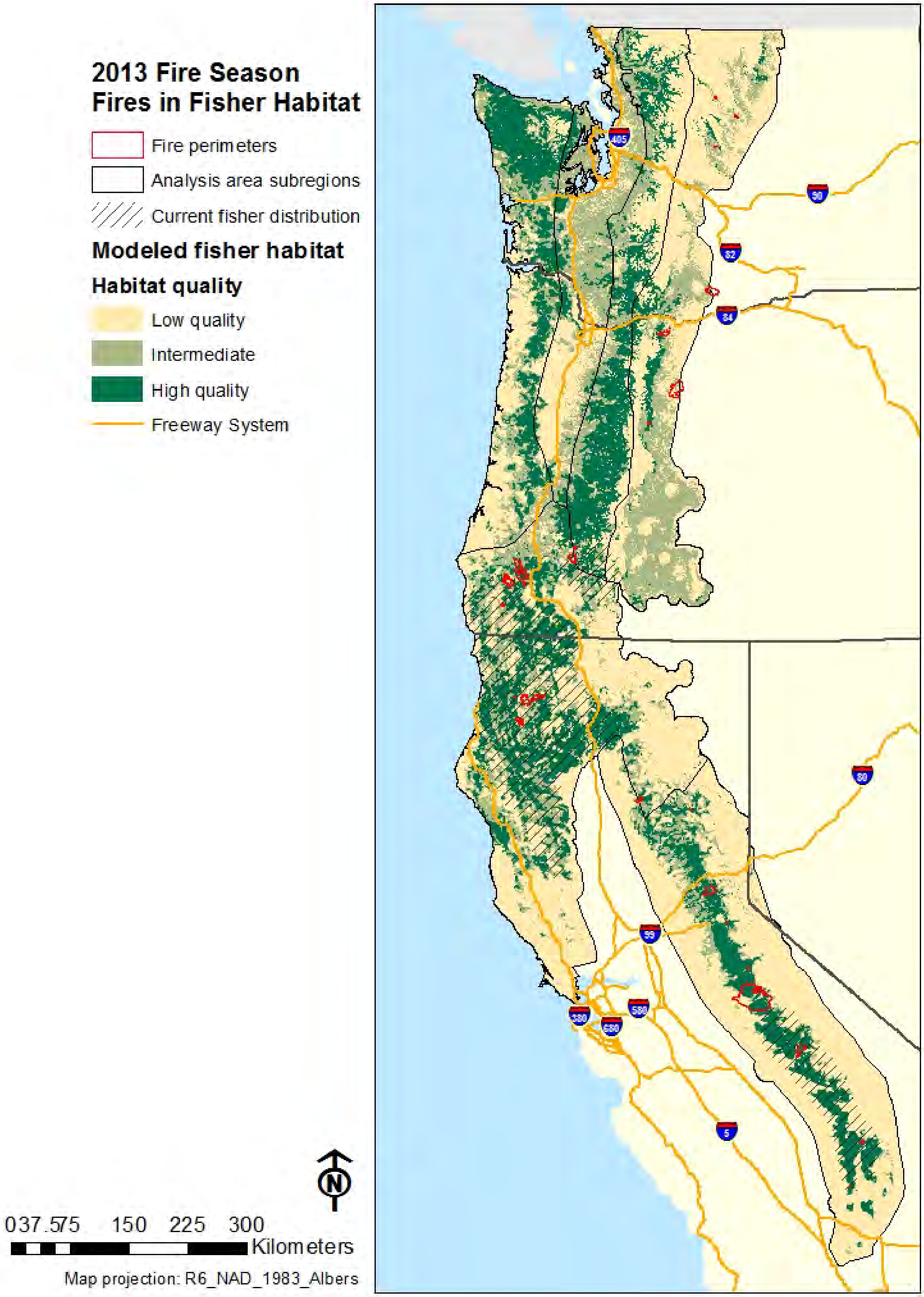

Figure 13. Fire perimeters within the analysis area for fire season 2013.

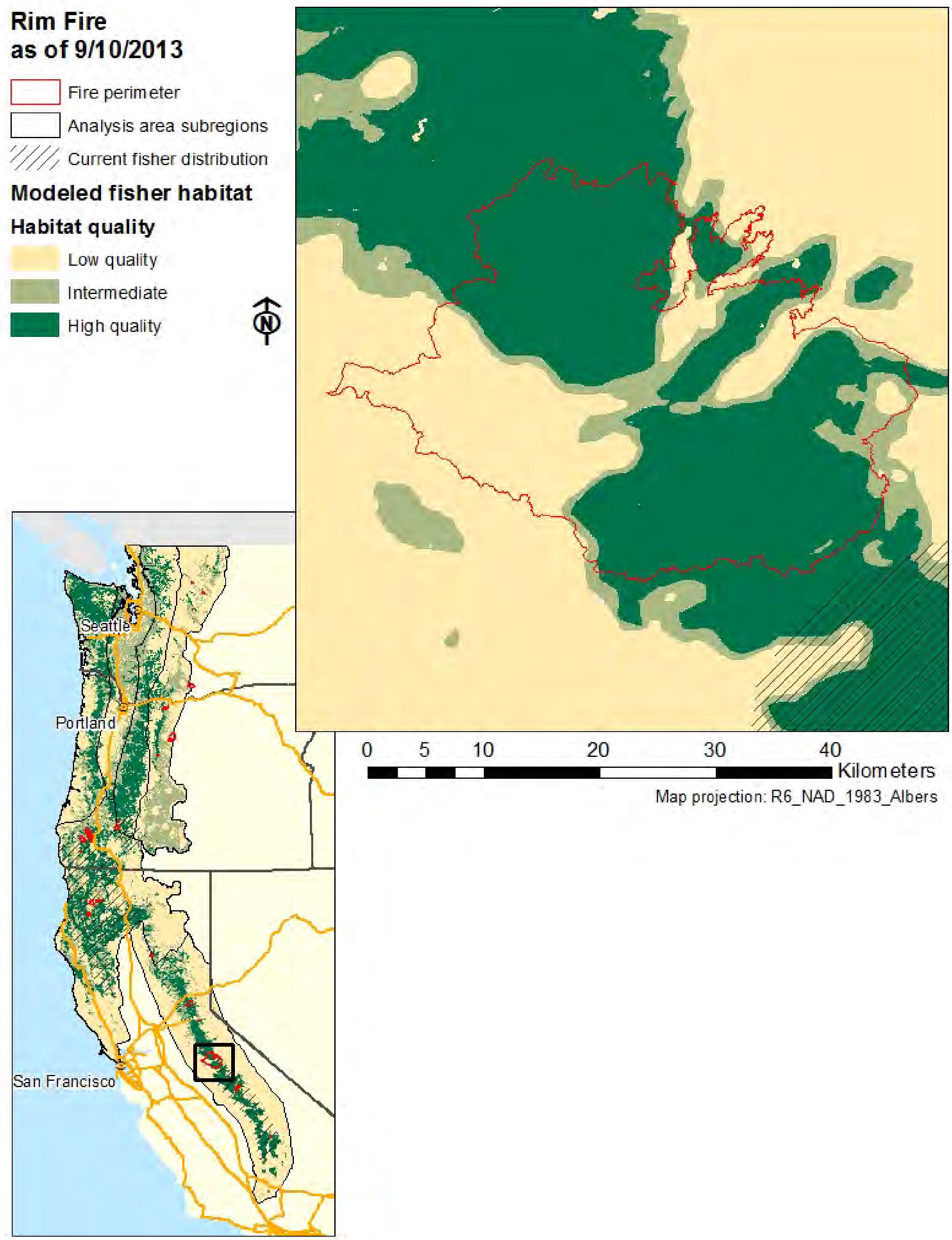

Figure 14. Inset depicts perimeter of the 2013 Rim fire as of 11 September 2013 in the Sierra Nevada. Hatch marks southeast of fire perimeter depict current distribution of the Southern Sierra Nevada fisher Population.

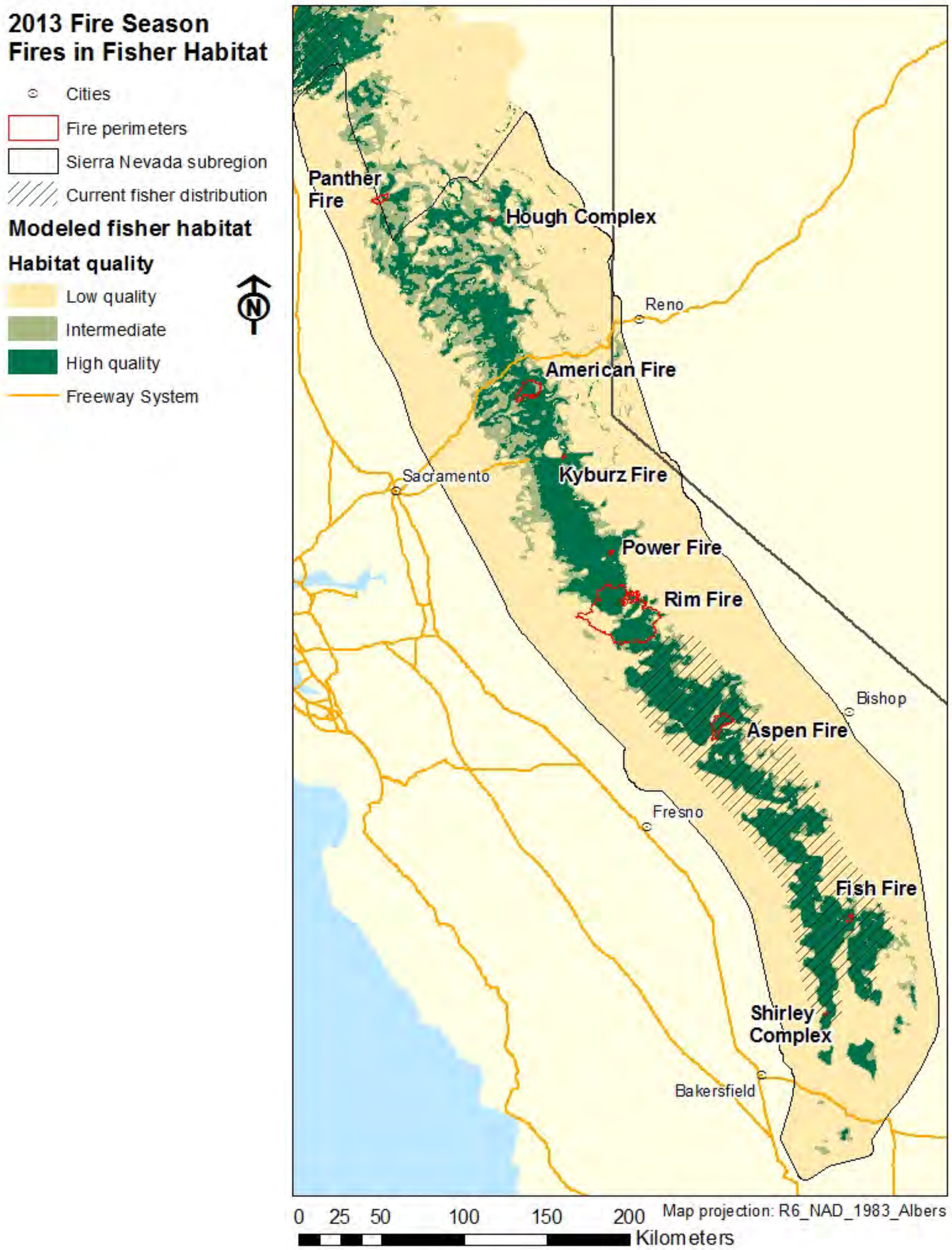

Figure 15. Sierra Nevada sub-region depicting 2013 fire perimeters as of 10 September 2013 to exemplify that the location of a fire may have impacts on habitat connectivity.

Table 4. Area (sq. km) of fisher habitat within fire perimeters during the 2013 fire season

	Fire name	High quality habitat (sq. km)	Intermediate habitat (sq. km)	Total area burned (sq. km)
All sub-regions total		**1075**	**531**	**1605**
Sierra Nevada		**840**	**151**	**991**
	Rim Fire*	655	114	768
	American Fire	89	20	109
	Aspen Fire*	78	9	86
	Fish Fire*	8	0	8
	Power Fire	4	0	4
	Kyburz Fire	2	0	2
	Shirley Complex	2	0	2
	Hough Complex	2	0	2
	Panther Fire	0	8	8
Northern California-Southwestern Oregon		**217**	**246**	**463**
	Douglas Complex	138	68	205
	Whiskey Complex	20	22	42
	Salmon Complex	20	25	44
	Corral Fire*	18	24	42
	Big Windy Complex*	12	50	62
	Butler Fire*	4	36	41
	Panther Fire	3	15	18
	Dance Fire	2	0	2
	Labrador Fire*	0	7	7
Western Oregon Cascades		**2**	**9**	**11**
	Whiskey Complex	2	9	11
Eastern Oregon Cascades		**16**	**87**	**103**
	Government Flats Complex	10	22	32
	Green Ridge Fire	6	0	6
	Sunnyside Turnoff Fire	0	65	65
Eastern Washington Cascades		**0**	**38**	**38**
	Mile Marker 28 Fire	0	27	27
	Eagle Fire	0	5	5
	25 Mile Fire	0	3	3
	Moore Point Fire	0	3	3

*Fire not contained as of 9/11/2013; final area burned may vary from area given here.

New information since Service (2014)

Results from the first 20 years of monitoring within the area covered by the NWFP include the entire fisher analysis area with the exception of the Sierra Nevada region and the eastern portions of the Eastern Oregon and Eastern Washington Cascades regions. On Federal lands, 6 percent of the older forests (classified as old-growth structural index of 80 or more ("OGSI-80")) were lost between 1993 and 2012 (this loss was offset by 3.1 percent increase due to ingrowth during that time period, for a total net change on Federal lands of -2.9 percent). Of that 6 percent loss, the majority (4.2 percent) was attributable to wildfire. However, the loss and ingrowth of OGSI-80 is variable by region. On private lands, 23.2 percent of OGSI-80 was lost in total (offset by 11.6 percent ingrowth, for a total net change on private lands of -11.7 percent), with 0.7 percent of that loss attributable to wildfire (most of the loss on private lands was due to timber harvest). In total, there was a net loss of OGSI-80 in the NWFP area of 5.9 percent. An estimated 573,900 ac of OGSI-80 were lost to wildfire between the years 1993 and 2012 on Federal and non-Federal lands within the NWFP area combined (Davis *et al.* 2015, pp. 27–28); see Table 6 in the *Vegetation Management* section for details). Similar data were not available for the southern Sierra Nevada area.

1.6 Conservation Measures that May Reduce Impacts of Fire Effects

The increasing frequency and magnitude of wildfires is recognized as a problem on both Federal and private lands throughout the western United States. As a result, both State and Federal agencies have developed and are implementing aggressive fire risk reduction programs. For example, in California the California Fire Safe Council provides wildfire prevention grants for hazardous fuels reduction on non-Federal lands, and the State Department of Forestry and Fire Protection (CAL FIRE) offers several such grant opportunities aimed at reducing the threat of wildfire effects and offers technical assistance to non-Federal landowners to design and implement fuels reduction projects. CAL FIRE additionally carries out a variety of fuels reduction projects in the State of California (*http://calfire.ca.gov/resource_mgt/resource_mgt_EPRP_FuelsTreatment*). The Oregon Department of Forestry and Washington Department of Natural Resources have similar programs dedicated to funding and technical assistance for fuels reduction projects.

The National Fire Plan, developed in 2000 by the US Department of Agriculture and the Department of the Interior (followed by the Healthy Forests Initiative of 2002), is aimed largely at reducing hazardous fuels through prescribed burns and other treatments on Federal lands. Most National Forests in the analysis area have many such projects underway; the Klamath National Forest, for example, has multiple fuels reduction projects under review or in various stages of implementation, as well as fire recovery projects (*http://www.fs.usda.gov/projects/klamath/landmanagement/projects*). The BLM, National Resources Conservation Service (NRCS), and other agencies similarly have fuels reduction projects planned or underway within the analysis area; examples include the Hellgate Recreation Area Hazardous Fuel Reduction Project and Ashland Forest All-Lands Restoration Project (*http://www.blm.gov/or/resources/recreation/rogue/rogue-haz-fuel.php; http://www.nrcs.usda.gov/wps/portal/nrcs/detail/or/programs/financial/eqip/?cid=nrcseprd355456*.)

All of these efforts are aimed at reducing the frequency, size, and severity of future wildfires within the analysis area. However, there are no published studies that evaluate whether implementation of these fuel reduction projects offset negative effects of this stressor on fishers within the analysis area.

1.7 Wildfire Conclusion

Wildfire is a natural ecological process that occurs with varying frequency and intensity throughout the range of the West Coast DPS of fisher. There are some indications that wildfire may be increasing in terms of frequency, magnitude, and severity and these projected increases are greater in California and southern Oregon than areas further north. Whether fires may be increasing in severity, is subject to continuing debate. Studies on the effects of wildfire on fisher, although limited, demonstrate a variety of both positive and negative consequences, depending on the size, severity and landscape position of the fire. If the severity and extent of the fire is such that substantial areas of canopy and large trees are lost, it may take decades for the area to support reproduction. If the fire severity is low or mixed, important habitat elements can be both created and removed within a home range, such that the burned habitat may continue to support both fisher foraging and reproduction. The degree to which fire may affect fisher populations is unknown, but all indications are that the population response would be specific to the landscape location, size, and intensity of the fire. Within the analysis area there are areas of suitable but unoccupied habitat which may or may not be accessible by extant fisher populations due to location (outside the current known distribution) or existing forested and non-forested landscape patterns. Much of the unoccupied suitable habitat occurs in the northern portion of the DPS with long fire return intervals. Based on our analysis, we consider wildfire to be a medium-level impact to fisher. The best available data indicate that the stressor is impacting habitat within the area currently occupied by populations of fisher. Therefore, we consider wildfire to be a medium-level impact to fishers currently and in the future.

2.0 Forest Insects and Tree Diseases

In most cases, the usual pattern of localized outbreaks and low density of tree-consuming insects and trees diseases are beneficial, providing structures conducive to rest and den site use by fishers or their prey. However, large area-wide epidemics of forest disease and insect outbreaks may displace fishers if canopy cover is lost and salvage and thinning prescriptions in response to outbreaks degrade the habitat (Naney *et al.* 2012, p. 36). In addressing outbreaks of the mountain pine beetle and other insects in British Columbia, Weir and Corbould (2008, pp. 161–162; 2010, pp. 408–409) state that reduction in overhead cover may be detrimental to fishers and that wide-scale salvage operation may substantially reduce the availability and suitability of remaining forests for fishers. For example, sudden oak death (*Phytophthora ramorum)* in southwestern Oregon and northwestern California could be a stressor if it spreads into areas and causes tree mortality in primary tree species used for fisher den and rest sites or tree species used as primary food sources for fisher prey. Insects and diseases that degrade habitat are not, by themselves, a significant stressor for fishers or their habitat. However, insect and tree disease outbreaks are also intricately related to wildfire and climate change. Synergies that increase the severities of these stressors are common. For example, trees damaged by wildfire or stressed by drought may be more susceptible to larger-scale outbreaks of forest insect pests and tree diseases. We evaluated those synergies in the *Climate Change* section of this report, as well as in the *Cumulative and Synergistic Effects of Stressors* section of *Stressors Related to Other Natural or Manmade Factors Affecting its Continued Existence*.

Overall, based on our current analysis, the best available information indicates there are no current outbreaks of insect or tree disease that are significantly impacting populations or the west coast DPS rangewide. Additionally, though there is potential for future impacts if an outbreak occurs, the best available information does not indicate a high likelihood of a population or rangewide impact in the future should an outbreak occur. Thus, impacts associated with forest insects and tree diseases are considered to be a low-level impact to fishers currently and in the future.

3.0 Climate Change

Our analyses include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). The term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2013, p. 1450). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (for example, temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2013, p. 1450).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring and that the rate of change has been faster since the 1950s. Examples include warming of the global climate system, substantial increases in precipitation in some regions of the world, and decreases in precipitation in other regions. (For these and other examples, see IPCC 2007, p. 30; and Solomon *et al.* 2007, pp. 35–54, 82–85.) The IPCC characterizes warming of the global climate system as "unequivocal" (IPCC 2013, p. 4), and reports that human influence has been detected in warming of the atmosphere and ocean, changes in the global water cycle, reductions in snow and ice, global mean sea level rise, and changes in some climate extremes (IPCC 2013, p. 17, Figure SPM.6, Table SPM.1; see also). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-twentieth century cannot be explained by natural variability in climate, and it is "extremely likely" (defined by the IPCC as 95 to 100 percent probability) that this change is due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities and other anthropogenic forcings (IPCC 2013, p. 17 and Figure SPM.6; Solomon *et al.* 2007, pp. 21–35). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011, p. 4), who concluded that it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (for example, Meehl *et al.* 2007, entire; Ganguly *et al.* 2009, pp. 15555, 15558; Prinn *et al.* 2011, pp. 527, 529). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2035 or mid-century (for example, IPCC 2013, pp. 955–956, 1037; IPCC 2014, p. 57). Although projections of the magnitude and rate of warming differ after about mid-century, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the twenty-first century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (Meehl *et al.* 2007, pp. 760–764 and 797–811; Ganguly *et al.* 2009, pp. 15555–15558; Prinn *et al.* 2011, pp. 527, 529; IPCC 2013, pp. 44–45. See IPCC 2013, entire, for other global projections of climate-related changes, such as frequency of heat waves and changes in precipitation). Long-term predictions of climate change effects vary depending upon alternative emissions scenarios, which in turn vary over a wide range depending on both socioeconomic development and climate policy; thus, uncertainty increases in the predicted magnitude of potential effects after mid-century (IPCC 2013, pp. 1035–1040; IPCC 2014, p. 56). For this reason, as described in the section **Classification of Stressors** *–Timing (Immediacy) of the Stressor*, for the purposes of making reliable predictions about both the direct and indirect effects of climate change on the West Coast DPS of fisher, we conclude that the near-term predictions supported by wide agreement across both models and emissions scenarios provide the most reasonable scientific basis for our evaluation. We estimated approximately 40 years as a reasonable period of time for reliably forecasting such effects.

Various changes in climate may have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time depending on the species and other relevant considerations, such as interactions of climate with other variables (for example, habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19). Identifying likely effects often involves aspects of climate change vulnerability analysis. Vulnerability refers to the degree to which a species (or system) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the type, magnitude, and rate of climate change and variation to which a species is exposed, its sensitivity, and its adaptive capacity (IPCC 2007, p. 89; see also Glick *et al.* 2011, pp. 19–22). There is no single method for conducting such analyses that applies to all situations (Glick *et al.* 2011, p. 3). We use our expert judgment and appropriate analytical approaches to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Global climate projections are informative, and in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (for example, IPCC 2007, pp. 8-12). For example, in analyzing the potential effects of climate change on tree mortality, Allen *et al.* (2015, p. 22) specifically warn that “many forest responses will be site- and region-specific, so it is important to be cautious about overgeneralizing.” We therefore use “downscaled” projections when they are available, and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (see Glick *et al.* 2011, pp. 58–

61, for a discussion of downscaling). With regard to our analysis for the West Coast range of the fisher, downscaled projections are available in some cases, as are some regional climate models, which provide higher resolution projections using a modeling approach that differs from downscaling.

Most reports discussing downscaled or regional projections of climate change for California and the Pacific Northwest use a suite of climate models along with two different emissions scenarios. The exact suite of models and scenarios varies among reports, but the climate models generally encompass a range of sensitivities to climate scenarios, and the emissions scenarios usually include a lower-emissions scenario along with a medium to high-emissions scenario. The differences between higher- and lower-emissions scenarios are minimal in the next few decades, but become increasingly pronounced after the mid-twenty-first century, thereby leading to greater uncertainty in projections beyond that timeframe (Cayan *et al.* 2009, p. 7; Mote and Salathé 2010, p. 39). However, the current emissions trajectory is higher than any of the emissions scenarios used in climate projections for California and the Pacific Northwest (Hansen *et al.* 2013, pp. 1–2). Therefore, the projections we discuss here may underestimate the potential effects of climate change. We note that although these projections are downscaled from the global projections, they do not capture the variation that occurs on the much finer local scale at which fishers select and use their environment.

3.1 Temperature

Historical records show increases in temperature throughout the analysis area over the last century. Weather stations in the Pacific Northwest showed a warming trend of approximately 0.8 degrees Celsius (ºC) (1.4 degrees Fahrenheit [ºF]) per century during the period from 1920–2000 (Mote *et al.* 2010, p. 17). All but two years since 1998 have had temperatures above the 20th century average (Mote *et al.* 2013, p. 28). In the Columbia Basin, which covers large portions of the analysis area in Washington and Oregon, average temperatures rose by 1 ºC (1.8 ºF) between 1950 and 2006 (Littell *et al.* 2011, pp. 9–11). In California, average temperatures rose by 0.36 ºC to 0.92 ºC (0.65 ºF to 1.7 ºF) between 1950 and 1999, with several datasets showing no recent temperature change in the vicinity of Mount Shasta, but relatively large amounts of warming in the Sierra Nevada (Bonfils *et al.* 2008, p. S49 and Fig. 1).

All simulations project a larger increase in temperature across the analysis area over the twenty-first century than occurred during the twentieth century. Projections for temperature increases across the analysis area range from 1 ºC to 3 ºC (1.8 ºF to 5.4 ºF) by mid-century and from 2 ºC to 5.8 ºC (3.6 ºF to 10.4 ºF) by late in the twenty-first century (Mote *et al.* 2013, p. 34; Pierce *et al.* 2013b, p. 844; Cayan *et al.* 2012, p. 4; Halofsky *et al.* 2011, p. 14; Mote and Salathé 2010, p. 41; Hayhoe *et al.* 2004, p. 12423). Some higher-emissions scenarios were not analyzed in these studies and would likely result in greater warming outside the range reported above (Mote and Salathé 2010, p. 41). Summer temperatures are projected to increase more than winter temperatures (Pierce *et al.* 2013b, p. 845; Cayan *et al.* 2012, p. 8; Mote and Salathé 2010, pp. 41–42; Salathé *et al.* 2010, pp. 65–66; Barr *et al.* 2010a, p. 8; Koopman *et al.* 2010, p. 8; see Table 5).

Table 5: Projected increases in average seasonal temperature due to global climate change (winter and summer). Note that some of these projections extend beyond the time frame of approximately 40 years.

Reference	Location	Winter	Summer
Pierce *et al.* 2013b, p. 845	California	<2 ºC by 2060 (3.6° F)	~3 ºC by 2060 (5.4° F)
Cayan *et al.* 2012, p. 8	California	1 ºC to 4 ºC by 2100 (1.8° F to 7.2° F)	1.5 ºC to 6 ºC by 2100 (2.7° F to 10.8° F)
Koopman *et al.* 2010, p. 8	Upper Fresno County Region	1.2 ºC to 2.3 ºC by 2040s (2.2° F to 4.1° F)	1.2 ºC to 3.3 ºC by 2040s (2.2° F to 6.0° F)
	(Southern Sierra Nevada)	2.3 ºC to 4.4 ºC by 2080s (4.1° F to 7.9° F)	3.2 ºC to 6.1 ºC by 2080s (5.8° F to 11.0° F)
Barr *et al.* 2010b, p. 9	Klamath Basin	1.0 ºC to 2.0 ºC by 2040s (1.7° F to 3.6° F)	1.2 ºC to 2.7 ºC by 2040s (2.2 ºF to 4.8 ºF)
		2.1 ºC to 3.6 ºC by 2080s (3.8° F to 6.5° F)	3.2 ºC to 6.6 ºC by 2080s (5. 8 ºF to 11.8 ºF)
Mote and Salathé 2010, p. 41	Pacific Northwest	1.6 ºC to 1.9 ºC by 2040s (2.9° F to 3.4° F)	1.9 ºC to 2.7 ºC by 2040s (3.4° F to 4.9° F)
		2.7 ºC to 3.3 ºC by 2080s (4.9° F to 5.9° F)	3.0 ºC to 4.6 ºC by 2080s (5.4° F to 8.3° F)
Barr *et al.* 2010a, p. 8	Deschutes River Basin	1.1 ºC to 2.4 ºC by 2040s (1.9° F to 4.3° F)	1.2 ºC to 2.7 ºC by 2040s (2.2° F to 4.9° F)
	(Central Oregon Cascade Range)	2.7 ºC to 4.3 ºC by 2080s (4.9° F to 7.7° F)	3.8 ºC to 7.3 ºC by 2080s (6.8° F to 13.2° F)
Doppelt *et al.* 2009, p. 5	Upper Willamette Basin	0.5 ºC to 1 ºC by 2040s (1° F to 2° F)	2 ºC to 3 ºC by 2040s (4° F to 6° F)
	(Western Oregon Cascade Range)	1.5 ºC to 3 ºC by 2080s (3° F to 6° F)	4 ºC to 7.5 ºC by 2080s (8° F to 13° F)
Doppelt *et al.* 2008, p. 5	Upper Rogue Basin	0.5 ºC to 1 ºC by 2040s (1° F to 2° F)	2 ºC to 3 ºC by 2040s (4° F to 6° F)
	(Southwestern Oregon)	1.6 °C to 3.3 °C by 2080s (3°F to 8 °F)	3.8 °C to 8.3 °C by 2080s (7 °F to 15 °F)

Trends likely will vary across the analysis area. In California and in Washington, models project a smaller temperature increase in coastal regions and a larger increase in the interior (Pierce *et al.* 2013b, p. 844; Cayan *et al.* 2012, p. 7; Salathé *et al.* 2010, pp. 65–66). For example, Pierce *et al.* (2013b, p. 844) projected an increase of 2.6 ºC by 2060 for inland California, but only a 1.9 ºC increase for the same time period along the California coast. In consequence, the SSN population is likely to experience greater warming than the NCSO population or the Olympic Peninsula Reintroduced Population. In all areas, heat waves are projected to increase in intensity and duration, especially under a higher-emissions scenario (Pierce *et al.* 2013b, p. 848; Cayan *et al.* 2012, p. 10; Salathé *et al.* 2010, p. 69; Tebaldi *et al.* 2006, pp. 191–200; Hayhoe *et al.* 2004, p. 12423), and this effect may be especially pronounced in the southwestern Olympic Peninsula and in inland California (Pierce *et al.* 2013b, p. 848; Halofsky *et al.* 2011, p. 15; Salathé *et al.*

2010, p. 69; Tebaldi *et al.* 2006, Fig. 3). See the *Direct climate effects to fishers* section below for information on how temperature increases are likely to affect fisher.

3.2 Precipitation

Historical precipitation trends are mixed (Mote *et al.* 2010, p. 17). In the Northwest, annual precipitation has been 16 percent more variable since 1970 than it was from 1895 to 1970, and the past 40 years have included both the wettest and driest years on record (Mote *et al.* 2013, p. 29). In the portion of the Columbia Basin within the analysis area, approximately 23 weather stations reported increases (four of them statistically significant) in precipitation between 1950 and 2006, although eight stations reported statistically insignificant decreases (Littell *et al.* 2011, p. 11 and Fig. 2.3). In California, precipitation increased between 1900 and 2006 at sites along one transect in the southern Cascades and two transects in the Sierra Nevada (Tingley *et al.* 2012, p. 3281).

There is considerable variation in the projections of future precipitation trends (Pierce *et al.* 2013a, entire), but most simulations show a north-south gradient across the region, with increasing precipitation along the northern coast of Washington and smaller increases or an overall drying trend for California (Littell *et al.* 2011, p. 74; Christensen *et al.* 2007, p. 890; Hayhoe *et al.* 2004, p. 12424 and Fig. 11; Ault *et al.* 2014, p. 7534, Figure 4). Nearly all simulations show a strong decrease in summer precipitation across the entire region, and many show an increase in winter precipitation, especially in Oregon and Washington (Mote *et al.* 2013, p. 35; Pierce *et al.* 2013b, p. 849; Cayan *et al.* 2012, pp. 13–20; Halofsky *et al.* 2011, p. 15; Mote and Salathé 2010, pp. 42–43). In California and southwestern Oregon, most simulations show a decrease in total yearly precipitation (Cayan *et al.* 2012, pp. 14–17), whereas in Washington and northern Oregon, simulations on average show little change in total yearly precipitation because drier summers are offset by wetter winters (Halofsky *et al.* 2011, p. 15 and p. 24; Mote and Salathé 2010, p. 41).

Precipitation trends likely will vary in particular parts of the analysis area. For example, coastal northwestern California and the western Sierra Nevada may see particularly marked decreases in precipitation (Hayhoe *et al.* 2004, p. 12424 and Fig. 6), whereas the Shasta region of California may experience wetter or more variable conditions (Cayan *et al.* 2009, p. 14). Farther north, winter precipitation may decrease in the Olympic Mountains and the Cascade Range, in contrast to the rest of Oregon and Washington (Halofsky *et al.* 2011, p. 16; Salathé *et al.* 2010, p. 61).

Precipitation extremes may become more frequent. In the Northwest, both the length of dry spells and the number of extremely wet days are likely to increase (Mote *et al.* 2013, p. 38). In California, the number of dry days is likely to increase, and some scenarios show an increase in the length of dry spells, while at the same time the intensity of precipitation events will likely also increase (Pierce *et al.* 2013a, p. 18; Cayan *et al.* 2009, p. 45; Hayhoe *et al.* 2004, Figs. 9–10). Some researchers forecast an increased risk of prolonged drought across the analysis area, with the probability of such events generally increasing from north to south (Ault *et al.* 2014, Figs. 8–13). The severity of drought in California, in particular, is predicted to increase substantially late in the 21st century (Cook *et al.* 2015, Figure 1, pp. 4, 6). Extensive areas of drought-killed trees have recently been observed through aerial surveys in the Sierra Nevada of

California (USFS 2015, unpublished data). Extreme high precipitation may increase along the northern California coast, on the southwestern Olympic Peninsula, and in the northern Cascades (Pierce *et al.* 2013b, p. 852; Halofsky *et al.* 2011, p. 15, Salathé *et al.* 2010, pp. 70–72, Tebaldi *et al.* 2006, Fig. 3).

Over the past 50 years, warming temperatures have led to a greater proportion of precipitation falling as rain rather than snow, earlier snowmelt, and a decrease in snowpack, especially in spring (reviewed in Halofsky *et al.* 2011, p. 21). These trends are likely to continue (Cayan *et al.* 2012, pp. 20–21; Littell *et al.* 2011, p. 60; Salathé *et al.* 2010, pp. 66–68; Hayhoe *et al.* 2004, p. 12423). Even if precipitation increases overall, the combination of warmer temperatures, shorter wet seasons, and decreased snowpack is likely to create drier conditions and an increased water deficit in forests of California and the Pacific Northwest by the 2040s (with localized exceptions in portions of the western Washington Cascades and Olympic mountains); that is, forests will lose more water to transpiration than they will gain from precipitation (Littell *et al.* 2013, p. 112; Cayan *et al.* 2012, p. 20; Halofsky *et al.* 2011, p. 17–20; Littell *et al.* 2011, p. 62). Increased water deficit is expected to decrease seedling establishment and tree growth; increase tree mortality, insect damage, and area burned; and alter tree species distributions (Littell *et al.* 2013, p. 112). In addition, loss of snowpack decreases albedo (incident light or radiation reflected by a surface), which can lead to an amplification of warming effects beyond those projected by downscaled climate models (Salathé *et al.* 2010, p. 64). As discussed in the section "Habitat Associations," above, some studies suggest that fishers tend to occupy areas with low or relatively lower snowfall (for example, Aubry and Houston 1992, p. 75; Krohn *et al.* 1997, p. 226), so a decrease in snowpack as a consequence of climate change could make more habitat available to fishers in the winter, as long as the habitat remains otherwise suitable (Krohn *et al.* 1997, entire). Some recent modeling efforts have projected a possible increase in suitable fisher habitat as a consequence of a warming climate and reduced snowpack; see, for example, the results of Olson *et al.* (2014, entire) in the <u>Summary of new information regarding climate change effects on fisher habitat</u> section below.

<u>3.3 Climate change effects on fisher habitat</u>

Climate change could potentially affect fisher habitat by altering the structure and tree species composition of forests within the analysis area and also through changes to the habitat of prey communities. Some of these effects could be negative, such as loss of rest and den structures resulting in decreased reproductive rates, altered behavioral patterns, or range shifts. Some effects could be positive, such as increased abundance of prey in response to vegetation changes or reduced snowpack. Alternatively, some of these effects could be essentially neutral. For example, a shift toward a greater hardwood component in what is now primarily conifer forest may not necessarily have negative impacts on fisher (as discussed below), and there are studies indicating that fisher prey species are likely to move upward in elevation as temperatures increase (Moritz *et al.* 2008, entire), thus maintaining a potential prey base even as vegetation shifts (although Schloss *et al.* (2012, entire) suggest that some mammals with poor dispersal abilities may be more limited in this regard). Importantly, although predictions of vegetation changes as a result of climate change abound, it is less clear how or at what rate those transitions may occur over time. However, Littell *et al.* (2010, p. 147) projected that the transitions will be driven more by disturbance (for example, fire, forest insects, and pathogens) than by gradual changes in vegetation populations as a result of life-history characteristics and phenology. See also the results from Ettinger and HilleRisLambers (2013) under the Summary of new information regarding climate change effects on fisher habitat section below.

Climate modeling and projections are done at a large scale and effects to species can be complex and unpredictable, given the ecological interactions among biotic and abiotic factors (Lawler *et al.* 2012 p. 396). For example, climate data sets and subsequent predictions of vegetation changes do not capture fine-scale topography and the smaller scale effects of slope, aspect, and elevation, nor do they capture how these may shape local climates and vegetation trends (Lawler *et al.* 2012, p. 385). Thus, interpretations of projected climate change effects, especially at local scales, must be tempered by these uncertainties.

Two studies have made projections for future range shifts specifically for fishers (Lawler *et al.* 2012, entire; Burns *et al.* 2003, entire; but also see Olson *et al.* 2014 in the Summary of new information regarding climate change effects on fisher habitat section below), and other studies have projected vegetation changes that overlap with the assessment area (Halofsky *et al.* 2011, pp. 68–73; Gonzalez *et al.* 2010, entire; Shafer *et al.* 2010, pp. 180–181; Lenihan *et al.* 2008a, entire; Hayhoe *et al.* 2004, entire; Lenihan *et al.* 2003, entire). Other studies have projected changes in fire frequency, forest disease, and insect damage, and other disturbance events that could affect fisher habitat quality or availability (Lawler *et al.* 2012, pp. 386–388; Halofsky *et al.* 2011, p. 67, Shafer *et al.* 2010, p. 183). In addition to effects on habitat, climate change may affect fisher directly by affecting thermoregulation, as will be discussed in the **Stressors related to other natural or manmade factors affecting its continued existence** section below. Climate change may also affect fishers' disease infection rates; this effect is discussed below in the **Cumulative and Synergistic Effects** section below.

In an effort to predict the effects of climate change on fisher habitat, Lawler and colleagues (2012, pp. 382–388) overlaid the fisher's current range within California on maps produced by Lenihan *et al.* (2003, entire; 2008a, entire) of vegetation types, fire frequency, and fire intensity, projected for the years 2071–2100. For the Klamath region, these models projected a shift from conifer to hardwood-dominated mixed forests and woodlands, accompanied by more frequent but less intense large fires, by the end of the twenty-first century (Lawler *et al.* 2012, pp. 385–386.). Since fishers in California already use mixed conifer-hardwood forests, so a shift toward this forest type is unlikely to be harmful. However, it is not clear if populations locally adapted to a particular vegetation type would readily adapt to a different type, even if conspecifics use it elsewhere. An overall shift toward woodland, however, is considered to represent a loss of habitat (Lofroth *et al.* 2010, pp. 81–121). For the southern Sierra Nevada, the same models also projected a similar shift toward hardwood-dominated mixed forests and woodlands, and toward more-frequent fires; however, unlike the Klamath region, the Sierra Nevada was projected to see an increase in grassland and shrubland, and portions of the current fisher range are projected to experience increased fire severity (Lawler *et al.* 2012, pp. 386–388). In the most extreme climate scenario, more than half of the area currently occupied by fishers in the southern Sierra Nevada was projected to convert to grassland, shrubland and woodland, with less than 10 percent of the landscape remaining in conifer forest by 2100 (Lawler *et al.* 2012, p. 388). In contrast, a different study used vegetation models to project range shifts due to climate change, and projected that fishers would remain present in the Yosemite area, even though they are one of the most climate-change sensitive carnivores in a nationwide dataset (Burns *et al.* 2003, p. 11476).

Other studies have made projections of vegetation shifts without specific reference to fisher habitat. Hayhoe *et al.* (2004, Fig. 17) included an analysis similar to those of Lenihan *et al.* (2003, entire; 2008a, entire), using different climate models and emissions scenarios, and came to similar conclusions for both the Klamath region and the Sierra Nevada, as did another study of the Klamath Basin (Barr *et al.* 2010b, pp. 8–9). Koopman *et al.* (2010, pp. 21–22) used a similar analysis for a subset of the Sierra Nevada region with still another set of climate models and projected that the Sierra Nevada will maintain conditions suitable for conifer forests, although the species composition may change. Gonzalez *et al.* (2010, Fig. 4) assessed vulnerability to climate-related biome change at a global scale. Their maps identify the Sierra Nevada as an area of high vulnerability to climate-driven change in vegetation type (for example, conversion of conifer forest to grassland [Gonzalez *et al.* 2010, Fig. 3]), in contrast to the Pacific Northwest, which they identify as an area of low vulnerability.

In contrast, a study of the California Floristic Province projected that both the southern Sierra Nevada and the Klamath region (along with the California Coast Range, in simulations showing larger climate changes), will act as climate refugia over the next 75 years for a variety of endemic plant species (Loarie *et al.* 2008, p. 4 and Fig. 4). If the same climate parameters are important to fishers and fisher habitat as to endemic plant species, this study implies that all areas currently occupied by native fisher populations will likely remain in climate refugia. However, not all species will find climate refugia in the same locations. A study of future distributions of breeding land birds in California projected relatively severe losses of up to 9.5 percent of bird diversity from parts of the Sierra Nevada and Klamath regions (Wiens *et al.* 2009, Figures 2 and 4). Since fishers often prey upon birds (Lofroth *et al.* 2010, p. 162), the loss of bird diversity may affect fishers even if the habitat otherwise remains suitable for them.

In Washington and Oregon, as in California, models suggest changes in forest type and area, but there is variation among bioregions and among models within bioregions. In Coastal Washington and Oregon and the Western Oregon Cascades, conifer forest is expected to decrease in area, and mixed evergreen and deciduous forests are projected to increase, though the area affected by this change varies greatly depending on the climate model used (Littell *et al.* 2013, p. 115; Halofsky *et al.* 2011, pp. 68–73; Shafer *et al.* 2010, pp. 180–181; Doppelt *et al.* 2009, p. 7; Lenihan *et al.* 2008b, p. 20; Rehfeldt *et al.* 2006, p. 1143). The range of Douglas-fir, currently a dominant tree species in much of the Pacific Northwest, is projected to contract in Coastal Washington and Oregon, and in some areas of the Cascades in Washington and northern Oregon, with 32 percent of its current range in Washington projected to become climatically unfavorable by 2060 (Littell *et al.* 2013, pp. 113–114; Littell *et al.* 2010, pp. 11–12; Whitlock *et al.* 2003, p. 16). In the Eastern Washington and Oregon Cascades, montane forest is projected to expand, while conifer forest types currently found at higher elevations will likely contract (Barr *et al.* 2010a, pp. 16–17; Rehfeldt *et al.* 2006, p. 1144). Although eastern Cascades forests may increase in extent, trees within these forests are likely to experience decreased growth rates (Littell *et al.* 2013, p. 120). As in California, it is not clear how these changes in forest type, species composition, or growth rates will affect the availability of fisher habitat or its ability to support fisher populations. In parts of the Eastern Washington Cascades and small areas of the

Western Washington Cascades, some models project that conifer forest may decrease in favor of woodland; in parts of the Western Oregon Cascades, conifer forest may decrease in favor of woodland or deciduous hardwood forest (Littell *et al.* 2013, p. 115; Doppelt *et al.* 2009, p. 7). Woodland, as described by Littell *et al.* (2013, p. 115) and Doppelt *et al.* (2009, p. 7), does not provide suitable fisher habitat, and fishers within the analysis area are not know to use deciduous hardwood forests. Fishers are known to utilize mixed hardwood-conifer forests, however, and in regions where both hardwoods and conifers occur, fishers tend to select hardwoods for reproductive dens, even when hardwoods represents a relatively minor component of the forest community, possibly due hardwoods' propensity to develop heartwood decay and cavities (Lofroth *et al.* 2010, p. 115). As discussed in the **Habitat Associations** section above, the physical structure of the forest and prey availability are thought to be the key features that explain fisher habitat use, as opposed to specific forest types (for example, Buskirk and Powell 1994, p. 286), which may serve to buffer fishers to some extent from the potential consequence of tree species range shifts in response to climate change.

3.4 Summary of new information regarding climate change effects on fisher habitat

Olson *et al.* (2014, entire) examined how dispersal ability and patch size may affect fisher distribution in response to climate change, modeling future habitat availability for fisher using a global climate model and two greenhouse gas emissions scenarios – A2 (high emissions) and B2 (reduced emissions) – at three time steps: 2030, 2060 and 2090. Although their geographic area of focus was the Rocky Mountains (western Montana and northern Idaho), the authors specifically note the similarity of fisher habitat in this area to that in Oregon and Washington (Olson *et al.* 2014, p. 95). The probability of fisher occurrence was highest in association with mesic forest types characterized by tall trees (25–50 m (82–164 ft), in turn highly correlated with canopy cover), high annual precipitation, and moderate winter temperatures (Olson *et al.* 2014, p. 93). Predictions of future fisher distribution with unimpeded dispersal and no limits on patch size projected an increase in fisher habitat relative to current conditions under the A2 scenario: a 12.1 percent increase by 2030, 21.4 percent increase by 2060, and 24.5 percent increase by 2090. Future fisher habitat was also predicted to increase, although to a lesser degree, in response to the B2 lower emissions scenario. In addition, suitable fisher habitat was predicted to shift northward (Olson *et al.* 2014, p. 93). When limitations were placed on both dispersal and patch size, increases were still forecast under most conditions for the A2 scenario (for example, dispersal distances unlimited, 10 km (6.2 mi), or 4 km (2.5 mi)), but not for B2 (Olson *et al.* 2014, pp. 94, 97). Differences in dispersal ability played a greater role in limiting future habitat availability than did minimum patch size in most cases. With a minimum patch size (125 km^2 (48.3 mi^2)), the total amount of future habitat gain for fishers was reduced when the dispersal distance was less than 4 km (2.5 mi) per time step. However, the amount of available fisher habitat was still projected to increase by 2090 under the A2 scenario if fishers have dispersal abilities between 4 km (2.5 mi) and 10 km (6.2 mi) (Olson *et al.* 2014, p. 97), which is well within observed dispersal distances for fishers (see the **Dispersal** section above). Although the total area of suitable habitat is projected to increase over time, that increase may not necessarily represent contiguous suitable habitat. While fishers may be capable of relatively long distance dispersal movements, habitat fragmentation and the challenges of moving through areas of intervening unsuitable habitat may prevent them from successfully doing so; a dispersal limit of 1 km through unsuitable habitat and a minimum patch size yields a loss of 25.8 percent of fisher habitat by 2090 (Olson *et al.* 2014, pp. 96–97).

It has been suggested that fishers avoid areas with deep snow pack, that snow depth may limit fisher dispersal, and that moving through deep snow may be energetically costly for fishers (Olson *et al.* 2014, p. 96, and references therein). Olson *et al.* (2014, p. 96) suggest that these observations are consistent with their results, which indicate that fisher prefer areas with high levels of precipitation in milder climates. In addition, they note that a shift in climate that results in lower snowpack may assist the dispersal of juvenile fishers, since they disperse in winter and snowpack may be limiting (Olson *et al.* 2014, p. 96). Taking all of these considerations into account, the authors conclude that predicted increases in precipitation and modulation of cold winter temperatures will result in greater area of wet, maritime-like forests and lower snowpack that fisher appear to prefer and that fishers may therefore benefit from climate warming. However, they caution that while their model predicts an expanded fisher distribution under future climate warming scenarios, this expanded distribution is dependent upon the capability of fishers to regularly achieve dispersal distances greater than 4 km through unsuitable habitat (Olson *et al.* 2014, pp. 96–97).

Spencer *et al.* (2015, entire) also investigated the effects of climate and vegetation change on fisher distribution, but here the study was specific to the Sierra Nevada. They projected the future distribution of fishers based on vegetation change projections and downscaled multiple general circulation models (GCM), emission scenarios, and resolutions. Their assessment of the species' present distribution supports previous findings that fishers select structurally complex forests with dense canopies, large trees, and abundant deadwood structural elements, as well as that fishers prefer areas with lower snowpack (Spencer *et al.* 2015, pp. 140, 143–144). Predicted changes in fisher distribution were best described by a combination of climate and vegetation variables (Spencer *et al.* 2015, p. 140), but the response of fishers to future modeled conditions were inconsistent. By the end of the century, depending on the emissions scenario, net changes in predicted fisher distribution ranged from a 33 percent loss to a 38 percent gain. Mid-century predictions (2046–2065) ranged from an 11 percent loss to a 14 percent gain, with 50 to 62 percent of the range remaining stable over that time period. Predicted geographic and elevation shifts were similarly inconsistent, with models projecting both upslope and downslope movements (Spencer *et al.* 2015, p. 143 and Table 9.6, Figures 9.3–9.5). The researchers point to the large uncertainties about future climate and vegetation conditions in the Sierra Nevada; although climate models are in agreement over the general warming trend, there is great variability in precipitation projections, and the predicted conditions differ depending on the GCM and emission scenario used (Spencer *et al.* 2015, p. 146). The response of fishers to these potential changes is similarly uncertain. For example, the authors suggest that although decreasing snow cover may benefit fishers, increasing temperatures and temperature variability are likely detrimental (Spencer *et al.* 2015, p. 146). Model projections for fisher response to future climate and vegetation conditions show either distribution expansions or contractions, and the authors conclude that it remains unknown whether fishers will move to stay within their preferred climate envelope (assuming the availability of appropriate forest structural conditions). They also note that despite their use of downscaled projections, microclimatic conditions that may provide refugia may not be captured at the scale of their models (Spencer *et al.* 2015, p. 147).

On a global level, substantial debate remains regarding future tree mortality risks as a consequence of climate change. Allen *et al.* (2015) present an exhaustive review of recent research, contrasting on the one hand those studies that point to *greater* vulnerability of forests, particularly to predicted hotter drought conditions (Allen *et al.* 2015, pp. 5–6, 9), with studies identifying compensatory factors suggesting potential *lesser* vulnerability to tree mortality during hotter drought (Allen *et al.* 2015, pp. 7–8, 9). Taking all of these studies into account, the researchers conclude that the future vulnerability of forests globally is underestimated, including the vulnerability of forests in wetter regions (Allen *et al.* 2015, p. 26). Similarly, McDowell and Allen (2015, p. 669) predict that drought and heat-induced tree mortality will increase as a consequence of climate warming. They also suggest that tall trees of old-growth forests, and conifers in particular, are at the greatest risk of loss globally (McDowell and Allen 2015, pp. 669–670).

Although many models project vegetation changes out to the end of the 21st century, there are questions as to how quickly species range shifts may actually occur on the landscape. Ettinger and HilleRisLambers (2013, entire), for example, studied range shift dynamics in a closed-canopy conifer forest, a habitat type that would be suitable for fisher. They predicted that changes in the tree populations in response to a warming climate would likely be small, due to weak climate sensitivity in tree performance in closed-canopy forests (Ettinger and HilleRisLambers 2013, p. 1351 and Figure 3). In addition, they noted that turnover in forest composition due to climate change is likely to be delayed because of the population dynamics in relatively long-lived tree species. These researchers conclude that forest turnover in association with climate change is likely to be slow, and "rapid dramatic responses to climate change may be the exception, rather than the rule" (Ettinger and HilleRisLambers 2013, p. 1351). They note two caveats to this conclusion: one, reaching a "climatic tipping point" may lead to a relatively sudden range shifts (for example, if the species in question is especially sensitive to drought stress); and two, if other indirect effects of climate change come into play (for example, if widespread tree mortality should occur all at once, as from a fire or disease outbreak), the rate of species turnover could be accelerated (Ettinger and HilleRisLambers 2013, pp. 1351–1353).

Loehle (2011, entire) suggests that in some respects the future adverse impacts of climate change have likely been overestimated. With regard to potential future geographic shifts in vegetation types, for example, Loehle (2011, p. 66) cites multiple studies suggesting that actual vegetation responses to even large shifts in climate are likely to occur slowly, particularly when long-lived tree species are involved, and additionally points to simulation models suggesting that such transitions should occur gradually [but see Allen *et al.* , 2015, and the <u>Effects of changes in disturbance regimes in fisher habitat</u> section below]. The author additionally notes that in modeling the potential future range of an animal species, the model is a proxy for the vegetation on which the animal depends. As such, habitat suitability models are correlational rather than fundamental, and it is important to consider model output with this consideration in mind (Loehle 2011, p. 67). The assumption that animals are limited by climate as defined by a niche model is virtually unverified (Loehle 2011, p. 69).

Temperature is only one of many climatic variables associated with climate change, and indications are that species are not exhibiting a simple, unidirectional response to a warming climate. Observations of recent biogeographic responses of species in California to 20th century climate change indicate that populations and communities are exhibiting a more complex response, indicative of the interplay of multiple factors; in addition, differences in life history and ecological attributes may lead species to respond differently to the same environmental changes (Rapacciuolo *et al.* 2014, entire). In a review of multiple studies reporting elevational range shifts, Rapacciuolo *et al.* (2014, pp. 2841, 2848) found that although some species are shifting upslope in response to warming temperatures as expected, a roughly equal number of species moved downslope or remained stable, contrary to prediction. The authors suggest several mechanisms that may lead to such unexpected responses, including the relative exposure of the species in question, the sensitivity of the population to climate factors, the adaptive capacity of the population, and the indirect effects of climate change, for example on biotic interactions with other species (Rapacciuolo *et al.* 2014, pp. 2848–2849, and references therein).

3.5 Effects of changes in disturbance regimes in fisher habitat

Several different kinds of forest disturbances are likely to increase due to climate change. Fires, insect and disease outbreaks, droughts, windstorms, and flooding events may all increase in some or all of the analysis area. These disturbances may alter important elements of fisher habitat within forest stands, such as moderate to dense canopy cover or structures or snags used for resting or denning (Lofroth *et al.* 2010, pp. 98–118). In some cases, changes in disturbance regimes may lead to major ecosystem changes (Lawler *et al.* 2012, pp. 386–388; Halofsky *et al.* 2011, p. 67, Shafer *et al.* 2010, p. 183). These factors are likely to have synergistic effects; for example, in the Sierra Nevada, disease and insect outbreaks may facilitate increases in wildfire and in exotic species invasions, which may together lead to rapid conversion from one ecotype to another (Lindenmayer *et al.* 2011, entire; Halofsky *et al.* 2011, p. 67; McKenzie *et al.* 2009, entire; Dale *et al.* 2001, p. 729).

Within the analysis area, climate is an important determinant of wildfire regimes (Marlon *et al.* 2012, p. E536; Whitlock *et al.* 2003, pp. 12–13) and is increasingly becoming the primary driver of fire regimes (Miller *et al.* 2012, p. 194; Miller *et al.* 2009, p. 30; Pechony and Shindell 2010, p. 19169). Recent climate change has already caused an increase in wildfire activity in some areas (Westerling *et al.* 2006, entire), and this trend is likely to increase as climate change progresses (Littell *et al.* 2010, pp. 12-14; Westerling and Bryant 2008, entire; Stavros *et al.* 2014, entire; Jolly *et al.* 2015, entire). Within the analysis area, the fire regime is predicted to show the most sensitivity to changes in the timing of the onset of spring in the Sierra Nevada, Oregon Cascades, and Olympic Mountains, and the least sensitivity to the timing of spring in the northern Cascades (Westerling *et al.* 2006, Fig. S2). As temperatures rise, the probability of large fire starts in northern California will likely increase by 15 to 90 percent by the years 2070–2099, and the projected increase in the Sierra Nevada is comparable over that timeframe (Westerling and Bryant 2008, p. S244 and Fig. 7). In the southern portion of the analysis area, the length of the fire season has increased, and throughout the analysis area long fire seasons have become more frequent (although again the trend is stronger in the south) (Jolly *et al.* 2015, p. 5, Figure 3). By the 2080s, annual burned areas are projected to increase by a factor of 3.8 in forested ecosystems in Washington (Littell *et al.* 2010, p. 13). At a smaller scale, the area burned is projected to nearly double from 63,000 to 124,000 hectares in the eastern Cascades, and an 8-fold increase from 1,100 to 9,100 hectares is projected for the western Cascades (Littell *et al.* 2010, Fig. 7). Even on the relatively wet Olympic Peninsula, models of some climate scenarios show the possibility of large increases in burned areas, especially after 2070 on the northeastern portion of the peninsula, which includes all sites of documented fisher reproduction following their reintroduction to Olympic National Park (Halofsky *et al.* 2011, pp. 73–75; Lewis *et al.* 2011, p. 13).

It is not clear whether these fires will become more or less severe, and changes in severity may vary across the analysis area. Lawler *et al.* (2012, pp. 385–388) reported that in most of the fisher's current California range, fires will likely become more frequent but less intense, whereas Fried *et al.* (2004, p. 179) predicted that climate change will result in larger, more intense fires in the Sierra Nevada and no change to fire behavior in the northern California redwood zone. In the northern Cascade range, Cansler and McKenzie (2014, pp. 1037, 1053) found a positive correlation between fire size and burn severity, suggesting that fire severity may therefore be greater if future warming and drying trends lead to larger fires, as predicted. In the Sierra Nevada and Southern Cascades, the mixed-conifer forest types that contribute to fisher habitat are the most likely to experience increasing wildfire severity, and the size of high-severity patches is likely to increase as the total size of the burned area increases (Miller *et al.* 2009, p. 28; Miller and Safford 2012, p. 48). A continent-scale model projects an increase of 10 to 30 percent in fire severity ratings across the analysis area, with larger increases to the north and east (Dale *et al.* 2001, Fig. 3). Changes in fire regime are likely to cause changes to the habitat elements that fishers use, such as large trees, snags, coarse woody debris, and canopy cover, although how the various elements will change depends on future fire frequency and severity (Lawler *et al.* 2012, pp. 388–393). Depending on multiple factors, fire does not necessarily eliminate all structures used by fishers for resting, nesting and denning; in some cases, for example in redwood forests, fire can lead to an increase in the structural elements used by fishers.

Increasing summer temperature and dryness also increase the extent and intensity of insect outbreaks, which in turn affect fire extent and intensity as well as other forest processes (Hicke *et al.* 2012, pp. 87–88; Halofsky *et al.* 2011, pp. 66–67; Littell *et al.* 2010, pp. 15–19; Spies *et al.* 2010, p. 7; Whitlock *et al.* 2003, p. 15). For example, in Oregon and Washington, mountain pine beetle (*Dendroctonus ponderosae*) outbreaks are predicted to become more frequent and spread upward in elevation, leading to loss of climatically suitable range for one or more pine species (genus *Pinus*) over 85 percent of the current range of pines in Washington (Littell *et al.* 2010, pp. 15–19; Littell *et al.* 2013, p. 114). The severity of Douglas-fir beetle (*Dendroctonus pseudotsugae*) outbreaks may also increase in Coastal Washington on the Olympic Peninsula (Halofsky *et al.* 2011, pp. 66–67). Warmer temperatures also cause trees to become more susceptible to the fungal diseases, Swiss needle cast (*Phaeocryptopus gaeumannii*) and sudden oak death (*Phytophthora ramorum*), and these two diseases are expected to spread northward in the Oregon Coast Range (Shafer *et al.* 2010, p. 185). These increases in forest disturbances may lead to an increase in the proportion of young forest, which does not provide suitable denning and resting habitat for fishers. As noted earlier, the critical limiting factor for fishers is the availability of suitable habitat elements to provide for successful reproduction and rest sites. On a small scale, Safford (2006 and references therein, p. 12) suggests that insect- or disease-caused tree mortality may actually benefit fisher by creating resting, denning, and foraging habitat, while noting that large scale tree mortality is likely to lead to the loss of essential structures through stand-replacing fire.

3.6 Summary of the Effects of Climate Change on Fisher Habitat

We have assessed the potential effects of climate change on fisher habitat and incorporated the most recent studies relevant to our analysis. Many predictions of future conditions are relatively general in nature and provide little specificity with regard to timeframes or geographic region of occurrence that would be informative in terms of our consideration of future habitat conditions for fishers within the analysis area. We therefore place relatively greater weight on studies or models that are more narrowly focused on fisher habitat needs, specifically, or are downscaled to our geographic region of interest.

There is general scientific agreement that climate throughout the analysis area will become warmer over the next century, and in particular that summers will be hotter and drier with more frequent heat waves. In the northern portion of the analysis area, winters will likely become wetter, but even these areas will likely experience increased water deficits during the growing season. Vegetative cover and species composition is predicted to shift and change in response to modified environmental conditions, although the exact nature and timing of such changes are uncertain. Many model results are based on projections out to the end of the century, and debate continues as to whether biogeographic range shifts in vegetation are likely to be realized before that time. Some researchers argue that such change will occur gradually, especially for long-lived tree species, whereas others argue that disturbance events can accelerate such change, leading to relatively rapid ecotype conversion. In addition, there is regional variation in vulnerability to vegetation shifts, which generally increases from north to south throughout the analysis area. Ecotypes that support fisher habitat may decrease in area, especially in the Sierra Nevada, but also in Northern California-Southwestern Oregon, the Western Oregon Cascades, and possibly the Washington Eastern and Western Cascades as a result of climate change. Where habitat area decreases, the number of fishers that can be supported by the habitat will also decrease.

In all or most sub-regions of the analysis area, fisher habitat will be altered, with likely shifts away from conifer forest and towards an increased hardwood component, or from maritime conifer forest to drier temperate conifer forest. Potential changes in habitat suitability and fisher response are likely to vary regionally (for example, an increased hardwood component in conifer forests may have a neutral or even positive effect on fishers, whereas replacement of mixed conifer-hardwood forests with woodland will have a negative effect). It is uncertain how these habitat shifts will affect fisher populations, as it is not clear whether fisher response to these changes will be positive, neutral, or negative. Projections of future conditions in some cases predict losses of suitable fisher habitat, whereas others predict potential increases in suitable fisher habitat. Many predicted habitat changes are projected to occur over a relatively long period of time, further adding to the uncertainty in our ability to reliable predict future conditions for fisher. Modeling projections are done at a large scale and effects to species can be complex, unpredictable, and highly influenced by local level biotic and abiotic factors. In addition, disturbance regimes will change. Through much of the analysis area, fires are expected to increase in frequency and area burned, although predictions regarding relative fire severity vary regionally. Insect and disease outbreaks will also increase. These changes will alter the structure of forested stands within the analysis area, may increase the proportion of early-successional forest on the landscape, and may also combine synergistically to alter ecosystem types, which could result in losses of fisher habitat throughout the analysis area.

Fisher populations are already fragmented and greatly reduced from their historical range. Loss of habitat could threaten the viability of native and reintroduced populations and would reduce the likelihood of reestablishing connectivity between populations. Studies specific to predicting the effects of climate change on suitable fisher habitat have produced conflicting results. Ecotype conversion to woodland, shrubland, or grassland would result in the loss of suitable fisher habitat; this type shift is predicted, for example, in the southern Sierra Nevada. On the other hand, shifts from conifer forest to hardwood-dominated mixed forest in the southern Sierra Nevada or Klamath region are unlikely to have negative effects on fishers, and the species' response may be relatively neutral to such a change. Some studies have suggested that fishers may experience an overall net gain of suitable habitat in response to climate change, for example due to reduced snowpack, or that areas inhabited by fishers will remain in climate refugia. Others predict that fisher distribution will remain largely stable. All of these predictions are accompanied by a wide range of assumptions and caveats. In sum, predictions regarding future habitat suitability for fishers in response to climate change and the likely specific response of the species to these predicted changes remain uncertain.

Climate change is ongoing and its effects are likely to increase and become more readily perceptible in the future. As described earlier, we concluded that for the purposes of making reliable predictions about the effects of climate change on the conservation status of the fisher, a timeframe of roughly 40 years is reasonable. This timeframe represents that period of time over which most climate models are in close agreement as to predictions of future conditions, regardless of emissions scenario. Predictions beyond this timeframe become increasingly variable and subject to various assumptions. Although many models project out to the end of century, we conclude that the uncertainty underlying those predictions is too great for us to rely upon them for the purposes of our analysis, as too many variables are subject to change over that period of time for us to reasonably predict future conditions specific to the potential effects on fisher.

In the following sections, we provide a summary of effects of stressors related to climate change in each of the analysis area sub-regions.

Sierra Nevada

Most projections indicate suitable fisher habitat in the Sierra Nevada as most vulnerable to the effects of climate change. Models of future vegetation type vary greatly, with the majority showing shifts from conifer forest to mixed-conifer hardwood forest, as well as losses of up to 62 percent of currently forested habitat by the late 21^{st} century as a result of disturbance and subsequent conversion to grassland, shrubland, or woodland; such a conversion would represent a long term loss of fisher habitat. Other projections do not show a loss of forested habitat and suggest the Sierra Nevada will maintain climate refugia for the foreseeable future. However, it is highly likely that the Sierra Nevada will experience climate-related increases in disturbance from fire, insect damage, and disease. The Sierra Nevada has been identified as an area where fire regime is particularly sensitive to changes in seasonal climate shifts. Two populations of fisher occur in this sub-region: the SSN population and the southern extent of the NCSO population.

Fisher populations are already fragmented and greatly reduced from their historical range. Loss of habitat could threaten the viability of fishers in the Sierra Nevada, in particular the SSN population, and could also reduce the likelihood of reestablishing connectivity between the SSN and NCSO populations.

Northern California – Southwestern Oregon

As in the Sierra Nevada, most projections indicate that climate change will lead to losses in fisher habitat in Northern California and Southwestern Oregon; however, these changes may be somewhat less widespread or less severe than in the Sierra Nevada. Within the next 40 years, large portions of this sub-region may experience shifts toward novel climate conditions, introducing greater uncertainty in our ability to predict whether and how suitable fisher habitat will be maintained. Nearly all models show shifts in future vegetation type from conifer forest to mixed-conifer hardwood forest; as noted earlier, this change may or may not have a negative effect on fisher populations. In addition, some areas will experience shifts toward unsuitable habitat types such as woodland and chaparral, which would represent a loss of fisher habitat. This sub-region will also experience climate-related increases in disturbance from fire, insect damage, and disease.

Western Oregon Cascades

In the Western Oregon Cascades, forest types are projected to shift from conifer forest to mixed conifer-hardwood forest or from the current moist conifer forest type toward a drier conifer forest type. In particular, parts of this sub-region are projected to become unsuitable for Douglas- fir, currently a major component of the forests that make up fisher habitat in this sub-region. Parts of this sub-region are projected to convert from conifer forest to open mixed woodlands, which do not provide fisher habitat, although very little of this conversion is predicted to occur within the next several decades. Conifer forest is also projected to convert to hardwood forest, which is not known to provide fisher habitat in the western United States. This sub-region will also experience climate-related increases in disturbance from fire, insect damage, and disease. The Oregon Cascades have been identified as an area where fire regime is particularly sensitive to changes in seasonal climate shifts.

Coastal Oregon

In Coastal Oregon, there is agreement among models that there will be a shift from maritime conifer forest toward mixed conifer-hardwood forests, although models differ in the extent of this change. Some models also project a shift toward drier conifer forest types on the eastern side of this sub-region. As noted above, the potential response of fishers to such conversion is unknown. Coastal Oregon will experience climate-related increases in disturbance from fire, insect damage, and disease, and in particular an increase in the areas affected by fungal diseases such as Swiss needle cast and sudden oak death.

Eastern Oregon Cascades

Forested area may increase in the Eastern Oregon Cascades but due to drier conditions will likely experience slower growth as compared with current forests in the same sub-region. This sub-region will also experience climate-related increases in disturbance from fire, insect damage, and disease. The Oregon Cascades have been identified as an area where fire regime is particularly sensitive to changes in seasonal climate shifts.

Western Washington Cascades

In the Western Washington Cascades, there may be shifts in forest types from maritime conifer forest to drier temperate conifer forest, and some conifer forest may shift to woodlands that will not provide suitable fisher habitat. The ranges of Douglas fir and some pine species are likely to contract. The Washington Western Cascades will experience climate-related increases in disturbance from fire, disease, and insects, including mountain pine beetle. Fire is currently so infrequent in this region that the total area burned will likely remain small relative to other sub-regions. The northern Cascades have been identified as a region in which fire regime is relatively insensitive to changes in the timing of spring. However, because fire has historically burned with stand-replacing severity in this sub-region, any fire may result in the loss of fisher habitat.
(These climate-driven fire effects were not accounted for in the section above discussing wildfire-related stressors.)

Eastern Washington Cascades

In the Eastern Washington Cascades, forested area may increase, but due to drier conditions, forests will likely experience slower growth as compared with current forests, and some conifer forest may shift to woodlands that will not provide suitable fisher habitat. The ranges of Douglas fir and some pine species are likely to contract. The Eastern Washington Cascades will experience climate-related increases in disturbance from fire, disease, and insects, including mountain pine beetle. The area burned in this sub-region is predicted to increase over time. However, the northern Cascades have also been identified as a region in which fire regime is relatively insensitive to changes in the timing of spring.

Coastal Washington

In Coastal Washington, there may be shifts in forest type from maritime conifer forest to mixed conifer-hardwood forest along the coast or to drier conifer forest types on the eastern side of the sub-region. Most of the potential effects of climate change in this region relate to disturbance events. The range of Douglas-fir in this sub-region is expected to decrease, and Douglas-fir beetle outbreaks may intensify. The range of pine species may also decrease in this sub-region due to increases in the range and population sizes of the mountain pine beetle. In addition, the Olympic Mountains have been identified as an area where the fire regime is especially sensitive to changes in the timing of spring. Some climate-driven fire models show large increases in the area burned in this sub-region (These climate-driven fire effects were not accounted for in the section above discussing wildfire-related stressors.) Because the fire regime in most of this sub-region has historically consisted of very infrequent stand-replacing fires, a shift toward more frequent fires could initially result in large areas of habitat lost to stand-replacing fire.

3.7 Conservation Measures to Address Climate Change

United States Climate Initiatives

In 2009, the Environmental Protection Agency (EPA) published final "Endangerment and Cause or Contribute Findings" under Section 202(a) of the Clean Air Act, finding that six key greenhouse gases constitute a threat to public health and welfare and that the combined emissions from motor vehicles cause and contribute to greenhouse gas pollution (74 FR 66496; December 15, 2009). The EPA's findings concluded that greenhouse gas pollution threatens Americans' health and welfare by leading to long-lasting changes in our climate that can have a range of negative effects on human health and the environment. Although the findings did not themselves impose any requirements on industry or other entities, this action was a prerequisite for implementing greenhouse gas emissions standards for vehicles and laid the groundwork for other subsequent regulatory changes as well. One of the first new regulations to address greenhouse gas emissions following this finding resulted in new fuel economy standards under the Energy Policy and Conservation Act for passenger cars, light-duty trucks, and medium-duty passenger vehicles to reduce greenhouse gas emissions (75 FR 25324; May 27, 2010). The EPA has since issues a series of rules under the Clean Air Act to limit greenhouse gas emissions, for example, setting thresholds to define when permits are required for new and existing industrial facilities (75 FR 82254; December 30, 2010).

In 2013, the Executive Office of the President released The President's Climate Action Plan (June 2013). In addition to outlining steps to prepare for the impact of climate change and to lead international efforts to combat global climate change, the plan outlines specific objectives for cutting carbon emissions in the United States. The plan was based on a goal of reducing greenhouse gas emissions in the United States by 17 percent below 2005 levels by the year 2020. It included directives to the Environmental Protection Agency (EPA) to complete carbon pollution standards for new and existing power plants, as well as to develop or further build upon standards for greenhouse gas emissions and fuel economy standards for cars and trucks. The plan also enjoins various Federal agencies to commit to increased development of clean and renewable energy sources, increase energy efficiency, reduce emissions of hydrofluorocarbons and methane, and conserve the nation's forests, which play a critical role in carbon sequestration. As a result of this plan, some new regulations have already been put in place, and others are still in the planning stage. In August 2015, the EPA issued the Clean Power Plan, which is intended to reduce carbon pollution from power plants while simultaneously advancing the development and deployment of clean energy technologies. The goal of the Clean Power Plan is to reduce carbon pollution from the power sector to 32 percent below 2005 levels by 2030. The Clean Power Plan sets interim and final carbon dioxide emission performance rates as goals, which are then to be met by States, Tribes, and U.S. territories under a partnership created through Section 111(d) of the Clean Air Act. States are expected to develop and implement plans that achieve interim target carbon dioxide emission rates between 2022 and 2029, and final targets for their State by 2030. The plan also allows for emissions trading to meet performance goals. On October 23, 2015, the EPA issued final carbon pollution standards for new, modified and reconstructed power plants under the Clean Air Act (80 FR 64661) and proposed a Federal Plan and model rule to assist states in implementing the Clean Power Plan (80 FR 64966). However, on February 9, 2016, the United States Supreme Court put the regulations that would require the reduction of greenhouse gas emissions from power plants on hold, so whether these regulations may actually be implemented is now uncertain.

Other regulatory initiatives in the United States to reduce greenhouse gas emissions include proposals to reduce methane gas emissions from landfills (80 FR 52099; August 27, 2015) and to reduce emissions of methane and volatile organic compounds from the oil and natural gas industry (80 FR 56593; September 18, 2015). Greenhouse gas emissions and fuel efficiency standards for medium and heavy-duty engines and vehicles have been proposed for the first time ever (80 FR 4013; July 13, 2015).

The United States is a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and submitted its target to cut net greenhouse gas emissions (Intended Nationally Determined Contribution, or INDC) to the UNFCCC in March 2015, in preparation for the twenty-first session of the Conference of the Parties in December 2015 (see below). The United States target is to reduce emissions by 26 to 28 percent below 2005 levels by 2025 and to make best efforts to reduce by 28 percent.

International Climate Initiatives

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty or multilateral environmental agreement that was adopted at the "Rio Earth Summit" in Rio de Janeiro, Brazil, in 1992. The primary goal of the UNFCCC is to stabilize greenhouse gas concentrations at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system. The UNFCCC entered into force in 1994. There are 195 countries that have ratified the convention and are thus "Parties to the Convention." The United States signed the treaty in June 1992.

The UNFCCC has held a series of conferences aimed at mobilizing the international community to reduce global greenhouse gas emissions. In an agreement made at the Copenhagen Conference in 2009, known as the Copenhagen Accord, it was agreed that at a minimum, global greenhouse gas emissions must be reduced to a level sufficient to limit the increase in global average temperature to no more than 2°C (3.6°F) above preindustrial levels by the end of this century in order to avoid the most dangerous and irreversible consequences of climate change. Although participating world governments agreed to targets to reduce greenhouse gas emissions, the Copenhagen Accord was not formally adopted by the Parties to the Conference, but only noted; therefore, no legally binding requirements were established.

The last major conference of the UNFCCC (known as a Conference of the Parties, or COP) was held in December 2015, in Paris, France. Every country was asked to submit proposals in advance that outlined their plans to reduce greenhouse gas emissions ("Intended Nationally Determined Contributions" (INDCs); UNFCCC 2015, p. 17). As of November 2015, 147 Parties representing 146 countries (75 percent of all Parties to the UNFCCC, which account for approximately 86 percent of the world's global emissions in 2010) had submitted their INDCs, which cover the time period through 2025 or 2030 (UNFCCC 2015, p. 18). The UNFCCC has aggregated all INDCs submitted to date to assess their potential effectiveness. Although the aggregated INDCs indicate significant reductions in emissions and slow future emissions growth, at present they are not sufficient to reverse the upward trend of global emissions. The UNFCCC has indicated that even if all INDCs were fully implemented and targets met, the goal of limiting the increase in global average temperature to 2°C (3.6°F) by the year 2100 would not be achieved (UNFCCC 2015, pp. 11, 45).

The INDCs submitted indicate a significant increase in the number of countries taking climate action, and all Parties have raised the ambition of their climate action in their INDCs compared with efforts for the pre-2020 period (UNFCCC 2015, pp. 12–13, 49–50). The global temperature at the end of this century will depend on both emissions up to 2030 and emissions in the post-2030 period. Temperature levels by the end of the century will strongly depend on assumptions on socioeconomic drivers, technology development, and action undertaken by Parties beyond the time frames stated in their INDCs (for example beyond 2025 and 2030) (UNFCCC 2015, pp. 12, 45). The UNFCCC concludes that the extent to which efforts to reduce emissions will be sufficient to limit the global average temperature rise to less than 2°C (3.6°F) above pre-industrial levels strongly depends on the long-term changes in the key economic drivers that will be modified by the implementation of the current INDCs, as well as the determination of Parties to increase levels of ambition before and after 2030, including through the multilateral process (UNFCCC 2015, pp. 48, 51–52).

3.8 Climate Change Effects on Fisher Habitat—Conclusion

Based on our current analysis, there is general scientific agreement that fisher habitat within the analysis area will be affected by changes in climate, including increased temperatures; changes in precipitation (increased drought in summer, or increased precipitation in winter, depending on the sub-region); increased disturbance from fire, disease, or insect outbreaks; and shifts in vegetative cover. There is not agreement, however, as to when and how these changes will occur, how they will affect the availability of suitable fisher habitat, or how fishers will respond to these changes. Studies specific to future fisher habitat in the face of predicted climate change have produced conflicting results, with some predicting habitat loss and some predicting habitat gain. There is thus great uncertainty with regard to the potential effects of climate change on fisher habitat.

At this time, there are no known conservation measures sufficient to ameliorate the potential effects of climate change on fisher habitat within the range of the West Coast DPS of fisher.

Based on our current analysis, we conclude that although we can make general predictions about future environmental conditions as a consequence of climate change on a relatively broad scale, the available scientific information does not allow us to draw any reliable conclusions with regard to the future availability of the specific habitat elements and conditions required to sustain fishers within the analysis area. Although climate change will affect fisher habitat throughout the entirety of the analysis area, the best scientific and commercial data available at this time do not indicate that any population- or rangewide-level impacts to fisher are occurring as a consequence of climate change, nor is there any indication that population or rangewide impacts are likely to be realized within the foreseeable future. For all of these reasons, we conclude climate change is resulting in a minor amount of habitat impacts now or in the future; therefore, we consider climate change to be a low-level impact on fishers in the West Coast DPS currently and in the future. We wish to emphasize, however, that this conclusion does not obviate the need for monitoring the ongoing effects of climate change and their potential impact on fisher habitat over the long term.

4.0 Vegetation Management

4.1 Re-analysis of Vegetation Management Data Used in the Draft Species Report

This section provides a qualitative analysis/discussion of the underlying data used for the quantitative analysis that was conducted and described in the draft Species Report (and now included in Appendix C of this document).

In the draft Species Report, we relied primarily on two data sets in the draft species report. To describe the trend of fisher habitat loss on Federal lands, we looked at the amount of northern spotted owl nesting, roosting, and foraging habitat (except in California, where foraging habitat was not included in the database) that was removed or downgraded, as documented through section 7 consultations within the range of the northern spotted owl. The data was available over a 7-year timespan (2006 to 2013) and identified planned timber harvest activities on Federal lands that adversely affected northern spotted owls and that could possibly affect suitable fisher habitat as well. The data was organized into physiographic provinces, which roughly corresponded with the fisher analysis area subregions that occurred within the northern spotted owl range; that is, the data covered roughly all fisher analysis subregions except for the Sierra Nevada. We were unaware of any large-scale database existing in the Sierra Nevada region to assess timber harvest on Federal lands in that region.

The northern spotted owl database showed that, over the 7 year timespan, 0.6 percent of suitable owl habitat was adversely affected by planned timber harvest activities on Federal lands, which translates to 0.86 percent per decade. In crosswalking the physiographic provinces to fisher subregions, some subregions showed relatively higher rates for the 7 year period, such as 2.5 percent for the eastern Oregon Cascades, and 1.1 percent for the western Oregon Cascades. The eastern Cascades of Washington showed a 0.8 percent rate, and the remaining subregions were 0.3 percent or less. The rates of loss for each fisher analysis area subregion were annualized and multiplied by 40 to represent a 40 year projection of management activity. That value was then multiplied by the area of fisher habitat within the respective subregion to calculate an area of fisher habitat projected to receive vegetation management treatments with the potential to remove habitat. The amount of fisher habitat on Federal lands projected to be affected by vegetation management over a future 40 year time period ranged from highs of 10 percent and 5 percent in the Eastern Oregon and western Oregon Cascades, respectively, to 2 percent or less in the remaining subregions within the range of the northern spotted owl. We had no analogous datasets specific to Federal lands in the Sierra Nevada subregion with which to derive timber harvest rates to use in projecting future fisher habitat loss.

To describe the trend of fisher habitat loss on non-Federal lands, we looked at the database of approved timber harvest plans (THP) submitted to the California Department of Forestry and Fire Protection (CAL FIRE) from 2003 to 2011, which reported acreages by county of submitted timber harvest plans in California (CAL FIRE THP tracking center, 2013). While Oregon and Washington tracked non-Federal timber harvests, the metric was not in acres but in timber volume, which is not readily translatable to acres affected by harvest. The data was reviewed over the most recent 10-year time span (2003 to2012). The data was reported by county, and organized into the two fisher analysis area subregions in California, Sierra Nevada and the California portion of the Northern California-Southwest Oregon subregion, based on the counties. The data showed the acres of timber harvest that were proposed in THPs that were approved by CALFIRE.

The CALFIRE database showed that, over a 10 year window, 13.3 percent of the non-Federal timberland acres in the northwestern California counties (those that overlapped the California portion of NCSO) had THPs approved by CALFIRE. Similarly, 14.1 percent of the non-Federal timberland acres in the Sierra Nevada counties (those that overlapped the Sierra Nevada subregion) had THPs approved by CALFIRE. As with the northern spotted owl database rates of loss, the CALFIRE THP rates of loss were used to project future fisher habitat loss in the same way. The amount of fisher habitat on non-Federal lands projected to be affected by vegetation management over a future 40-year time period was 15 percent for the Sierra Nevada subregion, and 22 percent for the California portion of the northern California-southwest Oregon subregion. We had no analogous datasets specific to non-Federal lands in Oregon and Washington with which to derive timber harvest rates to use in projecting future fisher habitat loss.

Overall, the draft Species Report assessment of the vegetation management information available indicated that some low-level impacts are likely occurring in some portions of the DPS. However, given the lack of information in portions of the DPS, it is possible that these impacts could result in either a low or a moderate-level of impacts, particularly given the potential future projections of fisher vegetation management activities in parts of California.

4.2 Analysis of the Best Available Vegetation Management Data (Includes New Information)

Vegetation management includes a wide assortment of timber harvest and other forest stand treatments that can affect the ability of the forest vegetation to provide fisher habitat, both positively and negatively. As noted above, we know fishers occur in landscapes and near stands where active vegetation management occurs, but our understanding of the effects of these activities on fishers and their populations is limited and results can vary with type, intensity, duration, and seasonality of treatment; scale of treatment; and the activity for which the fishers use a specific area (for example, denning vs. foraging). There is no analysis that explicitly tracks changes in fisher habitat in recent decades where loss to vegetation management specifically can be determined. Thus, we do not have the capability to assess vegetation management by assessing the specific vegetation management activities that may act as a stressor to fishers. Instead, we are limited to looking at existing data sets that track changes in forest types that best represent fisher habitat and teasing out the specific changes that were a result of vegetation management in the cases where general disturbance type (for example, fire vs. timber harvest) was categorized. After considering new data that became available since Service (2014), and in response to shortcomings pointed out by peer reviewers and the public regarding the vegetation management stressor analysis done in the draft species report (Service 2014, pp. 85–96) we chose to use several different sources to depict forest vegetation changes as caused by vegetation management activities in the DPS. With the exception of the non-Federal timber harvest database in California (CALFIRE THP 2013), all of these sources are either new or updated (Davis *et al.* 2015, entire; USFS 2016,entire; Spencer *et al.* 2016, entire; LEMMA 2016) since the draft species report (Service 2014).

The only available, large-scale, robust analysis of vegetation trends specifically tied to fisher habitat was done for the southern Sierra Nevada range where fishers currently occur (Spencer *et al.* 2016, pp. 41–45, Appendix A-3). Although this analysis tracked fisher habitat trends, it did not differentiate habitat changes by disturbance type, so we could not assess what portion of the change in fisher habitat was a result of vegetation management. Outside of this area, we were limited to looking at trends in vegetation classification based on pre-defined structural characteristics which we relate to fisher habitat quality. Within the NWFP area, we used the recent NWFP 20-year late-successional old-growth monitoring report (Davis *et al.* 20XX, entire [We note that Davis *et al.* have requested within this document, which is in the draft stage, that it be referenced as Davis *et al.* 20XX]). This analysis looks at changes in forests with old-forest structural characteristics for the 20 year implementation period of the NWFP (1993-2012), categorizing forest loss by different disturbance mechanisms, including timber harvest, and also recording ingrowth of older forests. This analysis also records activities within non-Federal as well as Federal ownership. It is the only large-scale vegetation trend analysis available that classified vegetation loss to type of disturbance (such as vegetation management activities vs. wildfire or some other disturbance type).

The remainder of the fisher analysis area that is outside of the NWFP area is in the Sierra Nevada fisher analysis subregion of California, and the eastern portions of the eastern Oregon Cascades and eastern Washington Cascades subregions. A small area lies along the eastern fringe of the NCSO subregion, but was not separated out for this analysis. For these areas, we looked at vegetation changes using the same base data source (Gradient Nearest Neighbor maps, LEMMA 2016) as did Davis *et al.* (20XX, entire) over the same time period. Similar to the Spencer *et al.* (2016, pp. 41-45, Appendix A-3) analysis, we could not derive what portion of the vegetation change was due to vegetation change. In this situation, we looked separately at timber harvest data, where available, to assess loss to vegetation management. Within California, we were able to obtain acreages of timber harvest data on non-Federal (CALFIRE THP 2013) and on USFS lands (USFS 2016, entire) to describe acreage affected by vegetation management activity. We were not able to obtain this same information for the eastern Cascades in Oregon or Washington outside of the NWFP area, so we relied on the Davis *et al.* (20XX, entire) analysis for an overall description of these two fisher analysis subregions.

As noted above, (Spencer *et al.* 2015, p. 4; 2016, pp. 41–45, Appendix A-3) modeled fisher habitat trends at a sub-regional level for the southern Sierra Nevada fisher conservation strategy, which covered generally the west slope of the Sierra Nevada Range south of the Mokelumne River. The authors modeled fisher habitat at the scale of a female home range (10 km^2, which the authors approximated to 4 mi^2) and tracked the habitat changes in home range-sized grid cells across the analysis area (3,907 mi^2 (10,120 km^2)), which included all areas considered likely to contribute substantially to sustaining the fisher population over the next 15–30 years

(Spencer *et al.* 2016, p. 27). Grid cells were not meant to represent actual home ranges, but to approximate the area needed to support a female and dependent kits.

In looking at vegetation changes from 1990 to 2012, the southern Sierra analysis indicated that forest growth in recent decades has more than compensated for disturbances like severe fire and timber harvest, combined, resulting in a net increase of 39 suitable home range grid cells from 1990–2012 (Spencer *et al.* 2016, p. 42). This is equivalent to an increase of 151 mi^2 (390 km^2) of fisher habitat at the female home range scale, or a 7.8 percent increase in suitable cells from 1990 to 2012 (Spencer *et al.* 2016, p. A-21). The authors did not state what proportion of actual disturbance was due to vegetation management. The authors went on to note that if disturbance and succession rates continued at the same rate through 2040, there would be an expected increase of approximately 30 suitable cells in the strategy area (from 415 to 445) (Spencer *et al.* 2016, p. 42); this is equivalent to a change in fisher habitat at the female home range scale from 1,602 mi^2 (4,150 km^2) to 1718 mi^2 (4,450 km^2). An assumption that future suitable habitat will be occupied may be optimistic but is consistent with evidence that the population in the southern Sierra Nevada reached its current northern extent by expanding northward over the past 2–3 decades, roughly the same distance as needed to expand into currently unoccupied areas (Spencer *et al.* 2015, p. 50; 2015b, p. 41).

The southeastern portion of the Southern Sierra Nevada analysis area is occupied by fishers, although the habitat analysis indicated that there were no suitable grid cells in this area, indicating the analysis underrepresents habitat value and home range capacity in this area, perhaps due to significant differences in ecological conditions on the Kern Plateau compared to the remainder of the area along the west slope (Spencer *et al.* 2016, p. 42). Predictions in this area (about 8 percent of the analysis area) should be considered unreliable, as stated in Spencer *et al* (2016, p. 42). Conversely, this analysis does not account for the recent large fires that occurred in 2013 and later, such as the Rim and French fires. The authors note that the 2013 Rim Fire, as an example, burned 29 cells at high severity over half of their area. While the determination of whether or not the cell continues to score as suitable fisher habitat has yet to be done, the authors estimate that the Rim Fire may have changed approximately 14 cells (an equivalent of 54 mi^2 (140 km^2) of home range grid cells, or 3.3 percent of suitable grid cells available in 2010) from suitable in 2010 to unsuitable in 2015 (Spencer *et al.* 2016, p. 44). This would still result in a net increase of 25 cells, so while the southern Sierra Nevada fisher habitat analysis appears to underestimate recent habitat loss due to fires, even after accounting for preliminary estimated losses from recent large-scale fires, there is still a resultant increase in fisher habitat over the past decades, indicating habitat recruitment is currently outpacing habitat loss.

For the remainder of the fisher analysis area, we are forced to look at trends in vegetation types that provide a rough approximation of fisher habitat. Davis *et al.* (2015, p. 1) monitored older forest changes throughout the NWFP area, including non-Federal lands, occurring from 1993 to 2012. Monitored older forests were defined using an "old-growth structure index" (OGSI) that consisted of measurable forest structure elements, such as density of large live and dead trees, diversity of tree size classes, and percent cover of down woody material (Davis *et al.* 2015, p. 5). These elements are commonly considered as key ecological and structural attributes of old-growth forests within the NWFP area, and are also valuable forest structures for fishers as well.

Low index values represent less structurally complex forests, whereas high index values represent older or more structurally complex forests. Mapped cells with an OGSI score of 80 (OGSI-80) were used to describe the general point on the forest succession time scale at which young forests generally begin to start exhibiting structural characteristics associated with older forests (Davis *et al.* 2015, p. 16). Consequently, OGSI-80 forests are not mapped based on age per se, but based on these stands beginning to show elements of mature forest structure regardless of stand age.

The authors' intent was to track older forests, not structurally complex early-seral forest; thus, their cutoff for including forests in their analysis likely eliminates some structurally complex younger stands that may provide for fishers at some scale. Consequently, this analysis does not account for the loss and recruitment of some unknown level of structurally complex younger forest habitats that may be used by fishers. For stands to even be considered in the analysis, they had to have greater than 10 percent tree canopy cover and had to either have at least one large live tree that exceeded the minimum DBH of the large live tree element for that vegetation zone, or an average stand diameter greater than half the size of that same element (Davis *et al.* 2015, Table 5, pp. 15–16). As an example, per Table 5 in Davis *et al.* (2015, p. 15), in both the Douglas-fir and the white fir/grand fir forest vegetation zones, for stands to be classed with an OGSI score, they had to be greater than 10 percent tree canopy cover, and had to have at least 1 large live tree greater than 75 cm (29.4 in) or an average stand diameter greater than half of 75 cm (29.4 in). For some vegetation zones, such a threshold would eliminate some stands known to be used by fishers, particularly if those stands retain complex structural features (for example, Higley and Matthews 2009, pp. 23–24). Conversely, these thresholds may include stands that may not be suitable for fishers, particularly in terms of inadequate canopy cover. Thus, we acknowledge some unknown level of over-representation and under-representation of fisher habitat using the OGSI-80 category of forests.

The OGSI-80 forest analysis in Davis *et al.* (20XX, entire) covers Federal and non-Federal lands within the NWFP area, which encompasses the fisher analysis area with the exception of the Sierra Nevada mountain range and the eastern extremes of the eastern Cascades subregions in Washington and Oregon. In NWFP area from 1993 to 2012, there was a 5.9 percent net loss (451,000 ha (1,115,000 ac)) in OGSI-80 forests across all ownerships, with a 2.9 percent net loss of OGSI-80 forests on Federal lands, and an 11.7 percent net loss on non-Federal lands (Table 6). Total losses totaled 914,000 ha (2,259,000 ac), with roughly one third of that loss coming from Federal lands and the remaining from non-Federal lands (Table 6). Almost half of the OGSI-80 forests lost to all disturbances combined were replaced by ingrowth, although replacement of an OGSI value is not necessarily by a forest of equivalent OGSI value. That is, ingrowth reflects forests that have, through succession, recently attained the characteristics sufficient to meet the OGSI-80 thresholds, but may not be as structurally complex as those stands that were removed via disturbance during the analysis time frame.

Timber harvest resulted in a loss of 630,000 ha (1,557,000 ac) of OGSI-80 forests from the NWFP area, which was 8.2 percent of the 1993 OGSI-80 amount of all ownerships combined. However, the difference in loss based on ownership is striking, with 570,000 ha (1,408,000 ac) of the loss coming from non-Federal land, and 60,000 ha (148,000 ac) coming from Federal land. OGSI-80 harvest was 1.2 percent of Federal OGSI-80 forest, and 21.8 percent of non-Federal

OGSI-80 forest (Table 6). When looking at the distribution of harvest losses across fisher analysis subregions, most subregions show a loss of 6.5 percent or less of OGSI-80 forest over the 20-year analysis window, resulting in less than a 3.3 percent per decade loss in these areas (Table 7). Two subregions, however, exhibit substantially higher levels of OGSI-80 forest loss compared to the NWFP-wide average. The coastal Washington subregion is a combination of the Olympic peninsula and western Washington lowlands physiographic provinces used in the NWFP report, and the large timber loss is heavily skewed by 78 percent of the timber harvest occurring in the western Washington lowlands of southwest Washington (Davis *et al.* 20XX, pp. 27–28). Given existing habitat condition and land-ownership patterns, this portion of southwest Washington is not identified as a fisher recovery area in Washington's fisher recovery plan Hayes and Lewis 2006, pp. 22–28, 35). Conversely, on the Olympic peninsula, which is a focus area for Washington fisher recovery efforts and where fisher reintroductions recently occurred, OGSI-80 forest loss due to timber harvest was comparable to other fisher subregions at 6.9 percent. This loss was mostly as a result of harvest on non-Federal lands, with loss on Federal lands for both the Olympic peninsula physiographic province and for the coastal Washington fisher analysis subregion at 0.3 percent.

The coastal Oregon fisher analysis subregion is another area with a comparatively high level of timber harvest of OGSI-80 forests, at 20.5 percent of 1993 levels over the 20-year analysis window (Table 7). This is mainly a consequence of the large area of non-Federal land in this subregion, where 96 percent of the OGSI-80 forests were harvested. Although recruitment of older-forest conditions may be limited on non-Federal lands in this region, Davis *et al.* (20XX, pp. 24–26, 45) observed increases in older forests (not just OGSI-80, but even more structurally complex forests in the OGSI-200 category) and a decrease in forest fragmentation as areas burnt in historically large wildfires of the mid-19th ore early 20th century continue their succession, with gains of 15 percent and above in the amount and connectivity of older forests in portions of the Oregon Coast Range on the Siuslaw National Forest. These areas are outside of the areas prone to more frequent large wildfires, and are likely to retain this condition or increase in structural complexity given the existing forest management regulations on the Siuslaw National Forest under the NWFP.

In summarizing conclusions from Davis *et al.* (2015, pp. 49–50), twenty years after implementation of the NWFP, net changes in amount of older forests on Federal lands has been small, with a 2.9 percent decrease in OGSI-80 forests. This has occurred despite losses from wildfire (4.2 percent of OGSI-80 losses), timber harvest (1.2 percent), insects and other causes (<1 percent), indicating that processes of forest succession have compensated for some of these losses. Loss to wildfire was similar to that expected when the NWFP was developed, though an increased occurrence of large wildfires, combined with potential effects of climate change in some areas is concerning. Losses from timber harvest are approximately one quarter of what was projected. The NWFP anticipated a 5 percent per decade loss of older forests due to timber harvesting and wildfires, combined with recruitment eventually expecting to exceed those losses; the NWFP further projected that 50 to 100 years after implementation began, older forests on Federal lands would return to within the range that occurred prior to logging and extensive fire suppression (Davis *et al.* 2015, p. 6). Thus, net loss of older-forests that could provide for fisher habitat are not occurring at a rapid rate on Federal lands, and are in line with projections made 20 years ago in the NWFP. If NWFP projections continue to hold, older-forests are expected to increase and return to the historical range that occurred prior to extensive logging and fire suppression.

Table 6. Change in older forests (OGSI-80) as described in Davis *et al.* (2015), Tables 6 and 7, by Federal and non-Federal ownership, within the Northwest Forest Plan area from 1993 to 2012. Non-percentage values are in thousand acres, and values in parentheses are thousand hectares.

Change in OGSI-80	**Federal**	**non-Federal**	**Total**
Net area change 1993-2012	-362 (-147)	-753 (-305)	-1,115 (-451)
Percent net change	-2.9	-11.7	-5.9
Total loss 1993-2012	758 (307)	1501 (607)	2,259 (914)
Percent loss	6.0	23.2	11.9
Total ingrowth 1993-2012	396 (160)	748 (303)	1,144 (463)
Percent ingrowth	3.1	11.6	6.0
OGSI-80 lost to Timber Harvest			
Acres lost since 1993	148 (60)	1408 (570)	1,557 (630)
Percent loss from 1993	1.2	21.8	8.2
Percent of total explained loss	19.6	93.8	68.9
OGSI-80 lost to Wildfire			
Acres lost since 1993	527 (213)	47 (19)	574 (232)
Percent loss from 1993	4.2	0.7	3.0
Percent of total explained loss	69.5	3.2	25.4
OGSI-80 lost to Insects			
Acres lost since 1993	61 (25)	45 (18)	106 (43)
Percent loss from 1993	0.5	0.7	0.6
Percent of total explained loss	8.0	3.0	4.7

Table 7. Change in older forests (OGSI-80) as described in Davis *et al.* (20XX), Tables 6 and 7, by Federal and non-Federal ownership, within the Northwest Forest Plan area from 1993 to 2012. Changes are summarized by fisher analysis area subregions, which are roughly equivalent to the physiographic province boundaries used in Davis *et al.* (20XX, p. 8). "Net area change" and "net percent change" values reflect all disturbances, not just timber harvest. Non-percentage values are in thousand acres, and values in parentheses are thousand hectares.

	Federal land					**Non-Federal land**					**All ownerships**				
Fisher analysis area subregions	net area change	net percent change	Area loss due to timber harvest	percent loss due to timber harvest	percent in-growth	net area change	net percent change	loss due to timber harvest	percent loss due to timber harvest	percent in-growth	net area change	net percent change	loss due to timber harvest	percent loss due to timber harvest	percent in-growth
Coastal Washington	3.9 (1.6)	0.4	2.5 (1.0)	0.3	1.4	-260.7 (-105.5)	-22.5	370.1 (149.8)	39.1	10.2	-256.8 (-103.9)	-12.2	372.6 (150.8)	17.7	6.2
Western Washington Cascades	19.1 (7.7)	1.1	8.4 (3.4)	0.5	2.2	-65.4 (-26.5)	-12.4	131.6 (53.3)	24.9	13.0	-46.3 (-18.7)	-2.1	140.0 (56.7)	6.3	4.8
Eastern Washington Cascades	-31.9 (-12.9)	-2.2	25.3 (10.2)	1.8	7.9	-70.0 (-28.3)	-12.0	106.0 (42.9)	18.1	9.5	-101.9 (-41.2)	-5.1	131.3 (53.1)	6.5	8.4
Coastal Oregon	6.2 (2.5)	1.0	12.2 (4.9)	1.9	3.0	-218.7 (-88.5)	-26.8	285.1 (115.4)	35.0	8.8	-212.5 (-86.0)	-14.7	297.3 (120.3)	20.5	6.3
Western Oregon Cascades	-128.5 (-52.0)	-4.9	35.5 (14.4)	1.3	--[1]	-106.2 (-43.0)	-22.3	158.7 (64.2)	33.3	12.3	-234.7 (-95.0)	-7.5	194.2 (78.6)	6.2	1.4
Eastern Oregon Cascades	-22.4 (-9.1)	-2.8	17.8 (7.2)	2.3	5.2	-33.3 (-13.5)	-14.1	48.8 (19.7)	20.6	11.0	-55.7 (-22.5)	-5.4	66.6 (27.0)	6.5	6.5
Northern California-South-western Oregon	-208.4 (-84.3)	-4.7	46.2 (18.7)	1.0	4.2	21.1 (8.5)	0.8	281.0 (113.7)	11.1	13.5	-187.3 (-75.8)	-2.7	327.2 (132.4)	4.7	7.6

[1]Percent ingrowth was calculated by comparing disturbance losses attributed in LandTrendr imagery with the net change in OGSI-80 forests during the analysis time frame. Map production processes are a source of potential error in deriving and comparing map processes. In the case of Western Oregon Cascades subregion, the LandTrendr analysis showed a larger value of OGSI-80 loss on Federal lands than what was reflected in the bookend analysis, which could be due to LandTrendr showing some erroneous mapped losses of older forests under certain conditions (Davis *et al.* 20XX, pp 48–49).

Outside of the NWFP area, we used gradient nearest neighbor maps (GNN) (LEMMA 2016) developed by the Landscape Ecology, Modeling, Mapping, and Analysis group in the Pacific Northwest (http://lemma.forestry.oregonstate.edu/). We used the following structural condition categories (Field Name "STRUCCOND") to represent changes in vegetation that may approximate fisher habitat: 1) Large/giant tree – moderate/closed (canopy cover >/= 40 percent, quadratic mean diameter of dominant trees >/=75 cm); 2) Large tree – moderate/closed (canopy cover >/= 40 percent, quadratic mean diameter of dominant trees 50–75 cm (20–30 in)); and 3) Small/medium tree-moderate/closed (canopy cover >/= 40 percent, quadratic mean diameter of dominant trees 25–50 cm (10–20 in)). We assumed the large/giant tree and large tree categories would be suitable fisher habitat, but limiting our analysis to these structural conditions would likely exclude forests that may comprise a smaller average dominant tree size, yet may still function as fisher habitat, particularly if sufficient structural features were present. Thus, we separately looked at the small/medium tree-moderate/closed structure condition category, realizing that, without further information on the specific structural condition, some unknown quantity of these mapped areas may represent suitable fisher habitat, while other areas may not.

The GNN results only showed net changes in these structure condition categories. We were not able to determine acres of ingrowth vs. loss to disturbance that occurred, nor what proportion of acreage loss was due to specific disturbance types (for example, timber harvest vs. wildfire). Outside of the NWFP area on the eastern edge of the eastern Washington and eastern Oregon Cascades, loss of the larger structural condition classes from 1993 to 2012 was 3.2 and 9.5 percent, respectively (Table 8). Though likely a conservative representation of fisher habitat, this represents less than a 5 percent loss of older forests per decade. Because the loss was not categorized into disturbance type, some level less than 5 percent was due to vegetation management. Similar to the analysis by Davis *et al.* (20XX, entire), there was a large difference in loss on Federal compared to non-Federal lands, with an actual increase in the large-structural condition class on non-Federal lands in eastern Washington (Table 8).

For the fisher analysis area in California outside of the NWFP area, the most recently available 20-year time frame yielded a 6.2 percent reduction in the larger structural condition classes across all ownerships. Contrary to the trend in the NWFP area, loss of this condition class was actually greater on Federal ownership (7.7 percent) than on non-Federal ownership (1.6 percent) (Table 8). Similar to the southern Sierra Nevada fisher habitat analysis (Spencer *et al.* 2016, p. 44), these values do not reflect the large fires of 2013 and 2014 that occurred in the Sierras.

Although this analysis did not identify disturbance type, we looked at timber harvest data, which was only available in the format of acres treated in California. However, idiosyncrasies in the USFS FACTS database (USFS 2016, FACTS database) (see Spencer *et al.* 2016, p. A-30) and the fact that the available private lands database (CAL FIRE timber harvest plans) did not indicate types of treatment or what portion of the plans may have actually been implemented make it difficult to translate acres of "treatment" as depicted in these databases into on-the-ground changes in forest vegetation types that could represent fisher habitat. Nevertheless, we present the available timber harvest information here as an indication of past vegetation management activity.

We obtained the area of USFS timber harvest activities from 1994 to 2014 within the fisher analysis area outside of the NWFP area (USFS 2016, FACTS database). We filtered the FACTS database to only include timber harvest activities; specifically, we used the activities identified in Table A-16 of Spencer *et al.* (2016) on the assumption that these timber harvest activity types were the most likely to result in changes to fisher habitat. In some areas, multiple activity types occurred in the same footprint; to avoid duplicating acreage tallies, we used the "dissolve" feature in GIS to eliminate duplication of acres and obtain a singular value of acreage affected by these treatments across the subject area. The result was a total of 983,301ac (397,942 ha) subject to timber harvest on National Forest lands in California within the fisher analysis area but outside of the NWFP area from 1994 to 2014. However, this is four times the net change in the older structural conditions for Federal lands as shown in the GNN analysis (Table 8). This may be caused by one or more of several factors. First, USFS treatments may not result in a total loss of older forest conditions at the stand level, resulting in a reduction of forest canopy, but still resulting in stands continuing to meet the structural condition categories identified in GNN. Likewise, such treatments may not result in the total removal of fisher habitat either, but rather result in modifying or degrading habitat condition that may still leave a stand functioning as fisher habitat, but perhaps of a lower quality (for example, some thinning treatments). Second, the FACTS database shows activities that were recently started but may have not yet been completed on the ground. Third, substantial recruitment of older forest habitat may have occurred to make up for potential reductions in older forest structure stands. Fourth, USFS activities may be occurring in younger stands not considered in the GNN analysis, such as precommercial thinning.

When the FACTS harvest layer was overlain on the fisher habitat model, the results showed 7.7 percent of fisher habitat (8.3 percent high quality and 6.9 percent intermediate) in California outside of the NWFP were subject to timber harvest activities recorded in FACTS over the past 20 years. This translates to 8.4 percent of USFS ownership, and 10.7 percent of fisher habitat in USFS ownership, or 4.2 and 5.4 percent per decade, respectively. However, not all treatments translate directly into loss of fisher habitat. For example, some treatments such as thinning and other partial tree removal treatments may result in functioning fisher habitat post treatment. Approved timber harvest plans (THPs) submitted to the California Department of Forestry and Fire Protection from 2003 to 2011 (THP Tracking Center 2013, see Service 2014, pp. 90–91) in the counties overlapping the Sierra Nevada region, totaled 421,562 ac (1,706 km^2) across almost 3 million acres of non-Federal timberland in this region. This results in 14.1 percent of the non-Federal ownership harvested over this 10 year period (assuming all plans were harvested). We did not have spatial THP data to determine the proportion of fisher habitat affected by private timber harvest actions.

For both the FACTS database on USFS land and the CAL FIRE THP data for non-Federal land, the proportion of ownership class harvested is greater than that represented in the GNN (Table 8). This difference is further increased knowing that the GNN analysis shows net change in vegetation as a result of all disturbance types, such as fire, and is not limited to vegetation loss due to vegetation management. That is, the vegetation change due to vegetation management, as represented in the GNN analysis, is some unknown quantity less than represented in Table 8 because vegetation management represents only a portion of the total net change. Although the GNN structural conditions analyzed (Large/Giant and Large combined) may under-represent some fisher habitat conditions by not including structurally complex stand with smaller tree sizes, or may over-represent other fisher habitat conditions by including stands that may not have suitable canopy cover or may have large tree sizes but lack the structural complexity, we consider it the best available information outside of the NWFP area because it tracks actual changes to on-the-ground vegetation, as represented through satellite imagery. Conversely, the timber harvest data available in California does not provide information on the specific treatment type and resultant loss or modification of vegetation that is suitable habitat for fishers, nor whether the project, or some portion thereof, actually occurred on the ground. Consequently, we rely more heavily on the net change in appropriate GNN structural conditions (Table 8) to assess change in vegetation conditions that approximate fisher habitat, realizing the net change includes all disturbance types and thus, over-represents the change due specifically to vegetation management activities.

4.3 Summary and conclusion

As described earlier, while historical loss of older forests via timber harvest through much of the 1900s resulted in a substantial loss of fisher habitat in the west coast fisher analysis area, harvest volume has sharply declined throughout this area since 1990, primarily on Federal lands, but also on non-Federal lands. Although timber harvest is still ongoing throughout the DPS, there is habitat ingrowth that is occurring. Modeling in the southern Sierra Nevada region indicates that ingrowth of fisher habitat has even replaced habitat loss by all disturbances in the southern Sierra Nevada region since 1990, resulting in a net gain of habitat since that time; this holds true even including the preliminary estimates of habitat loss as a result of the 2013 and 2014 fires in the region. On Federal lands in the NWFP region, habitat ingrowth has been greater than that lost due to timber harvest in all fisher subregions except for the western Oregon Cascades (Table 7), and ingrowth is expected to eventually outpace total losses under existing management to the degree that within 50 to 100 years, older forests would be within the range of amounts occurring prior to logging and extensive fire suppression. However, there is a concern that some of those gains may be outdone with potential increased losses to fire in some of the drier regions. Although non-Federal loss of older-forest habitat due to timber harvest (21.8 percent since 1993) was substantially greater than on Federal lands (1.2 percent since 1993), in combining all ownerships, the percent loss due to timber harvest was 8.2, (Table 6) which translates to 4.1 percent per decade. The net loss of habitat, however, is somewhat less because this does not include ingrowth of OGSI-80 stands, which were recruited at a rate of 6 percent over the 20-year period, or 3 percent per decade; however, it is not an entirely accurate representation to subtract total ingrowth from total loss to vegetation management without also considering all other disturbances that may be offset by ingrowth. We look at net vegetation change as a result of all disturbance types in the *Summary of Stressors Related to Habitat Loss and Fragmentation* section below.

In the Sierra Nevada region, the single analysis of fisher habitat trends indicate that fisher habitat is increasing and will continue to do so, although larger fires of higher severity in that region would limit the development of fisher habitat. However, preliminary data indicate that, in spite of habitat loss to recent large fires, recruitment still outpaced habitat loss. In this same region, the GNN vegetation trend analysis, which was used to approximate fisher habitat, indicated that loss of large forest structural conditions was 6.2 percent across all ownerships over the most

Table 8. Net change in forest structural condition within the fisher analysis area outside of the NWFP area between 1993 and 2012, as represented by Gradient Nearest Neighbor maps. Non-percentage values are in thousand acres, and values in parentheses are thousand hectares.

		Federal			**non-Federal**			**all ownerships**	
	GNN Structural Condition[1]	**net change**	**% change**		**net change**	**% change**		**net change**	**% change**
Washington									
	Large/Giant and Large combined	122 (49)	6.0		-221 (-89)	-21.1		-99 (-40)	-3.2
	Small/medium	-43 (-17)	-1.4		-248 (-100)	-6.6		-291 (-118)	-4.2
Oregon									
	Large/Giant and Large combined	-114 (-46)	-3.6		-280 (-113)	-28.1		-394 (-159)	-9.5
	Small/medium	372 (151)	10.2		-184 (-74)	-5.6		189 (76)	2.7
California									
	Large/Giant and Large combined	-221 (-89)	-7.7		-15 (-6)	-1.6		-236 (-96)	-6.2
	Small/medium	87 (35)	1.6		228 (92)	5.4		315 (127)	3.3

[1] GNN structure conditions are:
(1) Large/giant tree – moderate/closed (canopy cover >/= 40 percent, quadratic mean diameter of dominant trees >/=75 cm (30 in));
(2) Large tree – moderate/closed (canopy cover >/= 40 percent, quadratic mean diameter of dominant trees 50–75 cm (20–30 in)); and
(3) Small/medium tree-moderate/closed (canopy cover >/= 40 percent, quadratic mean diameter of dominant trees 25–50 cm (10–20 in)).

recently available 20-year time frame, a loss of 3.1 percent per decade. This was midway between changes in Washington (3.2 percent, or 1.6 percent per decade) and Oregon (9.5 percent, or nearly 5 percent per decade) (Table 8). This loss included all disturbance types across all ownerships, so some unknown but lesser quantity was due to timber harvest.

In looking at harvest records, we found that harvest on non-Federal lands, as recorded in timber harvest plans, was 14 percent of private lands in the Sierra Nevada area over a 10-year time frame, but it is now known what forest structural conditions these harvests occurred in and how that translates to the GNN forest trend change observed. Based on USFS timber harvest records, 8.4 percent of the acreage of USFS ownership in the Sierra Nevada region was subject to harvest over the past 20 years, representing 10.7 percent of the agency's available fisher habitat (4.2 and 5.4 percent per decade, respectively). However, there are concerns as to how these databases represent loss of fisher habitat as a result of vegetation management activities, as described earlier.

Timber harvest actions are widespread across ownerships throughout occupied and unoccupied regions of the fisher analysis area. There are large areas of suitable habitat throughout the fisher analysis area that are not yet occupied by fishers, suggesting that habitat may not currently be the limiting factor for fisher populations on the west coast. In the southern Sierra Nevada, fisher habitat appears to be increasing, despite losses to vegetation management and wildfires. Within the NWFP area, where we were able to explicitly track loss of older forest structural condition due to vegetation management activities, the scale of loss was at a low level (4.1 percent per decade) and was partly compensated by ingrowth. In the remainder of the analysis area, decadal levels varied by analysis sub-region, but were similar or less, and given that these levels included disturbance types other than vegetation management, the loss due to vegetation management is less to some unknown degree. Certainly individual fishers are affected at some level due to loss of cover and structural features associated with various vegetation management activities, but we have not found a population response to these activities. Fishers do occupy landscapes that are managed for timber (for example, Slauson *et al.* 2003, pp. 7-9; Self and Callas 2006, entire; Hamm *et al.* 2012, pp. 421-422; Clayton 2013, pp. 7-19; Niblett *et al.* 2015, entire) but there has yet to be information on how these activities affect fisher populations within the fisher analysis area; conclusions are further confounded because the category of vegetation management contains activities ranging from those that result in substantial loss of habitat attributes valuable to fishers (for example, large clearcut harvests that remove almost all tree canopy and structural features) to activities that modify habitat at small-scale levels yet retain functionality (for example, minor reductions in canopy cover and retention of structural features suitable for rest sites, den sites, or prey production).

Based on our analysis of the best available information, we consider vegetation management to be a low- to medium-level impact on fishers. In the sense that the amount of vegetation management occurring across the landscape is a relatively small portion of available older forest habitat, it is a low-level impact. However, given the large home range of fishers and the extent of forest management throughout the analysis area, a moderate portion of fisher individuals are likely affected, creating a moderate level impact. However, this is tempered by the fact that fishers appear to tolerate some levels of vegetation management, although population responses are not known, and where fisher habitat trends were modeled, fisher habitat was found to increase in spite of losses to vegetation management and other disturbances.

5.0 Development

Human population growth within the analysis area will increase needs for housing, services, transportation, and other infrastructure, placing ever-greater demands on land, water, and other natural resources (Bunn *et al.* 2007, p. 25; WDFW 2005, p. 21). Human infrastructure growth also includes recreation opportunities such as ski area developments, vacation cabins, trails, and campgrounds. Besides permanently removing potential fisher habitat, human developments in rural areas are changing land use from forest to other land cover types, which can fragment previously continuous habitat or hamper fisher movements.

The human population density within the analysis area varies considerably, with the largest population centers in the Puget Sound in Washington (from Bellingham south to Olympia), Willamette Valley in Oregon (particularly the Portland area), and the southwestern portion of California (CDOF 2013, p. 236; WDFW 2005, p. 14). Washington human populations are projected to grow from 5.97 million in 2,833,820 from 2000 to 8.80 million in 2040, an increase of 31 percent (SWOFM 2012, p. 6) (1,922,946 from 2013 to 2040). Oregon's population is projected to grow from 3.84 million in 2010 to 5.59 million by 2050, an increase of 45 percent. Within the Oregon counties that intersect with the analysis area, the population is projected to grow from 3.63 million in 2010 to 5.32 million in 2050, an increase of 47 percent (State of Oregon Office of Economic Analysis 2013, spreadsheet document). California's population is projected to increase from 37.31 million in 2010 to 50.37 million in 2050, an increase of 35 percent. Within California counties that substantially intersect the analysis area, the population is projected to increase from 5.09 million to 8.74 million over the same time period, an increase of 61 percent (Schwarm 2013, spreadsheet document). In several counties in the Sierra Nevada (Kern, Madera, and Yuba counties), the human population is expected to double or more between 2010 and 2050 (Schwarm 2013, spreadsheet document). Most of this growth is low-density, single-home and commercial development that lacks the benefit of regional conservation planning. Throughout much of the rest of the analysis area, human population density is relatively low and settlements consist of smaller, rural communities; however, housing density continues to increase within forest, agriculture, and mixed forest-agriculture dominant use areas (Bunn *et al.* 2007, p. 26; Stein *et al.* 2007, p. 2).

How future residents of Washington, Oregon, and California will occupy the landscape is less clear. Development stressors are expected to be higher in those areas where fisher habitat occurs close to rapidly growing urban and suburban areas. Urbanization has closely followed the early agricultural development in concentrated areas along important transportation corridors. For example, forests on the west slope of the northern Sierra Nevada face heavy development pressure due to access to major urban highways (for example, U.S. Highway 50 and Interstate 80; see Figure 16) (FRAP 2010, p. 58).

Figure 16. Prioritization of areas with ecosystems at risk due to projected population growth in California by the year 2050 (FRAP 2010, pp. 52–54). High priority areas are threatened over more than 25 percent of the landscape as well as at a localized level. Medium priority areas are threatened over 10-25 percent of the landscape.

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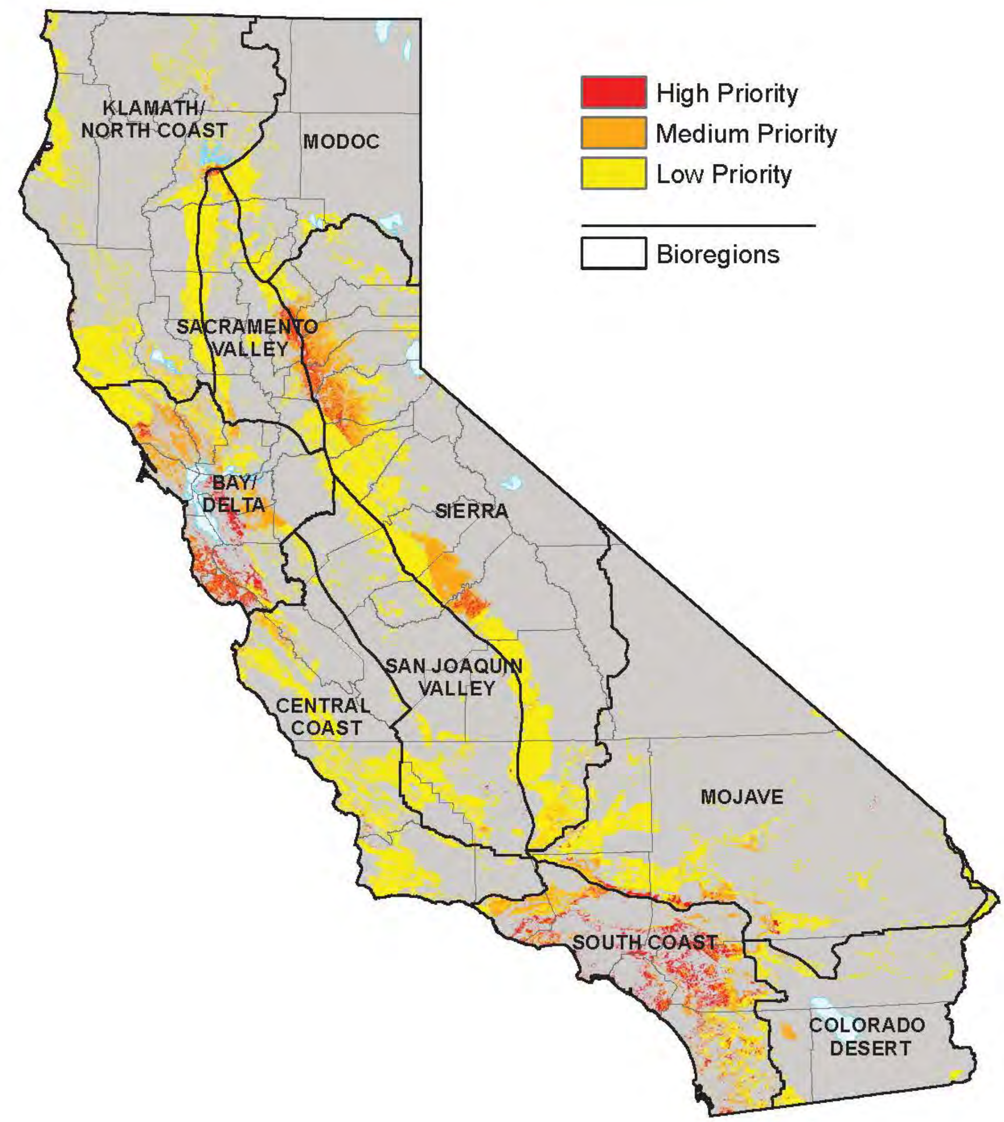

Figure 1.1.4.
Population growth and development impacts priority landscape.
Data Sources: Commission on Local Governance for the 21st Century (2000); California Tree Seed Zones, Buck, et al. (1970); Statewide Land Use / Land Cover Mosaic, FRAP (2006); ICLUS, U.S. Environmental Protection Agency (2009)

54

Fifty-one percent of medium- and high-quality suitable fisher habitat in Oregon is currently protected from development by Federal ownership. On the remaining private land, 79 percent is zoned as Forestry by Oregon's land use planning system, which does not allow for development activities that would have adverse effects on forest resources (OARE 660-015-0000(4)). Ultimately, less than 3 percent of the medium- and high-quality suitable habitat within the historical home range of the fisher in Oregon is on private property with a non-resource zoning that would facilitate easy development. In addition, population growth predictions through 2014 in Jackson County, Oregon are for continued growth in urban areas, but for population declines in rural areas that might abut fisher habitat (Jackson County 2007, pp. 18;14-18-15). Due to Federal ownership, Oregon's land use planning system, and low population growth in rural areas, development activities are unlikely to be a significant stressor to fisher in Oregon (Comment letter FWS-R8-ES-2014-0041-0409). We do not have a similar level of information for Washington or California, but the best available information suggests a similar pattern of development would occur in these states.

Overall, based on our current analysis, development activities may affect an insignificant amount of suitable habitat for fisher individuals within the range of the West Coast DPS. The best available scientific and commercial information at this time indicate that although an insignificant amount of suitable habitat is undergoing development pressures such that individual fishers may be impacted, there does not appear to be any population- or rangewide-level impacts to suitable habitat, nor is there any indication that population-wide of rangewide impacts to suitable habitat are likely to occur in the future. Thus, human development is considered to be a low-level impact to fishers currently and in the future.

6.0 Linear Infrastructure

We considered highways and forest roads, as well as railroads, canals, power lines and pipelines, to be permanent fixtures on the landscape. As well as being sources of vehicle-collision mortality (addressed below in the *Collision With Vehicles* section), most linear features represent some level of permanent removal or change of potential fisher habitat. Roads, highways, and associated developments can also substantially influence movement patterns of wildlife (Beier 1995, p. 234). Major highways and state highways may be impediments to fisher movements (for example, home range establishment, juvenile dispersal, breeding season movements by males), thereby potentially affecting population connectivity.

A single linear feature may have a small effect on fisher movements, but multiple linear features (for example, paved highways, railroad rights-of-way, and rivers) nearby may create more formidable filters and barriers to movement (Naney *et al.* 2012, p. 36). In one study in northern California (such as Farber and Schwartz 2007, Tab 6), there is information indicating that fishers cross the combined features of the Klamath River and a two-lane paved highway enough to maintain genetically homogenous populations on either side of these features.

The adverse impacts of roads on movement patterns are more severe on low-density carnivores like fishers compared to many wildlife species due to the fisher's large home range, relatively low fecundity, and low natural population density (Ruediger *et al.* 1999, p. 7). Disruption of movement patterns can contribute to a loss of available habitat (Mansergh and Scotts 1989, pp. 703–706), isolate populations, and increase the probability of local extinctions (Mader 1984, pp.

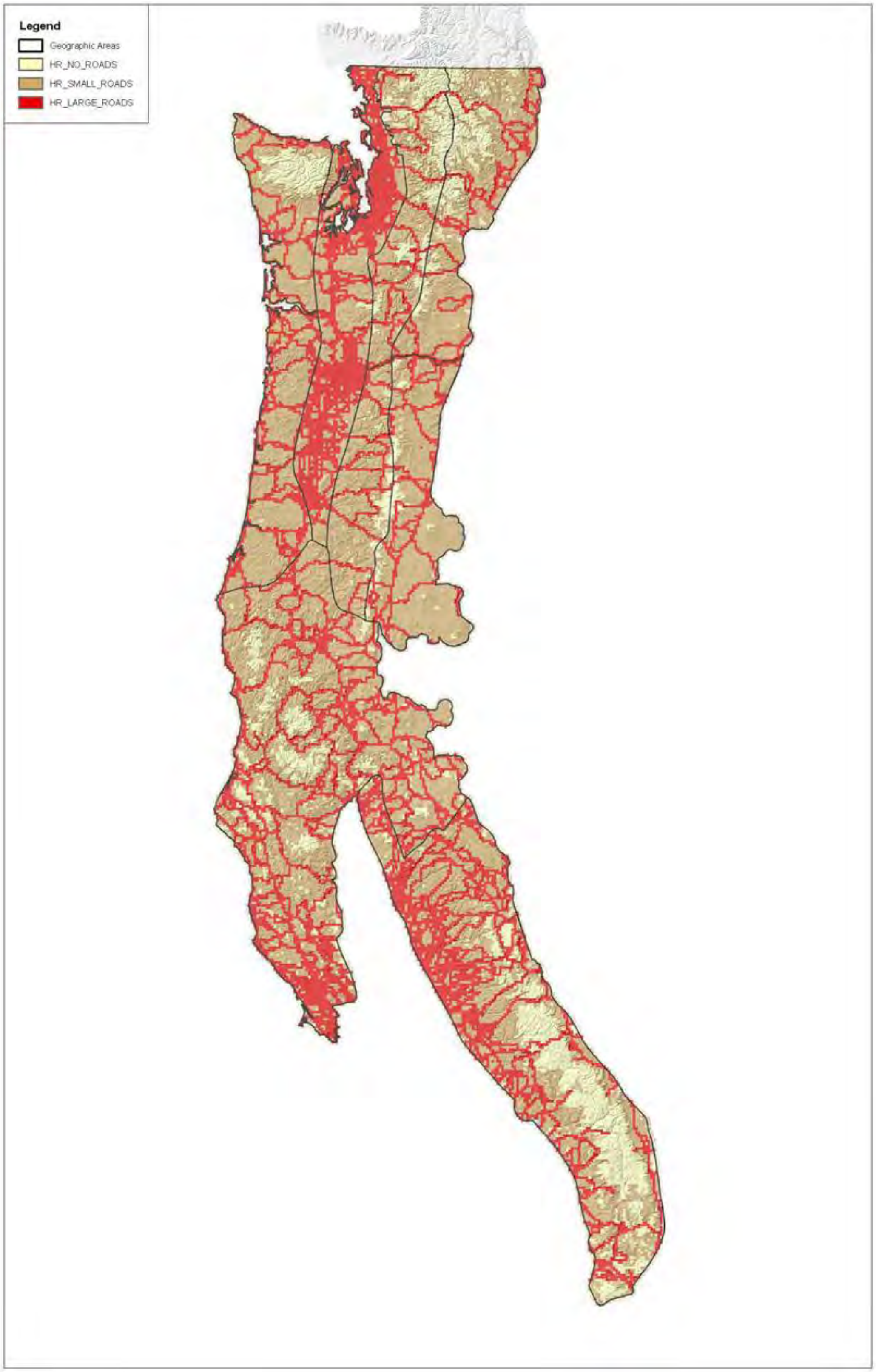

Figure 17. Fisher analysis area with 10 km^2 grid cells (to approximate a hypothetical female home range) that contain roads.

93–94). Adverse effects of roads and other linear features may also include displacement due to noise and human activity, secondary loss of habitat due to the spread of development, increased nonnative species invasion, increased wildfire starts, and increased vulnerability to predators (Naney *et al.* 2012, pp. 16, 22, 26, 36).

Conservation actions to minimize impacts associated with linear infrastructure could include rerouting roads away from high-quality fisher habitat. Future linear infrastructure projects could be planned to avoid these high quality areas. In occupied fisher habitat, undercrossings and overcrossings could be constructed to facilitate movement across these barriers.

Overall, based on our current analysis, the best available information suggests that potential impacts associated with linear infrastructure likely affect individual fishers and an insignificant amount of suitable habitat within the range of the West Coast DPS. The best available scientific and commercial information indicate that minor impacts from linear infrastructure may be occurring, and an overall insignificant amount of additional linear infrastructure may be built the future. However, there is no evidence to suggest that this stressor is affecting fisher at the population- or range-wide levels both currently and in the future. Thus, linear infrastructure is considered to be a low-level impact to fishers currently and in the future.

Conservation measures to reduce the stressors related to habitat or range of the species

U.S. Fish and Wildlife Service Habitat Conservation Plans

Some non-Federal lands in the analysis area are managed under Habitat Conservation Plans (HCPs) with strategies that conserve habitat for a variety of forest-associated species, particularly in western Washington and northwestern California. HCPs are planning documents required as part of an application for a permit to allow incidental take of a species listed under the ESA. They describe the anticipated effects of the proposed taking and how the impacts will be minimized. The fisher may be a covered species in a HCP (an incidental take permit was issued for the fisher in the event of a future listing), and may benefit from actions proposed under HCPs even if it is not a covered species; these HCPs provide some direct and incidental benefits to fishers on lands where conservation would otherwise be uncertain. The fisher is a covered species in nine HCPs within Washington and California, but the species is currently known to occur only on lands under three California HCPs and one Washington HCP. Late-seral conditions appear to be important for sustaining resident fisher populations, particularly for providing den and rest sites, but fisher may still use territories that also contain early- and mid-seral forest attributes. The quantity and location of late-successional habitat protected or promoted varies by HCP; some HCPs only protect or allow late-successional habitat to develop in riparian buffers and smaller blocks of remnant old forest, while other HCPs contain larger reserves and more conservative leave-tree strategies. HCP conservation strategies generally promote less late- seral forest conditions than Federal land management plans, but those strategies are certainly more protective of fisher than if the private land were converted to non-forest uses. HCPs are often voluntary agreements between land managers and the Service; although this outcome is rare, the HCP agreement can be terminated at any time by either party. The HCPs for which fisher is a covered species are described below.

Washington HCPs

The U.S. Fish and Wildlife Service has approved 20 HCPs and Safe Harbor Agreements with private, city, county, and state entities in Washington State. Of those plans, 16 pertain to forested areas within the range of the fisher, and six of them address the biological needs of fisher and provide mitigation for the fisher such that those HCPs were determined to be sufficient for section 10(a) purposes should the fisher become listed as threatened or endangered in the future. Those five HCPs are with the Washington Department of Natural Resources (state lands described above), City of Tacoma (Green River water supply), City of Seattle (Cedar River water supply), Plum Creek Timber Company, Murray Pacific Corporation, and Port Blakely Tree Farms. Cumulatively, the five HCPs cover 2,435,623 acres of forestlands, though only some of that land would be considered potential fisher habitat. HCPs that pertain to forested habitat within the Washington State portion of the analysis area provide protections for fisher habitat by increasing the connectivity of fisher habitat on private lands with adjacent National Park and National Forest lands, thereby increasing the total quantity of contiguous fisher habitat. However, these HCP lands contain typically less denning opportunities and a wider range of forest age classes, so it is likely that the fisher carrying capacity of HCPs is less than the adjacent National Park and National Forest lands.

Other HCPs, most notably the Forest Practices HCP (discussed below as a state regulation) and the Green Diamond Resource Company HCP (261,575 acres of forest adjacent to the Olympic fisher reintroduction) do not cover fisher, and therefore have not been analyzed to determine the adequacy of protective measures for the fisher. The Green Diamond Resource Company HCP is more protective than Washington Forest Practices in terms of wildlife management, leave trees, and riparian buffers. The Green Diamond Resource Company HCP also protects 1,138 acres of highly fragmented mature and old-forest habitat for the marbled murrelet (Simpson Timber Company HCP 2000, p. 26), and it is likely that those lands, in tandem with large riparian reserves, will contribute to fisher conservation. Fishers from the Olympic reintroduction project [Lewis *et al.* 2011, p. 9 (Figure 4), Lewis *et al.* 2012b, p. 6 (Figure 1), p. 9 (Figure 2)] used Green Diamond HCP lands, and one individual established a home range.

Oregon HCPs

The fisher is not a covered species under any HCPs in Oregon.

California HCPs

The Humboldt Redwood Company (formerly Pacific Lumber Company) is currently operating under a HCP that addresses multiple species including fishers on 85670 ha (211,700 ac). There are no other HCPs within California that specifically address fishers. There are several HCPs that contain fisher habitat in California totaling just under 200 ha (600 ac). Most HCPs in California that cover areas of fisher habitat and are presumably at least occasionally occupied by fishers were designed to address northern spotted owls. Most of these occur in the northwestern portion of California and do not extend into the eastern Klamath or Sierras portions of the fisher's range, therefore it is unknown if these HCPs are contributing to fisher conservation.

HCP summary

The fisher is a covered species for the purposes of section 10(a) under the Act in nine HCPs within Washington and California. The species is currently known to occur on lands under three California HCPs (two that do not cover fisher and one that does) and two Washington HCPs (two that do not cover fisher, and one that does). Six HCPs in Washington, totaling over 971,246 ha (2.4 million ac), cover the fisher for the purposes of section 10(a) should the species be listed. In California, the fisher is covered by one HCP totaling 85, 672 ha (211,700 ac). These HCPs provide exemptions to take prohibitions under section 9 of the Act, and in covering fisher, they are deemed to minimize and mitigate take and not appreciably reduce the likelihood of the survival and recovery of the fisher, should it become listed. Nearly all of the HCPs in California that cover areas of fisher habitat occur in the northwestern portion of the state and are focused on northern spotted owls. Most of the fisher habitat on private lands in California is not currently covered under any HCP(s).

Several HCPs, that do not include fishers as a covered species, provide ancillary benefits because they focus on providing habitat for species such as northern spotted owls and anadromous salmonids. These HCPs require maintenance of relatively intact mature forested habitats along streams, where fishers may also be present. By preserving or developing components of habitat structure, these HCPs may benefit fishers above and beyond what would otherwise be required by forest practice regulations in individual States. However, the size and amounts of structural components retained (for example, down wood, snags, live trees) are less than what are typically found in fisher habitat and may not be adequate for conserving fishers. Still other HCPs have resulted in the retention of large blocks of habitat that may provide refugia for fishers in areas that may otherwise not be conducive to fisher conservation.

Other Conservation Measures

Candidate Conservation Agreement with Assurances

The Service and Sierra Pacific Industries (SPI) finalized a Candidate Conservation Agreement with Assurances (CCAA) for the Fisher for the 65,000 ha (160,000 ac) Stirling Management Area on May 15, 2008. The CCAA's conservation measure consists of management of fisher denning and resting habitat on SPI lands in the Sierra Nevada. In addition, the CCAA provided an incentive to SPI to accept reintroduced fishers onto the enrolled lands. Fishers have been reintroduced to the Stirling Management Area (for current information refer to the Population Status, Introduced Populations, Northern Sierra Nevada Reintroduced Population section of this document) and this effort is providing both an opportunity to establish a self-sustaining population of fishers where they historically occurred and the opportunity to evaluate future larger scale reintroduction efforts based on monitoring mortality, movement patterns, and habitat use of released fishers.

The Notice of Availability announcing a second CCAA, and the accompanying NEPA Environmental Assessment, for approximately 607 thousand ha (1.5 million ac) of SPI private commercial forest in the southern Cascades and Sierra Nevada Mountains of California, will be published in the Federal Register in the near future. The CCAA covers activities that SPI routinely carries out during the management of their private forestland, including timber harvest and associated support activities. Conservation measures, implemented under the CCAA, will maintain habitat for fishers, avoid killing or harassing fishers to the extent possible, and identify and reduce known threats to fishers.

Among the SPI CCAA conservation measures are: retaining 50 percent of capable SPI lands in a mixed-aged, multilayer, structurally complex condition; retaining an average of 1 of the oldest and largest available wildlife trees in every 2 ha (5 ac) [such as leaving an average of 4 old large trees in every 8 ha (20 ac)]; maintaining 2 percent of each harvested area as a habitat retention area (composed of co-dominant and dominant trees representative of diameter classes present before harvest); retaining legacy trees wherever they exist [such as hardwoods greater than 91 cm (36 in) diameter at breast height (dbh) or non-merchantable live green conifers greater than 76 cm (30 in) dbh]; retaining non-merchantable trees to the extent possible; and actively identifying and remediating (removing toxicants) trespass marijuana cultivation sites. Because these conservation measures will be applied in areas currently occupied by fishers as well as areas where fishers are not currently known to occur, the CCAA will protect extant populations and may also facilitate the expansion of the fisher's geographic distribution in California.

Though not yet final, the Service is working on a template CCAA within the historical west coast fisher range in Oregon between the Service, prospective non-federal landowners, and managers who will voluntarily commit to conservation measures that protect occupied female den sites. An additional measure includes contributions, either monetarily or in-kind, to research and monitoring efforts that would fill key information gaps on fishers in western Oregon, as well as increase the likelihood of finding denning fishers. Such actions would further fisher conservation, increase the likelihood of detecting and protecting denning females, and further collaboration among government and non-government entities. The framework would also support future reintroductions in western Oregon, should the situation warrant. At this writing, we have received letters of commitment from five different landowners for enrolling over 375,000 ac (152,000 ha) and committing to specific financial and in-kind support towards the fisher monitoring and research program of work laid out in the CCAA. Overall, this CCAA would provide a variety of protection measures that will further the conservation of the fisher (for example, provide coverage or escape mechanisms for all man-made structures on enrolled lands that pose an entrapment risk to fishers, prohibit nuisance animal control activities on enrolled lands within 2.5 mi (4 km) of known occupied densities). The proposed template CCAA for fisher in Oregon and the draft environmental action statement published in the *Federal Register* on March 24, 2016 (81 FR 15737).

In January 2016, the Service received an application for an ESA Section 10(a)(1)(A) Enhancement of Survival Permit from the WDFW to implement a draft Candidate Conservation Agreement with Assurances (CCAA). The Service announced the availability of the draft CCAA and EA, and a 30-day open comment period on February 29, 2016 (81 FR 10269). If the Enhancement of Survival Permit is issued, WDFW would hold the permit and be responsible for enrolling non-Federal Washington landowners in the CCAA and issuing certificates of inclusion. Covered activities would include 1) Ongoing and planned land management practices as defined within the Washington State Forest Practices Act (RCW 76.09.020 definitions as of February 1, 2015), and 2) Implementation of conservation measures, inventory and monitoring activities, and changed circumstances measures described in the CCAA (WDFW 2016). Conservation measures would focus on protecting known fisher denning locations (many of which would be discovered and monitored during the ongoing fisher reintroduction in the Washington Cascades) and active participation in fisher monitoring efforts.

Draft Interagency Fisher Conservation Strategy

An interagency, intergovernmental team of biologists developed a conservation strategy for fisher that covers the analysis area. This strategy is a science-based guidance document that provides an integrated, regional approach to achieve self-sustaining, interacting populations of fishers within the analysis area. It provides a framework for local managers and biologists and promotes cooperation between and among agencies and stakeholders to implement conservation actions needed to meet fisher life history requirements at multiple spatial scales. A multi-scaled approach was developed to identify specific areas that protect extant populations and suitable habitat, restore connectivity among populations, and restore populations in areas where fishers have been extirpated. This approach encouraged areas for restoration activities to develop fisher habitat and to develop resilient landscapes.

Federal agencies within the analysis area chose not to finalize and formally adopt the draft strategy, although they encourage utilization of the information in the draft strategy to focus on protection and enhancement of existing populations (Hollen 2012, Fisher Steering Committee Meeting Notes). Currently Region 5 of the USFS is using this conservation strategy as the basis for the development of a southern Sierra Nevada conservation strategy for the USFS (USFS 2013). Region 6 of the USFS, along with Oregon/Washington region of the Bureau of Land Management (BLM), has chosen not to implement the strategy at this time (Chatel *et al.* 2013, pers. comm.; Hollen 2013, pers. comm.). The Service is currently using components of this strategy to inform, develop, and evaluate ongoing conservation approaches with both federal and non-Federal partners.

State of Washington Fisher Recovery Plan

A statewide recovery plan for the fisher was completed in 2006. The recovery plan identified that self-sustaining fisher populations in the state would not likely become re-established without human intervention. A reintroduction feasibility study was conducted for western Washington that identified three large areas of suitable habitat that may support fisher populations. The Olympic National Park was identified as the most suitable for the first reintroduction, and that reintroduction has taken place. The recovery plan identified the southwestern and northwestern Cascades as the next reintroduction location following the recent Olympic reintroduction. Reintroductions into Washington's south Cascade Mountains began in December of 2015. The recovery plan outlines strategies that, if implemented, will likely restore self-sustaining fisher populations to the three recovery areas identified in Washington: the Olympic Mountains, the South Cascade Mountains, and the North Cascade Mountains.

California Wildlife Planning Efforts

The California State Wildlife Action Plan (SWAP) (CDFG 2007, entire) does not identify any goals or objectives for conservation specifically for fishers in the state. The fisher is one of several species discussed in the SWAP to illustrate conservation issues within the Sierra Nevada and Cascade bioregion. The California Department of Fish and Game (CDFG) noted that the fisher is "a rare species of special concern," and that maintaining forest habitat and habitat connectivity are essential for fisher conservation (CDFG 2007, pp. 301–302). The California SWAP has been updated previously and is currently undergoing a 10-year update with a completion date of 2015. The State Wildlife Grants Program (SWGP) was adopted and enacted by Congress in 2000 to support state programs that broadly benefit wildlife and habitats but particularly “species of greatest conservation need.” It is uncertain whether the SWGP will direct funding towards fisher conservation through the SWAP.

Southern Sierra Nevada Fisher Conservation Strategy

The Southern Sierra Nevada Fisher Conservation Strategy, developed by the Fisher Interagency Leadership Team presents a framework for conservation and recovery for the fisher in the SSN population (Spencer *et al.* 2016, entire). The Conservation Strategy sets four goals: (1) Sustain and increase the size and distribution of the fisher population; (2) maintain the genetic diversity of the fisher population; (3) restore and maintain high quality and resilient fisher habitat conditions; and (4) reduce human-influenced mortality and disturbance factors to increase fisher survival and reproduction. There are details on how each of these goals would be accomplished (Spencer *et al.* 2016, pp. 7–9). The Strategy divides the SSN population into seven core areas, four of which are occupied by fishers, one sparsely occupied and two unoccupied at present. The Conservation Strategy also designates six linkage areas (Spencer *et al.* 2016, pp. 12–19). The SSN population area is divided into 1,012 grid cells of which 415 are considered currently suitable, 107 are considered permanently unsuitable, and 490 are considered potentially but not currently suitable. The Conservation Strategy sets a goal of converting 30 cells from potential to suitable habitat within 30 years. The Fisher Interagency Leadership Team estimates that, currently, there are 256 female fishers and that there will be an increase to 445 females within the 30-year time span (Spencer *et al.* 2016, pp. 27–44). They propose conservation measures designed to increase the abundance and vigor of larger trees and reduce the abundance of smaller trees. This would be accomplished by: (1) Retaining most if not all large trees and snags when implementing mechanical treatments, especially the largest available trees and those with structural deformities or decadence, and (2) judiciously removing smaller trees as necessary to promote recruitment and survival of the larger trees and increase habitat heterogeneity. In addition to habitat management, the Conservation Strategy proposes numerous conservation measures to reduce mortality including reducing poisoning from rodenticides, reducing predation by maintaining escape cover and eliminating unneeded linear features, and reducing deaths by vehicles by through vehicle speed reduction and installing wildlife under crossings (Spencer *et al.* 2016, pp. 63–66). At this time, it is unclear how or if this Conservation Strategy for the SSN population will be implemented by the USFS in their revised forest plans and day-to-day project planning and management.

Oregon Interagency Memorandum of Understanding

A memorandum of understanding (MOU) has been signed between Federal agencies (Service, BLM, National Park Service (NPS), USFS) and Oregon State agencies (Oregon Department of Forestry (ODF), ODFW) to conserve fishers in western Oregon. The purpose of the MOU is to provide a framework for cooperation and achievement of mutual goals regarding conservation of fisher within the historical west coast fisher range in Oregon. Party contributions include:

ameliorate threats to existing populations and facilitate expansion of populations, where ecologically appropriate; facilitate fisher reintroductions where appropriate and cooperate in developing regulatory assurance mechanisms to support reintroductions; share relevant data and information and provide technical assistance; clean up illegal grow sites on party ownership; establish and interagency carnivore working group to coordinate research, monitoring, and conservation actions for fishers.

Critical Habitat for Northern Spotted Owl

On December 2, 2012, the Service designated revised critical habitat for the northern spotted owl (Service 2012a, 77 FR 71875, December 4, 2012, entire) totaling 3,876,064 ha (9,577,969 ac) in 11 units and 60 subunits in within the range of the northern spotted owl in California, Oregon, and Washington. Approximately 3,871,521 ha (9,566,729 ac) of designated northern spotted owl critical habitat are within the fisher analysis area and encompass 27 percent of high quality fisher habitat (Table 9).

Table 9. Hectares of habitat quality derived from the Fisher Analysis Area Habitat Model within designated revised critical habitat for the northern spotted owl.

	Hectares Within Analysis Area	**Low Quality Habitat (ha)**	**Intermediate Quality Habitat (ha)**	**High Quality Habitat (ha)**
Fisher Analysis Area	35,395,622	18,658,517	8,851,089	7,886,016
Northern Spotted Owl Range within the Fisher Analysis Area (source: Regional Ecosystem Office)	22,838,141	10,014,440	6,490,959	6,332,742
Northern Spotted Owl Critical Habitat	3,871,521	986,952	737,117	2,147,455
Percent of Northern Spotted Owl Critical Habitat within the Fisher Analysis Area	11%	5%	8%	27%
Percent of Northern Spotted Owl Critical Habitat within the Northern Spotted Owl Range in the Fisher Analysis Area	17%	10%	11%	34%

The physical or biological features and primary constituent elements essential to the conservation of the northern spotted owl likely provide ancillary benefit to fishers and fisher habitat that occur within designated northern spotted owl critical habitat. The physical or biological features identified as essential to the conservation of the northern spotted owl are forested areas used or likely to be used by them for nesting, roosting, foraging, or dispersing. The primary constituent elements are described as important include: specific ranges of forest stand density and tree size distribution; coarse woody debris; specific resources, such as food (prey and suitable prey habitat), nest sites, and cover and are described in further detail in the Federal Register northern spotted owl critical habitat rule (Service 2012a, 77 FR 71875, December 4, 2012, p. 71904). Northern spotted owl primary constituent elements that may benefit fishers are summarized below.

The primary forest types that support the northern spotted owl (Sitka spruce, western hemlock, mixed conifer, mixed evergreen, grand fir, Pacific silver fir, Douglas-fir, white fir, Shasta red fir, redwood/Douglas-fir, and moister ponderosa pine) (Service 2012a,77 FR 71875, December 4, 2012, p. 72051) also support fishers. Nesting and roosting habitat identified for northern spotted owl likely provides more complex forest stands that may also provide structural features for resting and potentially for denning fishers (for example, trees with cavities and snags). These more complex nesting and roosting habitat stands also may provide forest conditions that provide thermoregulatory properties important to fishers as well as foraging habitat. Components of northern spotted owl nesting and roosting habitat expected to benefit fishers include: moderate to high canopy closure (60 to over 80 percent), multilayered and multispecies canopies with large overstory trees (51 to 76 cm (20 to 30 in.) diameter at breast height (dbh), basal area greater than 55 m^2/ha (240 ft^2/ac), high diversity of tree diameters, and a high incidence of large live trees with various deformities (for example, large cavities, broken tops, mistletoe infections, and other evidence of decadence), large snags and large accumulations of woody debris on the ground (Service 2012a, 77 FR 71875, December 4, 2012, p. 72051). Other aspects of northern spotted owl critical habitat include foraging and dispersal habitat that, depending on their amounts and configuration on the landscape, could prove beneficial for fishers. In general, stands with adequate tree size and dense canopy cover may provide movement and foraging opportunities.

Critical habitat receives protection under section 7 of the ESA through requiring that Federal agencies consult with the Service to ensure that their actions will not likely result in the destruction or adverse modification of critical habitat. In practice in the NWFP area, Federal agencies implement a form of section 7 consultation, “Streamlined Consultation,” where working together the Service and other Federal agencies can develop projects that minimize effects to critical habitat and thereby help to meet the Federal agencies’ responsibilities to conserve species and their critical habitat. Thus implementation of projects within northern spotted owl designated critical habitat often focuses on retaining many of the forest types and structural elements important to fishers and that constitute fisher habitat.

Summary of Stressors Related to Habitat Loss and Fragmentation

In conclusion, historical loss, modification, and fragmentation of fisher habitat have been substantial. Reductions of late-successional forest from large portions of the Sierra Nevada and Pacific Northwest (Aubry and Houston 1992, pp. 69, 74–75; McKelvey and Johnston 1992, pp.

225–232, 241; Franklin and Fites-Kauffman 1996, p. 648) have diminished habitat within the fishers' historical distribution on the west coast. Forested land cover in the Washington, Oregon, and California decreased by about 2.7 million ha (6.7 million ac) between 1953 and 1997 as a result of conversion to other uses (Smith *et al.* 2001, p. 65; Alig *et al.* 2003, pp. 56-57). Habitat components important to a fisher's use of stands and the landscape can be identified broadly as structural elements (for example, snags, down wood, live trees with cavities, and mistletoe brooms), overstory cover (dominant, co-dominant, and intermediate trees), understory cover (vertical and horizontal diversity), and vegetation diversity (floristic species) (Lofroth *et al.* 2010, pp. 119–121) and these habitat components are represented primarily, though not exclusively, in late-successional forests. The reduction in, or losses of, these components are outcomes of natural disturbance events (for example, wildfire, forest insects, and disease) and various vegetation management activities (for example, timber harvest, silvicultural practices, and fuel reduction techniques). However, these same natural disturbance events are important to the creation of suitable habitat structures, like den and resting cavities in live and dead trees and logs.

While there has been substantial historical loss of habitat as a result of timber harvesting, timber harvest has dropped dramatically since 1990 (Gale *et al.* 2012, pp. 4, 10,11; Charnley and Long 2014,pp. 631-632; Kennedy *et al.* 2012, p. 128; WDNR 2016, entire), primarily on Federal lands, but also to some degree on private lands. Private forests typically are not managed for features of fisher habitat and may be developed as human populations expand. Most Federal public lands with fisher habitat in the analysis area are managed under the NWFP or the Sierra Nevada Framework (See Existing Regulatory Mechanisms Section). In both the NWFP and Sierra Nevada Framework, some management actions may be consistent with the maintenance or development of fisher habitat, and may even reduce the risk of long-term loss of fisher habitat to large-scale stand-replacement fires. However, given the sources of data available for our analysis, we could not quantify what proportion of vegetation management activities meets these characteristics. State forest lands are managed for various purposes including wildlife, recreation purposes and for timber production (See Existing Regulatory Mechanisms Section). Where loss of older forests specifically to vegetation management is known (within the NWFP area), loss rates of OGSI-80 stands (representing fisher habitat) have been low since 1993, averaging 4.1 percent per decade across all ownerships (10.9 percent on non-Federal lands and 0.6 percent on Federal lands) (Table 6).

Wildfire is a natural ecological process that occurs throughout the range of the west coast fisher, and its effect on fisher habitat varies with the fire's scale and severity, having a range of effects that can benefit fishers (create decayed structures used for resting or denning or beneficial to fisher prey) and reduce or severely fragment habitat as a result of large-scale, high severity fires. Loss rates of OGSI-80 forests (representing fisher habitat) in the NWFP area has been low since 1993, averaging 1.5 percent per decade across all ownerships (0.4 percent on non-Federal land and 2.1 percent on Federal land (Table 6). However, recent large, high-severity wildfires raise concerns about future trends in fisher habitat retention, particularly in the drier portions of the analysis area such as the Sierra Nevada, Klamath province, and the eastern Cascades. Climate is an important driver of wildfire regimes, and recent climate change has been implicated in changes in wildfire activity and fires seasons in some areas. In the southern portion of the analysis area, the length of the fire season has increased, and long fire seasons are becoming more frequent elsewhere in the analysis area (Jolly *et al.* 2015, p. 5, Figure 3).

Forest insects and diseases are also a naturally occurring ecological process. Similar to wildfire, they can create structural features that benefit fishers, or, when occurring in epidemics affecting large-scale areas of forest, they can reduce and fragment habitat. Losses of OGSI-80 forests (representing fisher habitat) in the NWFP area to forest insects since 1993 show the lowest levels of any quantified disturbance type, averaging 0.3 percent per decade across all ownerships (0.35 percent on non-Federal lands and 0.25 percent on Federal lands) (Table 6). Increasing summer temperatures and dryness associated with climate change is expected to increase the extent and intensity of insect outbreaks, which can in turn affect fire extent and intensity. However, the extent of these changes and their direct implications on changes in fisher habitat and fisher populations is difficult to predict.

While warming of the global climate system is deemed "unequivocal" (IPCC 2013, p. 4), predicting specific effects to fisher habitat at the local scale is more difficult. Forest responses are expected to be site-and region-specific. Many predictions of future conditions are relatively general in nature and provide little specificity with regard to timeframes or geographic region of occurrence that would inform consideration of future habitat conditions for fishers in the analysis area. While vegetative cover and species composition is expected to change in response to changing climate, the exact nature, timing, and rate of change is uncertain. For example, some argue that such a change will occur gradually, while others argue that disturbance events will accelerate such changes, leading to rapid ecotype conversions. Fisher response to these changes is unclear, as some predictions are for loss of vegetative conditions considered suitable for fishers, while others predict increases in such conditions.

Loss of forest cover along the Pacific coast as a result of type conversion through development or other means is projected to continue through 2050 in Washington, Oregon, and California, with timberland area projected to be about 8 percent smaller in 2050 than in 1997 based on projections of relevant demographic and economic factors, which are more likely to change in the future than biophysical factors (Alig *et al.* 2003, pp. 1, 56-57).

Human population and income are expected to promote development in the region, as the population is projected to increase at rates above the national average, leading to more conversion of forest to non-forest uses (CDFG 2010, pp. 52–53), although such forest conversions typically occur near urban areas rather than in rural areas that might be more likely to be suitable fisher habitat (for example, Johnson *et al.* 2007, p. 41; Spies *et al.* 2007, p. 11). Given patterns of human population growth and recreational use of the forest in areas near and within fisher habitat, road development is expected to increase. However, losses of habitat due to development and linear features are expected to be low.

Net change in OGSI-80 forests (representing fisher habitat) in the NWFP area, considering losses resulting from all disturbance types and including ingrowth, was 5.9 percent on all ownerships, which is less than 3 percent per decade; loss was greatest on non-Federal lands (5. 8 percent per decade) compared to Federal lands (1.5 percent per decade) (Table 6). Although not directly comparable because trends of a structural condition different from OGSI-80 was measured, the net loss of GNN large structure condition (representing fisher habitat) outside of the NWFP area ranged from 1.6 percent per decade in the eastern edge of the eastern Washington Cascades, to 4.8 percent in the eastern edge of the eastern Oregon Cascades, with a 3.1 percent per decade loss in the Sierra Nevada region (Table 8). In the southern Sierra Nevada region, where fisher habitat was actually modeled and its trends tracked over time, fisher habitat actually increased, despite losses to vegetation management and fires. Overall, habitat loss is affecting a low to moderate amount of habitat. The consequent effect to fishers is considered also to be low- to moderate, although there are large areas of suitable but unoccupied habitat throughout the analysis area, suggesting that habitat may not be limiting for fishers.

Stressors Related to Direct Mortality of Fishers

7.0 Trapping and Incidental Capture

In the late 1800s and early 1900s, heavy trapping pressure on fishers resulted from the high value of pelts, the ease of trapping fishers (Powell 1993, pp. 19 and 77), year-round accessibility in the low- to mid-elevation coniferous forests where they live, and the lack of trapping regulations (Aubry and Lewis 2003, p. 89). Such unregulated overharvest, and the use of strychnine as a trapping and general predator control agent, in addition to habitat loss, eliminated or greatly reduced fisher numbers across their range by the mid-1900s (Douglas and Strickland 1987, p. 512; Powell 1993, p. 77). Aubry and Lewis (2003, p. 81) stated that over-trapping appears to have been the primary initial cause of fisher population losses in the Pacific States. The closure of trapping seasons in the 1920s and 1930s, reintroductions and augmentations, and land-use changes helped restore the fisher's presence in many parts of its range outside of the analysis area (Douglas and Strickland 1987, p. 512; Powell 1993, p. 80; Drew *et al.* 2003, 59; Vinkey 2003, p. 61). The regulation of trapping and the end to indiscriminate predator control has likely had a positive influence on fisher numbers.

In 1936, noting that fishers had disappeared from much of their former range in Washington, Oregon, and other states (USDA 1936, pp. 1–2), the Chief of the U.S. Biological Survey urged the closing of the hunting and trapping season for 5 years to save fishers and other furbearers from joining the list of extinct wild animals. Within the analysis area, fisher trapping seasons were closed, but the timing of the closure varied among states. Commercial trapping of fishers has been prohibited in Washington since 1933 (Lewis and Stinson 1998, p. 22), in Oregon since 1937, and in California since 1946 (Aubry and Lewis 2003, p. 86). Where trapping is legal in other states and in Canada, it is a significant source of mortality. Krohn *et al.* (1994, p. 139), for example, found that over a 5-year period, trapping was responsible for 94 percent (n = 47 of 50) of all mortality for a population of fishers studied in Maine. In British Columbia, the fisher is classified as a furbearing mammal that may be legally harvested; however, the trapping season for fishers has been closed in portions of the Province until it can be determined that the population can withstand trapping pressure (British Columbia Ministry of Environment 2009, p. 93).

Currently, it is not legal to intentionally trap fishers in Washington, Oregon, or California. However, fishers are susceptible to incidental capture in traps set for other species (Earle 1978, p. 88; Luque 1983, p. 1; Lewis and Zielinski 1996, pp. 293–295). In all three states it is legal to harvest many mammals that are found in fisher habitat, including bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), coyote (*Canis latrans*), mink (*Mustela vison*), and other furbearers. Red fox (*Vulpes vulpes*) and marten (*Martes americana*) may also be trapped in Washington and Oregon. In addition, it is unknown how many fishers are illegally harvested in each state each year.

Use of body-gripping or leg-hold traps are now illegal in Washington and California [Washington Administrative Code (WAC) 323-12-141(4), California Fish and Game Code § 3003.1, 4004)]. Incidental captures using these types of traps often result in crippling injury or mortality (Strickland and Douglas 1984, p. 3; Cole and Proulx 1994, pp. 14–15). Although data are not available from Washington and California to determine incidental trapping-related injury or mortality from non-body-gripping traps such as box traps, the use of these trap types suggests most trapped fishers could now be released unharmed, as the state laws require.

Body-gripping and leg-hold traps remain legal in Oregon where annual harvest reporting is mandatory. If a Harvest Report Card is not received by the Oregon Department of Fish and Wildlife (ODFW) by April 15 of each year, the trapper cannot purchase a trapping license for that year. Because fishers are classified as a Sensitive Species in Oregon, any captured fisher must be reported to ODFW. Information available on fisher impacts since 1975 include seven known incidental captures of fishers have been reported, two of these resulting in mortality, as well as one death from use of a leg-hold trap:

(1) An ODFW document from 1982 reports three instances of fishers caught in traps in Oregon: one was caught and escaped from a marten trap in Klamath County in 1980 near O'Dell Lake; one was trapped and killed in Douglas County in December 1979 on Clarks Branch Road; and one was trapped and released in Klamath County in 1975 on the west side of Crater Lake National Park (Robart 1982, pp. 3, 8).
(2) In December 1997, a fisher was found in a foot hold trap near the town of Williams by someone other than a trapper in Josephine County, Oregon; the animal was rehabilitated and released with a radio collar (ODFW 1998, entire).
(3) In February 2007, a local trapper in Klamath County reported incidentally snaring and killing a fisher while legally trapping bobcats in the vicinity of Upper Klamath Lake, Oregon (ODFW 2007, p. 1).
(4) A reintroduced fisher into the ONP population in Washington was recently found dead as a result of a leg-hold trap, which although illegal in Washington (see above), appear to continue to be used on tribal lands (Happe 2015, pers. comm.).
(5) Two fishers from the ONP population in Washington were found in live-traps targeted for bobcats and released unharmed (Happe 2015, pers. comm.).

The best available data indicate that incidental fisher captures are expected to remain infrequent into the foreseeable future assuming current trends continue. Hiller (2011, p. 31) reports the number of licensed trappers in Oregon generally follows that of the national decreasing trend since the fur boom of the 1970s and 80s. However, prices for furs have recently been rising rapidly (for example, see Fur Harvester Auction, Inc. 2013, p. 1; Dhuey 2013 pp. 1–2), which may lead to increased incidental trapping in the future. Fisher pelts are among the highest priced, which may offer incentives for poaching.

Summary Related to Trapping and Incidental Capture

Historically until approximately 1936, fishers were readily trapped (Lewis and Stinson 1998, p. 23) and unregulated; this historical trapping appears to have been the primary initial cause of fisher population losses in the Pacific states. Commercial trapping of fishers was discontinued in the 1930s in Washington and Oregon and in the 1940s in California, but harvest for other medium sized mammals that live in fisher habitat is legal in all three states. However, it is no longer legal to use body-gripping traps in Washington and California; thus, any fishers incidentally captured should be released unharmed. Further examination is needed to determine that extent or possible magnitude of using leg-hold traps on tribal lands, given the recent loss of one fisher on tribal lands in Washington. Fishers are occasionally captured incidental to pursuits for other species, resulting in a total of seven reported to date. The best scientific and commercial information available indicates that current mortalities and injuries from legal incidental capture of fishers in body gripping or leg-hold traps do not occur in Washington (with the exception of an unknown degree of this trap type use on tribal lands) and California as a result of regulations, and infrequent in Oregon. Trapping closures and other furbearer management methods that have been in place now for many decades have reduced deleterious population effects due to trapping, although a few individuals may still be impacted through incidental captures currently or in the future on a rare basis. If not adequately regulated, low levels of harvest-related mortality, added to natural mortality, have the potential to negatively impact small, local populations. In conclusion, the best scientific and commercial information available at this time indicate that population or rangewide impacts from trapping and incidental capture are not occurring, nor is there any indication that population or rangewide level impacts may occur in the future. Thus, this stressor is considered to be a low-level impact to fishers currently and in the future.

8.0 Research Activities

Scientific research is necessary to understand the various aspects of a species' life-history needs and population status. Some research techniques have potential risks to the individual fishers. As an example, the trapping, handling, and attachment of radio-telemetry transmitters to fishers can potentially lead to injury or mortality. Thompson *et al.* (2012, pp. 308–310) identifies three primary ways that radio-collars can negatively influence animal safety including: (1) Radio-collars can get caught on external objects (for example, sticks, wire fencing) or wedged in confined spaces (for example, rock crevices, tree cavities); (2) radio-collar fit may change over time causing lesions that can become infected; and (3) collar attachment can alter behavior of the animal and limit habitat-related choices (for example, a bulky collar may limit size of cavity opening). Mortality can result if animals become trapped by their collars or develop severe infections. It is unknown how the sub-lethal effects of mild infections or behavioral alterations as a result of research related activities are affecting fishers or fisher populations.

Ongoing fisher research projects conducted both in the SSN and NCSO populations report from 2–3 mortalities associated with human error from 2007 to 2012 (Gabriel 2013b, pers. comm.). Some other mortalities were initially suspected to be research-related; for example, three additional animals were thought to have died from anesthesia, but autopsy indicated that they actually died of disease. In these cases, mortality may have resulted from a combination of at least two factors.

Conservation measures to reduce stressors related to trapping and research activities

Current research projects within the analysis area typically have either approval from an Institutional Animal Care and Use Committee, state-issued scientific collecting permit, Memorandum of Understanding with the state agencies with jurisdiction over the research, or other documentation that includes specific details of the purpose of the research, methods, and animal care protocols. The intended purpose of the documentation is to ensure that the proposed research activities fall within existing policies regarding animal welfare. Aside from state and institutional rules and regulations, there are no known conservation measures related to research.

Overall, based on our current analysis, research activities can affect individual fishers within the range of the West Coast DPS of fisher. The best available scientific and commercial information at this time indicate that although present, population- or rangewide-level impacts from research activities are not occurring, nor is there any indication that significant impacts are likely to occur in the future. Thus, research is considered to be a low-level impact to fishers currently and in the future.

9.0 Disease

Disease in a wildlife population can contribute to the risk of extinction. First, it can kill animals at a faster rate than they can reproduce. Second, it can reduce the population size and increase the risk of extinction from stochastic events (Woodroffe 1999, p. 185). Third, diseases tend to have more severe effects on populations when the populations are small or insular or when the disease agent acts synergistically with other population-limiting factors (Gabriel *et al.* 2012b, p. 139).

Mustelids, including fisher, are susceptible to viral diseases, including rabies, canine and feline distemper, and parvovirus, as well as bacterial disease, including plague, which can be contracted from both domesticated and wild animals (reviewed by Lofroth *et al.* 2010, pp. 65–66). Information exists that show effects of disease outbreaks in populations of mustelids, including martens, sea otters (*Enhydra lutris*), black-footed ferrets (*Mustela nigripes*), and a number of other mustelids, as well as other carnivores such as the Santa Catalina island fox (*Urocyon littoralis catalinae*).

Evidence of plague was found in martens in California through detection of plague antibodies and host fleas (Zielinski 1984, pp. 73–74); while many carnivores seem to be either resistant to plague (Williams *et al.* 1988, p. 386) or show only transient clinical signs (Zielinski 1984, p. 170), they likely play a role in transmitting the disease among prey populations. Infectious disease caused the deaths of 38.5 percent of the sea otters examined at the National Wildlife Health Center collected in California from 1992–1995 (Thomas and Cole 1996, pp. 2–7).

Canine distemper virus is documented to affect multiple mustelids and other carnivores.
An epidemic of canine distemper virus in a small population of black-footed ferrets in 1985 led

to the extirpation of the species from the wild (Thorne and Williams 1988, pp. 67, 72; Williams *et al.* 1988, pp. 38–398). The disease is considered a major barrier to the reintroduction and recovery for the ferret.

Mustelids are especially susceptible to infection by canine distemper virus. In addition to the black-footed ferret, fatal infections have been observed in striped skunks (*Mephitis mephitis*), martens (*Martes* sp.), polecats (*Mustela putorius*), Eurasian badgers (*Meles meles*), American badgers (*Taxidea taxus*), European otters (*Lutra lutra*), weasels (*Mustela* sp.), and ferret-badgers (*Melogale* sp.) (Cunningham *et al.* 2009, pp. 1150–1157). American mink (*Neovison vison*) in southern Florida were infected by canine distemper virus, and four deaths were recorded in a four-month period (Cunningham *et al.* 2009; pp. 1150–1157). A canine distemper epidemic on Santa Catalina Island in 1999 caused a 95 percent decline in the island fox population (Timm *et al.* 2009, pp. 333-343).

Parvovirus, a group of closely related viruses found in many species of carnivores, have been found to infect a wide variety of mustelid species, causing illness, susceptibility to other diseases, and death (Steinel *et al.* 2001, pp.594–607). In southwestern France, parvovirus is believed to be implicated in the decline of the European mink (*Mustela lutreola*) (Fournier-Chambrillon *et al.* 2004, pp. 394–402; Philippa *et al.* 2008, pp.791-801). Other species of mustelids that are infected by parvovirus in this region of France are polecats, stone martens (*Martes foina*), and pine martens (*Martes martes*) (Fournier-Chambrillon *et al.* 2004, pp. 394–402). Parvovirus has also infected European mink in Spain and may also be contributing to the decline of the species there (Manas *et al.* 2001, pp. 138–144).

Multiple diseases discussed above are known to affect fishers in the past or currently, or to exist within one or multiple mammalian species within the range of the West Coast DPS of fisher. Thus, disease is considered an ongoing stressor. However, although diseases are present, including in some cases occurring as a natural source of mortality, it is unclear how they may affect fisher populations within the analysis area currently or in the future. At this time, the best available data indicate that at least one fisher found deceased due to vehicle collision, predation, toxicants, etc. from each of the five populations were also found to either harbor a disease or to have been exposed to a disease at some point in its life (such as carrying antibodies of a disease). Two relatively recent studies within a small portion of two populations (SSN and NCSO) provide minimal disease information within the analysis area (see first two bullets below), while other examples of disease in fishers occur outside the analysis area, as described below.

In the insular SSN fisher population, canine distemper virus caused mortalities in four radio-collared fishers within a short period of time (Keller *et al.* 2012, pp. 1035–1041). The infection rate, mortality rates, population control, and disease ecology of canine distemper virus in fishers are not well studied or understood, but the virus is known to cause illness and mortality in fishers and many other susceptible mustelids (Gabriel *et al.* 2010, pp. 966–970; Keller *et al.* 2012, pp. 1035–1041).

Antibodies to some canine viruses have been isolated from fishers in northwest California (Brown *et al.* 2008, p. 2). In addition, ongoing work in the analysis area and British Columbia (Gabriel *et al.* 2010, pp. 966–970) have documented the presence of antibodies from canine distemper virus, rabies virus (Family *Rhabdoviridae*), parvoviruses, canine adenovirus (the cause of canine infectious hepatitis), and West Nile virus. The extent of infection and disease ecology of parvovirus in fishers are not well studied, but the virus can cause illness and mortality in fishers (Gabriel *et al.* 2010, pp. 966–970).

Bacterial diseases have been documented to infect fishers. Brown *et al.* (2007, pp. 5–6) and Gabriel *et al.* (2010, pp. 966–970) documented *Anaplasma phagocytophilum* and *Borrelia burgdorferi* sensu lato in one study; however, it is not known what effect these bacterial diseases have on fisher populations.

Endoparasites (for example, nematodes and trematodes) are common in fishers (reviewed by Powell 1993, p. 72), and evidence of other bacterial, protozoan, and arthropod disease agents also have been identified in fishers (Banci 1989, p. v; Brown *et al.* 2008, p. 21). The protozoan *Toxoplasma gondii* is a documented cause of mortality as well as an immunosuppressive pathogen in fishers (Gabriel *et al.* 2010, pp. 966–970) and has also caused mortality in American mink (Jones *et al.* 2006, pp. 865–869). In captive mink, toxoplasmosis is often found as a secondary infection to animals that are infected with canine distemper virus (Jones *et al.* 2006, pp. 865–869). While these endoparasites and protozoan can cause illness and death in fishers, it is not known whether they have a negative effect on fisher populations within the analysis area.

Studies at the urban-wildland interface suggest a correlation between the prevalence of disease in wild populations and contact with domestic animals (Riley *et al.* 2004, pp. 18–19). Contacts between fishers and domestic dogs and cats, as well as other wild animals susceptible to such diseases (raccoons (*Procyon lotor*), coyotes, martens, bobcats, chipmunks, squirrels, etc.), have the potential to infect fishers. The level of risk of disease transmission to fisher populations is unknown. Within the range of the West Coast DPS of fisher, there is evidence from the Hoopa Valley Reservation that co-occurring carnivores may be potential hosts that can pass infections to vulnerable or insular fisher populations (Gabriel *et al.* 2010, pp. 966–970). However, the best available data at this time do not indicate a population- or DPS-wide impact of transmission. Additional research is ongoing in other fisher populations in California to determine if the findings in the Hoopa Valley Reservation or adjacent northern California lands where the studies took place (Gabriel *et al.* 2010, pp. 966–970) may affect more than a few fisher individuals.

<u>New information since Service (2014)</u>

We have become aware of information associated with disease that is related to canine distemper outbreaks in the Rogue River watershed in Oregon, which occurs north of the Oregon/California state boundary within the northern end of the NCSO population area. Specifically, ODFW reported that a recent outbreak (between January 2012 and January 2014) of canine distemper affected a wide variety of mid-size carnivores, potentially including fisher (Niemela 2015, pers. comm.).

Gabriel *et al.* 2015 (p. 1, 4) investigated causes of mortality in 167 fishers in California. Of those fishers where a cause of mortality could be determined, 16 percent (21 fishers) were attributed to natural disease. Forty eight percent were attributed to bacterial infections, 28 percent to emaciation, 14 percent to viral infections, five percent to protozoal infections, and five percent to cancer.

At this time, there are no known conservation measures to ameliorate stressors related to disease within the range of the West Coast DPS of fisher.

Overall, based on our current analysis, some diseases or antibodies for diseases are present in individual fishers within the range of the West Coast DPS of fisher. The best available scientific and commercial information at this time indicate that although present, population or rangewide impacts from disease are not occurring, nor is there any indication that population or rangewide spread of one or more diseases is likely to occur in the future. Thus, disease is considered to be a low-level impact to fishers currently and in the future. However, given the presence of some diseases or antibodies of diseases within the West Coast DPS of fisher's range (such as the recent outbreak of canine distemper in southern Oregon) and the potential for impacts to fisher, we believe it is important to determine the prevalence of disease factors in fishers and how they may affect fisher population levels.

10.0 Predation

Predation is a natural, ongoing source of mortality for the West Coast DPS of fisher (in other words, part of the natural condition in which the fisher evolved), potentially occurring throughout the West Coast DPS of fisher's range currently, and expected to continue in the future. Potential predators include mountain lions (*Felis concolor*), bobcats, coyotes, and large raptors (Powell and Zielinski 1994, p. 25; Truex *et al.* 1998, pp. 80–82; Higley and Matthews 2009, p. 14; Wengert 2010). Individuals weakened by parasitism or infectious diseases may also be more vulnerable to predation. Overall, researchers (for example, Powell and Zielinski (1994, pp. 7, 62), Truex *et al.* (1998, p. 3), and Higley and Matthews (2009, p. 22)) report that predation can be a significant source of mortality. However, predation would not be expected to negatively impact the viability of fisher populations in the analysis area unless annual predation rates, combined with all other mortality sources, exceed annual juvenile fisher recruitment rates.

Within the range of the West Coast DPS of fisher, and in the west in general, the population levels of generalist predators such as bobcats and mountain lions in dense mixed coniferous and evergreen forests are poorly known. Both feline species, for example, inhabit various forest types throughout the analysis area, including areas that have been altered (thinning and regeneration harvesting) from forest management. Information on predation of fishers within the analysis area includes the following:

<u>New information since Service (2014)</u>

Lewis (2014, p. 67) reported that the cause of mortality for 14 of 35 reintroduced fishers recovered from 2008 to 2010 within the ONP population died from predation. Wengert (2013, pp. 38–39, 52, 59) reported that 62 of 101 fisher carcasses recovered from two California research projects (one in a portion of the SSN population, Kings River Fisher Project; and one in a portion of the NCSO population, Hoopa Valley Indian Reservation Fisher Project) were attributed to predation.

Two ongoing studies in the SSN population reported that predation is the most common source of mortality of radio-collared fishers (Sweitzer *et al.* 2011). Wengert *et al.* (2011) identified genetic material (DNA) of predators from 26 fisher carcasses in California. Bobcats were responsible for 17 of the predation events, while mountain lions (7 events) and coyotes (2 events) were the other predators identified (Wengert *et al.* 2011). In the SSN population, Truex *et al.* (1998, pp. 80–82) stated that nine fisher mortalities were suspected to be from predation. In northern California, Buck *et al.* (1994, p. 373) found four fishers out of seven died from predation during an unrelated study, while the death of one juvenile was suspected to have been caused by another fisher.

Gabriel *et al.* 2015 (p. 1, 4) investigated causes of mortality in 167 fishers in California; the cause of mortality could be attributed to predation in 90 fishers (70 percent). Predators identified were bobcats, mountain lions, unidentified Felidae, coyotes, and domestic dogs and a single fisher was killed by a rattlesnake (*Crotalus oreganus oregnaus*)

At this time, there are no known conservation measures to reduce or ameliorate predation within the range of the West Coast DPS of fisher.

Based on our current analysis, predation has been documented at multiple locations within the West Coast DPS of fisher's range, with data records that indicate loss of individuals in portions of the DPS's range (although it is probable that individuals may be impacted throughout the DPS's range, given the presence of predators throughout the DPS's range). The best available data indicate that predation is a natural process resulting in impacts to individuals rangewide; thus, predation is considered a low-level impact to individuals across all six populations. We have no information to indicate that the level of predation is going to increase in the future. In conclusion, predation is considered to be a low-level impact to fishers currently and in the future.

Stressors related to other natural or manmade factors affecting its continued existence

Fishers in the West Coast DPS are affected by several other stressors resulting from natural and manmade stressors. Here we evaluate small population size and isolation, collision with vehicles, direct climate effects on fishers, exposure to toxicants, and cumulative and synergistic effects. Anthropogenic factors that contribute to individual fisher mortality and reductions in fitness include contaminants, pest control programs, non-target poisoning, and accidental trapping in manmade structures, poaching, and fatal injuries inflicted by domestic dogs, (Folliard 1997, p. 7; Truex *et al.* 1998, p. 34, Gabriel *et al.* 2011, Lofroth *et al.*, 2010. p. 63; Sweitzer *et al.* 2011), though not all of these factors were considered substantial enough to evaluate in detail in this section. Lofroth *et al.* (2010, pp. 63–64) reported anthropogenic sources of mortality accounting for an average of 21 percent of all radio-collared fisher deaths documented during eight west coast studies. It is likely that where fisher distribution overlaps with current and future human developments, these causes of mortality will continue to occur and potentially increase, with increases expected in rural development (Naney *et al.* 2012, pp. 21–23, 25–26).

11.0 Small Population Size and Isolation

A principle of conservation biology is that small, isolated populations are subject to an increased risk of extinction from stochastic, genetic, or demographic events (Brewer 1994, p. 616). In many instances, these types of changes can potentially reduce a species' effective population size (such as number of breeding individuals). According to Tucker *et al.* (2012, p. 7), the effective population sizes for the California portion of the NCSO population and the SSN population are estimated at last count as 129 and 167, respectively. Using modeled information, Tucker *et al.* (2012, pp. 7–8) also estimate the total population size for the California portion of the NCSO population and SSN population to be 258–2850 and 331–3380, respectively. These population values do not include any fishers that reside in the Oregon portion of the NCSO population; thus, we assume that both the effective and total population sizes for the NCSO population in its entirety are an unknown value greater than those estimates presented for the SSN population. Given the best available information on the native populations of fisher within the DPS, we evaluate information suggesting that either of the two native populations (NCSO and SSN) may be small or isolated from one another to the degree that such negative effects may be realized in the species.

Environmental changes such as drought, fire, or storms could have severe consequences (Brewer 1994, p. 616) if affected populations are small and clumped together. Three threat assessments completed in California for fishers in the analysis area (Green *et al.* 2008, pp. 26–27, 45; CDFG 2010, pp. 45–47, 53; Naney *et al.* 2012, p. 29) identified the greatest long-term risk to fishers as the isolation of small populations and the higher risk of extinction due to stochastic events; and other research supports this conclusion (Heinemeyer and Jones 1994, pp. 19, 29; Stacey and Taper 1992, pp. 25–27).

Territoriality and habitat specificity compounded by habitat fragmentation may contribute to the strong genetic structuring over intermediate geographic distances seen in fisher populations in other parts of the species' range (Kyle *et al.* 2001, p. 2345; Wisely *et al.* 2004, pp. 644, 646). Populations with small effective population size show reductions in population growth rates, loss of genetic variability, and increases in extinction probabilities (Leberg 1990, p. 194; Jimenez *et al.* 1994, p. 272; Allendorf *et al.* 2012, pp. 274–295). Higher levels of genetic structuring describe populations that are more genetically distinct and have less intrapopulation variation, a condition occurring in peripheral or more disturbed habitats of a species' range with low effective population sizes and limited genetic exchange (Kyle *et al.* 2001, p. 343). Where these conditions exist, species face an increased vulnerability to extinction (Wisely *et al.* 2004, p. 646).

<u>New Information Since Service (2014)</u>

In response to comments requesting a more extensive discussion of genetics, we have added the following paragraphs. All text between the asterisks is new to the final Species Report. In the descriptions of the genetics studies that follow, the populations described in the original manuscripts as "Southern California" are equivalent to the SSN, and "Northern California" or "Klamath and Siskiyou Mountains" are equivalent to the NCSO, unless otherwise noted.

* * * * *

Native fisher populations on the West Coast (SSN and NCSO) are genetically distinct from fishers in other geographic regions of North America (for example, Canada, Rocky Mountains, and Great Lakes) (Knaus *et al.* 2011, p. 3). Based on genetic evidence, and supported by paleontological and archeological evidence, Wisely *et al.* (2004, p. 643, 645) theorize that fishers probably colonized the West Coast from the north, moving southward from British Columbia in to California. Other studies of neutral genetic variation of fishers in the West Coast range also show a pattern of genetic diversity consistent with a history of colonization from the north (Drew *et al.* 2003, p. 59). Wisely *et al.* (2004, pp. 642-643) showed that genetic diversity generally decreased from north to south; measures of average expected heterozygosity (H_e) and allelic richness (A) in the native British Columbia populations (H_e =0.37, A= 2.6,) were nearly twice as high as the native population in the southern end of the range, in the Southern Sierra (North population H_e=0.16, A=1.4; South population H_e=0.20, A=1.7). The reintroduced SOC population had the highest measures of diversity of all populations tested, with H_e=0.42, and A=1.7, and also exhibited unique alleles; the authors attributed these characteristics to the mixing of the genes from two, possibly three, widely separated sources (animals introduced from British Columbia and Minnesota, with a low probability of contribution from undetected residual native animals) (Wisely *et al.* 2004, p. 646). These authors also reported a high level of genetic structure in the Southern Sierra populations, which they attributed to habitat specificity, limited gene flow, and barriers to dispersal, such as the Kings River separating the north and south populations sampled (Wisely *et al.* 2004, p. 644; but see work of Tucker *et al.* 2014, below).

The Southern and Northern California fisher populations are also highly genetically distinctive from each other (Knaus *et al.* 2011, p. 3). They are separated by a significant distance (roughly 430 km; 268 mi) as well as an absence of high quality habitat between them (Knaus *et al.* 2011, pp. 10-11). Based on studies of microsatellites (nuclear DNA (nDNA)), the results of Wisely *et al.* (2004, p. 643, Figure 3) suggested high genetic divergence between these populations of fishers. More recently, whole mitochondrial (mtDNA) genotyping by Knaus *et al.* (2011, pp. 3-4, 11) demonstrated that the divergence between the Southern and Northern California populations was greater than previously believed, on an order comparable to that observed between subspecies. Furthermore, they identified three haplotypes exclusive to California and Southern Oregon fishers, one restricted to fishers in the Sierra Nevada (SSN) and two to fishers in the Siskiyou and Klamath Mountains (NCSO); these haplotypes showed distinctive differentiation, with a minimum of 6 pairwise exonic differences (Knaus *et al.* 2011, p. 7). These three haplotypes are representative of three distinctive maternal lineages, one in Southern California and two sister lineages in Northern California (Knaus *et al.* 2011, pp. 11-12). One Northern California haplotype also showed evidence for non-neutral evolution, although whether due to accumulation of adaptive mutations from through positive selection or accumulation of slightly deleterious mutations through drift cannot be determined (Knaus *et al.* 2011, pp. 9-10). Using estimates of pairwise divergence and the synonymous mutation rate observed in carnivores, Knaus *et al.* (2011, pp. 10,11) hypothesized that the maternal lineages of the extant Northern and Southern California populations of fishers could have diverged on the order of nearly 16.7 thousand years ago (range 9.0 – 31.3 thousand years).

Recent analysis of 209 contemporary and historical genetic samples are consistent with the findings of Knaus *et al.* (2011) that the SSN is fixed for a unique haplotype that is not found in the NCSO (Tucker 2015, pers. comm., and references therein). Additional microsatellite (nDNA) work on 859 contemporary and historical fisher samples from across the DPS adds further support to the genetic differentiation of SSN from other fisher populations. This examination of population substructure (using the program STRUCTURE) demonstrated the most supported division was between the SSN and all other fisher samples (British Columbia, SOC, NCSO, the Cascades (historical), and Olympic Peninsula (historical) (Schwartz 2015, pers. comm.).

Tucker *et al.* (2012, p. 3) point out that the absence of a shared mtDNA haplotype between SSN and NCSO and the amount of genetic differentiation between them indicates long term isolation. Using microsatellites (nDNA), they investigated the question of whether fisher in the SSN became recently isolated (within the last 150 years) or if the population has been persisting in long term isolation. Based on a genetic signal for a decrease in effective population size of more than 90 percent, they estimate that two populations each contracted in size most likely over 1,000 years ago, although they could not definitively rule out the possibility that these declines occurred following European settlement (Tucker *et al.* 2012, pp. 7-8). In addition to this ancient range contraction that isolated the SSN, they also found evidence for a more recent population bottleneck in that population, likely associated with the impact of human development in the late 19th and early 20th century (Tucker *et al.* 2012, p. 8). The authors conclude that fisher distribution in California contracted to the two current population areas (SSN and NCSO) pre-European settlement, and that portions of the SSN subsequently experienced another more recent bottleneck as well.

Population structure in the SSN was later re-examined by Tucker *et al.* (2014) using microsatellites (nDNA), using a larger and more geographically continuous set of genetic compared to those available in the earlier study by Wisely *et al.* (2004). They found far less genetic structure than was reported by Wisely *et al.* (2004); although some structure was still observed, the authors characterize their results as indicative of areas of resistance to gene flow rather than major barriers (for example, Kings River). They suggest the greater levels of population structure originally reported by Wisely *et al.* (2004) were most likely due to the clustered sampling design (Tucker *et al.* 2014, p. 123, 133). They also observed that the genetic subdivision in the northern group of SSN fishers is potentially consistent with multiple founder events during a recent population expansion, and suggest that the reduced H_e in the northern versus the central and southern groups is consistent with this hypothesis (Tucker *et al.* 2014, p. 131). Although the lack of difference in allelic richness between the group does not support that theory, the authors suggest survey data supports the idea of a recent range expansion in the north SSN, noting that contemporary researchers are reporting increased numbers of fisher in the northern study areas where they were only rarely detected in the early 1990s (Tucker *et al.* 2014, p. 131). It is not clear from this account, however, whether survey effort was comparable between the time periods described.

Tucker *et al.* (2014, p. 134) observed that long distance movements were relatively uncommon in the SSN, and their results are consistent with relatively short dispersal movements (citing to Kyle *et al.* 2001; Tucker *et al.* 2014, p. 131). They attribute the observed population subdivision within the SSN to relatively recent, rather than historical, landscape conditions. However, they additionally note that the observed structuring may be the result of conditions over the last few decades rather than current conditions (Tucker *et al.* 2014, p. 134). They conclude by stating that the genetic subpopulations appear to be "connected by moderate amounts of gene flow that may actually help to counteract the effects of genetic drift due to small population size and help maintain genetic diversity within the SSN population over time" (Tucker *et al.* 2014, p. 134).

* * * * *

It is difficult for populations to interchange individuals or provide colonists when the populations are distributed in narrow, linear arrangements, which is evident with the SSN population's north-south peninsular linear arrangement. Although fishers are long-lived, they have low reproduction rates, and generally exhibit small dispersal distances though they are capable of long-distance movements. Small dispersal distances along with exposure to predators may be factors of fishers' reluctance to move through areas with no cover (Buskirk and Powell 1994, p. 286). Given the apparent reluctance of fishers to cross open areas (Coulter 1966, pp. 59–61; Kelly 1977, pp. 74–78, 81; Powell 1993, p. 91; Buck *et al.* 1994, pp. 373–375; Jones and Garton 1994, p. 385, Weir and Corbould 2010, pp. 407–408), it is more difficult for fishers to locate and occupy distant, disjunct, but suitable habitat. Thus, where habitat is fragmented (such as in portions of the NCSO and SSN populations), it is more difficult to locate and occupy distant yet suitable habitat; thus, it is possible that fishers could become aggregated into smaller interrelated groups on the landscape (Carroll *et al.* 2001, p. 974).

At the southernmost extent of the species' distribution, the SSN population may be at greater inherent risk because it exists at the edge of the DPS's geographic range. Loss of remaining genetic diversity could lead to inbreeding and inbreeding depression, which in turn can lead to an increased risk of extinction (Allendorf *et al.* 2012, pp. 274–295). Given evidence for elevated extinction rates of inbred populations, inbreeding may be a greater general threat to population persistence than is generally recognized (Vucetich and Waite 1999, p. 860). Tucker *et al.* (2012, p. 3) point out that if isolation of the SSN occurred recently then there is potential risk from inbreeding depression due to small population size, but if that isolation is long standing, introducing a new source of genetic diversity could actually trigger a reduction in fitness due to outbreeding depression. Based on their findings suggesting the SSN population has been isolated on a relatively ancient timeline, both Knaus *et al.* (2011, p. 11) and Tucker *et al.* (2012, pp. 3, 11) caution against conservation actions attempting to increase genetic diversity in the SSN population by restoring connectivity with the NCSO population, as such an action would be inconsistent with historical records, habitat models, and molecular data, and could run the risk of losing local adaptations that may have evolved with long-term isolation and be important to the persistence of this isolated population.

Fishers (in general) appear to have several characteristics related to small population size that increase the species' vulnerability to extinction from stochastic events and other threats on the landscape. Small populations of low-density carnivores, like fishers, are more susceptible to small increases in mortality factors due to their relatively low fecundity and low natural population densities (Ruediger *et al.* 1999, pp. 1–2). Fishers may also be prone to instability in population sizes in response to fluctuations in prey availability (Powell 1993, p. 86). Low reproductive rates retard the recovery of populations from declines, further increasing their vulnerability (Lehmkuhl and Ruggiero 1991, pp. 37–38). In western North America (including the geographic area that encompasses the West Coast DPS of fisher), the proportion of adult females that den in a given year is 0.64 (range = 0.39–0.89) (Lofroth *et al.* 2010, pp. 55–57). Female survival has been shown to be the most important single demographic parameter determining fisher population stability (Truex *et al.* 1998, p. 52; Lamberson *et al.* 2000, pp. 6, 9). Spencer *et al.* (2011, p. 797) concluded that a 10 to 20 percent reduction in survivorship interfered with population expansion in their modeling exercise for the SSN population. These factors together imply that fishers are highly prone to localized extirpation, their colonizing ability is somewhat limited, and their populations are slow to recover from deleterious impacts. The long-term persistence of these isolated populations is unknown.

Given the best scientific and commercial information available, we currently consider the SSN population to be isolated and small, harboring some fragmented habitat areas. Although fragmented areas exist, unoccupied suitable habitat remains in portions of the SSN population. The NCSO population, however, is likely to harbor less small population size impacts overall as compared to the SSN population based on a greater availability of suitable habitat and documented ability of this population to allow for migration between populations (as recently recorded between the native NCSO population and reintroduced SOC population). Regardless, the best available information suggests these populations are expected to remain small (as has been apparent since pre-European settlement). The SSN population is likely to remain smaller than the NCSO population into the future, primarily given the other stressors that have the potential to exacerbate the impacts of small population size. The NCSO population has a greater potential to increase in size over time given recent documentation of migration that we expect to continue into the future. Regardless of this potential for growth, we expect both native populations to be considered small into the long-term future. Therefore, at this time we consider this stressor to be a moderate-level to the DPS even though there is no empirical evidence that stressors are manifesting themselves to a significant degree across the DPS such that the fishers in the West Coast DPS are in decline across its range.

12.0 Collision with Vehicles

Roads, in addition to their disruption of habitat continuity, are sources of vehicle-collision mortality of fishers (Truex *et al.* 1998, pp. 53–54; Sweitzer and Barrett 2010; Naney *et al.* 2012, pp. 11–15), particularly in high-use, high-speed areas (Slauson *et al.* 2003, p. 12). Campbell *et al.* (2000, pp. 8, 36) stated that many records of fisher locations come from road kills; for example, Yosemite National Park reported 10 fishers killed by automobiles between 1993 and 2012 (Cline 2013, p. 32; Spencer 2015, p. 15). Between 2007 and 2012, 4 of 73 (5 percent) radio collared fishers in analysis area studies were determined to have been killed by vehicular strikes (Clifford *et al.* 2012, p. 5). Gabriel (2013, p. 126) found 8 percent of necropsied fishers in the southern Sierra Nevada between 2007 and 2012 died from vehicular strikes. In northern California, Gabriel (2013, p. 139) found three fishers that had been killed by vehicle collisions (7.3 percent of animals with known deaths). Washington Department of Fish and Wildlife and the National Park Service staff have recovered 11 fishers killed by vehicle collisions on the Olympic Peninsula from 2008 to 2013, as part of the Olympic National Park reintroduction effort (Lewis 2014, pers. comm.). Lewis (2014, p. iii) also reported that vehicle collisions were 20 percent of known fisher mortality tracked from 2008 to 2012 in the Olympics; these deaths may have additional significance when fishers, particularly lactating female fishers, are killed during the breeding season.

The type of road and its use level likely affects a fisher's susceptibility to collision mortality. Low use secondary roads seem to pose a reduced probability of vehicular collision compared to paved major roads, such as U.S. Highway 101 and U.S. Highway 41/Wawona Road (Lewis 2014, p. 71; Spencer *et al.* 2015, p. 15). For example, none of the 10 fishers in Gabriel's study (2013, p. 128) that had been killed by vehicle collision were done so on dirt or gravel roads. Five of the seven fishers killed by vehicle strikes in Lewis's (2014, p. 71) study were killed on U.S. Highway 101, and the other two were killed on other paved roads. The pavement itself is likely not relevant but correlates with faster travel speeds and a higher volume of traffic. We infer that fishers with home ranges containing fewer or no paved roads may be at a reduced risk of vehicle collision, but given the density of roads in the analysis area (Figure 17) and the large distances that fishers travel when dispersing and looking for mates, it is likely that most fishers will be exposed to the possibility of vehicles collision on paved roads sometime during their lives.

There are few known conservation measures presently in place to address potential impacts to fishers from collisions with vehicles, although Yosemite National Park has implemented a temporary road closure when a female fisher was known to be denning nearby (Cline 2013, p. 3). In addition, in the Sierra Nevada, the USFS, National Park Service, and Defenders of Wildlife are in the process of evaluating and improving culverts for use as wildlife crossings, have documented fisher use of these culverts, and are installing walkways to enable fishers to walk through culverts even when they are full of water (Cline 2013, pp. 41, 63; Thompson 2013, minutes 15:30–18:00; Spencer 2015, p 68).

Based on our current analysis, fisher collisions with vehicles have been documented at multiple locations within the West Coast DPS and it is currently considered a medium-level impact to individuals across all five populations. The best available data indicate that vehicle collisions are a substantial source of anthropogenic mortality for fisher populations, but we have no information to indicate that this source of mortality is having or will have a population- or rangewide-level effect on fishers. Additionally, the percentage of fisher mortality from vehicular collisions appears to be variable across the populations in the analysis area, for example few reported incidents in the NCSO population. Therefore, collisions with vehicles are considered likely to remain a medium-level impact to fishers in the future.

13.0 Direct climate effects to fishers

In addition to potential indirect impacts of climate change on fishers through effects to fisher habitat and disease transmission (discussed in the sections above on Stressors Related to Habitat and below on Synergistic Effects, respectively), climate change may also cause direct effects to fishers. In California, fishers choose rest sites in areas of cooler microclimate (Zielinski *et al.* 2004a, p. 488), and are more difficult to detect during summer months than at other times of the year (Slauson *et al.* 2009, p. 27). Researchers hypothesize that this is because fishers experience thermal stress at higher temperatures (Zielinski *et al.* 2004a, p. 488; Slauson *et al.* 2009, p. 27;

Facka 2013, pers. comm.; Powell 2013, pers. comm.). Captive fishers, unable to access thermal refugia, have been observed to drink enormous quantities of water in order to stay cool (Powell 2013, pers. comm.). Metabolic studies of active fishers had to be conducted at below-freezing temperatures because the animals overheated when running at normal room temperature (Powell 1979, p. 198). All of these observations suggest that fishers may be especially sensitive, physiologically, to warming summer temperatures, and that fishers likely will either alter their use of microhabitats or shift their range northward and upslope, in order to avoid thermal stress associated with increased summer temperatures predicted as a consequence of climate change (see paragraph on climate envelope models in the section discussing climate change effects to habitat). Safford (2006, pp. 1, 11) postulated that there will "undoubtedly" be significant direct climate effects to fishers, noting the dearth of information regarding the direct metabolic impacts of warming climates on fisher or its prey, and suggesting that these effects may even be more important to future fisher distribution than indirect effects to habitat. Recognizing that fishers are sensitive to microclimatic conditions and currently utilize relatively cooler microhabitats within their range, Safford hypothesizes that fishers in California will likely be forced to move higher in elevation in response to rising temperatures, on the order of 500-1,000 ft (150-300 m) upslope over the next century, to remain within cooler climes (Safford 2006, p. 11). At least one climate projection shows a marked increase in the number of especially warm nights (Salathé *et al.* 2010, pp. 69–70), so a shift toward nocturnal behavior patterns may not be helpful in avoiding thermal stress.

One study has used the climate envelope (that is, the composite of climate conditions) of fishers' current and historical ranges to project range shifts by the end of the twenty-first century, assuming a medium to high emissions-scenario (Lawler *et al.* 2012, pp. 377–382). This bioclimatic method projected contractions of most of the fisher's current range in California and southwestern Oregon, except for some parts of the Klamath and southern Cascades. In areas where fishers are currently likely extirpated, the model also projected loss of climatically suitable areas from Coastal Oregon and the Eastern and Western Oregon Cascades and gains in climatically suitable areas in Coastal Washington (Lawler *et al.* 2012, p. 380). This type of species distribution model may sometimes overestimate range contractions if the model is based on a current distribution that does not occupy all of the climatically suitable range (Smith *et al.* 2013, pp. 8EV–13EV). The current fisher range does not occupy all of the climatically suitable range since it is severely diminished from the historical range (see Figure 5). However, a model based on their historical range (Figure 18) showed a similar pattern to the model based on the current range, so if these maps overestimate range contractions, it is probably for some other reason. For example, fisher habitat suitability may be more directly related to vegetation type than to the climate envelope (see Effects of Climate Change on Fisher Habitat).

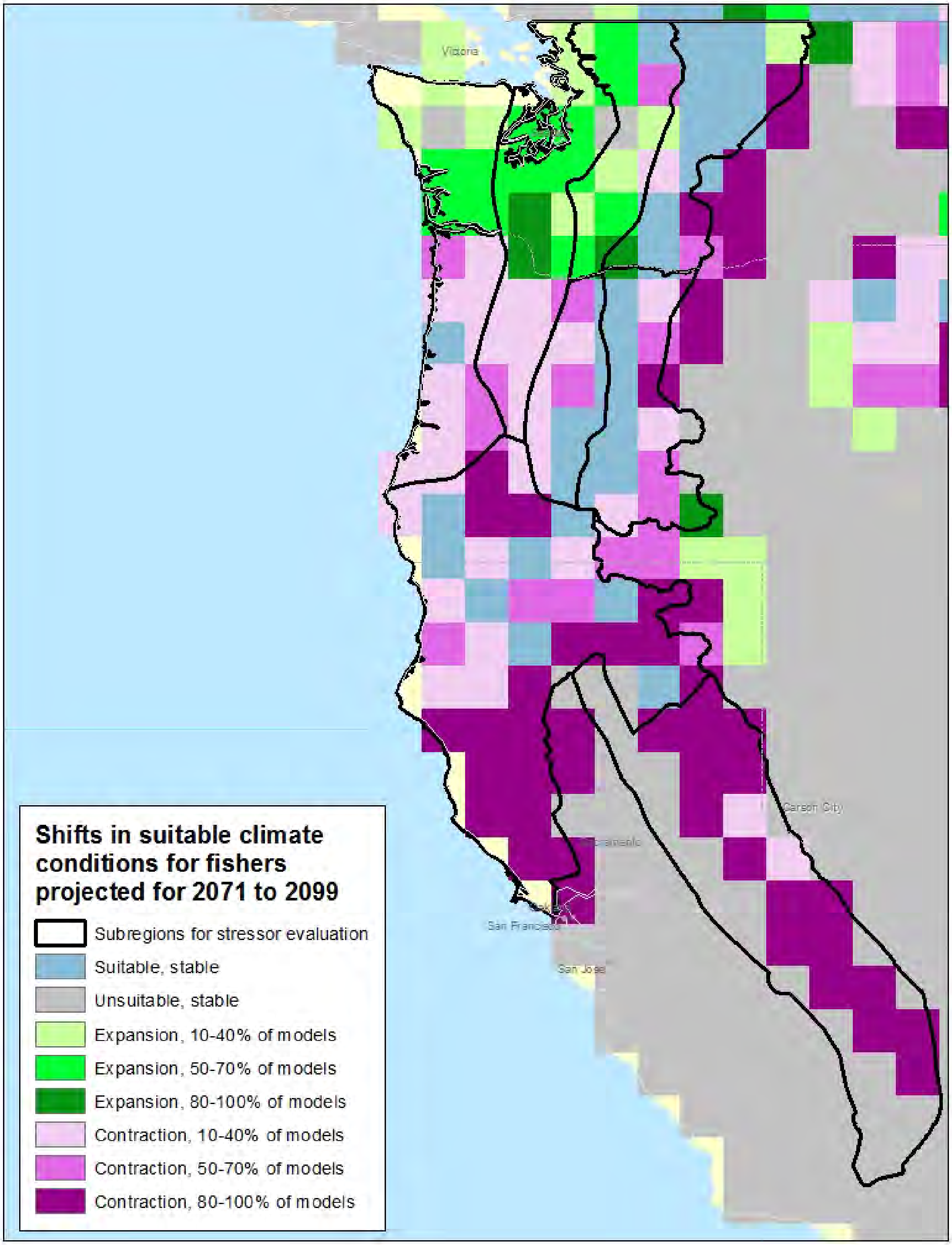

Figure 18. Changes in climate suitability for fishers, as defined by the climate envelope of the historical fisher range (see Figure 5). (Adapted from Lawler *et al.* 2012, Figure 16.3c, with additional data from Lawler 2013, pers. comm.)

Climate change is known to be occurring and is thus considered an ongoing stressor to fisher, with potentially indirect effects to suitable habitat (see Climate Change Effects to Fisher Habitat) as well as possible direct effects to individual fishers. Fishers may have limited thermal tolerance and therefore be vulnerable to the increased temperature extremes predicted as a consequence of climate change, and it is unclear how this might affect wild populations of fishers within the analysis area currently or in the future. Therefore, at this time, the best available scientific and commercial data do not suggest likely population or rangewide impact as a consequence of the direct effects of climate change on fishers, currently or in the foreseeable future.

At this time, there are no known conservation measures to ameliorate the potential direct impacts to fisher as a consequence of climate change (see *Conservation Measures to Address Climate Change* in the section on Climate Change Effects to Fisher Habitat, above).

Overall, based on our current analysis, it is possible that increasing temperatures and other consequences of climate change may have some direct effects on fishers. The most likely impact that has been described is the movement of fishers to remain within cooler microhabitats, as a consequence of possible physiological intolerance to heat. The best available scientific and commercial data at this time does not indicate that population or rangewide impacts from the direct effects of climate change are occurring, nor is there any indication that population or rangewide direct effects of climate change are likely to occur in the future. Thus, the direct effects of climate change on fisher are considered to be a low-level impact to fishers currently and in the future.

14.0 Exposure to Toxicants

Recent research documenting exposure to and mortalities from anticoagulant rodenticides (ARs), and other toxicants in California fisher populations, has raised concerns regarding both individual and population level impacts of toxicants within the fisher's range in the Pacific States (Gabriel *et al.* 2012a, entire). Exposure to ARs, resulting in death in some cases, has been documented in many mammalian predators, including fishers (Gabriel *et al.* 2012a, p. 6), stoats (*Mustela erminea*), ferrets (*Mustela furo*), and house cats (*Felis catus*) (Alterio 1996, entire); polecats (*Mustela putorius*; Shore *et al.* 1999, p. 202); American black bears (*Ursus americanus*; Schmidt 2014, pers. comm.); bobcats (*Lynx rufus*; Serieys *et al.* 2015, entire) and mountain lions (*Felis concolor*; Riley *et al.* 2007, p. 1877); Sierra Nevada red foxes (*Vulpes vulpes necator*; Clifford 2014, pers. comm.); American badgers (*Taxidea taxus*; Quinn *et al.* 2012, pp. 468, 471; Ruder *et al.* 2011, p. 214); and San Joaquin kit foxes (*Vulpes macrotis mutica*; McMillin *et al.* 2008, p. 165). Anticoagulant rodenticides have also been detected in numerous avian predator species (for example, Murray 2011, entire; Thomas *et al.* 2011, entire; Lima and Salmon 2010, p. 200). A U.S. Environmental Protection Agency (EPA) ecological incident report documented AR residues in 27 avian species and 17 mammalian species (EPA 2008, p. 8).

Evidence for exposure to ARs varies among the Pacific States. AR exposure in the two populations of California fishers appears to be widespread, with residues found in 65 of 77 (84 percent) fisher carcasses tested (Thompson *et al.* 2014, p. 96; Gabriel *et al.* 2012a, p. 5), and in 6 of 8 dead fishers tested from Washington (Gabriel *et al.* 2012b, p. 160; Gabriel 2013a, pers.

comm.). No AR residues were found in the single fisher carcass from Oregon that was tested (Gabriel 2013a, pers. comm.). Fishers in the Pacific States are generally found in remote forested habitats, far from the agricultural or urban areas where most AR legal use occurs. In addition, Clifford (Powell *et al.* 2013, p. 17) found AR residues in 3 of 4 fisher carcasses that were part of a reintroduction program in northern California. All fishers in the reintroduction program were captured in remote portions of northwestern California and released in remote portions of the northern Sierra Nevada, far from agricultural or urban areas where ARs are legally used to control rodent populations. Spatial analysis of AR exposure of fishers in California did not reveal any potential agricultural or urban point sources, suggesting that exposure was from some other widespread use of ARs across the landscape (Gabriel *et al.* 2012a, p. 5).

Anticoagulant rodenticides are intended to kill small pest mammals, including commensal rodents such as house mice (*Mus musculus*), Norway rats (*Rattus norvegicus*), and black rats (*R. rattus*) in and around residences, agricultural buildings, and industrial facilities, and agricultural pests such as prairie dogs (*Cynomys* sp.) and ground squirrels (*Spermophilus* sp.) in rangeland and crops. Anticoagulant rodenticides bind to enzymes in the liver responsible for recycling vitamin K, thus impairing the animal's ability to produce several key blood clotting factors (Berny 2007, p. 97; Roberts and Reigart 2013, pp. 173–174). Anticoagulant exposure is manifested by such conditions as bleeding from orifices (Brakes and Smith 2005, p. 121), bleeding nose and gums,, extensive bruises, anemia, fatigue, and difficulty breathing. Anticoagulants also damage the small blood vessels, resulting in spontaneous and widespread hemorrhaging. There is often a lag time of several days between ingestion and death during which a vitamin K antidote may be effective in restoring clotting function (Berny 2007, pp. 97–98; Roberts and Reigart 2013, pp. 174–175). Because an exposed rodent may live several days after an initial feeding, and can become physically or behaviorally [for example, lethargic, hunched posture Littin *et al.* 2000, pp. 311–312; Swift 1998, pp. 42–44; Swift 2014, pers. comm.] compromised by the ARs (Cox and Smith 1992, p. 169; Brakes and Smith 2005, p.121), a predator may have a better chance of locating and consuming an AR-exposed rodent over an unexposed rodent (Winters *et al.* 2010, pp. 1075; Vyas *et al.* 2012, p. 2515).

<u>New information since Service (2014)</u>

The total mortality of fishers in California due to toxicosis is 15 (Gabriel *et al.* 2015, p. 5; Wengert 2016, pers. comm.). Gabriel *et al.* 2015 (p. 7) reported for the fishers they analyzed in California the average incidence of toxicosis, from 2007-2011, was 5.6 percent. However, from 2012-2014, they detected an increase to 18.7 percent in incidence per year of toxicosis. In addition, Gabriel *et al.* 2015 (p. 7) found that, between 2012 and 2014, toxicant exposure of fishers in California has increased from 79 percent (46 of 58 individuals) to 85 percent (86 of 101 individuals).

Studies have documented that predators may preferentially select substandard prey, such as those which are compromised by an additional stressor, physiologically impaired, or exhibit increased activity (Galindo *et al.* 1985, entire; Temple 1987, entire; Hunt *et al.* 1992, entire; Taylor 2009, p. 642).

Anticoagulant rodenticides fall into two categories, first- and second-generation, based on toxicological characteristics and use patterns.

14.1 First-Generation ARs

First-generation ARs (FGARs), such as chlorophacinone, diphacinone, and warfarin, were introduced in the late 1940s and 1950s and were designed for commensal and field rodent control (Lund 1988, p. 342; Hadler and Buckle 1992, pp. 149–150). They often require multiple feedings to achieve a lethal dose, have a lower ability to accumulate in biological tissue, and have shorter liver elimination half-lives than do some of the SGARs (Fisher *et al.* 2003, pp. 7, 14, 16; Vandenbroucke *et al.* 2008, p. 443; Eason *et al.* 2010, pp. 176–177, 179; Crowell *et al.* 2013, entire).

14.2 Second-Generation ARs

In response to a developed resistance to FGARs by rodent populations in the U.S. and Europe, development of second-generation ARs (SGARs), including brodifacoum, bromadialone, difethialone, and difenacoum, began in the 1970s (for example, Hadler and Shadbolt 1975, p. 275; Hadler and Buckle 1992, pp. 150–151). SGARs have the same mechanism of action as FGARs, but are more likely to be acutely toxic and are more persistent in biological tissues. Brodifacoum has the longest persistence of any of the ARs, with a liver elimination half-life reported for mice of 307 days (Vandenbroucke *et al.* 2008, p. 443). A lethal dose of SGARs is more likely to be consumed in a single night's feeding. However, because death often does not occur until several days after consuming a lethal dose, target rodents can continue feeding on the SGARs leading to a very high concentration in their body tissues. A predator that consumes a rodent with a "super dose" of SGARs in their tissues could immediately be exposed to a lethal dose of SGARs without consuming the rodenticide directly.

New information since Service (2014)

Anticoagulant rodenticide baits contain extremely low concentrations of the active ingredient due to their high toxicity to rodents. Concentrations range from 0.0025–0.0050 percent (25 – 50 parts per million) for the SGARs, to 0.0050–0.01 percent (50 – 100 parts per million) for diphacinone and chlorophacinone, and as high as 0.0250 percent (250 parts per million) for warfarin (Erickson and Urban 2004, Table 1). The other proportion of the baits consists of grain and nontoxic fillers, in formulas proprietary to the manufacturers. Some, but not all, products contain dye to color the bait, and flavorizers such as fish, bacon, cheese, or peanut butter.

Exposure to ARs is confirmed by chemical analysis of the liver, other body tissues, or the whole carcass, for the specific AR compound (Vandenbroucke *et al.* 2008, p. 438; Rattner *et al.* 2014a, p. 8436). Given the low concentrations of the rodenticides in the baits, residue concentrations detected in exposed individuals are at similarly low levels, in the parts per million (ppm, mg/kg, or µg/g), or parts per billion (ppb or µg/kg) (Erickson and Urban 2004, Tables 13 and 17). Rodenticide levels found in tissues are determined by a multitude of factors, including the concentration in the bait (Kaukeinen 1982, p. 153; Merson *et al.* 1984, p. 214), the amount of bait consumed, the length of time the individual was exposed (single feeding or chronic (dietary)), the time elapsed since the last exposure (Merson *et al.* 1984, p. 214), the half-life of the compound in the tissue, and the rate at which an individual metabolizes and excretes the compound (Erickson and Urban 2004, p. 71). Residue values cannot be used to determine the magnitude of the dose an individual has been exposed to since they vary widely even between individuals exposed to the same dose (Fisher 2006, Table 2; Rattner *et al.* 2014b, Table 1). Due to these factors, residue values from individuals exposed to the same rodenticide application will vary (Merson *et al.* 1984, Figure 1; Primus *et al.* 2001, Table III; Ebbert and Burek-Huntington 2010, p. 155; Vyas *et al.* 2012, pp. 2514–2515; Spurr *et al.* 2013, pp. 6, 9).

Furthermore, there is considerable variation in the techniques used to recover rodenticides from sample matrices, as well as in the chemical analysis methods used to detect them (Goldade *et al.* 1998, entire; Marek and Koskinen 2007, p. 571; Vandenbroucke *et al.* 2008, p. 438; Thomas *et al.* 2011, p. 917). One study found that the chemical analysis method could significantly under-estimate the prevalence of SGARs in wildlife (Dowding *et al.* 2010, p. 165).

Numerous studies have attempted to associate residue concentrations with levels at which adverse effects occur, although no consistent trend has been identified (Erickson and Urban 2004, p. 94). For example, no correlations between residue level and mortality or symptoms of toxicosis were found in several studies on wild raptors environmentally-exposed to rodenticides (Albert *et al.* 2010, pp. 454–455; Murray 2011, pp. 95–96), whereas laboratory studies with controlled doses of diphacinone and chlorophacinone in kestrels did find correlations between mortality or symptoms of toxicosis and liver residue levels (Rattner *et al.* 2015, p. 1220; Rattner *et al.* 2011, p. 732). A probabilistic model for raptors estimated the liver residue value threshold for lethal exposure for barn owls at about 0.1-0.2 mg/kg for SGARs, but found significant differences between species (Thomas *et al.* 2011, pp. 916–917). A significant association between mortality from severe notoedric mange and AR residue levels was found in bobcats and mountain lions in southern California (Serieys *et al.* 2015, p. 13). Because residue concentrations have not been consistently linked to thresholds for which adverse effects are expected to occur in different species, diagnoses using these data are best coupled with full necropsy results (Ebbert and Burek-Huntington 2010, p.154; Murray 2011, p. 96).

14.3 Sources of Toxicants in the Environment

Legal Applications of ARs - Labeled (Registered) Uses

Legal uses of rodenticides may pose risks to fishers in some parts of their range. Rodenticides have a long history of use in forestry and crop agriculture. The aerial application of 1080 (sodium fluoroacetate) was once standard practice on both public and private forestry lands (Cone 1967, p. 133; Radwan 1970, p. 78). While the risks to fishers from direct poisoning would have been negligible from this use, it would have reduced the populations of the fisher's prey species. By the early 1970s, 1080 was being replaced by the two first generation ARs, diphacinone and chlorophacinone, which were aerially broadcast over large areas in northern California (Passof 1974, pp. 128–129). A change in forestry practices from aerial seeding to outplanting seedlings changed the pest species of concern from deer mice (*Peromyscus maniculatus*) to voles (*Microtus* spp.), pocket gophers (*Thomomys* spp.), and mountain beavers (*Aplondontia rufa*), which require different control strategies (Arjo and Bryson 2007, p. 145). In tree and forestry plantations, and Christmas tree farms, zinc phosphide and chlorophacinone are registered for use against voles (Arjo and Bryson 2007, p. 148); zinc phosphide, chlorophacinone, and strychnine are registered for use against pocket gophers (Arjo and Bryson 2007, p. 151); and chlorophacinone products are registered for use on mountain beavers in Washington and Oregon (Liphatech, no date, entire; Arjo and Bryson 2007, p. 154). Queries to the BLM and USFS in Oregon and Washington confirm that these agencies no longer apply ARs on their ownerships (Standley 2013, pers. comm.; Bautista 2013, pers. comm.; USDA Forest Service 2015), but information is not known on use by private companies.

Use by homeowners of "ranchette" properties (one to five acres of land per home) may also contribute a legal source of rodenticides adjacent to or within fisher habitat (CDPR 2013a, pp. 5–6; Thompson *et al.* 2013, p. 4). These homeowners may be more apt to shop at farm stores due to proximity, where SGAR's can be purchased in bulk quantities (CDPR 2013a, p. 6). Exposure to ARs from homeowner use is consistent with studies of raptors in central and southern California, where ARs detected in carcasses were much more likely to contain SGARs (registered only for commensal rodent control in and around structures) than FGARs (registered for agricultural as well as commensal use) (Lima and Salmon 2010, entire). In a survey of homeowners in two areas of California where nontarget mortality of carnivores has been linked to AR use (southwestern Bakersfield and in proximity to Santa Monica Mountains National Recreation Area), 41 and 59 percent, respectively, reported rodent or other animal control on their property. Snap traps and anticoagulants were the most commonly used physical and chemical control products, respectively (Morzillo and Mertig 2011, p. 250).

New information since Service (2014)

Illegal use of rodenticides is common by homeowners surveyed in several urban-wildland interface areas in Southern California (Bartos *et al.* 2012, p. 7), and brodifacoum and bromadiolone were the most commonly used ARs reported by residents and pest control operators (Bartos *et al.* 2012, p. 8).

The State of California requires that all agricultural pesticide use be reported monthly to county agricultural commissioners. The state maintains a broad definition of "agricultural use" so as to include applications to parks, golf courses, cemeteries, rangeland, pastures, and along roadside and railroad rights-of-way. The primary exceptions to the reporting requirements are that home-and-garden use, and most industrial and institutional uses are not required to be reported (California DPR website, http://www.cdpr.ca.gov). Therefore, we have concluded that the data pertaining to forest habitats (including habitat supporting fishers) is not captured adequately in these statistics nor does this reporting requirement represent the best source of data for assessing the potential effects on fishers from the use of ARs.

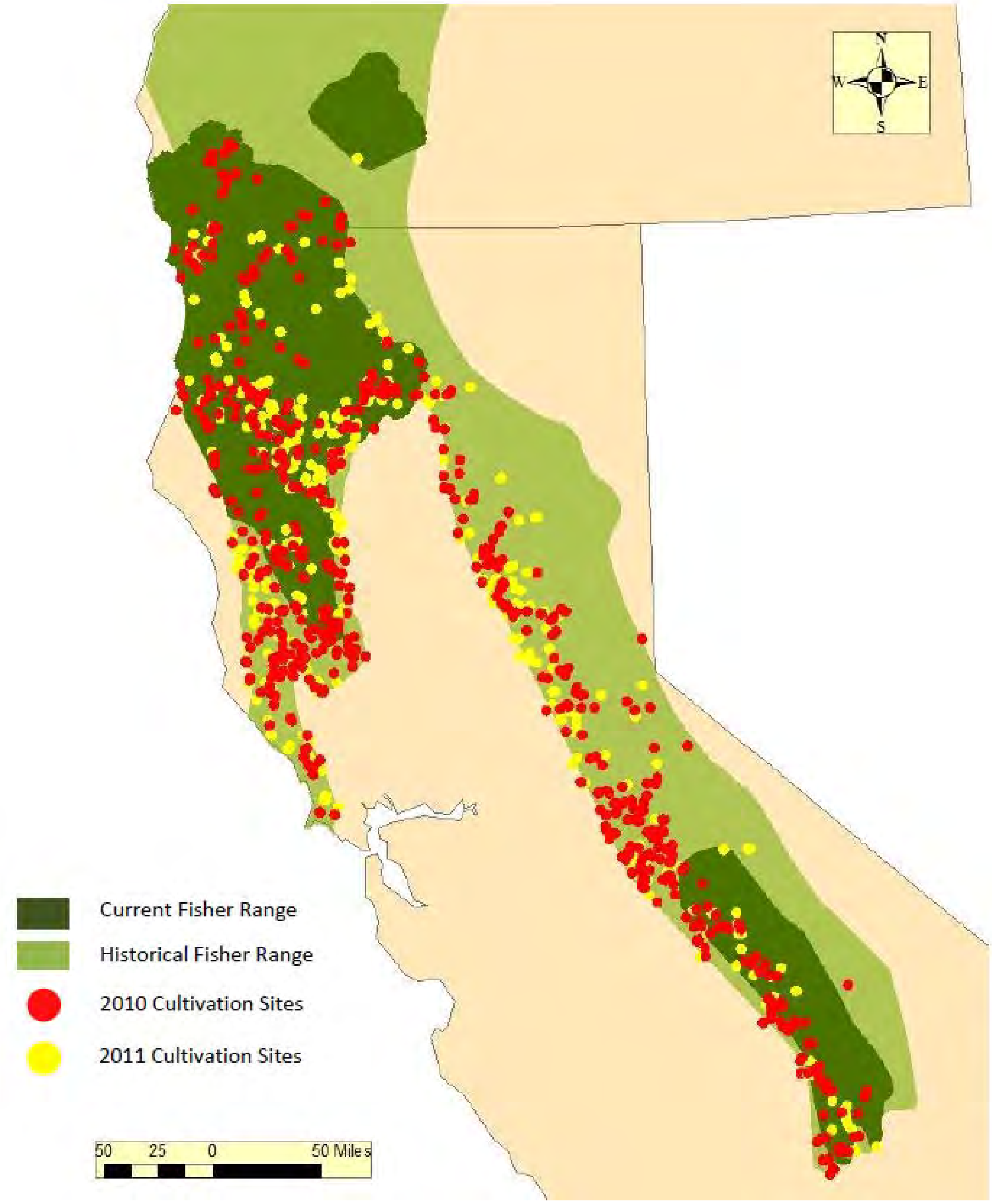

Figure 19. Cultivation sites eradicated on public, tribal, or private lands during 2010 and 2011 within both historical and current ranges of the fisher in California and southwestern Oregon. The central location for each eradicated illegal cultivation location is buffered by 4000 meter radius which approximates a hypothetical home range of a male fisher. Figure from Higley *et al.* 2013a.

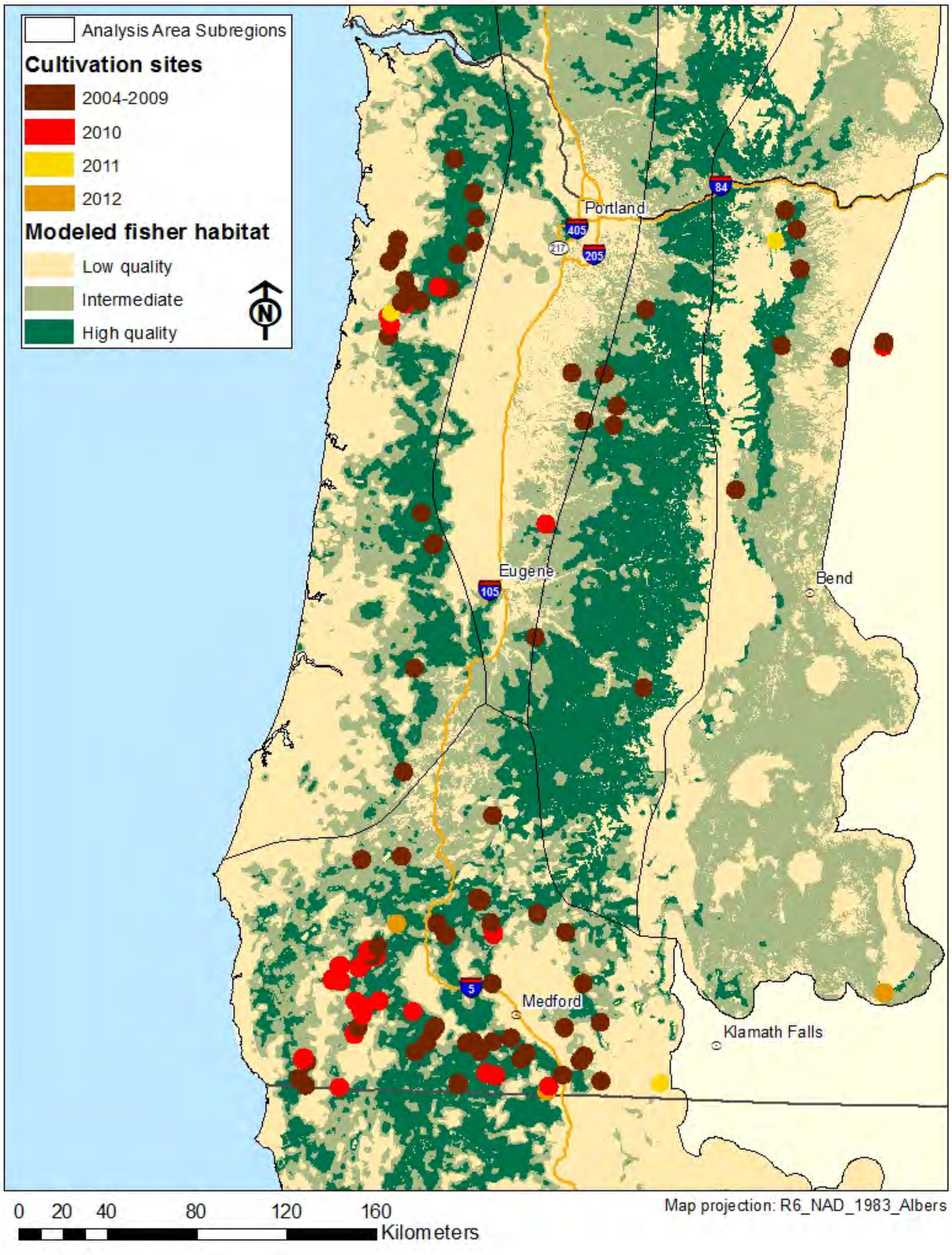

Figure 20. Marijuana cultivation sites eradicated between 2004 and 2012 in Oregon. The central location for each site is buffered by 4000 m to approximate the size of a male fisher home range. Cultivation site location data from ORHIDTA 2013.

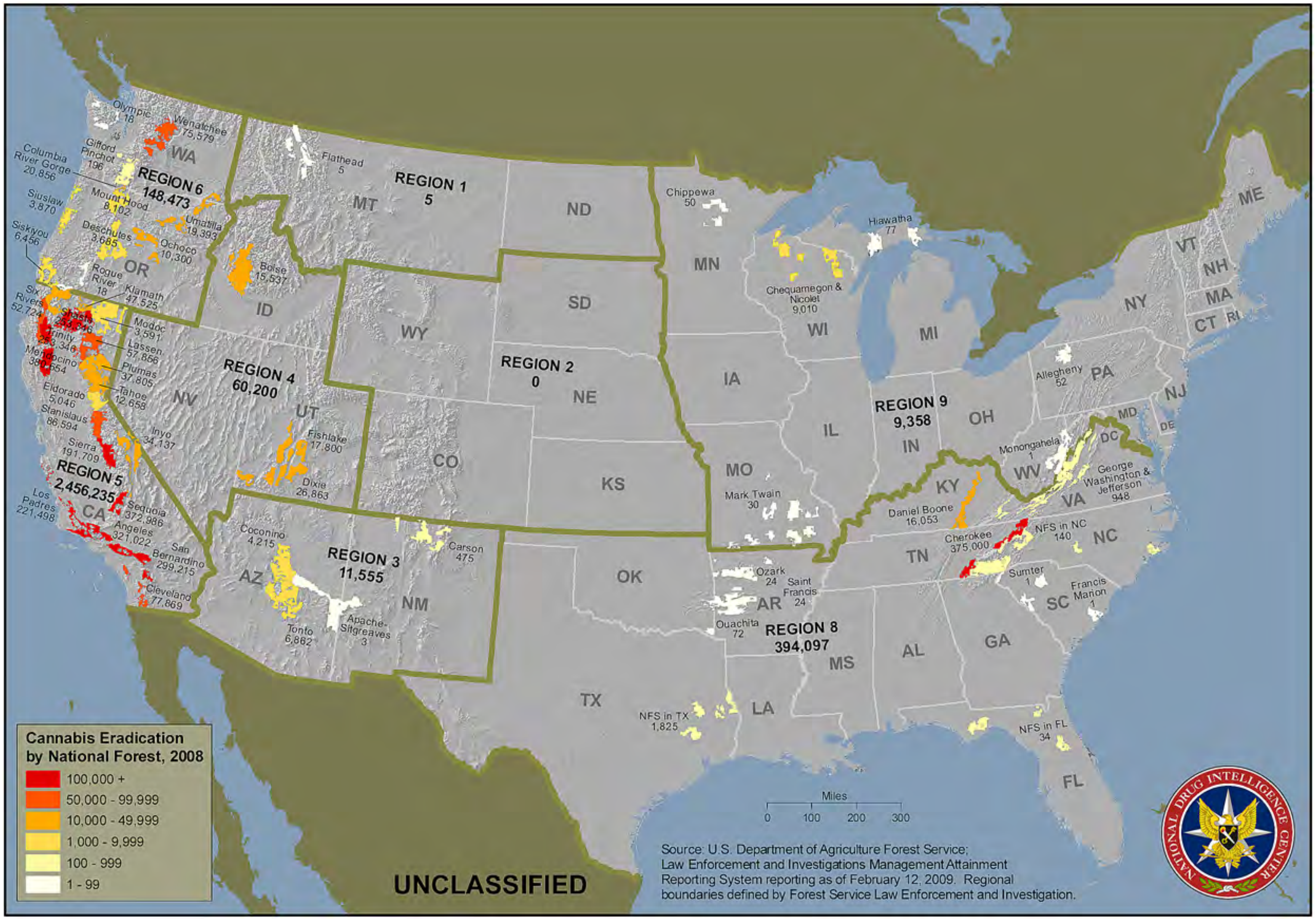

Figure 21. Cannabis eradication effort (number of plants) by national forest in 2008.

Illegal Applications of ARs - Marijuana Cultivation Sites

A comparison of the areas where ARs are reported as being applied under labeled uses in California in relation to areas that are supportive of fisher habitats demonstrates legal applications of ARs are not likely the source for the ARs that have been observed in fishers by researchers. Although all sources of AR exposure in fishers have not been conclusively determined, large quantities of ARs have been found at illegal marijuana cultivation sites within occupied fisher habitat on public, private, and tribal lands in California (Gabriel *et al.* 2012a, p. 12; Thompson *et al.* 2014, pp. 97–98); ARs are found in significant amounts scattered around young marijuana plants to discourage herbivory and along plastic irrigation lines to poison rodents that might chew on them. The proximity of a large number of marijuana cultivation sites to fisher populations in California and Oregon (Figure 19, Figure 20) and the lack of other probable sources of ARs within occupied fisher habitat have led researchers to implicate marijuana cultivation sites as the source of AR exposure in the California fishers (Gabriel *et al.* 2012a, p. 12; Thompson *et al.* 2014, pp. 97–98).

Marijuana cultivation was first detected on national forest lands (in southern California) in 1995 and by 2011 had expanded to 20 states and 67 national forests (U.S. Senate, Statement of Senator Feinstein, December 7, 2011, p. 1). The number of plants removed from national forests increased dramatically in each of the past 5 years, reaching a new record for eradication in 2010 of over 3.5 million plants from 59 national forests (USDOJ 2011, p 30; see Figure 21 for 2008 eradication effort). However, an apparent increase in illegal marijuana cultivation based solely on the number of plants eradicated each year may be misleading due to marked differences in eradication efforts between years. These national forests also account for the largest increase in the number of eradicated plants on public lands, which is due in part to intensified outdoor eradication operations (USDOJ 2011, p 30). Outdoor marijuana cultivation in California, Hawaii, Oregon, and Washington exceeds outdoor cultivation in all other areas of the country combined (U.S. Senate, Statement of Senator Feinstein, December 7, 2011, p. 1), and national forests in California account for the largest plant eradication total from public lands in any region (USDOJ 2011, p 30). The National Marijuana Initiative estimates that 60–70 percent of national marijuana seizures come from California and of these, 60 percent come from public lands (Gabriel *et al.* 2013a, p. 2). As an example of the magnitude of illegal marijuana cultivation on national forests, more than 600 large-scale marijuana cultivation sites have been found on only two of California's 17 national forests (Gabriel *et al.* 2013a, p. 2).

Studies of pesticides found at illegal marijuana cultivation sites are fragmentary or on a relatively small spatial scale (for example, National Parks in California; Jeffcoach 2012, entire), yet there are consistent reports of the use of FGAR and SGAR baits and organophosphate and carbamate pesticides at the majority of these sites (Gabriel *et al.* 2013a, pp. 2–3; High Sierra Volunteer Trail Crew 2011, pp. 3–4). Thompson *et al.* (2014, p. 95) reported that numerous pesticide compounds have been found at cultivation sites, including carbofuran, a neurotoxin insecticide banned in the U.S. in 2009 due to its high acute toxicity to humans and wildlife (EPA 2009, entire).

14.4 Toxicants Detected in Fishers

As mentioned above, first and second generation ARs have been detected in a majority of fishers tested in California (Table 10; Gabriel *et al.* 2012a, p. 5; Thompson *et al.* 2014, p. 96). The confirmed presence of ARs at marijuana cultivation sites within occupied fisher habitat suggests that there is the potential for fishers to consume ARs directly, especially if the AR baits contain flavorizers or are mixed with foods that appeal to fishers (for example, chicken, wet cat food, tuna fish), as well as through eating contaminated prey. Though no fisher necropsies in California have detected AR bait products in the stomach or gastrointestinal tract, primary poisoning cannot be completely ruled out (Gabriel *et al.* 2012a, p. 8). Gabriel *et al.* (2012a, p. 5) found that the frequency of exposure and the number of ARs per fisher were similar between the two California populations and between sexes. The SGAR brodifacoum was the most frequently detected AR in California fishers (Gabriel *et al.* 2012a, p. 5; Thompson *et al.* 2014, p. 96). Gabriel *et al.* (2012a, p. 5) detected brodifacoum in 44 of the 46 (96 percent) exposed fishers; followed by bromadialone (16 of 46; 35 percent), diphacinone (8 of 46; 17 percent), chlorophacinone (four of 46; 9 percent), difethialone (one of 46; 2 percent), and warfarin (one of 46; 2 percent). In addition to a high prevalence of exposure, tested fishers were exposed to more than one type of AR, with some individuals having liver residues containing as many as four ARs (Gabriel *et al.* 2012a, p. 5). The additive or synergistic effects to fishers of consuming multiple ARs are currently unknown.

Among the pesticides found at marijuana grow sites, ARs are the primary type of pesticide that has been analyzed in fisher tissue in connection with marijuana grows. They are persistent in liver tissue and sublethal exposure to one or more SGARs will allow detection in liver tissue for several months following exposure. In contrast, some other pesticides that have been documented at grow sites would be more likely to cause immediate mortality and are less persistent in tissue, making their recovery from carcasses less likely. However, fishers have only been screened for a select few of these potential pesticides. If these materials are found in forms attractive to fishers (for example, via flavorizors or food intentionally laced with poison to attract rodents and other pests), it is likely that fishers are also being exposed to them. To date non-AR pesticides such as organophosphates, carbamates, or organochlorines have been found in only a single fisher found dead immediately adjacent to (10 m) a grow site on the Six Rivers National Forest. This male fisher was confirmed to have ingested a hot dog intentionally laced with the poison carbamate (methomyl) (Gabriel *et al.* 2013b). Another male fisher from the NCSO population was suspected of succumbing to bromethalin (an acute rodenticide) toxicosis having exhibited neurological symptoms including ataxia, lethargy, and seizures (Gabriel 2013, p. 127). This fisher was near a trespass marijuana grow site discovered shortly after this fisher's death where bromethalin, carbamate insecticides, and numerous other organophosphates were documented. However, no toxicants were found in the gastrointestinal tract and no additional tissues had any detectable toxicants. All other potential mechanisms for this fisher's clinical signs were ruled out leading this case to be a classified as suspected toxicosis.

New information since Service (2014)

In OR, AR residues were found in two of the two fisher carcasses tested for residues (Gabriel 2015, pers. comm.). For the small, reintroduced ONP population, only brodifacoum and bromadiolone have been detected in carcasses. Six of eight fisher carcasses from the reintroduced individuals tested positive for brodifacoum exposure (Gabriel *et al.* 2012b, p. 160; Gabriel 2013a, pers. comm., Happe 2014, pers. comm; Happe et al 2014, pp. 38–39), but because these individuals all died within 20–268 days of capture in British Columbia (Happe cit), it is unknown whether these animals were exposed before or after their translocation to the Olympic Peninsula. These timeframes are well within the half-lives reported for brodifacoum persistence in mammalian tissue (Eason *et al.* 1996, p. 399; Vandenbroucke *et al.* 2008, p. 443). All six were captured near residential areas or private lands in B.C. (Happe cit), where brodifacoum could have been legally applied. Two out of an additional group of three translocated fisher carcasses tested positive for bromadiolone, 458 and 667 days after being released (Happe cit), too long after their relocation from B.C. to have been exposed there (liver half-life in mice: 28 days; Vandenbroucke *et al.* 2008, p. 443). Both of these fishers were found near rural housing areas (Happe cit), where bromadiolone could have been used legally. Of five more recent fisher mortalities, in 2013-2014, one tested positive for brodifacoum. This individual, born to a translocated female, was found on the border of the Port Angeles City Limits, surrounded by a low density housing area and commercial development (Happe *et al.* 2014, p. 39).

The best information we have about rodenticide exposure in Washington comes from eight dead fishers from the reintroduced ONP population that were either born on the Peninsula or had resided there for longer than the persistence time for the ARs detected (Happe citation). Three of the 8 had can confidently be considered to have been exposed to anticoagulant rodenticides in Washington, which is too small a sample size to extrapolate from. Some fishers in this population have been found near urban areas, so exposure may be from legal use in these areas rather than from marijuana cultivation (Lewis *et al.* 2012b, p. 9). We were unable to obtain data describing the prevalence or locations of marijuana cultivation sites in Washington. In western Washington, most marijuana is thought to be grown indoors, whereas most is grown outdoors in eastern Washington (NW HIDTA 2013, p. 16). Washington State legalized marijuana in 2012 and is the process of legislating legal growing operations. We are unable to speculate how the new laws will influence illegal outdoor marijuana growing operations. Therefore, we do not have sufficient information to estimate how much WA fisher habitat might be subject to AR exposure.

14.5 Effects of Rodenticide Exposure on Individual Fishers and Fisher Populations

Little is known of the individual or population level impacts of direct or indirect exposure of fishers to ARs, but several inferences can be made. For example, (1) direct consumption of one or more SGAR has a greater likelihood of resulting in death than secondary consumption, and (2) sublethal exposure to ARs likely results in sickness, which may increase the probability of mortality from other sources. The relationship between AR concentration found in exposed fishers and the rate of mortality or illness is currently unknown. Gabriel *et al.* (2012a, p. 11) found that the quantity of ARs observed in fisher liver tissues varied and overlapped extensively in both sublethal and lethal cases with no clear indication of a numeric threshold that might indicate an AR quantity leading to illness or mortality.

The EPA (Erickson and Urban 2004, entire) and the California Department of Pesticide Regulation (CDPR 2013a, p. 12) evaluated available toxicity values for several mammal species, most of which were rodent species. However, toxicity values for only a single mustelid species, mink (*Mustela vison*), and for only a single AR (brodifacoum), are available (Aulerich and Ringer, 1979, entire; unpublished data reported in Erickson and Urban 2004, p. 22). The median lethal dose (LD50) value given, 9.2 mg brodifacoum/ kg animal body weight, is among the highest values in this compilation, meaning that mink are relatively tolerant of brodifacoum when compared to other mammals for which LD50 studies have been conducted. However, the range given of LD50's indicates a wide variation in individual susceptibility. Furthermore, how applicable these toxicity values are to fishers is not known because of physiological differences between the species, which are not closely related. Using the value given for mink to calculate an LD50 of brodifacoum for the low end of the range of fisher body weights (1.5 kg for a female) gives 13.8 mg of brodifacoum, the amount in 276 g (9.7 oz.) of 0.005 percent brodifacoum bait, well below the amounts in commercial products available to the public. Individual units of brodifacoum bait range from blocks of 20 g each (sold in 16 lb./7.2 kg or 18 lb./8.2 kg buckets) to place packs of small pellets packaged in 25 g packets (sold in buckets of 8 lb. (150 packets) to 16 lb./7.2 kg (291 packets)). Fishers could also be exposed to rodenticides by consuming prey that has ingested bait. Calculations based on whole body residue values provide the most realistic exposure scenario from rodenticide-contaminated small mammals that would be entirely consumed (Giraudoux *et al.* 2006, p. 294). The literature was surveyed for whole body residue values for brodifacoum in small mammals to identify the maximum value detected and reported. The highest known application rate for a brodifacoum bait did not result in the highest whole body residue value. Brodifacoum pellets (0.0025 percent concentration) were aerially broadcast on Palmyra Atoll in the U.S. Pacific at 155 kg/ha to eradicate black rats, and the highest rat whole body residue was 6.800 mg/kg, from a live rat (Pitt *et al.* 2015, pp. 37, 43). However, the highest brodifacoum whole body carcass value for a small mammal found in the literature is 9.47 mg/kg from a live-trapped meadow vole (*Microtus pennsylvanicus*) (Merson *et al.* (1984, p. 213),from an orchard experimentally broadcast-treated with a 0.005 percent brodifacoum bait at 46 kg/ha,. Using this concentration as an estimate of the highest brodifacoum concentration that could be found in a small mammal exposed to brodifacoum under any application scenario, a female fisher would need to consume approximately 29 voles weighing 50 g each to reach the LD50 of 13.8 mg of brodifacoum. As stated previously, a fisher would need to find and consume 10 to 26 smaller prey items (for example, mice (*Peromyscus maniculatus*), which weigh 10-30 g) per day to meet their energetic needs (Golightly *et al.* 2006, pp. 40–41.). Thus, a fisher foraging in an area illegally baited with over-the-counter brodifacoum products could easily consume enough

Table 10. Pesticides found on marijuana cultivation sites.

Class	Compound	Mammalian Toxicity Category[1]	Persistence in Tissue[2]	Registered/Not registered[3]	Frequency on MJ sites	Documented exposure in fishers
Anticoagulant Rodenticide	Brodifacoum	Extremely toxic	High	Registered (21 products)	Many	Yes
	Bromadiolone	Extremely toxic	High	Registered (38 products)	Few	Yes
	Chlorophacinone	Extremely toxic	Medium	Registered (15 products)	Few	Yes
	Difenacoum	Extremely toxic	High	Registered (8 products)	None	Not tested
	Difethialone	Extremely toxic	High	Registered (12 products)	Few	Yes
	Diphacinone	Extremely toxic	Medium	Registered (47 products)	Few	Yes
	Warfarin	Extremely toxic	Medium	Registered (8 products)	Few	Yes
Acute Rodenticide	Aluminum Phosphide	Highly toxic	No residues expected	Registered (16 products)	Few	Not tested
	Bromethalin	Extremely toxic	Not available	Registered (48 products)	Few	Not tested
	Cholecalciferol	Extremely toxic	Low – Medium	Registered (6 products)	Few	Not tested
	Strychnine	Extremely toxic	Low	Registered (16 products)	Few	Not tested
	Zinc Phosphide	Highly toxic	No residues expected	Registered (25 products)	Moderate	Not tested
Organophosphate	Malathion	Slightly toxic	Low	Registered (20	Many	Not tested

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Class	Compound	Mammalian Toxicity Category[1]	Persistence in Tissue[2]	Registered/Not registered[3]	Frequency on MJ sites	Documented exposure in fishers
Insecticide				products)		
	Azinphos Methyl	Extremely toxic	Low	Not registered	Few	Not tested
	Diazinon	Moderately toxic	Low	Registered (11 products)	Moderate	Not tested
	Methamidophos	Highly toxic	Low	Not registered	Few	Not tested
	Methyl Parathion	Extremely toxic	Low	Not registered	Few	Not tested
	Acephate	Moderately toxic	Low	Registered	Few	Not tested
Carbamate Insecticide	Carbaryl	Moderately toxic	Low	Registered (23 products)	Moderate	Not tested
	Carbofuran	Highly toxic	Low	Not registered	Many	Not tested
	Methomyl	Highly toxic	Low	Registered (11 products)	Few	Not tested
	Propoxur	Highly toxic	Low	Registered	Moderate	Yes
Pyrethroid Insecticide	Bifenthrin	Slightly toxic	Medium	Registered (174 products)	Few	Not tested
	Deltamethrin	Slightly toxic	Low	Registered (99 products)	Few	Not tested
	Gamma Cyhalothrin	Slightly toxic	Low – Medium	Registered (133 products)	Many	Not tested
	Beta Cyfluthrin	Slightly toxic	Low	Registered (23 products)	Few	Not tested
Organochlorine Insecticide	DDT	Moderately toxic	High	Not registered	Few	Not tested
Other Insecticides	Fipronil	Moderately toxic	Medium	Registered (75 products)	Few	Not tested
	Imidacloprid	Slightly toxic	Low	Registered	Few	Not tested

Class	Compound	Mammalian Toxicity Category[1]	Persistence in Tissue[2]	Registered/Not registered[3]	Frequency on MJ sites	Documented exposure in fishers
	Abamectin	Moderately toxic	Low	Registered (65 products)	Few	Not tested
Fungicide	Chlorothalonil	Slightly toxic	Low	Registered (89 products)	Moderate	Not tested
Molluscicide	Metaldehyde	Moderately toxic	Low	Registered (35 products)	Moderate	Not tested

[1]Mammalian and avian LD_{50} (EPA): Extremely toxic = <10 mg/kg; highly toxic = 10–50 mg/kg; moderately toxic = 50–500 mg/kg; slightly toxic = 500–2,000 mg/kg; relatively non-toxic = >2,000 mg/kg.
[2]Low = half-life <1week, Med = half-life 1 week-2 months, High = half-life >2 months.
[3]Currently registered for use in the U.S.; does not imply registration on marijuana.

exposed rodents over several days to succumb to the poison, if fishers have approximately the same susceptibility to brodifacoum that mink do. More conservative exposure thresholds could be evaluated by calculating the amounts of brodifacoum, bait product, and prey based on the Lowest Lethal Dose and the Lowest Observed Effect Level if those had been available from the mink study.

AR exposure has been determined as the direct cause of death for 4 of 58 fisher mortalities in California (Gabriel *et al.* 2012a, p. 6). The cause of death for the remaining 54 fishers included predation, infectious and non-infectious disease processes, and vehicular strikes (Gabriel *et al.* 2012a, p. 6). The degree to which exposure of fishers to ARs increases the probability of mortality from these other causes is not known. However, evidence from laboratory and field studies for several other species suggest that pesticide exposure: (1) reduces immune system function (Repetto and Baliga 1996, pp. 17–37; Li and Kawada 2006, entire; Zabrodskii *et al.* 2012, p. 1; Golden *et al.* 2012, p. 274); (2) is associated with a higher prevalence of infectious disease (Riley *et al.* 2007, pp. 1878, 1882; Vidal *et al.* 2009, p. 270); and, (3) causes transient hypothermia (Ahdaya *et al.* 1976, entire; Grue *et al.* 1991, pp. 158–159; Gordon 1994, p. 432) which may lower the effective LD_{50} and increase mortality (Martin and Solomon 1991, pp. 122, 126).

Multiple studies have demonstrated that sublethal exposure to ARs or organophosphates (OPs) may impair an animal's ability to recover from physical injury. Many of these studies also show there can be wide variability in lethal and sublethal effects among and within taxonomic groups (Gabriel *et al.* 2012a, p. 11). As an example, a sublethal dose of AR can produce significant clotting abnormalities and hemorrhaging (Berny 2007, p. 98), and has been shown to reduce blood-clotting activity in golden eagles (Savarie *et al.* 1979, p. 77), screech owls (Rattner *et al.* 2012, p. 837), barn owls (Webster 2009, p. 70), rats (Bailey *et al.* 2005, p. 15) and weasels (Townsend *et al.* 1984, p. 630). Raptors with liver concentrations of ARs as low as 0.03 parts per million have died as a result of excessive bleeding from minor wounds inflicted by prey (Erickson and Urban 2004, pp. 90, 100, 184, 190–191). AR-exposed fishers may be at risk of prolonged bleeding if wounded when pursuing or killing prey, escaping or fighting predators, or by conspecifics (for example, during mating). Sublethal AR exposure may also combine with other stressors to have additive or synergistic adverse effects (Golden *et al.* 2012, entire). For example, only 6 percent of study rats died after 5 days of exposure to an anticoagulant compound (dicoumarol), but 50 percent died when exposed to the anticoagulant and additional stressors (Erickson and Urban 2004, p. 99; Jaques 1959, p. 851). Exposure to anticoagulants can result in changes to animals' behavior which makes them more susceptible to environmental stressors, such as adverse weather conditions, food shortages, and predation (Cox and Smith 1992, p.169; Brakes and Smith 2005, p. 121; La Voie 1990, p. 29; Golden *et al.* 2012, pp. 274–275). Finally, sublethal levels of rodenticide might predispose individuals to death from other causes (for example, collisions with automobiles, starvation) or may reduce the chance of recovery from injury (Littin et al 2000, pp. 311–313; Swift 1998, pp. 42–44; Golden *et al.* 2012, entire).

New information since Service (2014)

Reports in the veterinary and medical literature document multiple symptoms of toxicosis, which without treatment can lead to mortality (DuVall *et al.* 1989, p. 66; Merola 2002, p. 719; Murray and Tseng 2008, entire; Valchev *et al.* 2008, pp. 239–240; Spahr *et al.* 2007 entire). Symptoms include lethargy, anorexia, ataxia, anemia, lameness from bleeding in the joints, and difficulty breathing.

Gabriel *et al.* (2012a, p. 10) emphasized that it is unknown if stressors or injuries from environmental, physiological, or even pathogenic factors could predispose fishers to elevated mortality rates with the added stressor of AR exposure. Potential impacts of sublethal AR exposure in fishers include impaired blood clotting, reduced reaction time, loss of appetite, impaired locomotion, thermoregulatory difficulties, and increased susceptibility to diseases and parasites. In turn, these conditions may increase the frequency of death from minor wounds or infections, roadkill mortalities, fetal miscarriages, hypothermia, disease or extreme parasitism, accidents due to falls or drowning, predation, and starvation. ARs may reduce the reproductive potential of fishers.

Exposure to ARs has been documented to cause fetal abnormalities, miscarriages, and neonatal mortality in mammals (Mackintosh *et al.* 1988, p. 87; Munday and Thompson 2003, entire; Pauli *et al.* 1987, entire; Rady *et al.* 2013, entire). The timing of AR use at cultivation sites (April–May) may also be important, because this time coincides with increased energetic requirements of pregnant or lactating female fishers,

A critical conservation question is whether AR exposure in individual fishers inhibits population growth or causes population declines by lowering population demographic vital rates such as survival and reproductive success. Thompson *et al.* (2014, p. 96) found that female fisher survival rates decreased with an increase in the number of illegal cultivation sites found within their home range areas in the southern Sierra Nevada. Shaffer (1981, entire) asserts that small, isolated fisher populations like the SSN population are already vulnerable to stochastic events, which could be exacerbated if any additional reduction in survivorship decreases the probability of population persistence. Although the SSN population has shown stable occupancy rates for the past 8 years (Zielinski *et al.* 2013b, p. 10), it has not expanded despite the existence of suitable, unoccupied habitat (Spencer *et al.* 2011, p. 796). Predictive modeling suggested that a 10–20 percent mortality rate increase in the SSN population may be enough to prevent population expansion even in the absence of dispersal barriers (Spencer *et al.* 2011, p. 796), and that high mortality rates may be limiting geographic expansion. Spencer's model also showed that reductions in adult female survivorship resulted in disproportionately large declines in population size. If adult female survivorship is a major driver of demographic rates in the SSN population and perhaps others, the observed reduction in adult female survivorship for females with higher numbers of marijuana cultivation sites within their home ranges (Thompson *et al.* 2014, pp. 96–98) may result in significant population-level impacts in the near future.

A reduction in the density and distribution of potential mammalian prey from exposure to ARs at marijuana cultivation sites may result in additional negative impacts to fisher populations. Prey depletion has been associated with predator home range expansion and resultant increase in energetic demands, prey shifting, impaired reproduction, starvation, physiologic (hematologic, biochemical and endocrine) changes, and population declines in other species (Hayward *et al.* 2012, abstract; Karanth *et al.* 2004, p. 4858; Knick 1990, pp. 21, 32; Knick *et al.* 1993, entire). Small mammal mortality rates at marijuana cultivation sites have not been estimated.

Rodent diversity is reduced at marijuana cultivation sites treated with rodenticides, with only mice present, as compared to nearby untreated sites where large-bodied species (woodrats, chipmunks, squirrels) that form the main prey base for fishers are found (Wengert 2015, pers. comm.).

The timing of AR use at cultivation sites (April–May) may also be important, because a reduction in rodent prey at this time coincides with increased energetic requirements of pregnant or lactating female fishers, increasing the likelihood of miscarriages due to inadequate nutrition or starvation of dependent kits due to reduced fitness of the adult female. Reduced fitness in male fishers during the early spring due to limited availability of prey could reduce the potential of mating with available female fishers. Finally, reduced prey density and distribution could decrease juvenile fisher survival rates if they attempt to establish a home range that includes one or more marijuana cultivation sites that are using ARs to control rodents.

Mortality reports from the field confirm the hazards of pesticides to fishers, however the number of individuals poisoned is likely greater than the number found. For any contaminant, collection of dead or moribund individuals is likely to represent only a subset of the actual exposure or mortality attributable to that contaminant. In order to document mortality, a carcass must be observed, reported, collected, and chemically analyzed while still relatively fresh (Vyas 1999, entire). Individuals that die in the wild may be quickly removed by scavengers. For example, the loss rate of dead birds in this manner may be up to 98 percent, depending on season, location, and species, with losses generally occurring within 24 - 96 hours after placement of a carcass in experimental studies (Peterson *et al.* 2001, p. 183; Vyas *et al.* 2003, pp. 601–602; Prosser *et al.* 2008, entire). Carcass detection studies have found that even when searches are performed on carcasses known to exist (for example, placed by a researcher for study), a percentage will never be found due to scavenging, location in remote and inaccessible areas, or size or coloration that renders the carcass inconspicuous (Vyas 1999, pp. 187–188; Elliott *et al.* 2008, p. 454). The delayed toxicity of ARs and persistence within food webs can result in contaminated rodents being found within and adjacent to the treated area weeks or months after bait application (Geduhn *et al.* 2014, pp. 8–9; Tosh *et al.* 2012, pp. 1329–1330; Sage *et al.* 2008, p. 215). Public reporting of wildlife mortalities in general is limited both by detection of carcasses as well as uncertainty as to whether the incident should be reported and to whom it should be reported, procrastination, and apathy (Vyas 1999, p. 189). Even when a mortality incident is reported to the appropriate authorities, an immediate investigation may not be possible because of the distance, terrain, weather, private property restrictions, limited resources, and other on-going investigations. Consequently, when a carcass is recovered during a field investigation, the biological and chemical matrices which are used to confirm the cause of death may not be in analyzable condition due to decomposition or scavenging (Vyas 1999, pp. 188–189; Spurr *et al.* 2015, p. 14). Thus, given the obstacles in documenting incidents, the fisher mortalities known to have been caused by pesticide exposure nevertheless provide an invaluable window into the hazards of pesticides to fishers and it is reasonable to conclude that the number of fishers killed exceeds the carcasses that have been recovered.

Though not yet final, the template CCAA between the Service and western Oregon non-federal landowners (described in **Conservation measures to reduce the stressors related to habitat or range of the species**) would prohibit nuisance animal control activities on enrolled lands within 2.5 mi (4 km) of known occupied den sites. In addition, the MOU between government agencies in western Oregon (described in **Conservation measures to reduce the stressors related to habitat or range of the species**) calls for cleaning up illegal marijuana grow sites on party lands.

Summary of stressors related to other natural or manmade factors affecting its continued existence

Based on the best available information, we have identified several natural or anthropogenic factors that are likely stressors for fisher in the analysis area. These stressors may be more pronounced, particularly in the SSN population, because of small population size and factors consequent to small population size such as isolation, low reproductive capacity, and demographic and environmental stochasticity. Furthermore, the potential effects of stochastic events on small populations combined with difficult to quantify interactions and synergy among stressors (Naney *et al.* 2012, p. 36) can exacerbate risk.

Cumulative and Synergistic Effects of Stressors

Combinations of stressors accumulate and interact to increase the risk of extinction. Any given source of mortality or habitat loss may affect a small proportion of individuals or of the range, but when all sources are added together, the effect may be substantial. Furthermore, some combinations of stressors may act together synergistically to cause effects greater than the sum of the individual effects of each stressor. In the case of the fishers, all ongoing stressors also operate on a population already greatly reduced due to historical trapping and habitat loss.

Cumulative Effects

Stressor-related mortality may be additive (operates in addition to) or compensatory (compensates for) natural mortality. Mortality affecting juvenile fishers may not affect overall population growth rate, especially in areas of high population density, as many juveniles will be unsuccessful at establishing home ranges, and juveniles have a naturally higher mortality rate than adults (Krohn *et al.* 1994, p. 144). In contrast, increases in adult female mortality are more likely affect population size and stability, as population growth rates depend largely on adult female survival (Truex *et al.* 1998, p. 52; Lamberson *et al.* 2000, pp. 6, 9). We do not have detailed information for each stressor as to the ages and sexes of individuals affected, but all stressors addressed in this document affect adult female fishers to some extent (Gabriel 2013b, pers. comm.; Sweitzer 2013a, pers. comm.).

Using population models, both Spencer *et al.* (2011, p. 797) and Lamberson *et al.* (2000, pp. 18–20) found that 10-20 percent reductions within the reasonable range of mortality and reproductive rates would cause populations to shift from growth to population stagnation (lack of expansion) or decline. Fisher mortality related to research activities, collisions with vehicles, and anticoagulant rodenticide poisoning add, in aggregate, 3-17 percent annual mortality to naturally occurring mortality from disease and predation (collectively 6-32 percent mortality) and other natural sources such as starvation. Empirical estimates of population growth rates within the analysis area are very close to 1 (Higley and Matthews 2009, p. 66; Swiers 2013, p. 20; Sweitzer 2013b, pers. comm.), and small increases in mortality may be enough to shift a stable population into decline. It is probable that some stressors could increase to an unknown degree causing additional fisher mortality.

In addition to these concerns, all native and reintroduced populations within the analysis are relatively small and isolated, increasing the vulnerability of these populations to stochastic changes in survival and reproductive rates. Thus, if fisher mortality increases due to the stressors listed above, stochastic fluctuations in demographic parameters have the potential to cause sudden, sharp declines in the populations. However, at this time we are unaware of any empirical evidence that stressors are manifesting themselves to a significant degree across the DPS such that the fishers in the West Coast DPS are demonstrating population declines.

Synergistic effects

When stressors occur together, one stressor may exacerbate the effects of another stressor, causing additional effects not accounted for in the analysis of each stressor in isolation. For example: some alterations to habitat could increase fishers' vulnerability to predation; exposure to anticoagulant rodenticides could increase the fisher death rates from predation, collision with vehicles, disease, or intraspecific conflict; interactions between climate change, wildfire, forest disease, and environmental impacts of development activities could cause large-scale ecotype conversion; climate change could lead to increases in fisher or habitat disease; or development activities could increase fisher collisions with vehicles, conflicts with domestic animals, and infections contracted from domestic animals.

Fishers' vulnerability to predation by other carnivores may be heightened when forest fragmentation forces fishers to travel either without suitable hiding cover, or over longer distances to circumnavigate unsuitable areas (Heinemeyer 1993, p. 26; Powell and Zielinski 1994, p. 62). Fisher use of open or brushy habitat is associated with higher rates of predation by bobcats (Wengert 2013, p. 99). Similarly, Higley *et al.* (2013b, p. 33) found that habitat structure and anthropogenic features, such as roads and to a certain extent habitat edge, can influence the risk of interaction between bobcats and fishers. Encounters were more likely between bobcats and fishers in areas with greater density of roads and habitat edges, and higher proportions of mature, older forest surrounding fisher locations decreased the odds of encounters with bobcats (Higley *et al.* 2013b, pp. 33–34). Thus, it is possible that human development, linear features, and some types of vegetation management could magnify the severity of stressors due to predation.

There is a potential for synergistic effects between human development and vegetation management, particularly in wildland-urban interfaces. Vegetation management and fuels treatments often aggressive in these wildland-urban interface areas in order to prevent wildfire.

Anticoagulants increase bleeding by inhibiting clotting, otherwise minor injuries can become serious for animals that have been exposed to sublethal doses of anticoagulant rodenticides. Any conflict with another animal, including escapes from predators, intraspecific conflicts, conflicts with domestic animals, and even self-defense by prey, may be the source of such injuries. Sublethal effects of toxicants may also be causing an increased rate of mortality resulting from other causes, such as susceptibility to disease and parasites, and vehicle collision. For this analysis for the West Coast DPS of fisher, evidence for exposure to toxicants varies among the Pacific States, although toxicant exposure in the two populations of California fishers appears to be widespread. Numerous studies have attempted to associate residue toxicant concentrations with levels at which adverse effects occur, although no consistent trend has been identified (Erickson and Urban 2004, p. 94). The confirmed presence of numerous types of toxicants at marijuana cultivation sites within occupied fisher habitat suggests that is likely that fishers consume toxicants directly through ingestion of poisoned bait or indirectly through eating contaminated prey. At this time, however, limited data exist for toxicant exposure information for WA and OR. Long term studies on the Hoopa reservation report a toxicosis rate in male fishers of 35 percent from 2005 – 2012, which may be contributing to a decline in male fisher survival over the same time period (Higley 2014, pers. comm.). On the Sierra National Forest Thompson *et al* 2013 (p. 96) reported that female fisher survival was related to the number of marijuana cultivation sites the animal was likely to encounter. Female fishers exhibiting AR exposure had more cultivation sites within their home ranges than those without exposure. There are no population or rangewide studies to evaluate the population-level impacts across the DPS's. However, information to date indicates that where fishers are exposed to toxicants more information is necessary to evaluate effects of toxicants on local populations.

In several sub-regions, changes in temperature and precipitation as a result of climate change may cause reductions in habitat amounts due to shifts in vegetation types. Any reductions would be cumulative with those that may occur due to wildfire, ongoing vegetation management, and development. For example, as the climate warms and summers become drier, fires are projected by modeling to increase in frequency and extent, and possibly severity in some locations. Forest insects and disease agents, along with stresses due to smog in some locations (for example, the Sierra Nevada) could act in concert with climate change and fire to cause widespread ecotype conversions. Thus, it is possible that the amount of habitat loss in some sub-regions may be greater than other areas.

Climate change also may increase disease prevalence and spread, especially for diseases that are transmitted by insect vectors (Colwell *et al.* 1998, p. 451; Daszak *et al.* 2000, p. 444). These changes may be related to changes in species distributions that expose susceptible species to new diseases, or to increases in ideal conditions for disease transmission. For example, West Nile Virus is a mosquito-transmitted disease that is known to infect fishers, although it is not known whether it causes disease or mortality in fishers (Brown *et al.* 2008, p. 3). This disease has been recently introduced to the United States (Paz 2012, p. 255; Epstein 2001, p. 751). Warm conditions have been shown to lead to disease outbreaks in both humans and wildlife (Paz 2012, entire; LaDeau *et al.* 2011, p. 914). This relationship between climate and disease may affect other diseases as well, especially insect-borne diseases that infect fishers, such as granulocytic anaplasmosis, Lyme borreliosis, and Rocky Mountain spotted fever (Lofroth *et al.* 2010, p. 159). In addition, climate change may cause range shifts in a wide variety of animal species (Burns *et al.* 2003, entire), which may result in the introduction of new diseases to fisher populations. Thus, climate change has the potential to increase the severity of disease mortality. As human populations continue to encroach on fisher habitat, fishers will increasingly be exposed to pet animals and the diseases they carry; thus, development activities may also increase the severity of disease mortality.

Cumulative and Synergistic Effects Summary

Stressors operating at the population level include disjunct and small population size and on-going habitat changes from vegetation management, development, and climate change (and the associated increase in wildfire). Additional sources of direct mortality to individual fishers that could play a role in cumulative or synergistic effects are consumption of toxicants and collision with vehicles. Just as stressors, as evaluated, are not occurring in equal scope and severity across range of the DPS, any potential cumulative and synergistic effects from these stressors may be occurring more in some sub-regions than others. On-going cumulative and synergistic stressors will be increasingly important to consider for potential impacts into the twenty-first century, particularly in areas not managed for retention and recruitment of fisher habitat attributes, areas sensitive to climate change and areas where direct mortality of fishers reduces their ability to maintain or expand their populations. Overall, the best scientific and commercial information indicate some cumulative or synergistic impacts may be occurring currently or in the future, although no information at this time indicates these impacts are cumulatively resulting in declines of the extant populations.

EXISTING REGULATORY MECHANISMS THAT MAY ADDRESS STRESSORS

Existing regulatory mechanisms that impact fishers include laws and regulations promulgated by the Federal and individual State governments. Tribal governments, as sovereign entities, are not subject to these laws and regulations, but have their own system of laws and regulations on tribal lands. Principal threats to the fisher for which governments may have regulatory control include injury or mortality due to trapping, habitat modification or loss, and legal uses of pesticides including anticoagulant rodenticides. These regulations differ among government entities and are explained in separate sections below. Although an identified threat, illegal use of pesticides at marijuana cultivation sites are not analyzed here because existing regulatory mechanisms have little bearing on activities that intentionally disregard applicable laws. We do include information relevant to the legal uses of pesticides at the end of this section.

Federal Regulations

There are a number of federal agency regulations that pertain to management of fisher (and other species and habitat). Most Federal activities must comply with the National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. §§ 4321 *et seq*.). NEPA requires Federal agencies to formally document, consider, and publicly disclose the environmental impacts of major Federal actions and management decisions significantly affecting the human environment. NEPA does not regulate or protect fishers, but requires full evaluation and disclosure of the effects of Federal actions on the environment. NEPA does not require or guide potential mitigation for impacts.

USFS and BLM

Over 13.1 million ha (32.2 million ac) of USFS land is in the analysis area. National Forest management is directed by the Multiple-Use Sustained-Yield Act of 1960, as amended (16 U.S.C. §§ 528 *et seq*.) and the National Forest Management Act of 1976, as amended (NFMA) (90 Stat. 2949 *et seq*.; 16 U.S.C. §§ 1601 *et seq*.). NFMA specifies that the USFS must have a land and resource management plan (LRMP) to guide and set standards for all natural resource management activities on each National Forest or National Grassland. The USFS has recently revised their NFMA planning rules (77 FR 21162, April 9, 2012, entire), which will apply to future LRMPs. Current LRMPs were developed under the 1982 planning rule (47 FR 43026, September 30, 1982, pp. 43037-43052), which required the USFS to maintain viable populations of existing native and desired non-native vertebrate species in the planning area. The revised rule requires plans to use an ecosystem and species-specific approach to provide for the diversity of plant and animal communities and maintain the persistence of native species in the plan area. This would include contributing to the recovery of federally listed threatened and endangered species, conserving proposed and candidate species, and maintaining viable populations of species of conservation concern (77 FR 21162, April 9, 2012, pp. 21169-21272). Directives for implementing this rule have not been finalized, so it is unclear how this change will affect fishers and their habitat, but fishers will likely become a species of conservation concern under the new policy. While there is concern over the removal of the requirement to maintain viable populations of vertebrate species, and the increase in discretionary language compared to the previous rule (Schultz *et al.* 2013, p. 442), the obligation to ensure that populations of native species persist remains in effect.

The USFS policy manual (USFS 2005, section 2670.22) allows for designation of sensitive species of management concern. The fisher has been identified as a sensitive species throughout the analysis area (USFS 2007 and USFS 2011, unpublished data). The Sensitive Species Policy is contained in the USFS Manual, section 2670.32 (USFS 2005, section 2670.32) and calls for National Forests to assist and coordinate with other Federal agencies and States to conserve these species. Special consideration for the species is made during land use planning and activity implementation to ensure species viability and to preclude population declines that could lead to a Federal listing under the ESA (USFS 2005, section 2670.22). Additionally, programs and activities must be analyzed for their potential effect on sensitive species. If species viability is a concern, impacts are to be avoided or minimized; if impacts cannot be avoided, a further analysis of the significance of potential adverse effects is required; the action must not result in loss of species viability or create significant trends toward Federal listing (USFS 2005, section 2670.32). How sensitive species status protects fishers depends on Land and Resource Management Plans for individual forests, and on site-specific project analyses and implementation. At present, all 10 forests in the Sierra Nevada have standards and guidelines in their forest plans that provide some level of conservation for the fisher. Many of the forest plans in northwest California and the remainder of the analysis area do not provide specific management guidelines for fishers but conservation guidelines for other species do provide some conservation value for the fisher.

BLM lands make up almost 2 million ha (5 million ac) in the analysis area, and management is directed by the Federal Land Policy and Management Act of 1976, as amended (FLPMA) 43 U.S.C. §§ 1704 *et seq*.). This legislation provides direction for resource planning and establishes that BLM lands shall be managed under the principles of multiple use and sustained yield. This law directs development and implementation of resource management plans (RMPs), which guide management of BLM lands at the local level. RMPs are the basis for all actions and authorizations involving BLM-administered lands and resources. RMPs may contain specific direction regarding fisher habitat, conservation, or management, but to date, none specifically address the fisher's needs.

Fishers are also designated as a sensitive species throughout the analysis area on BLM lands (BLM 2008a and BLM 2010, unpublished data). The special status species policy contained in the BLM Manual section 6840.02B (BLM 2008b, section 6840.02B) directs BLM to initiate conservation measures that reduce or eliminate threats and minimize the likelihood of listing under the ESA. Section 6840.2A1B (BLM 2008b, section 6840.2A1B) states that RMPs must address sensitive species, while implementation-level planning should consider site-specific procedures needed to bring species and their habitats to the condition where sensitive species policies would no longer be necessary.

Protection afforded the fisher as a sensitive species on USFS and BLM lands largely depends on the individual unit's management plan (LRMP or RMP) and on site-specific project analyses and implementation. With the exception of some National Forests within the Sierra Nevada Forest Plan Amendment area, National Forests and BLM districts do not have fisher-specific standards and guidelines within their management plans.

<u>Northwest Forest Plan</u>

The Northwest Forest Plan (USDA and USDI 1994a, entire; USDA and USDI 1994b, entire) was adopted by the USFS and BLM in 1994 to guide the management of over (24 million ac) (9.7

million ha) of Federal lands (USDA and USDI 1994b, p. 2) in portions of western Washington and Oregon, and northwestern California within the range of the northern spotted owl. The NWFP amends the management plans of National Forests and BLM Districts and is intended to provide the basis for conservation of the spotted owl and other late-successional and old-growth forest associated species on Federal lands. The NWFP is important for fishers because it created a network of late-successional and old-growth forests that currently provides fisher habitat, and the amounts of habitat are expected to increase over time. The following descriptions of NWFP land allocations and standards therefore define the existing regulations that guide forest management of fisher habitat in the referenced areas. The BLM, however, is revising their RMP, which, if approved, would change their management direction from the existing NWFP. This revision is further discussed at the end of this section.

Most of the NWFP area lies within the analysis area. Of the 9.9 million ha (24.4 million ac) of Federal lands included within the NWFP, 5.9 million ha (14.7 million ac) are within reserved land allocations (Congressionally Reserved Areas and Late Successional Reserves) and are managed to retain existing natural features or to protect and develop late-successional and old-growth forest ecosystems. There are roughly 1.6 million ha (4 million ac) of the NWFP area that is classified as "Matrix," where scheduled timber harvest is permitted (USDA and USDI 1994b, p. A-4). Protections for occupied marbled murrelet sites, spotted owl sites, and other species also overlay Matrix lands, further reducing the area available for timber harvest (USDA and USDI 1994b, p. C-10). Riparian Reserves overlay all land allocations and emphasize protection of riparian dependent resources from a minimum of 30 to 91 m (100 to 300 ft) wide on each side of the stream, depending on the water body (USDA and USDI 1994b, pp. C-30–C-31). Timber harvest is restricted in riparian reserves to vegetation management activities that are consistent with Aquatic Conservation Strategy objectives (USDA and USDI 1994b, pp. C-30–C-31). Although timber harvest is not programmed in Late Successional Reserves, vegetation management activities such as thinning and understory removal of vegetation may occur in this allocation to develop late-successional forests or to reduce the risk of large-scale stand-replacement disturbances; treatments must meet the objectives of conserving and developing late-successional conditions.

The annual volume of timber offered for sale in the NWFP area has been greatly reduced since 1990, in part due to implementation of the NWFP. The annual probable sales quantity (PSQ or targeted timber volume) under the NWFP is just over 800 million board feet, only 18 percent of the volume annually offered in the 1980s by Federal agencies in the NWFP area (Grinspoon and Phillips 2011, pp. 3 and 5). The actual effect on the ground is even less because actual harvested timber sales from inception of the NWFP through 2008 have averaged 469 million board feet per year, or 58 percent of PSQ (Grinspoon 2012, pers. comm.). Thus, the threat of habitat loss from forest management activities on Federal lands within the NWFP area has been substantially reduced.

Fisher habitat was modeled throughout the analysis area and was categorized as low, intermediate, or high quality. High quality fisher habitat comprises 38 percent of the NWFP area, and intermediate habitat is 20 percent of the NWFP area. In both Congressionally

Reserved and Late-Successional Reserves combined there are 2,142,264 ha (5,291,392 ac) of high quality habitat and 1,031,086 ha (2,546,782 ac) of intermediate quality habitat (22 percent high quality and 11 percent intermediate) within these reserve areas. This is a slight underestimate of the amount of habitat that may be reserved because it does not account for approximately 1.0 million ha (2.6 million ac) of riparian reserves within the Matrix allocation that may contribute to overall fisher habitat quality in the Matrix. Thus, approximately 58 percent of the NWFP area comprises high to intermediate quality fisher habitat, and of that, 33 percent is in a reserve land allocation that promotes retention and recruitment of forest structures and habitat important for fishers.

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It was expected that implementation of the NWFP would reduce the rate of loss of older forests on federally managed lands and, over time, would result in an increase in older forests as younger forests in reserved land use allocations developed into older forests. A continued loss of existing older forests of about 5 percent per decade from timber harvest and wildfire was anticipated, but ingrowth of older forests was expected to eventually exceed these losses, with older forests returning to historical levels within 50 to 100 years (Davis *et al.* 2015, p. 6). Monitoring results of late-successional and old-growth over the last 20 years within the NWFP area are consistent with these predictions, with losses of older forests being less than projected overall, and recruitment exceeding loss overall (Davis *et al.* 2015, p. 49).

How NWFP implementation will affect fisher habitat is a complex evaluation. For example, Zielinski *et al.* (2006, pp. 409–430) concluded that the current NWFP reserve network, "may lack the connectivity necessary for wide-ranging and non-volant mammals, such as the fisher", and "we should not assume that fisher viability in northern California is insured by protections for the spotted owl included in the Northwest Forest Plan (Zielinski *et al.* 2006, pp. 426–427). However, one reason for this conclusion may be that the modeled fisher habitat used by the authors showed that much of the best fisher habitat was on non-federal lands, "probably because of regional gradients in geoclimatic factors and vegetation type rather than seral stage, because private lands have much less old forest compared to federal lands" (Zielinski *et al.* 2006, p. 426), indicating that federal lands may not play the same role for fishers that they may for other species. Subsequent to Zielinski *et al.* (2006), updated fisher habitat models have been produced (refer to Habitat Associations, Habitat Models section of this document) that could be evaluated in a similar manner, to confirm or refute the conclusions reached by the FEMAT process and the conclusions reached in Zielinksi *et al.* (2006).

The BLM is revising their RMPs for units within the NWFP area. A draft RMP/EIS was published in April 2015 (BLM 2015, entire), and a Record of Decision is tentatively scheduled for the summer of 2016. Once signed, this revision would replace the NWFP for BLM-administered lands in western Oregon, totaling approximately 2.5 million ac (1.0 million ha). Although a decision has yet to be made, BLM's preferred alternative (Alternative B), as stated in their EIS (BLM 2015, p. 76), would allocate a slightly less amount of their landscape to timber harvest management as compared to the NWFP (22 percent and 28 percent, respectively). Just over half of the harvest land base in BLM's preferred alternative is in a sub-allocation that require restrictions beyond what is currently allowed in the NWFP Matrix allocation, such as limiting treatments to thinning, prescribed fire, single-tree selection harvest, and group selection harvest, or requiring basal area retention of 15-30 percent of pre-harvest conditions (BLM 2015, pp. 35, 47). The remaining harvest land allocations require tree retentions similar in basal area to what is currently required in the NWFP. Similar to the NWFP, the BLM has a Late-Successional Reserve allocation that has objectives similar to existing Late-Successional Reserves in the NWFP; acreages and locations of the large blocks of Late-Successional Reserves are similar to the NWFP. The BLM preferred alternative, however, shows a larger amount of Late-Successional Reserve acreage than what is designated under the NWFP; part of that is due to removing Riparian Reserves that were counted as Late-Successional Reserve, but another reason is that BLM is adding all stands identified as structurally complex forest, creating scattered patches of older-forest reserves across BLM ownership (BLM 2015, pp. 32–33, 50). The greatest difference in management would be a reduction in Riparian Reserves from 38 percent of the BLM NWFP area to 15 percent of the area in BLM's preferred alternative. In its analysis of fishers, the BLM determined that current management under the NWFP would lead to continual loss of fisher habitat over the next 50 years, whereas all action alternatives in the RMP would result in a slight loss of fisher habitat in the first two decades, but that additional habitat would develop in subsequent decades, eventually surpassing current conditions (BLM 2015, p. 701). However, because BLM's decision is not final, our analysis in this document is limited to their existing management under the NWFP.

Non-NWFP

Additional management incorporated by the USFS and BLM within the analysis area focuses on additional riparian and old-forest structure protections outside of the NWFP area. Under the PACFISH strategy (USDA and USDI 1995, entire), National Forests and BLM units with anadromous fish watersheds to provide riparian habitat conservation area buffers ranging from 50 to 300 ft (15 to 91 m) on either side of a stream, depending on the stream type and size. With limited exceptions, timber harvesting is generally not permitted in riparian habitat conservation areas (USDA and USDI 1995, Appendix C). Within the analysis area in eastern Oregon and eastern Washington, riparian protections similar to PACFISH were incorporated for non-anadromous fish species (INFISH) on National Forests outside of the NWFP and PACFISH strategies (USFS 1995a, pp. I-4, A-5, A-7). The INFISH strategy does not apply to BLM lands. Finally, National Forests in Oregon and Washington that are outside of the NWFP also must provide additional protection of late and old-forest structure (USFS 1995b, entire; USFS 1995c, entire; USFS 1995d, entire). Commonly referred to as "eastside screens," this interim direction proclaims no net loss of late and old-structure habitat in areas with levels below historic range of variability (USFS 1995d, pp. 9–13). Very little of the area under any of these strategies occurs within the analysis area, and even fewer acres occur in areas occupied by fishers. However, the additional protection guidelines may provide refugia and connectivity among more substantive blocks of fisher habitat.

USFS lands outside of the NWFP area and within California (southern Cascades and Sierra Nevada) operate under LRMPs that have been amended by the Sierra Nevada Forest Plan Amendment (SNFPA), which was finalized in 2004 (USFS 2000, volume 3, chapter 3, part 4.4.1, pp 2-18; USFS2001, entire; USFS 2004, entire). Only two forest LRMPs (Sequoia and Sierra National Forests) within the SNFPA provide any additional protections to fishers or fisher habitat. The SNFPA includes measures that are expected to lead to an increase over time of late-successional forest, retention of important wildlife structures such as large diameter snags and coarse downed wood, and management of about 40 percent of the plan area as old forest emphasis areas.

The SNFPA also established a 602,100 ha (1,487,800 ac) Southern Sierra Fisher Conservation Area (SSFCA) with additional requirements intended to maintain and expand the fisher population of the southern Sierra Nevada. Conservation measures for the SSFCA include maintaining a minimum of 50 percent of each watershed in mid-to-late successional forest (28 cm [11 in] dbh and greater) with forest canopy closure of 60 percent or more. The plan also includes seasonal protections for fisher natal and maternal den sites that are located. However, authorized and pre-existing activities in the fisher conservation area include recreation residence tracts, organizational camps, lodges and resorts, prescribed fire, managed wildfire, mechanical treatments for fuels reduction, administrative facilities, utility corridors, firewood cutting, and special forest product production. In addition, all of the fisher conservation area overlaps the Wildland Urban Interface and the Tribal Fuels Emphasis Treatment Area. Fuels treatment in these land classifications allows for removal of small trees up to 7.7 m (25 ft) in height and reducing crown cover to an unspecified amount over 85 percent of the treatment area. In short, while the SSFCA is intended to maintain and expand fisher populations, and may protect the few individual fisher den sites that are located by researchers, the authorized activities mentioned earlier in this paragraph, along with the fuels reduction program, have the potential to greatly limit the positive effect of the conservation area on fisher populations.

Giant Sequoia National Monument is managed by the USFS Sequoia National Forest. The monument was created by presidential proclamation in 2000 and is 142,900 ha (353,000 ac), of which 126,100 ha (311,500 ac) are included in the Southern Sierra Fisher Conservation Area discussed above. Although monument status removed the area from consideration for commercial timber harvest projections, USFS plans to address habitat management from a fuel hazards standpoint have been continually challenged by lawsuits and appeals from the public since the monument's establishment. After 13 years, a monument management plan has still not been approved and consequently, monument management direction and its effects on fishers are unclear.

The USFS is in the process of developing a Southern Sierra Nevada Fisher Conservation Assessment and Strategy which when completed could provide a basis for management of this population. A fisher Analysis Suitability Tool has been used in the southern Sierra Nevada since 2010 to analyze project level direct, indirect, and cumulative effects. In addition, Sierra National Forest has developed leave tree marking guidelines and training for their timber marking crews on how to select the best number, quality, and location of trees for retention for fisher use. When fully implemented these plans and tools could form the basis for management of fishers in the Southern Sierra Nevada.

BLM manages very little fisher habitat in the Sierra Nevada. The Bakersfield Field Office of the Central California BLM District manages Case Mountain (18,500 ac, 7,500 ha), a Giant Sequoia grove, which provides habitat for the species. The Bakersfield Field Office has recently produced a proposed RMP which would designate the 33,600 ac (13,600 ha) Kaweah Area (including Case Mountain) as an Area of Critical Environmental Concern (ACEC) and would manage the area to support the fisher population. The proposed RMP provides no details on specific management actions that would support fishers. Only the Case Mountain portion of this new ACEC contains habitat for fishers. The final RMP is not yet in place.

In summary, management of BLM and USFS lands within the analysis area focuses on habitat management and, with the exception of seasonal protections for fisher den sites in the Southern Sierra Fisher Conservation Area, does not provide species-specific guidelines for managing fishers. The threat of habitat loss through timber harvest within the NWFP area has been substantially reduced with the implementation of the NWFP. Almost 60 percent of the NWFP area comprises either intermediate or high quality habitat, with over half of that habitat in reserve allocations that may benefit fisher through the retention and development of blocks of late-successional habitat. The current location and connectivity of the reserve network has been highlighted as a concern for fishers in the northern California portion of the analysis area (Zielinski *et al.* 2006, pp. 426–427), although riparian reserves and other habitat patches within the Matrix may facilitate connectivity.

National Park Service

Statutory direction for the 1.6 million ha (4 million ac) of National Park Service lands in the analysis area is provided by provisions of the National Park Service Organic Act of 1916, as amended (16 U.S.C. §§ 1 *et seq.*) and the National Park Service General Authorities Act of 1970 (16 U.S.C. §§ 1a-1). The purpose of national parks, monuments, and reservations is to, "conserve the scenery and the natural and historic objects and the wild life [*sic*] therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 U.S.C. §§ 1 *et seq.*). More specifically, natural resources are managed to, "preserve fundamental physical and biological processes, as well as individual species, features, and plant and animal communities" (NPS 2006, p. 36). Land management plans for the National Parks within the west coast analysis area do not contain specific measures to protect fishers, but areas not developed specifically for recreation and camping are managed toward natural processes and species composition and are expected to maintain fisher habitat. Prescribed fire is often used as a habitat management tool by the Park Service. The effects of these burns on fishers are not known, but if key fisher habitat elements can be retained, fuels reduction through prescribed fire may benefit fishers in the long term by reducing the threat of fisher habitat loss (Truex and Zielinski 2013, p. 90; Zielinski 2013, pp. 19–20). Hunting and trapping are generally prohibited in National Parks (for example, 16 U.S.C. §§ - 60, 98, 127, 204c, 256b). Park Service policy allows these activities on Park Service lands if the actions do not unacceptably impact park resources or natural processes (NPS 2006, pp. 46–47), but they are not currently allowed on National Parks within the analysis area (Graber 2013, pers. comm.).

National Parks within the analysis area include Olympic, North Cascades, and Mount Rainier in Washington, Crater Lake in Oregon, and Redwood, Lassen Volcanic, Yosemite, and Sequoia-Kings Canyon in California. In addition, the National Park Service manages other lands in the analysis area outside of national parks (for example, Oregon Caves and Lava Beds National Monuments). Fisher habitat occurs within National Parks and Monuments in the analysis area, but not all of the area is suitable habitat. Fishers have not been found north of the Merced River in the northern 60 percent of Yosemite National Park. In addition, higher elevation areas comprise much of National Park lands in the analysis area; these areas are typically classified as alpine and above elevations expected to contain suitable fisher habitat.

Department of Defense

The Department of Defense manages forested lands in Washington State within the potential range of the fisher. Specifically, Joint-Base Lewis-McChord (JBLM) has approximately 21,900 ha (54,000 ac) of forest that are managed with the base's Integrated Natural Resources Management Plan and Endangered Species Management Plans (Department of the Army 2006, entire). The plan maintains forested cover for other species in some cases, but no specific protections for fisher are given. Forested lands on JBLM are not well connected to other forested lands in the range of the fisher, and are not likely to contribute to fisher populations in the future because of their limited size and extensive fragmentation.

Federal Regulatory Summary

The fisher is a sensitive species on all BLM and USFS units in the analysis area. Protections afforded the fisher as a sensitive species largely depend on individual RMPs or LRMPs and on site-specific project analyses and implementation. Though the NFMA and FLPMA give the USFS and BLM authority to address the needs of fishers, few units have developed fisher-specific guidelines leaving any fisher-explicit management to occur on a project-by-project basis. Although a Southern Sierra Fisher Conservation Area was established to provide for fishers, a large portion overlaps with Wildland Urban Interface and Tribal Fuels Emphasis Area; while this could result in removal of key fisher habitat components, it may with careful implementation benefit fisher habitat in the long-term. The BLM is proposing to designate an ACEC in the southern Sierras that would be managed to support fishers, but neither the designation nor the proposed management standards are final. The threat of habitat loss through timber harvest within the NWFP area has been substantially reduced. Thus, much of USFS and BLM lands are managed within reserved land allocations to provide habitat that may be conducive to fishers, as well as develop more habitat within reserve land allocations. Even if proposed revisions to BLM RMPs within the NWFP area go into effect, BLM's analysis indicates fisher habitat trends would overall improve from the NWFP. However, fisher specific guidelines are lacking in most of the area and the limited application of an integrated, rangewide conservation strategy limits the opportunities to implement range-wide integration of habitat and population conservation and recovery goals that may benefit fisher.

Lands managed by the National Park Service are expected to maintain fisher habitat given the agency mission and management direction. Most units within the analysis area have substantial areas of higher elevations. High elevation areas have traditionally been considered low-quality or non-habitat for fisher. However, fishers may occasionally use unmanaged subalpine forests, as indicated by data from Olympic Peninsula Reintroduced Population (Lewis 2013a, pers. comm.).

Management of forested areas on Department of Defense lands (Joint Base Lewis-McChord) neither contributes to, nor detracts from, the adequacy of existing regulatory mechanisms for fishers because of the limited size and high degree of forest fragmentation.

Tribal Governments

A variety of tribal governments exist within the range of the fisher, many of which own forest lands or have rights for management of lands not currently under tribal ownership (for example, the Klamath Tribes). Below we present greater detail for those tribes that either explicitly manage for fisher, or manage substantial areas of potential fisher habitat.

Tribes within Washington

The largest forested reservations in proximity to fisher habitat are the Quinault, Makah, and Yakama Reservations. Other tribal lands within the potential range of the fisher are either not forested or are too small to substantially contribute to current or future fisher populations. Forest management plans on the Quinault, Makah, and Yakama Reservations could provide some protection for fisher habitat, although only the Makah protect fisher specifically. Trapping for fisher and body-grip trapping for all furbearers are still allowed on the Quinault, Makah, and Yakama Reservations because state trapping laws [Revised Code of Washington (RCW) RCW 77.15.194; 2003 c 53 § 374; 2001 c 1 § 3 (Initiative Measure No. 713, approved November 7, 2000)] do not apply. However, the Quinault Reservation does not often receive requests for trapping permits (Ravenel 2013, pers. comm.) and trapping restrictions for fisher on the Makah Reservation are currently in development (McCoy 2013, pers. comm.).

Approximately 7,000 ha (173,000 ac) of forested land are under tribal and Bureau of Indian Affairs (BIA) timber management on the Quinault Reservation. The Quinault Forest Management Plan is similar to Washington Forest Practices Rules (WAC 222, as amended) in that forested conditions are maintained along riparian zones and wetlands in some cases, but all other trees are subject to harvest on a ~50-year rotation. Riparian harvest buffers are generally smaller than those under the State's Forest Practices Rules. Logging salvage of cedar stumps and logs on the reservation has significantly reduced forest decadence in Quinault forests, and it is likely that denning opportunities for fisher have been lost (Harke 2013, pers. comm.). The Quinault Reservation has one designated reserve for late succession forest, the 4,000-ac (1,600-ha) North Boundary Conservation Easement.

The Makah Reservation contains 30,100 ac (12,200 ha) of land, 83 percent of which is forested and administered by the Makah Forest Management Plan. Lands managed for timber have similar prescriptions to Washington State Forest Practices Rules found in the Washington Administrative Code (WAC) (WAC 222, as amended) in that riparian buffers provide the primary means for growing and conserving late succession features. The Makah Forest Management Plan also states that "habitat components" will be retained within harvest units, but this requirement is nearly identical to Washington Forest Practices Rules (WAC 222, as amended) in that a small number of trees and logs must be left and those trees and logs can be counted from riparian reserves. However, the Makah have larger riparian buffers than the Forest Practices Rules. In addition to forests managed for timber, the Makah Reservation has 3,600 ac (1,500 ha) of forests that are being conserved as wilderness, mature forest, and cultural areas. These conserved lands, however, are highly fragmented on the landscape. Fisher are protected under the Makah Forest Management Plan as a sensitive species, meaning that detected fishers would receive no-harvest buffers and seasonal restrictions for their "specific habitat requirements and site specific conditions" (Makah Nation and USDI 1999, p. A-4). A radio-collared male fisher from the Olympic reintroduction dispersed to the Makah Reservation and set up a home range, but the fate of that individual, and whether he reproduced with an un-collared female, is unknown.

The Yakama Reservation contains 650,000 ac (263,100ha) of forest that are managed under the Yakama Forest Management Plan (Yakama Nation and USDI 2005, p. 13). These forested areas are within the analysis area for west-coast fisher, although much of the Yakama Nation is non-forest and outside of the analysis area. The reservation currently has 14,500 ac (5,900 ha) of old-growth forest that will remain old-growth forest under the Yakama Forest Management Plan. Much more forest on the reservation would be considered mature forest, though not all of this mature forest is managed solely to be mature forest (for example, some of that mature forest may be harvested). Several categories of land (including the old-growth) totaling tens of thousands of acres are managed for values other than timber production (Yakama Nation and USDI 2005, p. 27). Lands managed for timber production on the Yakama Reservation receive silvicultural prescriptions with a much more generous leave tree and canopy retention strategy than state and private lands in Washington (Yakama Nation and USDI 2005, pp. 49–50). The total quantity of old-growth forest, unmanaged forest, and forest managed for mature forest attributes on the

Yakama Reservation is large and highly likely to provide for the habitat needs of fisher if fisher colonize the reservation in the future. In the 2000s, the Yakima Nation used trap camera and track plates to search for fishers on the reservation, but none were found.

Tribes Within Oregon

None of the tribes in Oregon specifically manage for fisher or fisher habitat on their lands, and most of the reservations and other tribal lands in Oregon are outside of the range of the fisher.

The Warm Springs Indian Reservation is the largest block of Indian land in Oregon, at approximately 263,100 ha (650,000 ac), primarily in Jefferson and Wasco Counties. Forest lands on the reservation comprise 178,100 ha (440,000 ac), with approximately 110,500 ha (273,000 ac) available for commercial timber harvest (Warm Springs 2013, pp. 9–10). Trapping is allowed under tribal regulations, which do not mirror State regulations. However, there are only 2 to 3 known trappers that primarily trap for bears, coyotes, and bobcats (Calvin 2013, pers. comm.). The reservation is outside the known current fisher populations.

The Confederated Tribes of Siletz Indians manage approximately 5,900 ha (14,500 ac) of tribal forest in Lincoln and Douglas Counties (Confederated Tribes of Siletz Indians 1999, pp. 1-3, 2-6, 2-7; Confederated Tribes of Siletz Indians 2010, p. 1-1; Kennedy 2013a, pers. comm.). Most of this land is managed for commercial timber harvest, but almost 1,700 ha (4,300 ac) were recently acquired as compensation for injuries to marbled murrelets as a result of a 1999 oil spill from the freighter vessel M/V New Carissa. The Tribes have entered into a conservation easement wherein the property will be managed as habitat for the marbled murrelet, with habitat protections to be sustained even if the marbled murrelet no longer is afforded protection under the Endangered Species Act. Existing habitat will be protected, while remaining property will be managed to move even-aged stands towards more diverse structure, providing for other late-successional forest species including the fisher (Confederated Tribes of Siletz Indians 2010, pp. 1-1, 1-2, 3-1, 4-1, 4-2). Maintaining this area as murrelet habitat may also be beneficial for fisher habitat because many of the forest structures and stand conditions found in murrelet habitat can benefit fishers by providing rest and dent sites, although fishers do not currently occur in the area. Though not known to occur, trapping is allowed on Siletz lands by tribal members and follows Oregon State trapping regulations (Kennedy 2013b, pers. comm.).

The former Klamath Indian Reservation is currently part of the Fremont-Winema National Forest. The Klamath Tribes and the USFS have signed a memorandum of agreement (MOA) describing the process for government-to-government relations regarding management of the former reservation (Klamath Tribes and USFS 2005, entire). In the MOA, the USFS agrees to incorporate the Tribes and Tribal policy and guidelines into their development of plans and natural resource activities. Management activities proposed by the Klamath Tribes on the Fremont-Winema National Forest are generally consistent with the NWFP, and follow a tribal plan to restore forests to a structurally complex ponderosa pine and mixed-conifer dominated forest (Johnson *et al.* 2008, p. 2). Fishers have been observed on former reservation lands. Fishers are not explicitly managed for under the NWFP or by the Klamath Tribes, although restoration of structurally complex forests per the tribe's forest plan (Johnson *et al.* 2008, entire) could be beneficial to fishers.

The Confederated Tribes of Grand Ronde manage approximately 10,000 ac (4,050 ha) of tribal forest in Yamhill County, Oregon, outside the known current fisher populations. The tribal forest is managed for commercial timber harvest (Confederated Tribes of the Grand Ronde 2012, pp. 3, 6–7). The forest is open to the public for hunting and fishing, but the tribe neither explicitly allows nor prohibits trapping; they currently have no trapping regulations and do not block access for trapping. Any trapping that does occur would have to abide by State Regulations (Belonga 2013, pers. comm.).

The Coquille Indian Tribe manages the 5,400 ac (2,200 ha) of Coquille Forest located in Coos County, just north of the existing fisher population in NW California/SW Oregon. This land was formerly managed by the BLM, Coos Bay District, and is to be managed according to the standards and guidelines of the district's final resource management plan, as amended by the NWFP (Coquille Indian Tribe 1998, pp. 10–12). Although the Coquille Forest is managed in accordance with the NWFP, the land allocations on the forest are Matrix overlain by Riparian Reserves (Coquille Indian Tribe 1998, p. 17). Consequently, the only habitat components provided for fishers are structural features provided by green tree, snag, and down wood retention requirements within the Matrix, and protection provisions of the Riparian Reserves. In addition to the Coquille Forest, the tribe manages another 1,000 of tribal trust lands on which operational forestry occurs (Robison 2013, pers. comm.). While canopy cover suitable for fisher occupancy would likely not be maintained under the tribe's management, residual levels of resting structures and small patches of late-successional forest retention may facilitate fisher movements across the landscape between surrounding Federal lands. Trapping on the Coquille tribal forest is managed by the State (James 2013, pers. comm.; Robison 2013, pers. comm.).

Tribes Within California

In California, the Hoopa Valley Indian Reservation forest management plan (Hoopa Valley Tribe 2012, entire) addresses the 89,000 ac (36,000 ha) reservation where fishers are known to be present, and contains about 75,000 ac (30,400 ha) of commercial timberland. The forest management plan also recognizes fisher as a traditional and culturally important species and designates fishers as a species of special concern. The Hoopa Valley Tribal Forestry Department is committed to ecological research and monitoring of fishers on the reservation and continues to be one of the leaders conducting ecological studies of fisher in the State of California. Their forest management plan contains some protective measures such as setting aside three to seven habitat reserves (each 50 ac (20 ha) or less in size) to provide benefits for pileated woodpeckers (*Dryocopus pileatus*), mink (*Neovison vison*), and other species such as fishers, which use similar habitat components. Intensive timber harvest will not occur within the reserves. The plan also establishes 32 no-harvest reserves for a total of at least 777 ha (1,920 ac) for late-seral, cultural, sensitive, and federally listed species.

The Yurok Indian Reservation along the Klamath River in northwestern California, is 21,900 ha (54,200 ac) in extent and contains habitat for the fisher. Fishers are considered a culturally significant species to the Yurok Tribe. The Yurok Tribe has a timber harvest program on the reservation. It has a wildlife management program in development, but no specific guidelines for protection or management of the fisher.

The Tule River Indian Reservation located in Tulare County is 20,400 ha (55,400 ac). The reservation is within the range of the fisher and there are recent records for the species within the area. The Tribe has collaborated with the U.S. USFS Pacific Southwest Research Station to confirm these occurrences and participate in fisher research efforts (Peyron 2013, pers. comm.). The reservation has a forestry management program which harvests timber below the maximum sustainable yield with no annual timber harvest targets and balances timber production with watershed and cultural values (Baker and Stewart 1996, p. 1358). Protection of the watershed is the primary forest management goal and reducing the threat of catastrophic wildfire is a high priority. Timber harvest is used as part of these fuel reduction efforts and to minimize large-scale insect outbreaks. The Tribe uses an all-aged, mixed species forest management approach (Peyron 2013, pers. comm.). The reservation does not have a management plan for fisher, but desirable elements for fisher habitat are incorporated into silvicultural prescriptions for fuels reduction, forest improvement, and timber harvesting projects (Peyron 2013, pers. comm.). Trapping is not known to occur on these Tribal lands (Peyron 2013, pers. comm.). While the reduced risk of catastrophic fire may serve to maintain the area in forest cover, without information regarding specific habitat retention practices, the effects of forest management on fishers in the Tule River Tribal forest is unknown.

There are 24 additional Indian reservations and rancherias in the North Coast Range and the Southern Sierra Nevada. All of these reservations and rancherias are small (most less than 81 ha [200 ac] in extent) and nearly all are located in the foothills below the elevation of suitable fisher habitat. Nearly all are in sparse oak woodland or shrub habitat or have been cleared for homes and vegetable gardens with only a scattering of single trees.

Tribal Governments Summary

Several tribes in the analysis area recognize fishers as a culturally significant species, but only a few tribes (for example, Hoopa and Makah) have fisher-specific guidelines in their forest management plans. Some tribes, while not managing their lands for fishers explicitly, manage for forest conditions conducive to fisher (for example, marbled murrelet habitat, old-forest structure restoration). Many of these areas are outside the current range of fisher in the analysis area and may not directly benefit existing populations. Still many more tribal lands are managed for commercial timber production. While most plans call for retention of some components of fisher habitat (for example, snags, logs, large trees), information regarding the size and abundance of these retained elements is lacking or indicates that these components tend to be smaller and fewer than what is typically found in fisher habitat.

Trapping is typically allowed on most reservations and tribal lands, and is frequently restricted to tribal members. Whereas a few tribal governments trap under existing State trapping laws, most have enacted trapping laws under their respective tribal codes. However, trapping is not known to be a common occurrence on any of the tribal lands.

State Regulations

Washington State Regulatory Mechanisms

In October 1998, the State of Washington listed the fisher as Endangered (WAC 232-12-014, Statutory Authority: RCV 77.12.020 WSR 98-23-013 (Order 98-232), §232-12-014, filed 11/6/98, effective 12/7/98). This designation imposes stringent fines for poaching and establishes a process for environmental analysis of projects that may affect the fisher. However, there are no specific regulations to protect habitat for fishers or to conduct surveys for this species prior to obtaining forest activity permits.

In 2006, the WDFW published a recovery plan for the fisher (Hayes and Lewis 2006, entire). This fisher recovery strategy, although it does not commit funds or resources or legally regulate any actions, is a planning mechanism that can help define and prioritize conservation actions for fishers within Washington State. For instance, fishers were introduced to the Olympic Peninsula as part of the Washington State recovery plan, and the State and other partners are is currently in the process of monitoring that population. As of December 2015, the State began implementing another reintroduction in the southern Washington Cascades and, upon its completion, is planning a third re-introduction in the North Cascades.

Trapping of fishers has been prohibited in Washington since 1934. However, fishers across their range are frequently caught in traps set for other species (Lewis and Zielinski 1996, p. 291; Weir 2003, p. 24), and those captures often lead to injury or mortality (Strickland and Douglas 1984, p. 3; Lewis and Zielinski 1996, p. 293). In 2000, Washington banned the use of body-grip traps to capture furbearers, prohibited the sale of furbearer pelts that were obtained by body-gripping traps, and directed that a permit system be used to capture only live animals involved in nuisance or danger activity on private land [RCW 77.15.194; 2003 c 53 § 374; 2001 c 1 § 3 (Initiative Measure No. 713, approved November 7, 2000)]. These restrictions do not apply to members of treaty tribes in Washington. The trapping laws in Washington are likely to reduce the effects of intentional and incidental capture of re-introduced fishers and dispersing fisher from other states and Canada in the future.

The Washington Department of Natural Resources (WDNR) manages 0.9 million ha (2.3 million ac) of State lands within the analysis area in Washington. WDFW manages 760 ha (1,800 ac) of State lands across 5 wildlife area units. State lands occupy a substantial portion of the fisher's historical range in Washington, consisting of roughly 647,500 ha (1.6 million ac) of forest within the range of the spotted owl (primarily lands west of the crest of the Cascade Range). Much of this forest within the range of spotted owls is also considered to be within the historical range of fishers, and because these lands generally occur at lower elevations than National Forest lands, a higher proportion is within the elevation range preferred by fishers (Aubry and Houston 1992, p. 74–75; WDNR 1997, p. 12). State lands have the potential to provide an important contribution to the conservation of fishers, however, over half of all WDNR forests are less than 60 years in age, and less than 150,000 ac (60,700 ha, about 9 percent) are over 150 years in age, indicating that most old growth on Washington State lands has been lost (WDNR 1997, p. I-2).

Fisher is a covered species in the WDNR State Trust Lands HCP (WDNR 1997, pp. IV-143, IV-168–IV-169), which means that the plan analyzed the proposed conservation and mitigation strategies relative to their benefits to fishers. The HCP concluded that "the combination of the riparian, spotted owl, and marbled murrelet conservation strategies is expected to provide forest conditions suitable for fisher breeding, foraging, and resting habitat" (WDNR 1997, p. IV-168). In rare instances where a fisher den site might be located without the aid of telemetry, the HCP prohibits most activities within 0.8 km (0.5 mi) of known active fisher den sites located in spotted owl nesting/roosting/foraging management areas between February 1 and July 31 (WDNR 1997, p. IV-169). Spotted owl nesting/roosting/foraging management areas in this HCP total 81,700 ha (202,000 ac) and are primarily located around Late-Successional Reserves in the Cascades (WDNR 1997, p. IV-4).

Within the analysis area, Washington State Parks comprise 180,000 ha (444,000 ac). Several State Parks contain remnant stands of mature and late- successional forest and may have suitable habitat for fishers. Like elsewhere, these parks are widely scattered and isolated by large areas of industrial forest land or urban and rural development that is unsuitable for fishers. A few state parks and forests, such as Mount Pilchuck State Forest, and Rockport, Ollalie, Hamilton Mountain, Beacon Rock, Twin Falls, and Wallace Falls State Parks have limited habitat which may provide some foraging opportunities for dispersing fishers and extend the habitat on Federal lands in the Cascades.

About 2.8 million ha (7 million ac) of private forest lands exist within the historical range of the fisher in the Olympic Peninsula and Cascades in Washington and about 2 percent (approximately 61,600 ha [152,300 ac]) was assumed to be suitable habitat for fishers (Lewis and Hayes 2004, p. 34), though more recent data may indicate that that there is more fisher habitat on the Olympic Peninsula than originally predicted (Lewis 2013b, pers. comm.). The primary regulatory mechanism on private forest lands in western Washington is the Washington State Forest Practices Rules, Title 222 of the Washington Administrative Code. These rules apply to all commercial timber growing, harvesting, or processing activities on private lands, and they give direction on how to implement the Forest Practice Act (RCW 76.09) and Stewardship of Non-Industrial Forests and Woodlands (RCW 76.13). The rules are administered by the WDNR, and related habitat assessments and surveys are coordinated with the WDFW.

The Washington State Forest Practices Rules do not specifically address fishers and their habitat requirements; however, some habitat components important to fishers, like snags, down wood, and canopy cover, are likely to be retained in riparian management zones as a result of the rules. Washington's forest practices rules limit regeneration harvest areas to 50 ha (120 ac) in size with exceptions given up to 100 ha (240 ac). In all cutting units, three wildlife reserve trees (over 30 cm [12 in.] dbh), two green recruitment trees (over 25 cm [10 in.] diameter, 9 m [30 ft] in height, and 1/3 of height in live crown) and two logs (small end diameter over 30 cm [12 in.], over 6 m [20 ft] in length) must be retained per acre (0.4 ha) of harvest. Wildlife reserve trees and green recruitment trees would continue to grow during the next stand rotation, but may be removed during subsequent harvests when other trees that meet the minimum standards are retained instead. Wildlife reserve trees and green recruitment trees may be counted from those left in the "riparian management zones," which range in size from 25 to 62 m (80 to 200 ft) for fish-bearing streams, depending on the size of the stream, the class of site characteristics, and whether the harvest activity is east or west of the Cascade crest (WAC 222-30, as amended). Riparian management zones for non- fish-bearing streams are 15 m (50 ft), applied to specified areas along the streams. Riparian buffers may provide some habitat for fishers, primarily along perennial fish-bearing streams where the riparian buffer requirements are widest. Some management may occur within riparian buffers as long as certain pre- and post-management conditions are met (WAC 222-30-21,22, as amended), and over time these areas are anticipated to develop old-growth characteristics. In upland habitats, it is very unlikely that these rules will result in residual habitats that support fisher resting sites (Aubry *et al.* 2013, p. 974) or den sites (Weir and Corbould, 2008, p. 147; Weir *et al.* 2012, p. 230) unless the chosen leave trees are significantly larger than the minimum requirements and forest processes that contribute to decadence and tree cavity formation are retained. In Northern Spotted Owl Special Emphasis Areas, 28 ha (70 ac) of habitat must be protected around all known spotted owl activity centers, which may incidentally protect fisher habitat from harvest as well. Outside of these areas, the 28 ha (70 ac) of habitat may be harvested outside of the spotted owl breeding season, which may also remove potential fisher habitat.

Land conversion from forested to non-forested uses is interrelated to private timber harvest, but is primarily regulated by individual city and county ordinances that are influenced by Washington's Growth Management Act (RCW 36.70a). In some cases, these ordinances result in maintaining forested areas within the range of the fisher, but the Growth Management Act and associated local regulations are not designed to maintain or create the mature forest conditions that fishers require.

In 2012, Washington voters passed Washington State Initiative 502, decriminalizing recreational marijuana. The new law allows the creation of a licensed and regulated system of marijuana production and distribution, similar to the state's liquor controls. It is too soon to assess how the legalization of production and use of recreational marijuana use in Washington will affect the magnitude of illegal marijuana trespass grows on public lands in the west coast range of the fisher.

Washington State Regulatory Summary

Washington State regulatory mechanisms provides protection from targeted and incidental effects to individual fishers (specifically, conservative trapping laws and protections for known denning sites on state land) and the WDFW fisher recovery plan provides a mechanism for directed and prioritized fisher recovery efforts across the state. Washington State-owned lands contribute to the availability of fisher habitat in key locations to support recovery due to reserve areas and their proximity to National Forests and National Parks. However, current regulatory mechanisms on private lands in Washington (principally, Washington Forest Practices Rules) may not protect and provide for enough fisher habitat to support fishers unless those habitats are adjacent to HCP lands, State Lands, or Federal Lands that provide greater habitat protection.

Oregon State Regulatory Mechanisms

In Oregon, the fisher is a protected non-game species [Oregon Administrative Rules (OAR) 635-044-0130], a regulatory designation making it illegal to, "hunt, trap, pursue, kill, take, catch, angle for, or have in possession, either dead or alive, whole or in part," fishers and other protected non-game species. This fisher is also listed as a "Sensitive Species-Critical Category," meaning the species is threatened with extirpation from a specific geographic area due to small population size, habitat loss or degradation, or other immediate threats (ODFW 2008, pp. 2, 13). The Sensitive Species list is not a regulatory mechanism and is not used as a "candidate" list for species to be considered for listing under the Oregon Threatened and Endangered Species rules. Rather, it is used to encourage voluntary actions that will improve the species status and prevent species from declining to the point of qualifying for listing (ODFW 2008, p. 1).

The fisher is also listed as a species of conservation concern in the Oregon Conservation Strategy (ODFW 2006, p. 320), which is Oregon's State Wildlife Action Plan. The Strategy is a non-regulatory adaptive and comprehensive framework for positive action and innovation to conserve Oregon's biodiversity and ensure the continuation or restoration of intact habitats. The strategy defines key conservation issues that threaten species and their habitats and offers a menu of recommended voluntary actions to address these problems. One of these issues is loss of connectivity, which has been shown to directly affect the pacific fisher by isolating populations and interfering with potential dispersal (Aubry *et al.* 2004). Based on recommendations in the Conservation Strategy ODFW continues to work with transportation agencies to identify key wildlife crossing points throughout the state's highway and road system. The Strategy identifies the fisher as a strategy species (low and declining or otherwise at-risk) and recommends maintaining late successional forest, improving patch size and connectivity, and potentially initiating a reintroduction program pending the results of a feasibility analysis.

The ODFW does not allow trapping of fishers in Oregon (ODFW 2012, p. 4), though fishers can be injured and/or killed by traps set for other species. Body-gripping traps are allowed in Oregon, reducing the chance of removing an incidentally caught fisher alive or without injury. However, incidental capture in Oregon is rare (5 known since 1975, with 2 resulting in mortality). Training and testing is required of applicants for trapping licenses in order to minimize the potential take of non-target species such as fishers (ODFW 2012, p. 1).

State parks in Oregon comprise 45,000 ha (112,000 ac), many of which may provide forested habitats suitable for fisher. These parks are managed by the Oregon Parks and Recreation Department, with a mission to "provide and protect outstanding natural, scenic, cultural, historic, and recreational sites for the enjoyment and education of present and future generations." (OPRD

2014, p.1). Fisher habitat modeling indicates that 7 percent of State Park land in the analysis area is high quality habitat, and 27 percent is of intermediate quality. Most of the state parks are scattered small (several hundred acres) parcels that provide mainly recreational opportunities such as camping and picnicking, with little benefit to fishers. Some of the larger parks (for example, Silver Falls at 3,600 ha [9,000 ac]) may provide areas of intact forest habitat that may provide suitable fisher habitat now or in the future.

The Oregon Forest Practice Administrative Rules (OAR chapter 629, division 600, as revised) and Forest Practices Act [Oregon Revised Statutes (ORS) 527.610 to 527.770, 527.990(1) and 527.992) (ODF 2010a, entire)] apply to all non-Federal and non-Tribal lands in Oregon, regulating activities that are part of the commercial growing and harvesting of trees, including timber harvesting, road construction and maintenance, slash treatment, reforestation, and pesticide and fertilizer use. The OAR provides additional guidelines intended for conserving soils, water, fish and wildlife habitat, and specific wildlife species while engaging in tree growing and harvesting activities, but these rules do not directly protect the fisher or its habitat. Application of the rules may, however, retain some structural features (snags, green trees, down wood) that contribute to fisher habitat. For example, in regeneration harvest units that exceed 10 ha (25 ac), operations must retain two snags or two green trees, and two downed logs per acre (0.4 ha). Green trees must be over 28 cm (11 in) dbh and 9 m (30 ft) in height, and down logs must be over 1.8 m (6 ft) long and 0.28 cubic m (10 cubic ft) in volume (ORS 527.676). These residuals, however, are substantially smaller than those typically selected by fishers at resting sites (Aubry *et al.* 2013, Appendix).

Prohibition of timber harvest within a maximum of 6 m (20 ft) of streams may provide some narrow, linear strips of older forests that may contain some structural features of benefit to fishers. Riparian management areas are also required around all fish-bearing streams and large or medium non-fish-bearing streams, with distances ranging from 20 to 100 ft (6 to 30 m) beyond the stream bank, depending on the stream size and status. Within these riparian management areas, from 40 to 300 f^{t2} (4 to 28 m^2) of basal area must be retained for every 1,000 ft (305 m) of stream length, with retention levels depending on stream size, fish presence, and type of harvest; trees within the no-harvest 20 ft (6.1 m) buffer count towards these retention requirements (OAR 629-640-0100 through 629-640-0400). The lack of canopy cover in these riparian management areas immediately post-harvest would typically render them unsuitable for fisher habitat, although the basal area retention may provide some structural habitat for fishers as the new stand regenerates.

In addition, retention buffers are required on private lands around northern spotted owl nest sites (70 ac (28 ha) of suitable habitat) (OAR 629-665-0210), bald eagle nest sites (330-ft (100-m) buffer) (OAR 629-665-0220), bald eagle roost sites (300-ft (100-m) buffer) (OAR 629-665-0230), and great blue heron nest sites (300-ft (91-m) buffer) (OAR 629-665-0120). In addition, foraging trees used by bald eagles (OAR 629-665-0240) and osprey nest trees and associated key nest site trees (OAR 629-665-0110) are also protected from timber harvest. In all cases, protections of these sites are lifted when the site is no longer considered active (OAR 629-665-0010). These retention areas might provide some small pockets of mid- to late-successional habitat, and some old-forest structures that are desirable fisher habitat components may occur within these retention patches. However, these are not intended to be retained long-term. Furthermore, these areas, at best, would only provide individual structures and small pockets of habitat in a landscape that is otherwise typically managed for industrial timber harvest with short rotations and limited opportunity to grow into suitable fisher habitat.

There are approximately 821,000 ac (332,300 ha) of State forest lands within the analysis area that are managed by the Oregon Department of Forestry (ODF). These lands include small scattered parcels, but most occur within one of six State forests, the largest being the Tillamook State Forest at 364,000 ac (147,300 ha). Management of State forest lands are guided by forest management plans (ODF 1995, entire; ODF 2010b, entire; ODF 2010c, entire; ODF 2011 entire). The Oregon Department of Forestry has a species of concern policy for managing those species "at risk due to factors such as declining populations, limited range, or low quality or quantity of habitat" (ODF 2010d, p. 9). Only ODF districts in northwest Oregon have identified their sensitive species so far, and the fisher is not on these lists (ODF 2010d, pp. 10–11).

State forests in western Oregon are managed for specific amounts of forest structural stages. The objective is to develop 15 to 25 percent of the landscape into older forest structure (32 in (81 cm) minimum diameter trees, multiple canopy layers, diverse structural features, and diverse understory) and 15 to 25 percent into layered structure (two canopy layers, diverse multi-species shrub layering, and greater than 18 in (46 cm) diameter trees mixed with younger trees) over the long term (ODF undated, pp. 4–7). State forests in northwest Oregon currently have 6 percent of their land base in the layered and older forest structure categories, combined (ODF undated, p. 7). Our fisher habitat model indicates that 36 percent of State Forest land currently provide high quality fisher habitat, while 16 percent is in intermediate habitat. Managing for the structural habitats as described should increase habitat for fishers on state forests.

Management plans for Oregon's State Forests do not provide specific provisions for conserving the fisher or its habitat, although management for other species and resources may provide retention of some fisher habitat elements and patches of fisher habitat. Examples include 1,000 to 6,000 ac-units (400 to 2,400 ha) of "anchor habitats" (for example, ODF 2010d, pp. 4-82–4-83) designed to benefit species associated with older forest and interior habitat conditions in the short term, allowing them to persist and re-colonize new habitat created on the landscape over time (ODF 2010d, pp. 4-82–4-83; Dent 2013, pers. comm.). Spotted owl nest sites are protected by retaining a core area (250 ac (101 ha) on Tillamook and Clatsop State Forests; core areas retained are 70-ac (28-ha) elsewhere and maintenance of 500 ac (202 ha) of suitable habitat within 0.7 mi (1.1 km) of the nest, and 40 percent of habitat within the provincial home range (ranging from 1.2 to 1.5 mi (1.9 to 2.4 km) radius of the nest, depending on what physiographic province the nest is in) (ODF 2013a, pp. 3-4; 2013b, pp. 17-18). Marbled murrelet management areas (MMMAs) are established around marbled murrelet occupied sites (ODF 2013c, pp.3-5); timber harvest related activity and stream restoration within MMMAs are limited to those actions with a low likelihood of take (ODF 2013c, p4). Sizes of MMMAs vary with local conditions and habitat. In the northern Coast Range they total 2,542 ha (6,281 ac), averaging 150 ac (61 ha) in size (Weikel 2011, pers. comm.). In the south-central Coast Range on the Elliott State Forest, 3,385 ac (1,370 ha) of MMMAs are designated, with an additional 10,811 ac (4,375 ha) that overlap designated spotted owl protection areas (Dent 2013, pers. comm.). Many of these retention blocks are not large enough to support a fisher home range, but they may provide habitat patches that allow fisher to move across the landscape. Furthermore, these areas are managed for retention even if the site is not currently occupied, having the potential for longer term persistence on the landscape than the buffers used under the Oregon Forest Practices act.

Retention of green trees and snags within harvest units differs among State forests, ranging from 2 to 4 live trees per acre on the Elliott State Forest to landscape-level targets of 5 trees per acre and 2 snags per acre (Dent 2013, pers. comm.). Riparian buffers include a 25 ft (7.6 m) no-cut area, with varying tree retention requirements out to 100 or 170 ft (30 to 52 m), depending on the stream size, use, and whether or not fish are present (ODF 2010b, pp. J-7–J-10; Dent 2013, pers. comm.) These sites would not meet fisher habitat needs post-harvest due to reduced stand densities and lack of crown continuity (for example, ODF 2010c, pp. C-7–C-10). However, the retained trees would contribute to the development of the older forest and layered structural stages that the state is working to develop and that may provide future fisher habitat.

Land use planning in Oregon is built on a foundation of 19 statewide planning goals, each representing a specific policy and approach to a specific land-use issue. Goal 4 (OAR 660-015-0000(4)) addresses issues related to maintaining the forest land base and the state's forest economy, ensuring, "economically efficient forest practices that assure the continuous growing and harvesting of forest tree species as the leading use on forest land consistent with sound management of soil, air, water, and fish and wildlife resources and to provide recreational opportunities and agriculture" (Walker and Hurley 2011, pp. 32–33). Goal 4 limits activities on forest-zoned lands across the state to only forestry related uses, severely restricting residential or other commercial development of forest lands in the state (Walke and Hurley 2011, p. 33).

In 2014, ballot measure 91 was passed by Oregon voters and allows Oregonians to grow limited amounts of marijuana on their property and to possess personal limited amounts of recreational marijuana for personal use. The measure also gives the Oregon Liquor Control Commission (OLCC) authority to tax, license, and regulate recreational marijuana grown, sold, or processed for commercial purposes. The OLCC recently began issuing commercial recreational marijuana licenses to growers, wholesalers, processors, and retail outlets on January 4, 2016 (OAR 845-025-1000 to 845-025-8590). It is too soon to assess how the legalization of production and use of recreational marijuana use in Oregon will affect the magnitude of illegal marijuana trespass grows on public lands in Oregon.

Oregon State Regulatory Summary

There is no fisher trapping season in Oregon, although incidental injury and mortality is likely to occur while trapping for other species given that body-gripping traps are legal. Fishers are a protected non-game species, making take of the species illegal. Fishers are also listed as a sensitive species in the critical category and as a species of conservation concern, but neither of these designations are regulatory mechanisms; rather, these designations are used to encourage voluntary actions to improve the species status or prevent population declines. Fisher is not a species that is explicitly managed for on State forest lands, or by regulation within the Oregon Forest Practices Act.

Lands regulated by the Oregon Forest Practices Act may provide for some retention of habitat or components that may be used by fisher, but they are not designed to protect fishers and do not provide many fisher dens, rest sites, or landscape conditions that are likely to support fisher reproduction. Furthermore, lands managed as industrial forests, with short timber rotations, precludes forests from developing into fisher habitat.

Management on State lands provides for retention of structural features and habitat blocks on the landscape. Many of these retention blocks are not large enough to support a fisher home range, but they may provide long-term habitat patches that allow fisher to move across the landscape. This may be particularly valuable where State lands lie between large blocks of Federal lands managed as late-seral habitat. Because the State is managing to increase the development of layered and old-forest structural categories to 30-50 percent of their land base, these management goals may benefit fishers in the future as surrounding stands are allowed to develop into a structural condition more suitable to fishers.

California State Regulatory Mechanisms

<u>California Endangered Species Act (CESA)</u>

The status of fishers in California has been the focus of much attention for the past several years and the subject of recent findings by the California Fish and Game Commission as well as the courts (Case No. CGC-10-505205, Superior Court of California, County of San Francisco, 2013, p. 2). On June 10, 2015, the California Department of Fish and Wildlife submitted its status review of the fisher to the Fish and Game Commission, indicating that listing of the fisher in the Southern Sierra Nevada Evolutionarily Significant Unit (ESU) as threatened was warranted, but that fishers in the Northern California ESU were not threatened (CDFW 2015, entire). On August 6, 2015, the California Fish and Game Commission voted to list the southern Sierra Nevada ESU of the fisher as a threatened species under the California Endangered Species Act. Consequently, take, under the CESA definition, is prohibited.

<u>California Trapping Regulations</u>

It is illegal to intentionally trap fishers in California. The State of California classifies the fisher as a furbearing mammal that is protected from commercial harvest, and provides protection to fishers in the form of fines between $300 and $2,000 and up to a year in jail for illegal trapping [California Fish and Game Code §465.5(h)]. It is unknown how effective this regulation is at stopping illegal trapping. In addition, it is unknown how many fishers are captured as non-target species during legal trapping of other species. Between 2000 and 2011, approximately 150 trapping permits have been sold annually in California so the effects of legal trapping to all species combined are probably fairly low (Callas 2013, pers. comm.). Licensed trappers must pass a trapping competence and proficiency test and must report their trapping results annually. Scientists who are trapping fishers for research purposes must obtain a Memorandum of Understanding from the State (California Fish and Game Code, § 650, 1002, 1003).

California Environmental Quality Act (CEQA)

The California Environmental Quality Act (CEQA) can provide protections for a species that, although not listed as threatened or endangered, meets one of several criteria for rarity (CEQA Guidelines; Cal. Code Regs. Title 14 § 15380). Fishers meet these criteria. Under CEQA, a lead agency can require that adverse impacts be avoided, minimized, or mitigated for projects subject to CEQA review that may impact fisher habitat.

California State Lands

The State of California manages relatively little forested lands. California has seven Demonstration State Forests with 25,148 ha (62,115 ac) in the analysis area. While these forests are managed primarily to achieve maximum sustained production of forest products balanced against the avoidance of environmental degradation (California Public Law 4512(a) and 4513), they are not primarily managed for late-successional characteristics. Fisher habitat modeling indicates that 1,607 ha (3,969 ac) of State Forests provides high quality fisher habitat, and 2,617 ha (6,464 ac) provide intermediate quality fisher habitat.

California has about 280 State Parks of which 106 have all or some the park within the analysis area [196,499 ha (485,352 ac)]. No State Parks are located in the southern Sierra Nevada. A part of the State Park's stated mission is to help "preserve the State's extraordinary biological diversity." Fisher habitat modeling indicates that 31,922 ha (78,847 ac) of State Parks provides high quality fisher habitat, and 31,144 ha (76,925 ac) provides intermediate quality fisher habitat.

Z'Berg Nejedly Forest Practice Act of 1973 (FPA)

All non-Federal forests in California are governed by the state's Forest Practice Rules (FPR) under the Z'Berg Nejedly Forest Practice Act of 1973 (FPA) [California Public Resources Code (PRC) § 4511 *et seq*.], a set of regulations and policies designed to maintain the economic viability of the state's forest products industry while preventing environmental degradation. The FPA requires that any timber harvest on private lands must be conducted in accordance with an approved Timber Harvesting Plan (THP) prepared by a State-registered professional forester (RPF), in consultation with other experts (such as biologists, hydrologists, engineers, etc.), as needed.

The California Forest Practice Act applies to other non-timber resources such as recreational opportunities, aesthetic enjoyment, watershed protection, and fisheries and wildlife (California Public Law 4512(a) and 4513). The regulatory framework provided by the FPA and FPRs serves as the basis for the regulation and enforcement (including criminal and civil penalties for violations) of forest management practices that affect fishers. The effectiveness of the FPRs in maintaining viable fisher populations, however, has been questioned by both environmental organizations and the California Department of Fish and Wildlife (CDFW-formally California Department of Fish and Game, CDFG) (CDFG 2010, p. 71) because the FPRs do not contain rules specific to fishers. Surveys are not required for fishers that could be potentially impacted by timber harvesting activities; thus, it is difficult to ascertain whether fishers are present within a THP area and could be harmed or otherwise affected by operations. Nonetheless, it is up to the RPF to explain and demonstrate in the THP that take of listed species is avoided and functional wildlife habitat is maintained.

The FPRs include broad objectives in several places and include such items as "avoiding or mitigating adverse effects to late successional habitat," "maintaining functional wildlife habitat," and prohibiting actions that "result in take of listed species" (see California Code Regs. Title 14, § 757, 897, 898.2, 919.16, 939.16, 959.16). These objectives might provide sufficient protection for fishers, though specific and enforceable standards are lacking, leaving uncertainty as to what protections the FPRs are providing for fisher denning, resting, and reproduction. Enforcement of the FPRs includes on-site inspections prior to, during, and following operations (California Pub. Res Code (PRC) § 4585, 4586, 4588, 4604) and State agencies other than CAL FIRE may attend. It is unknown whether CDFW regularly participates in these inspections and whether an evaluation of the impacts to fishers occurs.

Timber Harvest Plans (THPs) and Forest Practice Rules (FPRs)

CEQA and the FPRs are applied in parallel and a state approved THP is the functional equivalent of a CEQA document (the timber harvest regulatory program was certified in 1976 under California Public Resources Code (PRC) Chapter § 21080.5). The FPRs are administered and enforced by CAL FIRE, but other state agencies including the CDFW, Geological Survey, and Regional Water Quality Control Boards are closely involved. The public as well as other state agencies likewise have the opportunity to review and comment on proposed timber harvesting plans.

Generally, silvicultural methods available under the FPRs can negatively affect fisher habitat suitability by significantly altering or removing forested areas that provide fisher habitat. However, given the large home ranges used by fishers, small changes that can result from some silvicultural treatments may not reduce the amount of available habitat for fishers to the extent that fishers are adversely affected; this is especially true if structural elements, such as large trees with cavities and platforms are retained. Fishers are currently protected in California by virtue of their status as Candidates and also likely meet the criteria of "rare" under Section 15380 of CEQA. Because CEQA (and the FPRs as an extension of CEQA) requires that impacts to rare and listed species (both State and Federal) be avoided, minimized, and mitigated, an effective framework for fisher conservation exists in at least the southern Sierra Nevada ESU now that fishers there are state-listed in this portion of the DPS's range in California.

For land owners whose holdings exceed 50,000 ac (20,235 ha), specific rules apply that require a balancing of timber growth and yield over time (a 100-year planning horizon), which likely benefits fishers. There are several options available within the FPRs from which large landowners can choose. One option referred to as a Sustained Yield Plan can apply a programmatic assessment of potential impacts to wildlife species and watershed processes and also serve to fulfill the requirements of the FPRs with respect to avoiding cumulative effects. Another option (Option A) must account for constraints to timber yield from resource protection measures but site-specific impacts need not be addressed. Separate rules are available to landowners wishing to more closely follow the CEQA process by preparing a Programmatic Timber Environmental Impact Report which then governs subsequent THPs.

Regardless of the option chosen, most large landowners incorporate wildlife management objectives into their long-term plans and specifically identify the types of habitat features they will retain across the landscape, some of which may benefit fishers. From a purely regulatory perspective, however, these plans may often include a great deal of flexibility that limits the certainty that the desired habitat benefits will be effective.

The FPA also allows forest owners with less than 2,500 ac (1,012 ha) to use Non-Industrial Timber Management Plans that are generally designed to provide continuous forest cover over the long term. However, because fishers use large home ranges, effective management of populations is difficult for such landowners. In short, these owners may benefit fishers by managing their land to provide forest cover over the long term, but they do not have control of enough land to ensure that functional fisher habitat is maintained over time.

Significant loss of forested habitat that fishers may use commonly occurs as the result of intense wildfire; fuels reduction treatments are often applied on both federal and non-federal lands in order to limit the potential for wildfires to become devastating in both scale and intensity (that is, burning very hot over large areas). Fuels reduction treatments typically focus on the removal of excess small diameter trees, the retention of larger fire resistant trees, and the reduction of accumulated dead woody material on the forest floor. These treatments can affect fishers by removing fallen logs that are used as resting or denning sites. The FPRs contain numerous sections that address the need to reduce fuels within managed forests. While these treatments are designed to limit the potential that wildfire will completely consume large areas of forest and thus render it unsuitable for fishers, they paradoxically may also remove important yet scarce elements of fisher habitat in the form of large downed logs and debris accumulations.

The California State Board of Forestry approved the “Drought Mortality Amendments, 2015,” which was an interim regulation to give persons cutting or removing dead or dying trees of any size, in response to drought related stress, an exemption from preparing and submitting THPs. The Board is currently proposing to “make permanent” this rule until December 31, 2018. (CBOF 2016a,b entire). Because this exemption targets dead and dying trees, there is the potential to remove current and future structures suitable for fishers at a large scale on private land in California.

Snags (standing dead or partially dead trees) are commonly used by fishers for denning and resting (Zielinski *et al.* 2004a, p. 482; Reno *et al.* 2008, p. 14). Although the FPRs require that all snags be retained (unless they pose a safety hazard), "merchantable" snags may be harvested, and merchantability varies with market conditions. The FPRs only require retention of existing snags when present, however the recruitment of future snags is not required. As detailed above, there are general rules that apply to the maintenance of habitat, cumulative effects, and the protection of rare or listed species.

On March 11, 2013, CAL FIRE issued a memorandum stating that the CESA prohibition of take in Fish and Game Code § 2080 applies to fisher as a candidate species and CAL FIRE must ensure that adequate measures to avoid take of fisher are included in each timber harvesting plan (THP) it approves. Take avoidance guidelines were issued by CAL FIRE that require THPs to identify areas of potential fisher occurrence, habitat elements (snags, hardwood trees, large woody debris, areas of dense mature forest, etc.), den sites, resting structures, and the need for seasonal restrictions during the breeding and rearing season.

Other methods to avoid take described by CAL FIRE include identifying and retaining trees with fisher den and resting site structural characteristics, assessing potential impacts when operating in late successional or late seral forest stands, halting harvest activity in the event of a fisher sighting in an area of operations, identifying the potential for cumulative impacts and limits on the recruitment of habitat features over time, and seeking advice from wildlife biologists during the preparation of timber harvesting plans (CAL FIRE 2013b).

California State Regulatory Summary

The southern Sierra fisher ESU was listed under the CESA and take is prohibited. Outside of the southern Sierra ESU where listing was not found to be warranted by the State, take prohibitions do not apply. Trapping regulations are in place throughout the State. In California, the use of body gripping traps and trapping of fishers is prohibited and enforced, but injury or mortality of fishers is likely to occur during illegal trapping. In general, legal trapping is unlikely to result in significant mortality to fishers because only use of live traps is allowed. However, the extent of illegal trapping and mortality to fishers is unknown. In terms of effects to fisher habitat or incidental harm to fishers from timber harvesting or other types of land disturbing projects, California has regulations that act in combination to disclose, avoid, or mitigate environmental degradation. Cumulative effects analysis to listed and non-listed species is required in both CEQA and the California Forest Practice Rules. Interim regulations aimed specifically at protecting fishers are currently in place but their efficacy is not yet known

Rodenticide Regulations

The use of rodenticides is regulated under the Federal Insecticide, Fungicide, and Rodenticide Act of 1947, as amended (FIFRA) (7 U.S.C. §§ 136 *et seq.*) via the registration of labels by the U.S. Environmental Protection Agency (EPA). Each label describes the permitted use for an individual rodenticide product and must be supported by rigorously collected and analyzed efficacy and environmental safety data. The majority of registrations are sponsored by private manufacturers for large uses in commensal and agricultural settings, including forestry. In addition, there are a number of labels currently under registration to the U.S. Department of Agriculture (USDA) and state agencies for agricultural and wildlife damage control purposes. Eleven rodenticide compounds are currently registered with the EPA as solid baits for use against a number of vertebrate species. These are categorized by their mode of action: first generation anticoagulants (chlorophacinone, diphacinone, warfarin), second generation anticoagulants (SGARs) (brodifacoum, bromadiolone, difenacoum, difethialone), and non-anticoagulant/acute (bromethalin, cholecalciferol, zinc phosphide, strychnine).

The states have authority to regulate pesticides, implemented under laws and regulations unique to each state, but stepped down from FIFRA. They can register additional pesticide products at the state level as well as restrict or deny uses previously approved by the EPA. For California, the state Department of Pesticide Regulation is the regulatory authority which implements Title 3. (Food and Agriculture), Division 6 (Pesticides and Pest Control Operations) of the California Code of Regulations. Enforcement is carried out at the county level. The Oregon Department of Agriculture's Pesticides Program is charged with enforcing State and Federal regulations regarding the licensing, sale, distribution, and use of pesticides. The Oregon Department of Agriculture has created a list of 257 pesticide products to guide marijuana growers and pesticide applicators throughout the state. This list is intended to aid growers in distinguishing those pesticide products whose labels do not legally prohibit use on cannabis from those that clearly do not allow use; there currently are no registered pesticide products in Oregon that are specifically labeled for use on marijuana (ODA 2016, all). The Pesticide Management Division of the Washington State Department of Agriculture is responsible for registering and licensing pesticides in Washington and enforcing Federal and State regulations.

The EPA is required by multiple statutes [FIFRA, ESA, Migratory Bird Treaty Act of 1918, as amended (MBTA) (16 U.S.C. §§ 701-12), and Bald and Golden Eagle Protection Act of 1940, as amended (BGEPA) (16 U.S.C. §§ 668-668c)] to ensure that the use of a pesticide label does not result in mortality to non-target species. The process of registration of a pesticide with the EPA and the licensing of it for use at the state level must include a determination of what effects, if any, the proposed use would have on listed species. The EPA has conducted formal Section 7 consultations with the Service on the effects of rodenticides (for example, Service 1993, entire; Service 2012b, entire; Service 2012c, entire), resulting in substantial changes to labels. Endangered Species Considerations are detailed for each listed species within the potential use area, with instructions to contact the nearest USFWS office, or the appropriate State Agency, for more information. At the user level, misuse of a pesticide resulting in take of a protected species can be prosecuted under the above statutes.

EPA's Endangered Species Protection Program Bulletins set forth geographically specific pesticide use limitations for the protection of endangered or threatened species and their designated critical habitat. When referenced on a pesticide label, Bulletins are enforceable use limitations under FIFRA.

The primary regulatory issue for rodenticides and fishers is the availability of large quantities of rodenticides that can be purchased under the guise of legal uses, which can then be used illegally in marijuana grows within fisher habitat. In 2008, after reviewing the scientific literature and reported nontarget exposures to children and wildlife, the EPA issued its Risk Mitigation Decision for Ten Rodenticides (EPA 2008, entire), which evaluated the risk for all of the registered rodenticides except strychnine. In its Decision, EPA issued new legal requirements for how rodenticides could be labelled, packaged and sold, stating that the SGARs "…shall only be distributed to or sold in agricultural, farm and tractor stores or directly to PCOs [Pest Control Operators] and other professional applicators…" (EPA 2008, p. 14). The Decision explains, "...EPA has decided to use sale and distribution limitations – rather than restricted use classification – to minimize the use of second generation anticoagulants in settings where the risks outweigh the benefits (i.e., most residential settings)." (EPA 2008, p. 15). Based on its concerns about the widespread exposure to SGARs in wildlife in California (CDPR 2013a, entire), the state of California proposed a change to existing regulations making all SGAR products in California-restricted, which limits their possession or use to those who are licensed applicators, or under a licensed applicator's direct supervision (CDPR 2013b, entire). Concern in particular about exposure to fishers is stated as one of the reasons for eliminating general consumer access to the second generation ARs: "By restricting the general users [sic] access to all SGARs, the opportunities for illegal marijuana growers to readily purchase and deliberately misuse SGARs would be significantly reduced" (CDPR 2013b, p. 9). This proposed rule change was finalized in March 2014, and became effective on July 1, 2014. It is premature to evaluate if this rule change will diminish the use of SGARs in illegal marijuana grows within the state. In addition, all ARs continue to be widely available and used by consumers, those with a certified pesticide applicator's license, and can be brought into California and the United States if purchased legally elsewhere (CDPR 2013a, entire; CDPR 2013b, entire).

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Appendix A. Results of fisher analysis area habitat model.

	Hectares Within Analysis Area	Percent of Analysis Area	Low Quality (ha)	Intermediate (ha)	High Quality (ha)
Analysis Area					
Entire Analysis Area	35,410,649	100	18,666,439	8,854,847	7,889,364
National Park Service	1,604,601	4.53	1,017,798	136,928	449,875
US Forest Service	13,057,959	36.88	6,301,070	2,689,182	4,067,707
Bureau of Land Management	2,004,636	5.66	998,306	496,846	509,483
Tribal Governments	890,721	2.52	435,147	316,664	138,910
Other Federal	207,080	0.58	128,661	72,433	5,986
State	1,598,281	4.51	631,035	460,065	507,180
Local	276,469	0.78	174,560	63,819	38,090
Private	15,770,903	44.54	8,979,862	4,618,909	2,172,131
National Park Service					
NPS Olympic	364,685	1.03	72,130	57,095	235,460
NPS North Cascades	275,530	0.78	242,123	14,350	19,058
NPS Mt. Rainier	95,659	0.27	88,257	890	6,512
NPS Crater Lake	73,887	0.21	64,022	7,127	2,738
NPS Redwood National Park	31,602	0.09	5,734	6,437	19,431
NPS Lassen	43,466	0.12	41,917	1,254	296
NPS Yosemite	302,197	0.85	202,911	29,305	69,981
NPS Sequoia-Kings Canyon	735,114	2.08	570,089	36,657	128,367
National Monuments	5,248	0.01	5,060	0	188
US Forest Service					
Okanogan-Wenatchee National Forest	1,526,924	4.31	1,309,525	177,934	39,465
Mount Baker-Snoqualmie National Forests	710,023	2.01	463,795	28,035	218,193
Gifford Pinchot National Forest	549,046	1.55	217,609	68,120	263,317
Olympic National Forest	255,523	0.72	23,266	7,748	224,509
Columbia River Gorge National Scenic Area	33,460	0.09	5,620	12,127	15,714
Mount Hood National Forest	415,164	1.17	160,902	29,736	224,525

	Hectares Within Analysis Area	Percent of Analysis Area	Low Quality (ha)	Intermediate (ha)	High Quality (ha)
Willamette National Forest	681,070	1.92	139,317	38,929	502,823
Siuslaw National Forest	252,917	0.71	123,137	99,052	30,727
Umpqua National Forest	398,866	1.13	75,872	68,885	254,109
Deschutes National Forest	649,179	1.83	274,900	341,428	32,851
Fremont-Winema National Forest	671,465	1.9	237,549	413,540	20,375
Rogue River-Siskiyou National Forest	696,874	1.97	179,316	248,564	268,994
Six Rivers National Forest	470,500	1.33	69,483	159,567	241,450
Klamath National Forest	604,755	1.71	248,660	150,712	205,384
Modoc National Forest	214,788	0.61	209,816	3,245	1,728
Shasta-Trinity National Forest	860,466	2.43	252,645	206,901	400,921
Lassen National Forest	464,552	1.31	369,327	63,163	32,062
Plumas National Forest	484,850	1.37	224,989	131,714	128,147
Mendocino National Forest	369,562	1.04	125,072	135,619	108,871
Tahoe National Forest	339,037	0.96	159,209	61,827	118,000
Lake Tahoe Basin Management Area	60,477	0.17	53,876	6,365	236
Eldorado National Forest	243,021	0.69	100,729	48,934	93,358
Humboldt-Toiyabe National Forest	245,046	0.69	236,858	7,510	678
Stanislaus National Forest	360,504	1.02	184,802	41,789	133,913
Sierra National Forest	528,215	1.49	239,983	57,518	230,713
Sequoia National Forest	443,808	1.25	153,437	43,973	246,397
Inyo National Forest	447,612	1.26	423,506	12,699	11,407
Eastside Screen	1,078,960	3.05	358,405	705,178	15,377
Northwest Forest Plan					
Congressionally reserved	3,131,491	8.84	1,990,384	451,444	689,663
Late-Successional Reserves	2,874,292	8.12	842,049	579,642	1,452,601
Managed Late-Successional Areas	40,656	0.11	25,641	8,448	6,567
Adaptive Management Areas	599,903	1.69	176,073	81,036	342,794
Adaptive Management	126,498	0.36	26,252	25,922	74,325

	Hectares Within Analysis Area	Percent of Analysis Area	Low Quality (ha)	Intermediate (ha)	High Quality (ha)
Reserves					
Administratively Withdrawn	620,495	1.75	381,358	92,385	146,752
Matrix	2,655,174	7.5	797,423	757,533	1,100,218
Sierra Nevada Framework					
Sierra Fisher Conservation Area	602,324	1.7	138,180	48,551	415,592
Bureau of Land Management					
Spokane	35,497	0.1	26,706	8,489	302
Salem	162,535	0.46	12,255	36,600	113,680
Eugene	127,210	0.36	6,904	55,624	64,682
Roseburg	172,391	0.49	14,424	84,289	73,677
Coos Bay	132,081	0.37	61,169	57,811	13,101
Medford	351,266	0.99	73,126	118,059	160,081
Redding	92,845	0.26	41,368	12,871	38,606
Arcata	53,492	0.15	16,347	20,806	16,339
Ukiah	64,552	0.18	61,604	2,415	534
Alturas	69,695	0.2	69,549	146	0
Eagle Lake	12,789	0.04	12,101	410	279
Mother Loade	93,607	0.26	73,530	12,975	7,102
Bakersfield	54,186	0.15	49,201	2,046	2,939
Tribal Governments					
Hoopa	35,633	0.1	569	13,188	21,875
Yurok	21,953	0.06	4,831	9,559	7,563
Tule River	21,857	0.06	10,668	1,635	9,555
Conf. Tribes of Siletz Indians	1,452	0	1,435	16	0
Klamath	150	0	28	0	122
Coquille Indian Tribe	2,549	0.01	1,340	1,209	0
Quinault Indian Nation	81,611	0.23	16,155	37,164	28,291
Makah Nation	11,832	0.03	1,473	4,094	6,266
Yakima	360,392	1.02	217,414	135,590	7,389
Department of Defense					
Joint Base Lewis McChord,	35,075	0.1	10,281	24,793	0

	Hectares Within Analysis Area	Percent of Analysis Area	Low Quality (ha)	Intermediate (ha)	High Quality (ha)
WA					
State					
State of California	15,444,474	43.62	9,823,524	2,349,759	3,271,191
CA State Forests	25,148	0.07	20,924	2,617	1,607
CA State Parks	196,499	0.55	133,433	31,144	31,922
State of Oregon	10,636,173	30.04	4,460,478	3,526,210	2,649,484
OR State Forests	300,346	0.85	141,728	49,484	109,134
OR State Parks	45,772	0.13	29,721	12,595	3,457
State of Washington	9,330,002	26.35	4,382,436	2,978,877	1,968,689
WA Dept of Natural Resource	951,754	2.69	235,137	341,657	374,959
WA State Parks	21,559	0.06	7,062	12,477	2,019

Appendix B. Habitat Modeling Methods

Habitat Modeling Methods for the Fisher West Coast Distinct Population Segment Species Assessment

Authors: Katherine Fitzgerald[1], Wayne Spencer[2], Heather Rustigian-Romsos[2], and Dave LaPlante[3]

This document describes the methods used to create the fisher habitat models for the Endangered Species Act listing evaluation status assessment for the West Coast distinct population segment (DPS) for fisher. The model information is useful to understand habitat value and distribution, habitat connectivity, and population distribution maps under current conditions.

Introduction

An Interagency Biology Team composed of nearly 20 representatives of wildlife and land management agencies and native tribes in the western U.S. and Canada (Lofroth *et al.* 2010, p. iii) was convened in 2005 and tasked with developing a comprehensive Conservation Strategy for the West Coast distinct population segment (DPS) of fishers (*Pekania pennanti*) in California, Oregon, and Washington, as well as adjacent areas in south-central British Columbia. This region, however, lacked comprehensive and accurate maps of fisher habitat value and connectivity that the team could use as decision-support models to assess likely effects of threats such as climate change, changing fire regimes, forest management, and other factors on fisher. As part of the species status assessment underway for the federal Endangered Species Act listing evaluation by the U.S. Fish and Wildlife Service, likely effects of threats were needed. Therefore, two models, a fitted Maxent model by the Conservation Biology Institute (CBI) and an expert model, were utilized to inform the scientific status assessment.

The fisher species assessment analysis area encompasses a range of ecoregions within the historical range of the West Coast DPS, and the availability of fisher location data varies widely between ecoregions. Therefore, in order to address data gaps and increase accuracy of ecological associations, the authors divided the analysis area into several modeling regions and used different modeling methods as appropriate in each region. Model inputs consisted of verified fisher detection locations (where available) and between four and eight environmental data layers, depending on modeling region. Model output consisted of a number between 0 and 1 representing habitat quality, which was then classified into "low quality," "intermediate quality," and "high quality" habitat. (Note that "low quality" habitat also includes non-habitat.)

Modeling regions

The study area was subdivided into 9 modeling regions (Figure 1), based on ecoregional subsection divisions; the Merced River, which divides the currently occupied and unoccupied portions of the Sierra

[1] U.S. Fish and Wildlife Service, Yreka Fish and Wildlife Office
[2] Conservation Biology Institute
[3] Natural Resources Geospatial

Nevada; Interstate 5, a convenient dividing line running through mostly unsuitable habitat in the valleys between areas of potentially suitable habitat in the Cascades and the Coast Ranges; and measures of environmental similarity. Initially, Maxent was used to produce habitat models throughout all 9 modeling regions. However, for the Western Cascades, Eastern Cascades, and Olympic Mountains, the final model output comes only from the expert model. In the remaining subregions, the final model output was generated using Maxent.

Model types used in each modeling region

In the three regions containing verified fisher detection locations (Southern Sierra Nevada, Klamath – Southern Cascades, and California Coast Range), models were fitted to the fisher data using Maxent. On the Washington and Oregon Coast and in the Northern Sierra Nevada, where verified fisher detection data were lacking and environmental conditions were similar to those in neighboring regions with fitted Maxent models, those models were projected into the region lacking fisher data. In the California Coast and Klamath overlap region and the Northern Sierra Nevada, models from the neighboring regions were combined using distance weighted averaging to account for geographic variation across the landscape, such as coastal to inland or north to south climate gradients. Projections were not used in the Western Cascades, Eastern Cascades, or Olympic Mountains, because the differences in environmental conditions between these regions and the neighboring regions were so great that they introduced large uncertainties in the statistical projections. The results of projections in these three regions were at odds with expert input of biologists familiar with potential fisher habitat suitability in the Cascades and Olympic regions. Instead, an expert model was constructed for these regions.

Model fitting using Maxent

Occurrence Data

Over 5,000 fisher detections and over 12,000 non-detections from the early 1900s through 2013 were submitted by 29 individuals from tribal, state and federal agencies, universities, non-profit organizations, and private companies (Table 1). Not all the detections and non-detections were independent; some were reported in multiple submissions. Maxent uses only detection data, so submitted detections were compiled and filtered to create a set of independent detections for modeling. Fisher detection points were filtered by removing non-verified detections (no physical evidence to verify fisher identification), detections prior to 1970, detections of translocated animals, and telemetry detections. Remaining localities were further filtered to ensure spatial independence by using a minimum nearest-neighbor distance of 5 km. If two or more detections were within 5 km of one another, the most reliable and recent was retained, or in case of a tie, by random selection. A total of 456 detections remained after filtering for model calibration, with 72 from the Southern Sierra Nevada, 185 from the Klamath and Southern Cascades, and 199 from the California and Southern Oregon Coast.

Predictors

An array of 22 potential environmental predictor layers was created including vegetation, climate, elevation, terrain, and Landsat-derived reflectance variables at 30-m and 1-km resolutions (Table 2). Environmental variables were averaged over a 10-km^2 moving window and then resampled to 90 m. Urban and open water land covers were masked out. Predictor correlation (defined as $|r| \geq 0.7$) was tested for each model calibration region using ENMTools 1.3 (Warren *et al.* 2010, entire).

Variable Selection and Model Construction

Maxent was run separately on the three calibration regions, using 10-fold cross validation, logistic output, and default settings, initially using all 22 environmental predictors. Next, correlated variables ($|r| \geq 0.7$) were eliminated by retaining the one that yielded the maximum decrease in training gain when excluded from the model. Then variables that provided the minimum decrease in training gain when excluded were systematically removed using a stepwise procedure until obtaining a model with the fewest predictors having an average training gain not significantly different than the full model. Significance was defined as lack of overlap between 95% confidence intervals for training gain averages (calculated in R version 2.15.3; R Core Team 2013). The final variables selected for each modeling region are listed in Table 4. In areas of overlap, regional models were combined using distance-weighted averaging.

Classification of low, intermediate, and high quality habitat

Modeled habitat was classified as low quality, intermediate quality, or high quality habitat based on strength of selection curves (Hirzel *et al.* 2006, p. 144). Habitat was considered to be low quality if habitat with equal or lower value was used at a rate at least 1.5 times less than would be expected based on habitat availability. Habitat was considered to be high quality if habitat with equal or higher value was used at a rate at least 1.5 times greater than expected based on availability. Intermediate quality habitat was used at approximately the same rate as expected based on availability. The model output values corresponding with these points on the strength-of-selection curves varied between regions, so habitat was classified separately in each region. In the Coast Range and Klamath overlap region, distance-weighted averaging was applied to the classification thresholds as it was to the model output.

Projections to regions lacking verified fisher data

The model from the California Coast Range was projected to the Oregon and Washington Coast Ranges. Model output was then classified using the strength-of-selection values from the California Coast Range. In the Northern Sierra Nevada, the models from the Southern Sierra Nevada and the Klamath – Southern Cascades were combined using distance-weighted averaging, similar to that used for the overlap between the Klamath – Southern Cascades and California Coast Range, both for the model output and for the classification thresholds.

Expert model

Expert model process

To predict fisher habitat suitability in the Olympic Mountains and the Oregon and Washington Cascades, we used an expert modeling process. First, we thoroughly reviewed the fisher literature for previous models and other habitat association studies from adjacent regions (California, British Columbia, and Northern Rocky Mountains). From the literature, we made a list of variables for which data layers were available for Washington and Oregon, and categorized them based on which functional aspects of fisher habitat use they represented (Table 3). We then gathered input regarding this list of variables from ten fisher experts (see acknowledgements), who commented on the importance and functional relationship of each variable to fisher habitat. Some of the experts also proposed additional variables that they thought were important to fisher habitat.

We used the experts' input, as well as our own expert knowledge of fisher biology, of relationships among environmental variables, and of habitat models, to select our final list of variables and data sources. The selected variables were dense forest, old-growth structure index, tasseled-cap greenness, a prey availability index, a "fluffy snow" variable combining winter temperature and precipitation as snow, and land cover types identifying non-forested areas (Table 5).

<u>Creation of data layers</u>

Data layers were readily available for dense forest, old-growth structure index, and land cover types, and a tasseled-cap greenness layer had already been created for the Maxent models (see Table 2). These variables were sampled on a 30 m grid. Except for land cover types, these variables were then averaged over a 10-km^2 moving window. We prepared additional layers for prey index and snow conditions.

<u>Prey index</u>

Prey data layers for Washington (Johnson *et al.* 1997; Smith *et al.* 1997) were downloaded from the Washington Department of Fish and Wildlife GAP analysis website. For Oregon, we obtained the data layers used to create the habitat maps shown on the Oregon Wildlife Explorer webpage (OSU 2013, website; Bernert 2013, pers. comm.)

We included in our prey index (Table 6) all species that met the following criteria: (1) The species was a mammal or a bird of the order Galliformes. (2) The species belonged to a genus or larger group that was present in at least 5% of fisher scats and/or intestinal tracts examined in the studies listed in Lofroth *et al.* 2010 (pp. 161-163), and/or in any of the 4 study areas described by Golightly *et al.* (2006, pp. 16-22). One species, mountain beaver (*Aplodontia rufa*), did not fit this criterion but were included because fishers reintroduced to the Olympic Peninsula have been observed to prey on mountain beavers (Lewis 2013, pers. comm.). (3) The species had an average mass greater than 10 g. (4) The species was present in either Oregon or Washington, or both, and current habitat map data were available for the species. In one case (water shrew, *Sorex palustris*) , only historical habitat map data were available. However, based on the images shown on the Oregon Explorer website, the current and historical habitat appear to be very similar in extent, if not in quality, so we included the historical habitat data in place of the current data.

Habitat maps from Washington divided habitat into three categories for each species: core, peripheral, and non-habitat. Habitat maps from Oregon divided habitat into four categories for each species: good, fair, poor, and non-habitat. In each case, we maintained the non-habitat classifications, and reclassified all other categories (core, peripheral, good, fair, or poor) into one habitat category.

We obtained masses from each species from the following reference books and online reference databases: (Jameson and Peeters 2004, pp. 116-365; Nowak 1999, pp. 1297, 1460, 1466; Myers *et al.* 2013, website; Costello and Rosenberger 2013, website; Sibley 2003, pp. 122-132). When a source gave an average mass for the species, this was the value we used. If the source gave a range but no average, we used the midpoint between the minimum and maximum. If the source gave a single value for each sex, we used the midpoint between the two sexes' masses. If the source gave a range for each sex, we used the value midway between the minimum for the small sex and the maximum for the large sex. We divided the species list into quartiles by mass: 50 g or less, 50-250 g, 250-850 g, and 850 g or more.

In order to calculate the prey index for a given pixel, we determined which species had habitat present at that pixel. The index was calculated as a count of the number of species for which habitat was present, weighted by quartile. Each species in the lightest quartile was worth one point, the lower middle quartile species were worth two points, the upper middle quartile species were worth three points, and those in the heaviest quartile were worth four points. These points were added up to give the index for each pixel. The pixel values were the averaged over a 10-km^2 moving window.

<u>Snow layer</u>

Precipitation as snow and mean winter temperature data for the period from 1991 to 2010 were extracted using ClimateWNA (Wang *et al.* 2013, software). Climate data were sampled on a 450 m grid, except for on the Olympic peninsula, where the data were sampled on a 180 m grid. Sites with average winter temperature < 0 °C and with 225 mm precipitation as snow (PAS) are likely to have enough fluffy snow that fishers' movements may be impeded or it may be difficult to find prey (Iredale *et al.* 2012, pp. 10-11, 15, 19; Weir 2013, pers. comm.). In the Olympic Mountains, these thresholds identified as non-habitat many areas where fishers have been observed. After examining the fisher locations as portrayed in reports of the Olympic National Park fisher reintroduction (Lewis *et al.* 2010, pp. 10, 14; Lewis *et al.* 2011, pp. 9, 13; Lewis *et al.* 2012, pp. 6, 10), we adjusted the temperature threshold to -1 °C mean winter temperature for the Olympic peninsula only.

Non-habitat masking

Some variables appeared in the model as binary variables (presence/absence or a threshold) to distinguish possible habitat from definite non-habitat. Non-forested land cover types (generally defined as areas not capable of supporting at least 10% tree cover; see Appendix A) were assumed be non- habitat and received a model value of 0. At sites that exceeded the snow and temperature thresholds described above, the habitat was assigned a model value of 0. If the prey diversity index indicated that there were either no large prey species, or only a small number of any species present (prey index <16), we assumed that fishers would not be able to support themselves and the habitat was assigned a value of 0.

Logistic model

The remaining variables appeared in the model as continuous variables in a logistic equation. These variables were canopy cover, old growth structure index, tasseled-cap greenness, and prey index (for all sites with prey index > 16). For each variable, the logistic model contained two parameters: one to center the variable and another to weight it relative to the other variables. There were two additional parameters adjusting the entire equation: an intercept, which allows the average value across the range to be adjusted up or down; and a smoothing parameter, which controls the steepness of the curve, and therefore the sharpness of the contrast between low-quality habitat and high-quality habitat. The centering parameters for canopy cover and tasseled-cap greenness were derived from statistically fitted models of fisher habitat in California that used the same variables. The centering parameters for old growth structure index and for the prey index were chosen based on our best judgment and were adjusted during our evaluation of preliminary models. Weighting parameters were chosen based on the relative ranks of related variables in our survey of fisher experts, and were adjusted during evaluation of preliminary models. The intercept and smoothing parameter were chosen in order to best match the Maxent model in the areas where the two models overlapped. Model output was classified into three categories, with the classification thresholds chosen to best match the categorized Maxent models. Choosing the intercept, smoothing, and classification parameters to match the Maxent models allowed for a reasonably smooth transition between one modeling region and another. Because the input layers for the expert model covered the entire analysis area within Oregon and Washington, the output also covered the whole Oregon and Washington portions of the analysis area. However, the expert model was only used in those modeling regions that were too environmentally different from areas with fitted models for those fitted models to be usefully projected.

Combined model output

The Maxent and expert models were combined into one habitat model layer (Figure 2). This layer was used in the draft species assessment report of stressors affecting fishers in the West Coast DPS. See the Draft Species Report (USFWS 2014) for these analyses.

Acknowledgements

We would like to thank the fisher experts whose input was useful in the expert modeling process. Scott Yaeger (former U.S. Fish and Wildlife Service, Yreka Fish and Wildlife Office) proposed the use of the expert model and offered expert input. We also appreciate the extensive expert input from Bill Zielinski

(USFS, Pacific Southwest Research Station), Rich Weir (British Columbia Ministry of Environment), Roger Powell (North Carolina State University, Department of Applied Ecology), Sean Matthews (Wildlife Conservation Society), Jeff Lewis (Washington Department of Fish and Wildlife), J. Mark Higley (Hoopa Valley Tribal Forestry), Jeff Dunk (Humboldt State University, Department of Environmental Science and Management), and Keith Aubry and Cathy Raley (USFS, Pacific Northwest Research Station). Patti Happe (National Park Service, Olympic National Park) and Kurt Jenkins (U.S. Geological Survey) provided feedback on model performance in the areas used by fishers reintroduced to the Olympic Peninsula. Andrew Gray (U.S. Forest Service, Pacific Northwest Research Station) provided additional information regarding his published work. Steve West (University of Washington, School of Environmental and Forest Sciences) and Joe Bernert (Oregon State University, Institute for Natural Resources) responded to inquiries about prey habitat.

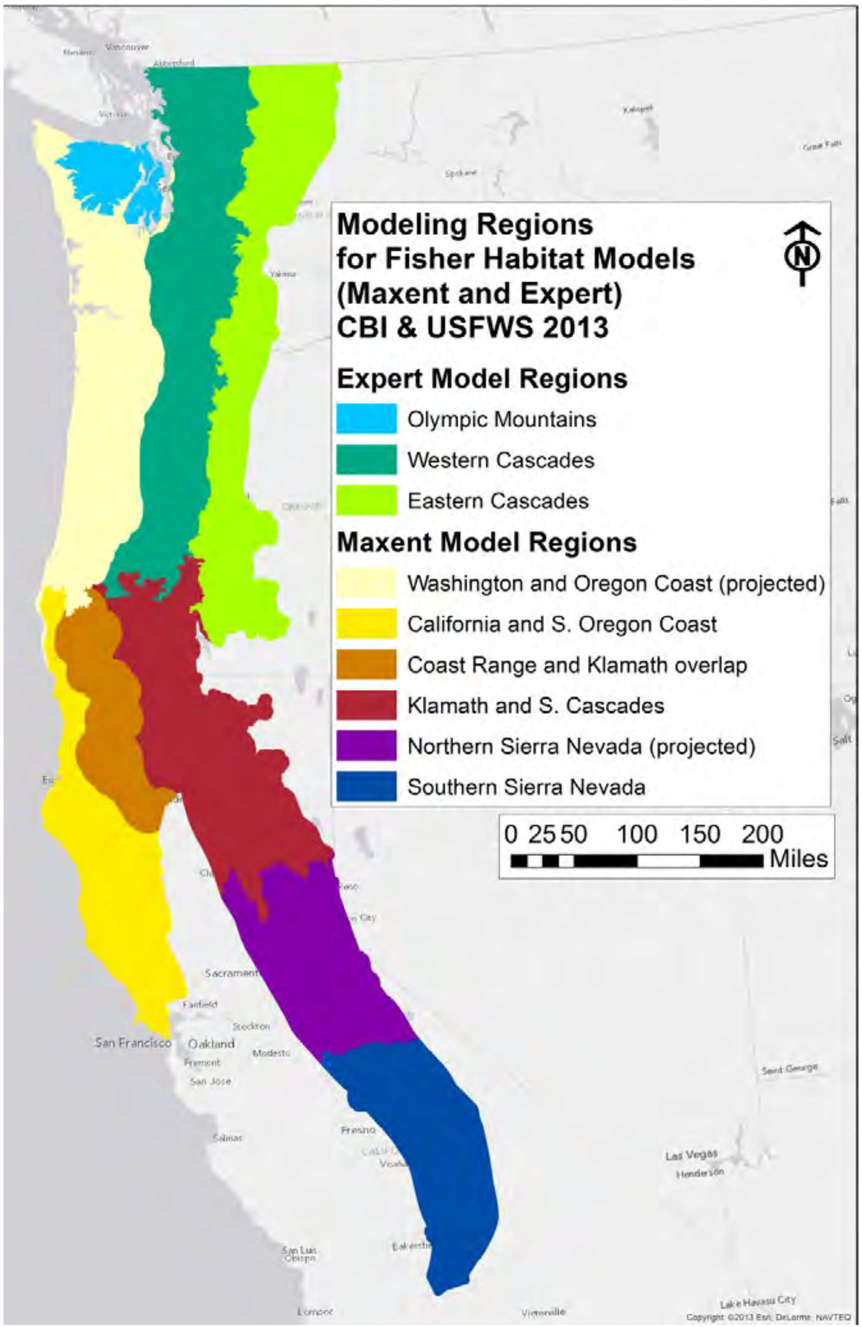

Figure 1. Modeling regions

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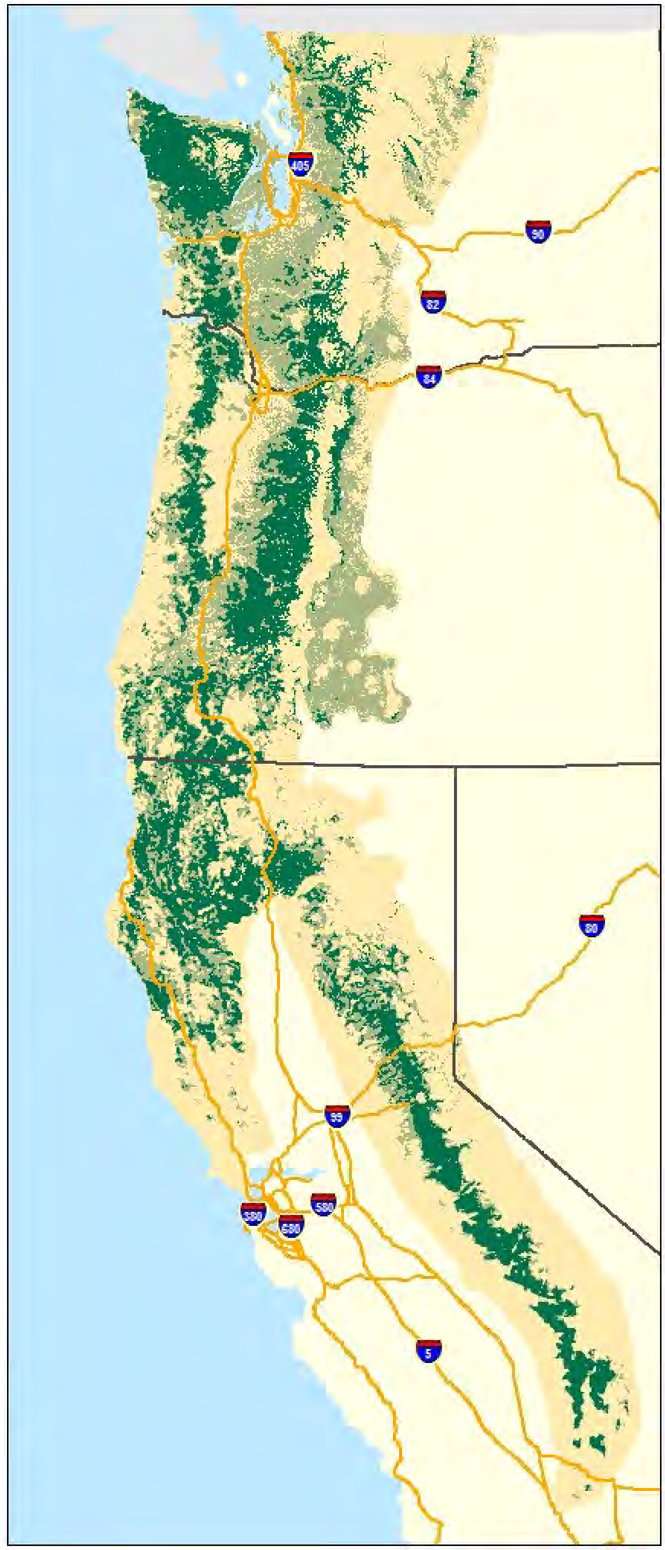

Combined Maxent and Expert
Fisher Habitat Model Output

Modeled fisher habitat

Habitat quality

Low quality

Intermediate

High quality

037.575 150 225 300

Kilometers

Map projection: R6_NAD_1983_Albers

Figure 2. Combined model output

Table 1. Fisher location data submissions. These data were filtered as described in the text before use in the model process. Some submissions consisted only of negative surveys; these are acknowledged here even though we did not use them in the creation of the models.

Contributor	**Affiliation**	**Fisher locations**	**Location**	**Date range**
Max Allen and Bryn Evans	California Department of Fish and Wildlife	33	Mendocino National Forest, Northwestern California	2010-2012
Stan Beech	(none given)	1	Mendocino National Forest, Northwestern California	2013
Richard Callas	California Department of Fish and Wildlife	1	Weed, California (Northern California)	2013
Sal Chinicci	Humboldt Redwood Company	31	Northwestern California	2000-2012
Dave Clayton	U.S. Forest Service Rogue-River Siskiyou National Forest	21	Rogue-River Siskiyou National Forest, Southern Oregon	2010-2012
Gary Diridoni	Bureau of Land Management- Redding district	10	South of Shasta-Trinity National Forest, Northern California	2012-2013
Tom Engstrom	Sierra Pacific Industries	45	Sierra Nevada between Lassen and Stanislaus National Forest, and Weaverville area in Northern California	2005-2012
Aaron Facka	North Carolina State University	181	Stirling (Northern Sierra Nevada reintroduction area)	2009-2012
Stuart Farber	W.M. Beatty and Associates	19	Hancock Forest near Shasta-Trinity National Forest and W.M. Beatty and Associates land near Lassen National Forest, Northern California	2004-2012
Katherine Fitzgerald	U.S. Fish and Wildlife Service, Yreka Fish and Wildlife Office	1	College of the Siskiyous, Weed, California	2013
Brett Furnas	California Department of Fish and Wildlife	83	Northern California	2009-2012
Stephen Haney	Bureau of Land Management—Medford district	13	Southern Oregon	2005-2012
Shiloh Halsey	Portland State University	0 (negative surveys only)	Washington	2012
Brian Hudgens	Institute for Wildlife Studies	1	Kings Canyon and Sequoia National Park, Southern Sierra Nevada	2006
Michele Huffman	U.S. Forest Service Pacific Northwest Region	197	Oregon and Washington	1911-2012
Jesse Irwin	Bureau of Land Management –Arcata district	19	West of Six Rivers National Forest, Northwestern California	2009-2011

Contributor	Affiliation	Fisher locations	Location	Date range
Todd Johnson	U.S. Forest Service, Shasta-Trinity National Forest	2	Shasta-Trinity National Forest, Northern California	2010-2011
Julie Kelley	Sierra Pacific Industries	50	Sacramento Canyon and Weaverville, California	2006-2012
Patti Kreuger and Victor Soto	U.S. Forest Service Pacific Southwest Region	1846	California	1990-2012
David Lamphear	Green Diamond Resource Company	245	Northwestern California	1994-2012
Dave LaPlante	Natural Resources Geospatial	467	Data compiled from a variety of sources including Bureau of Land Management (Southern Oregon), Klamath National Forest, and others in Northern California	1966-2011
Sean Matthews	Wildlife Conservation Society	478	Hoopa Valley Tribal lands, Northwestern California	2004-2012
Lindsey Myers	Central Sierra Environmental Resource Center	1	Yosemite National Park and Stanislaus National Forest, Sierra Nevada	1998-2012
John Perrine	California Polytechnic State University	0 (negative surveys only)	Lassen Peak region, Northern California	1992-2002
Don Schmidt	(none given)	1	Mendocino County, Northwestern California	2013
Jeff Stephens	Bureau of Land Management – Medford district	18	Southern Oregon	2012
Rick Sweitzer, Craig Thompson	University of California-Berkeley, U.S. Forest Service Pacific Southwest Research Station	187	Kings River and Sierra Nevada Adaptive Management Project, Sierra Nevada	2008-2011
Robert Swiers	North Carolina State University	810	Eastern Klamath Study Area, Northern California and Southern Oregon	2006-2011
Linda Thomasma	Collins Pine Company	0 (negative surveys only)	South of Lassen Volcanic National Park, Northern California	2012
Mark Vargas	Oregon Department of Fish and Wildlife	0 (negative surveys only)	Southwestern Oregon	2010-2012
Janet Werren	U.S. Forest Service Pacific Southwest Research Station	86	Northwestern California and Southwestern Oregon	1996-2009
Scott Yaeger	U.S. Fish and Wildlife Service, Yreka Fish and Wildlife Office	560	Sierra Pacific Industries Lassen district; Shasta-Trinity, Klamath, and Six Rivers National Forests; and other Northern California locations	1992-2012

Table 2. Environmental predictors tested for Maxent models

Predictor	Citation	Resolution	Time Period	Source
Mean diurnal range (Mean of monthly (max temp - min temp)); °C * 10	Hijmans *et al.* 2005	30 arc second (~ 1 km^2)	1960-1990	http://www.worldclim.org/current
Isothermality ((Mean diurnal range / temperature annual range) * 100); °C * 10	Hijmans *et al.* 2005	30 arc second (~ 1 km^2)	1960-1990	http://www.worldclim.org/current
Max temp warmest month; °C * 10	Hijmans *et al.* 2005	30 arc second (~ 1 km^2)	1960-1990	http://www.worldclim.org/current
Min temp coldest month; °C * 10	Hijmans *et al.* 2005	30 arc second (~ 1 km^2)	1960-1990	http://www.worldclim.org/current
Mean temp coldest quarter, °C * 10	Hijmans *et al.* 2005	30 arc second (~ 1 km^2)	1960-1990	http://www.worldclim.org/current
Annual precipitation, (mm)	Hijmans *et al.* 2005	30 arc second (~ 1 km^2)	1960-1990	http://www.worldclim.org/current
Precipitation coldest quarter, (mm)	Hijmans *et al.* 2005	30 arc second (~ 1 km^2)	1960-1990	http://www.worldclim.org/current
Temperature seasonality, (standard deviation * 100)	Hijmans *et al.* 2005	30 arc second (~ 1 km^2)	1960-1990	http://www.worldclim.org/current
Slope, %	USGS 2009	1 arc second (~ 30 m)		http://viewer.nationalmap.gov/viewer/
Latitude-adjusted elevation (0.625m added to elevation for every km north from southernmost point in study area)	USGS 2009; Davis *et al.* 2007	1 arc second (~ 30 m)		http://viewer.nationalmap.gov/viewer/
Local relief, (standard deviation of elevation in 5x5 moving window)	USGS 2009; Davis *et al.* 2007	1 arc second (~ 30 m)		http://viewer.nationalmap.gov/viewer/
Ruggedness, (vector ruggedness measure, calculated in 5x5 moving window)	USGS 2009; Sappington *et al.* 2007	1 arc second (~ 30 m)		http://viewer.nationalmap.gov/viewer/
Insolation (solar insolation index, s = 2 – (sin((slope/90)180))* (cos(22 – aspect) + 1)	USGS 2009; Gustafson *et al.* 2003	1 arc second (~ 30 m)		http://viewer.nationalmap.gov/viewer/
Biomass (aboveground live dry biomass); kg/m^2 * 10.	Kellndorfer *et al.* 2000	30 m	2000	http://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1081

Predictor	Citation	Resolution	Time Period	Source
Canopy height (basal area-weighted canopy height, weights contribution of trees to stand height by their basal area); m * 10	Kellndorfer *et al.* 2000	30 m	2000	http://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1081
Conifer forest, % of 10 km^2 moving window classed as conifer forest	USGS 2010	30 m	2008	http://landfire.cr.usgs.gov/viewer/viewer.html
Mixed forest, % of 10 km^2 moving window classed as mixed conifer-hardwood forest	USGS 2010	30 m	2008	http://landfire.cr.usgs.gov/viewer/viewer.html
Dense forest , % of 10 km^2 moving window classed as forest with $\geq$ 60% canopy cover	USGS 2010	30 m	2008	http://landfire.cr.usgs.gov/viewer/viewer.html
Hardwood forest, % of 10 km^2 moving window classed as hardwood forest	USGS 2010	30 m	2008	http://landfire.cr.usgs.gov/viewer/viewer.html
Forest Stand Age	Pan *et al.* 2012	1 km	2006	http://daac.ornl.gov
Tasseled cap greenness (transformation to condense Landsat spectral data into component associated with vegetation characteristics).	Crist 1985; Huang 2002; Masek *et al.* 2006; USGS 2013; CBI 2013a	30 m	2000	Derived from Landsat Ecosystem Disturbance Adaptive Processing System (LEDAPS) Landsat-7 ETM+ data products freely available through the USGS EarthExplorer website, http://earthexplorer.usgs.gov/, using Landsat Climate Data Record (CDR) surface reflectance data circa 2000 with minimal cloud contamination
Tasseled cap wetness (transformation to condense Landsat spectral data into component associated with vegetation characteristics).	Crist 1985; Huang 2002; Masek *et al.* 2006; USGS 2013; CBI 2013b	30 m	2000	Derived from Landsat Ecosystem Disturbance Adaptive Processing System (LEDAPS) Landsat-7 ETM+ data products freely available through the USGS EarthExplorer website, http://earthexplorer.usgs.gov/, using Landsat Climate Data Record (CDR) surface reflectance data circa 2000 with minimal cloud contamination

Table 3. Environmental predictors considered for expert model

Variable	Measures used in previous studies	Citations
Biotic variables		
Dense forest	Percent of area with canopy cover >60%	Maxent models (this document)
		Zielinski and Yaeger, unpublished models
		Davis *et al.* 2007, pp. 2198-2208
	Canopy cover	Zielinski *et al.* 2012, pp. 38-40
	Crown closure	Iredale *et al.* 2012, pp. 9-12
	Canopy closure moving average	Carroll *et al.* 1999, pp. 1348-1357
		Carroll 2005, pp. 3-8
Tree size or age	Basal area-weighted canopy height	Maxent models (this document)
	Coniferous canopy height	Iredale *et al.* 2012, pp. 11-12
	Quadratic mean diameter	Iredale *et al.* 2012, pp. 9-10
		Carroll *et al.* 1999, pp. 1348-1355
	Size class of stands	Carroll 2005, pp. 3-5
		Zielinski *et al.* 2010, pp. 1582, 1585
		Spencer *et al.* 2007, pp. vi-24
	Mean age of dominant conifer trees	Zielinski *et al.* 2012, pp. 38-40
	Maximum forest age	Spencer *et al.* 2007, pp. vi-41
		Spencer *et al.* 2008, pp. 34-119
	Stand age	Iredale *et al.* 2012, pp. 9-10
		Jones and Garton 1994, pp. 379-383
Conifer forest	Percent of area with conifer forest	Maxent models (this document)
		Carroll *et al.* 1999, pp. 1348-1355
		Carroll 2005, pp. 3-7
	Mixed conifer, spruce, subalpine fir, or cedar-hemlock stands	Davis 2003, pp. 12-14
		Roy 1991, pp. 43-61, 82
Hardwood component	Percent area in mixed conifer-hardwood	Maxent models (this document)
	Proportion of area with hardwood forest	Zielinski *et al.* 2010, pp. 1583-1587
		Zielinski and Yaeger, unpublished models
		Spencer *et al.* 2007, pp. iv-17
	Hardwood stands	Roy 1991, pp. 42-82
	Proportion of area in large size class hardwood stands	Spencer *et al.* 2008, pp. xvi-37
	Hardwood basal area	Zielinski *et al.* 2012, pp. 38-40
	Biomass of black oak	Spencer *et al.* 2008, pp. 43-58
	Presence of cottonwood or aspen stands	Iredale *et al.* 2012, pp. 9, 12
		Davis 2003, pp. 12-14
	Deciduous percentage (check wording)	Iredale *et al.* 2012, p. 12
	Montane hardwood or montane hardwood-conifer rating	Davis *et al.* 2007, pp. 2198-2208
Landscape diversity	Shannon Diversity Index	Zielinski and Yaeger, unpublished models

Variable	**Measures used in previous studies**	**Citations**
Decadence	Coarse woody debris	Davis 2003, pp. 12-14
	Size of largest conifer snag	Zielinski *et al.* 2012, pp. 38-40
	Density of large snags	Zielinski *et al.* 2012, pp. 38-40
	Tree species' relative probabilities of producing a den cavity	Iredale *et al.* 2012, p. 9
	Structurally complex forest (compound variable)	Zielinski *et al.* 2010, pp. 1583-1587
		Davis *et al.* 2007, pp. 2198-2207
Primary productivity	Basal area	Zielinski *et al.* 2012, pp. 38-40
	Biomass	Spencer *et al.* 2007, pp. iv-41
		Spencer *et al.* 2008, pp. xvi-37
	Aboveground live dry biomass	Maxent models (this document)
	Biomass excluding red fir	Spencer *et al.* 2007, pp. vi-41
	Tasseled-cap greenness	Maxent models (this document)
Prey availability	Habitat suitability for mammalian prey	Zielinski *et al.* 2010, pp. 1582-1587
		Zielinski and Yaeger, unpublished models
		Iredale *et al.* 2012, pp. 11-12
	Habitat suitability for ruffed grouse	Iredale *et al.* 2012, p. 12
Abiotic variables		
Precipitation	Annual precipitation	Spencer *et al.* 2007, pp. vi-20
		Spencer *et al.* 2008, pp. ix-47
		Carroll *et al.* 1999, pp. 1348-1356
		Carroll 2005, pp. 3-7
		Davis *et al.* 2007, pp. 2198-2208
	Precipitation as snow	Iredale *et al.* 2012, pp. 9-19
Winter temperature	Minimum temperature of coldest month	Maxent models (this document)
	Mean temperature of coldest quarter	Maxent models (this document)
	Maximum winter temperature	Iredale *et al.* 2012, pp. 9-12
Summer temperature	Maximum temperature of warmest month	Maxent models (this document)
Temperature stability	Isothermality	Maxent models (this document)
	Mean diurnal temperature range	Maxent models (this document)
Elevation	Latitude-adjusted elevation	Zielinski *et al.* 2010, pp. 1582-1587
		Spencer *et al.* 2008, pp. ix-43
		Spencer *et al.* 2007, pp. iv-41
		Davis *et al.* 2007, pp. 2198-2208
Sun exposure	Insolation index	Zielinski *et al.* 2010, pp. 1582-1587
		Spencer *et al.* 2008, pp. xix-43
		Spencer *et al.* 2007, pp. iv-41
		Zielinski and Yaeger, unpublished models
Ruggedness	Percent slope	Maxent models (this document)
		Zielinski *et al.* 2012, pp. 38-40
		Davis 2003, pp. 12-14
	Relief (standard deviation of elevation)	Davis *et al.* 2007, pp. 2198-2207
		Zielinski and Yaeger, unpublished models
	Terrain ruggedness index (average elevation difference between a cell and its neighbors)	Carroll 2005, pp. 3-7

Interactions	Citation
Canopy closure and percent conifer	Carroll *et al.* 1999, pp. 1350-1353
	Carroll 2005, p. 6
Tree size and annual precipitation	Carroll *et al.* 1999, pp. 1350-1356
	Carroll 2005, p. 6
Winter temperature and percent conifer	Maxent models (this document)
Winter temperature and summer temperature	Maxent models (this document)
Winter temperature and biomass	Maxent models (this document)

Table 4. Environmental predictors selected for Maxent models. See Table 2 for descriptions of each variable.

	Modeling Region		
Predictor	**Southern Sierra Nevada**	**Klamath and Southern Cascades**	**California and Southern Oregon Coast**
Canopy height	X		
Min temp coldest month	X		
Tasseled cap greenness	X		
Dense forest	X		
Tasseled cap wetness		X	
Conifer forest		X	
Latitude-adjusted elevation		X	
Slope		X	X
Biomass			X
Mean temp coldest quarter			X
Isothermality			X
Max temp warmest month			X

Table 5. Final variable list for expert model

Variable	Description	Explanation for inclusion	Citation for data source	Variable from data source	Form in model
Non-habitat	Land cover types that are clearly not habitat; see Appendix A for list	Some land cover types are not thought to provide fisher habitat, regardless of the value of other variables (for example, prey habitat or primary productivity). Within the model, these locations may still contribute to the moving averages of other variables.	LEMMA 2008; LEMMA 2012	ESLF_NAME	Threshold: areas within the listed land cover categories were assigned a habitat value of 0.
Fluffy snow	Winter temperatures on average below freezing, precipitation as snow is > 225 mm	Deep, fluffy snow is likely limiting to fishers, as it is energetically costly for them to move through.	Wang *et al.* 2013	PAS and tave_wt (average of values 1960-2011; recent decades weighted more heavily)	Threshold: If tave_wt < 0 (tave_wt < -1 for Olympic Peninsula) and PAS > 225, habitat value is 0.
Prey diversity index	Body-mass weighted index of prey species habitat; see text and Table 4	Prey availability is clearly necessary in order to support predator populations.	Bernert 2013, pers. comm.; Johnson *et al.* 1997; OSU 2013; Smith *et al.* 1997	Composite variable; see text	Threshold and logistic: If index indicates all small body size or very low diversity, habitat value is 0. Otherwise, habitat value increases with prey diversity index.
Dense forest	Proportion of 10 km^2 neighborhood with canopy cover >60% (>40% for Eastern Cascades)	Dense forest is the variable most consistently associated with fisher habitat according to the experts and the literature.	LEMMA 2008; LEMMA 2012	cancov	Logistic: Habitat value increases with proportion of neighborhood in dense forest. The logistic form leads to a zero habitat value at low proportions and levels off at high proportions.

Variable	Description	Explanation for inclusion	Citation for data source	Variable from data source	Form in model
Decadence and tree size/age	Proportion of 10 sq km neighborhood with Old Growth Structure Index > 50.	Fisher den cavities (and often rest sites) are located in large old trees and snags. High diameter diversity and volume of large downed wood are likely to provide hiding cover for fishers.	LEMMA 2008; LEMMA 2012; Spies *et al.* 2007, pp. 51-52	OGSI (Incorporates tree age, density of large trees, diameter diversity, density of large snags, and volume of large downed wood. Values of 50 or greater indicate old- growth characteristics.)	Logistic: Habitat value increases with proportion of neighborhood in old growth conditions. The logistic form leads to a zero habitat value at the very lowest proportions and levels off at medium and high proportions.
Tasseled cap greenness	Derived from satellite data, gives a measure of photosynthesis. Smoothed over a 10 sq km neighborhood.	This variable is a proxy for primary productivity, which is expected to be important for fishers (as it is for many organisms). Of the measures of primary productivity we considered, tasseled cap greenness was the least correlated with the other model variables.	Crist 1985; Huang 2002; Masek *et al.* 2006; USGS 2013; CBI 2013a	Tasseled cap greenness	Logistic: Habitat value increases with tassel-cap greenness.

Table 6 Prey species included in prey diversity index

Name	Mass (g)	Source for mass	Weight in model	WA	OR	Notes
California quail *Callipepla californica*	170	Price (2000, p. 2)	2	x	x	Galliformes in 8.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Northern bobwhite *Colinus virginianus*	155	Chumchal (2000, p. 2)	2	x		Galliformes in 8.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Mountain quail *Oreortyx pictus*	220	Sibley (2003, p. 132)	2	x	x	Galliformes in 8.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Chukar *Alectoris chukar*	595	Peterson (2001, p. 2)	3	x	x	Galliformes in 8.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Ruffed grouse *Bonasa umbellus*	644	Haupt (2001, p. 2)	3	x	x	Galliformes in 8.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Spruce grouse *Dendragapus canadensis*	460	Sibley (2003, p. 126)	3		x	Galliformes in 8.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Blue grouse *Dendragapus obscurus*	1050	Sibley (2003, p. 127)	4		x	Galliformes in 8.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Wild turkey *Meleagris gallopavo*	7300	McCullough (2001, p. 2)	4	x	x	Galliformes in 8.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Gray partridge *Perdix perdix*	390	Sibley (2003, p. 122)	3	x	x	Galliformes in 8.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Ring-necked pheasant *Phasianus colchicus*	1263	Switzer (2011, p. 3)	4	x	x	Galliformes in 8.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Sharp-tailed grouse *Tympanuchus phasianellus*	880	Sibley (2003, p. 123)	4		x	Galliformes in 8.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
White-tailed ptarmigan *Lagopus leucurus*	388	Hitztaler (2001, p. 3)	3		x	Galliformes in 8.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Mountain goat *Oreamnos americanus*	59450	Costello and Rosenburger (2014a)	4	x	x	Ungulates in >20% of ID fisher gastrointestinal tracts & scats (Jones 1991, p. 87)
Bighorn sheep *Ovis canadensis*	91500	Costello and Rosenburger (2014b)	4	x	x	Ungulates in >20% of ID fisher gastrointestinal tracts & scats (Jones 1991, p. 87)
Moose *Alces alces*	390000	Costello and Rosenburger (2014c)	4		x	In >10% of ID & BC fisher gastrointestinal tracts & scats (Jones 1991, p. 87; Weir *et al.* 2005, p. 14)
Elk *Cervus elaphus*	372500	Jameson and Peeters (2004, p. 244)	4	x	x	In >5% of ID fisher gastrointestinal tracts & scats (Jones 1991, p. 87)
Mule deer *Odocoileus hemionus*	125000	Burke Museum (2014)	4	x	x	*Odocoileus* spp. in 3-25% of CA, BC, MT & ID fisher gastrointestinal tracts & scats (Lofroth *et al.* 2010, p. 162)

Name	Mass (g)	Source for mass	Weight	WA	OR	Notes
White-tailed deer *Odocoileus virginianus*	97000	Dewey (2003, p. 3)	4	x	x	*Odocoileus* spp. in 3-25% of CA, BC, MT & ID fisher gastrointestinal tracts & scats (Lofroth *et al.* 2010, p. 162)
Striped skunk *Mephitis mephitis*	2900	Jameson and Peeters (2004, p. 185)	4	x	x	Mephitinae in 9.5% of fisher scats on Shasta-Trinity NF (Golightly *et al.* 2006, p. 18)
Western spotted skunk *Spilogale gracilis*	500	Jameson and Peeters (2004, p. 186)	3	x	x	Mephitinae in 9.5% of fisher scats on Shasta-Trinity NF (Golightly *et al.* 2006, p. 18)
American marten *Martes americana*	1000	Jameson and Peeters (2004, p. 182)	4	x	x	In 10.7% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Marsh shrew *Sorex bendirii*	16	Jameson and Peeters (2004, p. 116)	1	x	x	*Sorex* spp. in 0.8-14.9% of OR, CA & BC fisher GI tracts & scats (Lofroth *et al.* 2010, p. 161)
Water shrew *Sorex palustris*	11	Jameson and Peeters (2004, p. 118)	1	x	x	*Sorex* spp. in 0.8-14.9% of OR, CA & BC fisher GI tracts & scats (Lofroth *et al.* 2010, p. 161)
Fog shrew *Sorex sonomae*	10	Costello and Rosenburger (2014d)	1	x		*Sorex* spp. in 0.8-14.9% of OR, CA & BC fisher GI tracts & scats (Lofroth *et al.* 2010, p. 161)
Shrew-mole *Neurotrichus gibbsii*	12	Jameson and Peeters (2004, p. 125)	1	x	x	In 5.7% of NW CA fisher scats (Golightly *et al.* 2006, p. 17)
Broad-footed mole *Scapanus latimanus*	22	Jameson and Peeters (2004, p. 126)	1	x		In 12.5% of CA fisher stomachs (Grenfell and Fasenfast 1979, p. 188)
Coast mole *Scapanus orarius*	58	Jameson and Peeters (2004, p. 127)	2	x	x	*Scapanus* spp. in 14.7% of NW CA fisher scats (Golightly et al. 2006 ,p. 17)
Townsend's mole *Scapanus townsendii*	133	Jameson and Peeters (2004, p. 127)	2	x	x	*Scapanus* spp. in 14.7% of NW CA fisher scats (Golightly et al. 2006, p. 17)
Pygmy rabbit *Brachylagus idahoensis*	422	Costello and Rosenburger (2014e)	3	x	x	Lagomorphs in up to 50% of OR, CA and ID fisher gastrointestinal tracts & scats (Lofroth *et al.* 2010, p. 161)
Snowshoe hare *Lepus americanus*	1000	Jameson and Peeters (2004, p. 361)	4	x	x	In up to 50% of BC, MT and ID fisher gastrointestinal tracts & scats (Lofroth *et al.* 2010, p. 161)
Black-tailed jack rabbit *Lepus californicus*	1750	Jameson and Peeters (2004, p. 362)	4	x	x	Lagomorphs in up to 50% of OR, CA and ID fisher gastrointestinal tracts & scats (Lofroth *et al.* 2010, p. 161)
White-tailed jack rabbit *Lepus townsendii*	3500	Costello and Rosenburger (2014f)	4	x	x	Lagomorphs in up to 50% of OR, CA and ID fisher gastrointestinal tracts & scats (Lofroth *et al.* 2010, p. 161)
Brush rabbit *Sylvilagus bachmani*	700	Jameson and Peeters (2004, p. 365)	3	x		In 12.5% of CA fisher stomachs (Grenfell and Fasenfast 1979, p. 188)
Eastern cottontail *Sylvilagus floridanus*	1167	Costello and Rosenburger (2014g)	4	x	x	Lagomorphs in up to 50% of OR, CA and ID fisher gastrointestinal tracts & scats (Lofroth *et al.* 2010, p. 161)
Mountain cottontail *Sylvilagus nuttallii*	815	Jameson and Peeters (2004, p. 366)	3	x	x	Lagomorphs in up to 50% of OR, CA and ID fisher gastrointestinal tracts & scats (Lofroth *et al.* 2010, p. 161)
American pika *Ochotona princeps*	125	Jameson and Peeters (2004, p. 359)	2	x	x	Lagomorphs in up to 50% of OR, CA and ID fisher gastrointestinal tracts & scats (Lofroth *et al.* 2010, p. 161)

Name	Mass (g)	Source for mass	Weight	WA	OR	Notes
Mountain beaver *Aplodontia rufa*	900	Jameson and Peeters (2004, p. 256)	4	x	x	Observations of fisher predation on *A. rufa* from Olympic population (Lewis 2013, pers. comm.)
American beaver *Castor canadensis*	18500	Jameson and Peeters (2004, p. 285)	4	x	x	In 5.5-28.6% of ID & BC fisher gastrointestinal tracts & scats (Jones *et al.* 1991, p.87; Weir *et al.* 2005, p. 18)
Western jumping mouse *Zapus princeps*	23	Jameson and Peeters (2004, p. 288)	1	x	x	In 5.5% of ID fisher scats (Jones *et al.* 1991, p.87)
Pacific jumping mouse *Zapus trinotatus*	20	Jameson and Peeters (2004, p. 288)	1	x	x	*Zapus* spp. in 0.2-5.5% of OR and ID fisher scats (Jones et al. 1991, p.87; Aubrey & Raley 2006)
Common porcupine *Erethizon dorsatum*	14000	Jameson and Peeters (2004, p. 254)	4	x	x	In 1.8-19.5% of OR, BC, MT and ID fisher gastrointestinal tracts & scats (Lofroth *et al.* 2010, p. 162)
Botta's pocket gopher *Thomomys bottae*	156	Jameson and Peeters (2004, p. 291)	2	x		In 3.8-6.1% of CA fisher scats (Zielinski *et al.* 1999)
Western pocket gopher *Thomomys mazama*	105	Jameson and Peeters (2004, p. 292)	2	x	x	*Thomomys* spp. in 0.5-6.1% of OR, CA and ID fisher scats (Lofroth *et al.* 2010, p. 161)
Northern pocket gopher *Thomomys talpoides*	110	Costello and Rosenburger (2014h)	2	x	x	*Thomomys* spp. in 0.5-6.1% of OR, CA and ID fisher scats (Lofroth *et al.* 2010, p. 161)
Camas pocket gopher *Thomymys bulbivorus*	401	Costello and Rosenburger (2014i)	3	x		*Thomomys* spp. in 0.5-6.1% of OR, CA and ID fisher scats (Lofroth *et al.* 2010, p. 161)
White-footed vole *Arborimus albipes*	23	Jameson and Peeters (2004, p. 341)	1	x		*Arborimus* spp. in 9.2% of Six Rivers NF fisher scats (Golightly *et al.* 2006, p. 17)
Red tree vole *Arborimus longicaudus*	36	Costello and Rosenburger (2014j)	1	x		*Arborimus* spp. in 9.2% of Six Rivers NF fisher scats (Golightly *et al.* 2006, p. 17)
Gapper's red-backed vole *Myodes gapperi*	24	Costello and Rosenburger (2014k)	1		x	In 5.5-28.6% of ID & BC fisher gastrointestinal tracts & scats (Jones *et al.* 1991, p. 87; Weir *et al.* 2005, p. 14)
Western red-backed vole *Myodes californicus*	28	Nowak (1999, p. 1460)	1	x		*Myodes* spp. in 0.2-28.6% of CA, ID & BC fisher gastrointestinal tracts & scats (Lofroth *et al.* 2010, p. 161)
Sagebrush vole *Lemmiscus curtatus*	28	Costello and Rosenburger (2014l)	1	x	x	Unknown voles in 27.7% of ID fisher scats (Jones *et al.* 1991, p. 87)
California vole *Microtus californicus*	54	Jameson and Peeters (2004, p. 346)	2	x		*Microtus* spp. in 0.5-12.5% of CA, MT & BC fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Gray-tailed vole *Microtus canicaudus*	45	Costello and Rosenburger (2014m)	1	x	x	*Microtus* spp. in 0.5-12.5% of CA, MT & BC fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Long-tailed vole *Microtus longicaudus*	39	Jameson and Peeters (2004, p. 347)	1	x	x	*Microtus* spp. in 0.5-12.5% of CA, MT & BC fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Montane vole *Microtus montanus*	48	Jameson and Peeters (2004, p. 348)	1	x	x	*Microtus* spp. in 0.5-12.5% of CA, MT & BC fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Creeping vole *Microtus oregoni*	20	Jameson and Peeters (2004, p. 349)	1	x	x	*Microtus* spp. in 0.5-12.5% of CA, MT & BC fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)

Name	Mass (g)	Source for mass	Weight	WA	OR	Notes
Meadow vole *Microtus pennsylvanicus*	49	Costello and Rosenburger (2014n)	1		x	*Microtus* spp. in 0.5-12.5% of CA, MT & BC fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Richardson`s (Water) vole *Microtus richardsoni*	114	Costello and Rosenburger (2014o)	2	x	x	*Microtus* spp. in 0.5-12.5% of CA, MT & BC fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Townsend's Vole *Microtus townsendii*	79	Jameson and Peeters (2004, p. 350)	2	x	x	*Microtus* spp. in 0.5-12.5% of CA, MT & BC fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Bushy-tailed woodrat *Neotoma cinerea*	328	Jameson and Peeters (2004, p. 325)	3	x	x	*Neotoma* spp in 0.2-7% of CA, BC & MT fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Dusky-footed woodrat *Neotoma fuscipes*	271	Jameson and Peeters (2004, p. 326)	3	x		*Neotoma* spp in 0.2-7% of CA, BC & MT fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Common muskrat *Ondatra zibethicus*	1250	Jameson and Peeters (2004, p. 351)	4	x	x	In 17.2% of BC fisher stomachs (Weir *et al.* 2005, p.14)
Canyon mouse *Peromyscus crinitus*	17	Costello and Rosenburger (2014p)	1	x		*Peromyscus* spp in 0.5-25% of CA, BC, MT & ID fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Forest deer mouse *Peromyscus keeni*	20	Costello and Rosenburger (2014q)	1		x	*Peromyscus* spp in 0.5-25% of CA, BC, MT & ID fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Deer mouse *Peromyscus maniculatus*	20	Jameson and Peeters (2004, p. 336)	1	x	x	In 15.8% of BC fisher stomachs (Weir *et al.* 2005, p. 14)
Pinyon mouse *Peromyscus truei*	25	Jameson and Peeters (2004, p. 336)	1	x		*Peromyscus* spp in 0.5-25% of CA, BC, MT & ID fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Heather vole *Phenacomys intermedius*	38.	Nowak (1999, p. 1466)	1	x	x	*Peromyscus* spp in 0.5-25% of CA, BC, MT & ID fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Western harvest mouse *Reithrodontomys megalotis*	12	Jameson and Peeters (2004, p. 337)	1	x	x	In 12.5% of CA fisher stomachs (Grenfell and Fasenfast 1979, p. 188)
Northern flying squirrel *Glaucomys sabrinus*	118	Nowak (1999, p. 1297)	2	x	x	In 0.5-8.4% of OR, CA & BC fisher scats & stomachs (Lofroth *et al.* 2010, p. 161)
Hoary marmot *Marmota caligata*	5500	Costello and Rosenburger (2014r)	4		x	*Marmota* spp in 5.5-14.3% ID fisher gastrointestinal tracts & scats (Jones *et al.* 1991, p. 87)
Yellow-bellied marmot *Marmota flaviventris*	2750	Jameson and Peeters (2004, p. 269)	4	x	x	In 5.5-14.3% ID fisher gastrointestinal tracts & scats (Jones *et al.* 1991, p. 87)
Olympic marmot *Marmota olympus*	6000	Costello and Rosenburger (2014s)	4		x	*Marmota* spp in 5.5-14.3% ID fisher gastrointestinal tracts & scats (Jones *et al.* 1991, p. 87)
Yellow-pine chipmunk *Neotamias amoenus*	43	Jameson and Peeters (2004, p. 278)	1	x	x	*Tamias* spp in 1-11.3% of OR, CA, MT & ID fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Least chipmunk *Neotamias minimus*	44	Costello and Rosenburger (2014x)	1	x	x	*Tamias* spp in 1-11.3% of OR, CA, MT & ID fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Allen's chipmunk *Neotamias senex*	84	Jameson and Peeters (2004, p. 282)	2	x		*Tamias* spp in 1-11.3% of OR, CA, MT & ID fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)

Name	Mass (g)	Source for mass	Weight	WA	OR	Notes
Siskiyou chipmunk *Neotamias siskiyou*	75	Jameson and Peeters (2004, p. 283)	2	x		*Tamias* spp in 1-11.3% of OR, CA, MT & ID fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
Townsend`s chipmunk *Neotamias townsendii*	104	Costello and Rosenburger (2014y)	2	x	x	*Tamias* spp in 1-11.3% of OR, CA, MT & ID fisher scats (Lofroth *et al.* 2010, p. 161)
Western gray squirrel *Sciurus griseus*	818	Jameson and Peeters (2004, p. 270)	3	x	x	In 0.2-12.5% of OR & CA fisher stomachs & scats (Lofroth *et al.* 2010, p. 161)
California ground squirrel *Spermophilus beecheyi*	475	Jameson and Peeters (2004, p. 262)	3	x	x	In 3.8-11.1% of OR & CA fisher scats (Lofroth *et al.* 2010, p. 161)
Belding's ground squirrel *Spermophilus beldingi*	216	Jameson and Peeters (2004, p. 263)	2	x		*Spermophilus* spp in 1-11.1% of OR, CA & ID fisher scats (Lofroth *et al.* 2010)
Colulmbian ground squirrel *Spermophilus columbianus*	576	Costello and Rosenburger (2014t)	3		x	*Spermophilus* spp in 1-11.1% of OR, CA & ID fisher scats (Lofroth *et al.* 2010, p. 161)
Golden-mantled ground squirrel *Spermophilus lateralis*	191	Jameson and Peeters (2004, p. 264)	2	x	x	*Spermophilus* spp in 1-11.1% of OR, CA & ID fisher scats (Lofroth *et al.* 2010, p. 161)
Cascade golden-mantled ground squirrel *Spermophilus saturates*	250	Costello and Rosenburger (2014u)	3		x	*Spermophilus* spp in 1-11.1% of OR, CA & ID fisher scats (Lofroth *et al.* 2010, p. 161)
Townsend`s ground squirrel *Spermophilus townsendii*	150	Costello and Rosenburger (2014v)	1		x	*Spermophilus* spp in 1-11.1% of OR, CA & ID fisher scats (Lofroth *et al.* 2010, p. 161)
Washington ground squirrel *Spermophilus washingtoni*	210	Costello and Rosenburger (2014w)	2		x	*Spermophilus* spp in 1-11.1% of OR, CA & ID fisher scats (Lofroth *et al.* 2010, p. 161)
Douglas' squirrel *Tamiasciurus douglasii*	250	Jameson and Peeters (2004, p. 273)	3	x	x	In 2.6-11.1% of OR & CA fisher scats (Lofroth *et al.* 2010, p. 161)
Red squirrel *Tamiasciurus hudsonicus*	195	Costello and Rosenburger (2014z)	2		x	In 14.3-33.5% of BC & ID fisher gastrointestinal tracts & scats (Weir *et al.* 2005, p. 14; Jones *et al.* 1991, p. 87)

Appendix A: Full list of non-habitat land cover classifications (ESLF_NAME: LEMMA 2008, LEMMA 2013)

California Central Valley and Southern Coastal Grassland; Southern California Coastal Scrub; Central California Coast Ranges Cliff and Canyon; Emergent Herbaceous Wetlands; Grassland/Herbaceous; Unconsolidated Shore; Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland; Rocky Mountain Alpine Fell-Field; Barren Land (Rock/Sand/Clay); Cultivated Crops and Irrigated Agriculture; Rocky Mountain Alpine Bedrock and Scree; Invasive Annual / Perennial Grassland / Forbland; Agriculture; Conservation Reserve Program; California Mesic Serpentine Grassland; California Northern Coastal Grassland; California Xeric Serpentine Chaparral; Columbia Basin Foothill and Canyon Dry Grassland; Columbia Basin Foothill Riparian Woodland and Shrubland; Columbia Basin Palouse Prairie; Columbia Plateau Ash and Tuff Badland; Columbia Plateau Low Sagebrush Steppe; Columbia Plateau Scabland Shrubland; Columbia Plateau Silver Sagebrush Seasonally Flooded Shrub-Steppe; Columbia Plateau Steppe and Grassland; Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland; Great Basin Xeric Mixed Sagebrush Shrubland; Inter-Mountain Basins Alkaline Closed Depression; Inter-Mountain Basins Big Sagebrush Shrubland; Inter-Mountain Basins Big Sagebrush Steppe; Inter-Mountain Basins Cliff and Canyon; Inter-Mountain Basins Greasewood Flat; Inter-Mountain Basins Mixed Salt Desert Scrub; Inter-Mountain Basins Playa; Inter-Mountain Basins Semi-Desert Grassland; Inter-Mountain Basins Semi-Desert Shrub-Steppe; Inter-Mountain Basins Volcanic Rock and Cinder Land; Klamath-Siskiyou Cliff and Outcrop; Mediterranean California Alpine Bedrock and Scree; Mediterranean California Alpine Dry Tundra; Mediterranean California Alpine Fell-Field; Mediterranean California Eelgrass Bed; Mediterranean California Foothill and Lower Montane Riparian Woodland; Mediterranean California Northern Coastal Dune; Mediterranean California Serpentine Barrens; Mediterranean California Serpentine Fen; Mediterranean California Serpentine Foothill and Lower Montane Riparian; Mediterranean California Subalpine Meadow; Mediterranean California Subalpine-Montane Fen; North American Alpine Ice Field; North American Arid West Emergent Marsh; North Pacific Alpine and Subalpine Bedrock and Scree; North Pacific Alpine and Subalpine Dry Grassland; North Pacific Avalanche Chute Shrubland; North Pacific Bog and Fen; North Pacific Coastal Cliff and Bluff; North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow; North Pacific Herbaceous Bald and Bluff; North Pacific Hypermaritime Shrub and Herbaceous Headland; North Pacific Intertidal Freshwater Wetland; North Pacific Lowland Riparian Forest and Shrubland; North Pacific Maritime Coastal Sand Dune and Strand; North Pacific Maritime Eelgrass Bed; North Pacific Montane Grassland; North Pacific Montane Massive Bedrock, Cliff and Talus; North Pacific Montane Riparian Woodland and Shrubland; North Pacific Montane Shrubland; North Pacific Serpentine Barren; North Pacific Shrub Swamp; North Pacific Volcanic Rock and Cinder Land; Northern and Central California Dry-Mesic Chaparral; Northern California Claypan Vernal Pool; Northern California Coastal Scrub; Northern Rocky Mountain Montane-Foothill Deciduous Shrubland; Northern Rocky Mountain Subalpine Deciduous Shrubland; Rocky Mountain Lower Montane Riparian Woodland and Shrubland; Rocky Mountain Subalpine-Montane Riparian Shrubland; Temperate Pacific Freshwater Aquatic Bed; Temperate Pacific Freshwater Emergent Marsh; Temperate Pacific Freshwater Mudflat; Temperate Pacific Intertidal Mudflat; Temperate Pacific Subalpine-Montane Wet Meadow; Temperate Pacific Tidal Salt and Brackish Marsh; Willamette Valley Upland Prairie and Savanna; Willamette Valley Wet Prairie; Inter-Mountain Basins Montane Sagebrush Steppe; Open Water; Perennial Ice/Snow; Developed, Open Space;

Developed, Low Intensity; Developed, Medium Intensity; Developed, High Intensity; Pasture/Hay; Cultivated Crops; Introduced Upland Vegetation – Shrub; Introduced Upland Vegetation - Annual and Biennial Forbland; Introduced Upland Vegetation - Annual Grassland; Northern Rocky Mountain Subalpine-Upper Montane Grassland; Recently burned grassland; Recently burned shrubland; High Structure Agriculture; Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland; Rocky Mountain Cliff, Canyon and Massive Bedrock

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Appendix C. Quantitative analysis, as presented in the 2014 draft Species Report (Service 2014).

We are no longer using the quantitative analysis values for scope and severity (for eight subregions) that we presented in the draft Species Report (Service 2014) and summarized in the West Coast DPS of fisher's proposed listing rule (79 FR 60419). Instead, we have provided a qualitative explanation of the underlying data used for that analysis (see "REVIEW OF STRESSORS" section of this report), in addition to our reanalysis of that underlying data and review of new information made available since the proposed listing rule. This change is due to the concerns raised by peer reviewers, partners, and the public during the open comment periods on the proposed listing rule regarding the usefulness of quantitative measures, as well as our subsequent internal deliberations in response to those comments regarding the subjectivity of those values (for example, assumptions that were made to estimate what maybe occurring in suitable, unoccupied habitat within the analysis area). We have concluded that our previous analyses heavily relied on *subjective values* (through the quantitative analyses) of how a particular stressor may be impacting the DPS currently and into the future. In contrast, our reanalysis of the best available information and our consideration of new information (when applicable) since the time of the proposed listing is an *objective qualitative examination* of the best available data, which demonstrates the magnitude and extent of how a particular stressor may be impacting the DPS at the individual-, population-, or rangewide-levels both currently and into the future. However, we believed it important to retain the previous quantitative analysis as part of this record. Thus, the following paragraphs include our previous quantitative analysis and associated discussion, including the calculated values for scope and severity, followed by the overall summary tables that were presented in the draft Species Report (Service 2014).

Scope of the Stressor

Scope is the proportion of the fisher analysis area sub-region that can reasonably be expected to be affected by a stressor within the appropriate time period of the stressor, given continuation of current circumstances and trends (Figure 1). Current circumstances and trends include both existing and potential new stressors. We derived the scope of the stressor from the overall percentage of the population or analysis area sub-region that may potentially be impacted by the stressor. We emphasize that these are estimates and not the exact number of fishers at each location. However, this is the best scientific data available at this time.

For an example of scope, consider the stressor of toxicants associated with the illegal cultivation of marijuana. We assigned a scope ranging from 23 to 95 percent based on the following rational (see section Exposure to Toxicants below for additional detail). When a 4 km buffer (approximating the area that a male fisher may encompass as a home range) is applied to illegal marijuana cultivation sites eradicated by law enforcement over a two-year period, the sum area of those buffers roughly approximates 23 percent (low scope) of the fishers' current range in California (Higley 2013, pers. comm.). Because the number of illegal cultivation sites detected and eradicated annually is estimated to be between 15 to 50 percent of active sites, and many sites have not been remediated (toxicants removed), it is possible that as many as 95 percent (large scope) of fishers may be exposed to toxicants associated with these sites over the next 40 years.

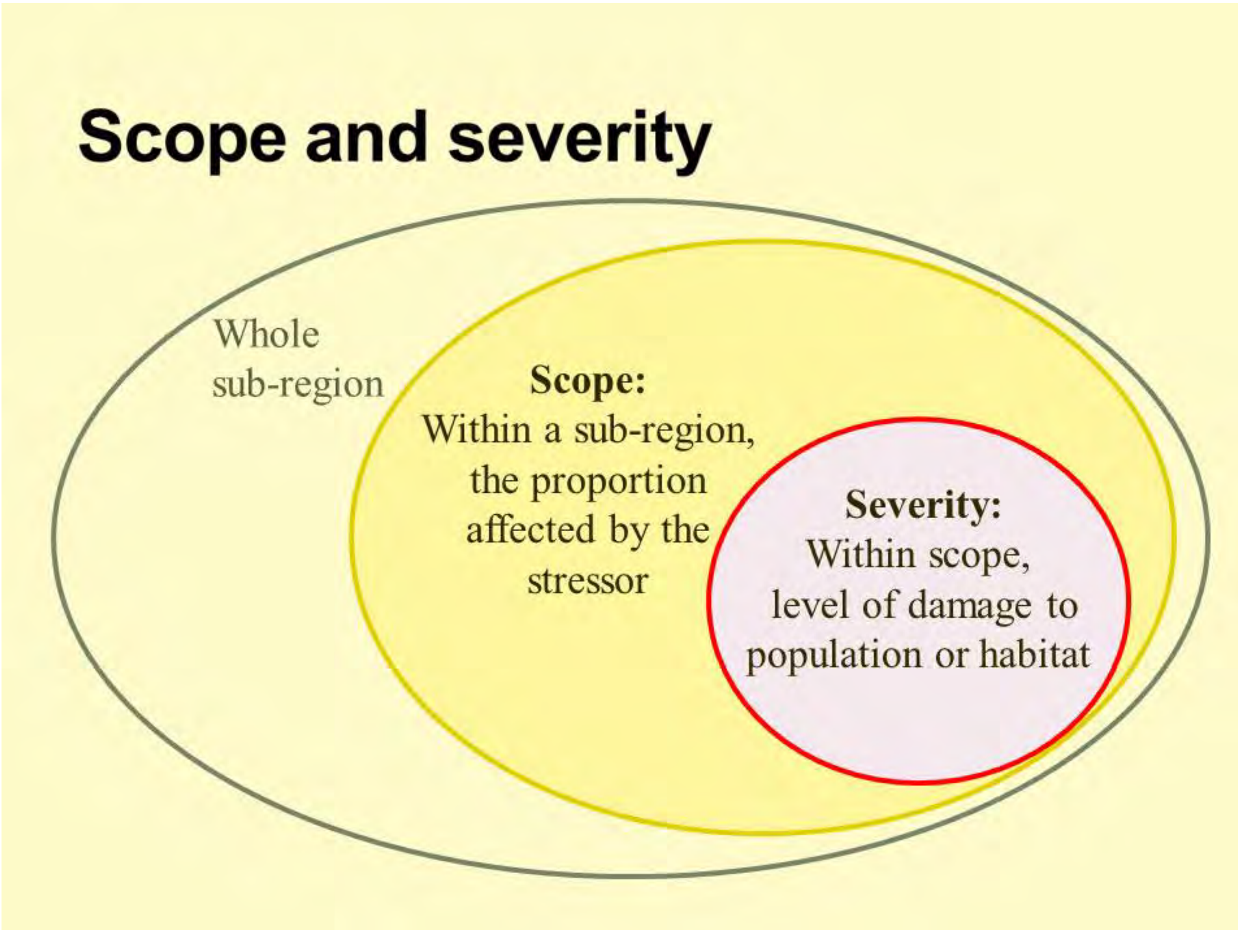

Figure 1. Relationship between a population, and the scope and severity of a stressor acting within that population.

Severity of the Stressor

Within the scope of the stressor, the severity is the level of damage to fisher populations or their habitat that can reasonably be expected from the stressor within the appropriate period for the given stressor assuming continuation of current circumstances and trends (Figure 1). For habitat-related stressors, we calculated the severity as the proportion of habitat within the scope that we expect to be lost or rendered significantly less suitable for fisher use due to the stressor.

For most stressors that affect fishers directly (as opposed to stressors that affect habitat), we derived severity estimates from preliminary data reporting specific sources of mortality affecting study populations of fishers in California (Gabriel 2013b, pers. comm., Sweitzer 2013a, pers. comm.). We determined what proportion of all reported mortality was due to a specific stressor, and then adjusted that proportion to correct for the fact that the stressor only affects those fishers within the scope of the stressor. This adjustment for scope was necessary, because if only part of the study population was within the scope of the stressor in question, but we assumed that the whole study population was within the scope, we would underestimate the severity of the stressor. We give a range of severity estimates for many stressors because there is a range of data sources available, and because the severity calculations vary depending on the assumptions we make about the scope. For these stressors, our severity numbers give estimates of the percentage of fishers that die annually due to the stressor in question.

To illustrate a severity calculation, we continue with the toxicant stressor. For ease of describing calculations, we assume a population size of 1,000 fishers living in Northern California-Southwestern Oregon (Table 1). A population size of 1,000 is within the range of estimates given for this population (Tucker *et al.* 2012, p. 10), but we use it here for illustrative purposes, not to imply that it is the best estimate. Using an estimate of 36 percent mortality for all sources of mortality in this region (Swiers 2013, p. 19), 360 fishers from our hypothetical population of 1000 die in a given year. As a specific source of mortality, toxicosis caused 12 percent of all deaths (5 of 41) of fishers in one study in northern California (Gabriel 2013b, pers. comm.), but it was not clear how many of the fishers in the study fell within the scope of the stressor. Extrapolating this study result to our hypothetical population of 1000 fishers, toxicosis would account for 43 fisher mortalities (12 percent of the 360 annual mortalities) of our hypothetical population. These 43 mortalities need to be considered within the scope of potential exposure (described above as between 23 percent and 95 percent). Using first the small scope of 23 percent, 230 (of the 1000) fishers were exposed to toxicants, resulting in 43 deaths attributed to toxicosis. Therefore, within the scope, severity is 19 percent (43 of 230 fishers). If we used the larger 95 percent scope in this example, without altering any other numbers, the severity calculation would return a value of 5 percent. Note that the severity calculation is higher if the scope is small, because the same number of fisher deaths due to toxicosis are distributed among a smaller number of animals. We calculated the severity in this way because we have better information about mortality due to each stressor than we do about the proportions of animals that are exposed to each stressor, or the sublethal consequences of such exposure. Our severity calculation given in the Exposure to Toxicants section below differs from the calculation given above, because we were able to find a study that allowed us to identify the scope for the animals within the study. We provide the above calculation to illustrate why the scope must be taken into account in calculations of severity.

Following are the individual quantitative analyses for each stressor as presented in the Draft Species Report (Service 2014).

Table 1. Steps to calculate low and high severity (as annual mortality) of toxicant exposure.

1000	Hypothetical population to illustrate calculation
36%	One estimate of regional mortality (Swiers 2013, p. 19)
360	Number of fishers that die annually (all causes of mortality) [36% of 1000]
12%	Percentage of all deaths that are due to toxicosis
43	Number of mortalities due to toxicosis [12% of 360]
23%	Small scope (percent population potentially exposed to toxicants)
95%	Large scope (percent population potentially exposed to toxicants)
230	Number of fishers potentially exposed with small scope estimate [23% of 1000]
950	Number of fishers potentially exposed with large scope estimate [95% of 1000]
19%	Severity with small scope - percent annual mortality attributed to toxicosis [43/230]
5%	Severity with large scope - percent annual mortality attributed to toxicosis [43/950]

Wildfire, Emergency Fire Suppression Actions, and Post-fire Management Actions

The naturally-occurring fire regimes vary widely across the analysis area, and therefore the effects of wildfire are also likely to vary geographically. In general, high severity fire has the potential to permanently remove suitable fisher habitat, and is very likely to remove habitat for a period of many decades while the forest regrows. Moderate severity fire may also remove habitat, but likely in smaller patches and for a shorter length of time. Low severity fire may both reduce and create some elements of fisher habitat temporarily (snags, down logs, damage to trees leading to potential for fungi creation of cavities), and in general is unlikely to remove habitat. Fishers' behavioral and population responses to fires are unknown, but it seems likely that large fires, particularly those of higher severity and larger scale, could cause shifts in home ranges and movement patterns, lower the fitness of fishers remaining in the burned area (due to increased predation, for example), or create barriers to dispersal. Fire suppression actions and post-fire management have the potential to exacerbate the effects of wildfire on fisher habitat.

The timing of stressors related to wildfire is ongoing, and the frequency and size of wildfires appear to be increasing. Among fires larger than 1000 ac (4 km^2) between 1994 and 2010, the Pacific Northwest and California showed a trend toward larger fires on average during the period 2000-2005 as compared with 1984-1999, but there was no indication that wildfire severity had increased (Schwind 2008, p. 26). The proportion of fires that burn at high severity has not shown any trend, positive or negative, during the past 25 to 30 years in Washington, Oregon, and northwestern California, (Dillon *et al.* 2011, p. 8, 18; Miller *et al.* 2012, p. 161). However, even if there is no change in the proportion burned at high severity, given the trend to larger fires, the absolute area burned at high severity will increase. In addition, at least one forest type used by fisher, the yellow pine-mixed conifer forests in the Sierra Nevada, may have been subject to increasingly severe, as well as increasingly large, fires (Miller and Safford 2012, p. 46), although not all researchers agree with this result (Hanson and Odion 2013, p. D). Thus, the scope is likely to increase over time, and the severity may increase over time in some ecotypes.

To calculate the scope of the stressors related to wildfire (Table 2), we mapped fires of all severities, over 4 km^2 (1000 ac) that burned between 1984 and 2011 (MTBS 2013, shapefiles) over the fisher habitat map developed for this species report. Within each sub-region of the analysis area, we calculated the amount of high quality and intermediate habitat that burned over this time period, and extrapolated the amount that will likely burn over the next 40 years and the next 100 years, assuming that the average area burned per year remains the same. In the Sierra Nevada, Northern California – Southwestern Oregon, the Eastern Oregon Cascades, and the Eastern Washington Cascades, the fire return interval is short enough that many areas are likely to burn more than once over 100 years, and would be double-counted by our estimation technique, leading to an overestimation of scope. However, the area burned per year is likely to increase in the future, which may cause us to underestimate the scope of wildfire-related stressors. Wildfire suppression actions and post-fire management generally take place within or at the edges of a fire's footprint, and therefore do not increase the scope of wildfire related stressors beyond what is already calculated here.

Table 2. Scope (percent) of wildfire-related stressors

Percent of available habitat (high & intermediate quality) burned at all severities	over 40 years	over 100 years
Sierra Nevada	24	60
Northern California - Southwestern Oregon	22	56
Western Oregon Cascades[B]	6	17
Eastern Oregon Cascades[B]	13	33
Coastal Oregon[A]	<1	<1
Western Washington Cascades[A]	<1	<1
Eastern Washington Cascades[A]	15	38
Coastal Washington[B]	<1	<1

[A]Sub-region where fisher populations are considered likely extirpated.
[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

To calculate the severity of the stressors related to wildfire (Table 3), we mapped areas within high quality and intermediate fisher habitat that burned at moderate or high severity between 1984 and 2011 (MTBS 2013, shapefiles). We assumed that areas burned at high severity would likely be unsuitable as fisher habitat for several decades post-fire, and would not develop the structures necessary for fisher resting and denning for approximately 100 years. In addition, some burned areas may be permanently converted to shrublands (Perry *et al.* 2011, pp. 707, 709), and others are likely to be converted to plantations, which if not carefully managed may be more likely to burn again at high severity, or to develop into stands that lack the structural diversity that contributes to high quality fisher habitat (USFS 2002, entire; Kobziar *et al.* 2009, p. 799). Over the next century, recruitment of some fisher habitat will occur as forests that are currently in mid- and early-seral stages continue to develop; however, the amount of fisher habitat recruitment is difficult to predict (Service 2011, pp. B7-B8). Our estimate of the severity of the wildfire-related stressors includes only an estimate of the habitat that will be lost to fire over this time period. Because the area burned by moderate and severe wildfire is likely to increase in the future, this estimate is likely an underestimate. Areas burned at moderate severity may continue to function as fisher habitat, or may represent a habitat loss. Therefore, our estimates give a range of severity values. The smaller value includes only areas burned by high severity fire, and the larger value includes all areas burned at moderate or high severity. Fire suppression actions, such as fuel breaks or other measures that remove strips of habitat or substantially reduce the large snag component of stands, may increase the severity of wildfire-related stressors beyond what we are able to estimate. Post-fire salvage and hazard-tree removal may also lead to increased severity of wildfire-related stressors, and potentially delay the recruitment of high quality fisher habitat in the burned area.

Table 3. Severity of wildfire-related stressors.

Sub-Region	Percentage of burned habitat lost (Severity)	Percentage of all available habitat lost to fire (scope multiplied by severity)	
		over 40 years	over 100 years
Sierra Nevada	21-44	5-11	13-26
Northern California-Southwestern Oregon	17-37	4-8	9-21
Western Oregon Cascades[B]	18-37	1-3	3-6
Eastern Oregon Cascades[B]	18-41	2-5	6-14
Coastal Oregon[A]	11-35	<1	<1
Western Washington Cascades[A]	5-27	<1	<1
Eastern Washington Cascades[A]	20-48	3-7	8-19
Coastal Washington[B]	10-34	<1	<1

[A]Sub-region where fisher populations are considered likely extirpated.
[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

Anthropogenic Influences, Insects, and Habitat Disease

No quantitative analysis was provided in the draft Species Report for this stressor (Service 2014).

Climate Change

All fisher habitat is likely to be affected by climate change (scope is 100 percent), but severity will vary among different regions, and will likely increase from the present time, through the foreseeable future, and into the late twenty-first century.

Severity estimates (Table 7) relate to reductions due to climate change in the amount of suitable habitat available in the region. These estimates are based on projected habitat loss, and we assume that changes between conifer forest types, or from conifer forest to mixed conifer-hardwood forest, will not be detrimental to fisher habitat; but that changes from forest to woodland, chaparral, grassland, or other open ecotypes will represent a loss of habitat. In cases where the amount of forested habitat is projected to stay the same, we still estimated a small amount of habitat loss due to climate-related increases in insect damage and disease, as these factors were not included in the vegetation models. In addition, some locations throughout the analysis area are projected to shift to novel climate conditions unlike any previously recorded for the western United States, which increases uncertainty about projected vegetation communities and future habitat suitability for fishers (Ackerly *et al.* 2012, pp. 19-34; Rehfeldt *et al.* 2006, p. 1142). Severity estimates for the late twenty-first century are based on projections for that time frame. Severity estimates for the mid-twenty-first century were estimated as being about half as severe as the late twenty-first century estimates, except where otherwise noted.

In addition to habitat losses due directly to changes in temperature and precipitation, climate change will influence habitat losses due to fire and forest disease. The severity of all of these may greatly increase from the present time, through the mid-twenty-first century, and on through the late twenty-first century. As discussed in the section on Cumulative and Synergistic Effects, these factors are likely to act synergistically to lead to habitat loss beyond what is described in Table 4, and beyond what is described in the stressor assessment for fire individually.

Table 4. Estimates of severity for climate-related loss of habitat.

Analysis area sub-region	Scope %	Severity % (mid-21st century)	Severity % (late 21st century)	Source for severity based on projected habitat loss
Sierra Nevada	100	1-31	1-62	Lawler *et al.* 2012, p. 387
Northern California-Southwestern Oregon	100	4-14	9-28	Lawler *et al.* 2012, p. 387
Oregon West Cascades[B]	100	1-4	3-55	Doppelt *et al.* 2009, p. 7 (modeled for 2035-2045; high estimate includes habitat changes from conifer to hardwood forest)
Oregon East Cascades[B]	100	1-5	1-10	Barr *et al.* 2010a, p. 17
Coastal Oregon[A]	100	1-5	1-10	Littell *et al.* 2013, p. 115
Washington West Cascades[A]	100	1-7	1-15	Littell *et al.* 2013, p. 115
Washington East Cascades[A]	100	1-10	1-20	Visual estimate from Littell *et al.* 2013, p. 115 (Fig. 5.3)
Coastal Washington[B]	100	1-5	1-10	Halofsky *et al.* 2011, pp. 68-73

[A]Sub-region where fisher populations are considered likely extirpated.
[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

Vegetation Management

Vegetation management activities (for example fuels reduction and timber production) that reduce large structures and overstory cover can negatively affect fisher reproduction, survival, recruitment, and availability of prey, as well as many other aspects of fisher biology and ecology (Naney *et al.* 2012, p 25). However, "vegetation management" is a broad category, and not all activities in this category are necessarily detrimental to fisher habitat, depending on their objectives and their implementation. For example, some activities may be designed to put low quality or non-habitat on a trajectory to attain fisher habitat, while others are designed to retain habitat conditions that support fishers. Still other activities, such as fire risk reduction when appropriately applied, may reduce habitat quality at the local scale in the short term to facilitate reducing the scale and severity of future fires in the landscape. Quantifying the effects to fisher habitat across the analysis area is difficult due to many factors including differences in forest types, silvicultural practices, project specific objectives, and regulatory mechanisms across this large area. Because there are no available data sources tracking changes specific to fisher habitat across the analysis area, our evaluation of the scope and severity of vegetation management relies upon several differing sources of information described below. The effects discussed below consider only ongoing and future (approximately 40 years) vegetation management activities and do not include habitat loss from other stressors such as wildfire or urbanization (see other stressor discussions above and below for summary of their effects).

We used the fisher analysis area habitat model as a reference point from which to evaluate current habitat conditions across the analysis area and estimate the future losses due to ongoing vegetation management activities. We assumed that harvest rates over the recent past (within 10 years) provide reasonable projections of ongoing and future habitat loss due to vegetation management activities and that land ownership generally affects the rates of vegetation management. That is, Federal lands generally manage at lower rates than non-Federal lands. To assist with our evaluation of the effects of vegetation management, we derived "coefficients of management activity" for Federal and non-Federal lands to obtain an index of the potential exposure (scope) of vegetation management resulting in habitat loss in each analysis area sub-region. In interpreting the output of this analysis, we must caution that the fisher analysis area habitat model identified significantly more acres of intermediate and high-quality fisher habitat within the NWFP area than was identified as suitable northern spotted owl nesting/roosting habitat by Davis *et al.* (2011, pp. 21-99, Appendix D-3) (see Northwest Forest Plan values in Appendix A of this document compared to Appendix D-3, p. 123, of Davis *et al.* 2011). There are many potential reasons for this difference. For instance much of the area in Oregon and Washington in the fisher habitat model is an expert model. In this area we were unable to base the modeled habitat on actual fisher detection locations due to the lack of available data from fisher studies in the reintroduced populations or because fishers have not been detected. In areas where the fisher model was based on fisher detections, these were from survey stations or incidental camera captures, and do not represent den sites. The Davis northern spotted owl habitat model was based on northern spotted owl nest locations throughout the various sub-regions within the NWFP area. Because the fisher detection data represent locations that may be anywhere within a fisher home range, the underlying environmental data for the fisher model was smoothed over a 10 km^2 neighborhood representing the size of a fisher home range; in their northern spotted owl nesting habitat model, Davis *et al.* (2011, p. 42) modeled the habitat value at much finer spatial scales. As a result, Service review of the model output in Washington shows that fisher habitat includes some younger forest stands and intensively managed timber lands, and this may apply to other areas as well. Note that the two models cannot be compared in the Sierra Nevada or along the eastern edge of the analysis area, because the Davis *et al.* (2011) model extent was limited to the NWFP area.

Without an available large-scale fisher habitat tracking database, our scope estimate for Federal land used a summary of northern spotted owl suitable habitat that was removed or downgraded as documented through Section 7 consultations within the NWFP area. Because of the similarity between the two animals' habitat requirements (see above), we determined this to be one of the best sources of data to evaluate the potential effects of vegetation management on loss of fisher habitat on Federal lands throughout the analysis area. The Service's Environmental Conservation Online System (ECOS) database tracks Section 7 consultations under various categories including: land management agency, land-use allocation, physiographic province, and type of habitat affected. This data source allowed us to compare the pre-existing baseline of northern spotted owl habitat amounts and summary of effects by State and Physiographic Province, from 2006 to July 18, 2013, by identifying past vegetation management activity on Federal lands that adversely affected northern spotted owl habitats and that could potentially affect suitable habitat for fishers (Table 5). We divided the acres of habitat that were removed or downgraded by the evaluation baseline to quantify the proportion of each provincial baseline managed over the seven-year period, which provides us an index of potential management within fisher habitat on Federal ownership that we refer to as the "coefficient of vegetation management."

We provide this analysis, based on data in Table 5, with caveats to consider. First, we used acres of vegetation management treatments in northern spotted owl habitat; which, is a reasonable surrogate for fisher habitat but not equivalent. Second, we only considered the acres of northern spotted owl habitat that were either removed or downgraded by vegetation management treatments. Data in Table 5 include not only northern spotted owl habitat that is removed (such as habitat that is treated to the point where canopy cover drops below 40 percent), but also treatments that downgrade habitat, that is, remove specific features such that the area may continue to provide some life history needs of the species, but may no longer support other needs. For example, Table 5 includes vegetation management in northern spotted owl foraging habitat that temporarily reduces the canopy cover below 60 percent. Thus, some treated areas represented in this table may continue to meet some northern spotted owl needs, as well as provide low- or moderate-quality fisher habitat and we have reflected these effects to fisher habitat in the estimated range of severity values. Lastly, in using northern spotted owl habitat data presented in Table 5 the removal or downgrading of foraging habitat in California is not specifically included in Table 5, thus resulting in an under-representation of spotted owl habitat (and by representation fisher habitat) removed or downgraded in the NWFP area of California. In that respect, our estimates of effects to fisher habitat for this analysis may be an underestimate. Lastly, we note that these data represent projects planned by the Federal agencies at the time, and it is not known what proportion was actually implemented or if the final effects were as severe as described in the Section 7 consultation process. For example, harvest units can be removed from a project based on non-ESA natural resource concerns, and whole projects can be delayed or withdrawn based on agency funding and litigation outcomes, thus the potential effects may not have been realized.

Table 5. Summary of northern spotted owl suitable habitat acres removed or downgraded as documented through Section 7 consultations on all Federal Lands within the Northwest Forest Plan area. Environmental baseline and summary of effects by State, Physiographic Province, and Land Use Function from 2006 to July 18, 2013.

State	Physiographic Province[1]	Evaluation Baseline (2006/2007)[2]	Habitat Removed/Downgraded[3]			Percent Provincial Baseline[6] Affected (7 yr.)
			Land Management Effects			
		Total Nesting Roosting Acres	Reserves[5]	Non-Reserves	Total	
WA[4]	Eastern Cascades	643,500	2,700	2,238	4,938	0.8
	Olympic Peninsula	762,400	6	0	6	0.0
	Western Cascades	1,278,200	529	831	1,360	0.1
	Western Lowlands	24,300	0	0	0	0.0
OR	Cascades East	376,900	2,748	6840	9588	2.5
	Cascades West	2,214,800	1,126	22,820	23,946	1.1
	Coast Range	607,800	183	838	1021	0.2
	Klamath Mountains	884,300	2,617	4,676	7,293	0.8
	Willamette Valley	3,300	0	0	0	0.0
CA	Cascades	204,600	10	1	11	0.0
	Coast	143,000	274	1	275	0.2
	Klamath	1,412,100	75	646	721	0.1
Total		**8,555,200**	**10,268**	**38,891**	**49,159**	0.6

Table 5 Notes:
Defined in the Revised Recovery Plan for the Northern Spotted Owl (Service 2011, p. A-3) as Recovery Units as depicted on page A-3. The northern spotted owl physiographic provinces are analogous to those used in this fisher evaluation, but not perfectly aligned with one another. In WA and northern OR, the provinces corresponded one-to-one with our fisher sub-regions, albeit with slightly different boundaries. The Northern California – Southwestern Oregon fisher subregion substantially overlaps the Oregon Klamath Mountains Province and all three CA provinces, so we pooled these four provinces to calculate the coefficient of management for this subregion.

Spotted owl nesting and roosting habitat on all Federal lands (includes USFS, BLM, NPS, DoD, USFWS, etc.) as reported by Davis *et al.* (2011, Appendix D). Nesting and roosting habitat acres are approximate values based on 2006 (Oregon & Washington) and 2007 (California) satellite imagery.

Estimated nesting, roosting, foraging habitat that was removed or downgraded from land management (timber sales) as documented through section 7 consultations or technical assistance. Effects reported here include all acres that were removed or downgraded from 2006 to July 18, 2013. Effects in California reported here only include effects to nesting and roosting habitat. Foraging habitat that is independent of nesting and roosting habitat but is removed or downgraded in California is not summarized in this table.

Nesting, roosting, foraging habitat. In WA/OR, the values for nesting and roosting habitat generally represent the distribution of suitable owl habitat, including foraging habitat. In CA, foraging habitat occurs in a much broader range of forest types than what is represented by nesting and roosting habitat. Baseline information for foraging habitat as a separate category in CA is currently not available at a provincial scale in this database; however, California consultations use locally derived information to assess effects to foraging only.

Reserve land use allocations under the NWFP intended to provide demographic support for spotted owls include Late Successional Reserve, Managed Late Successional Area, and Congressionally Reserved Area. Non-reserve allocations under the NWFP intended to provide dispersal connectivity between reserves include Administratively Withdrawn Area, Adaptive Management Area, and Matrix.

Provincial baseline affected provides an index of potential management within fisher habitat. We use this “coefficient of vegetation management” for sub-region impact from federal vegetation management activities.

There is no similar data source for tracking effects to California spotted owl (*Strix occidentalis occidentalis*) habitat within the range of fishers in the Sierra Nevada so we used the northern spotted owl Section 7 database to infer the potential effects to fisher habitat for the Federal land in the Sierra Nevada sub-region. We used the coefficient from the northern spotted owl California Klamath Physiographic Province as a surrogate because it is one of the closest geographically and shares the most overlapping forest types with the Sierra Nevada fisher sub-region. Again, the Section 7 database we used did not account for treatments in northern spotted owl foraging habitat in California and therefore may under-represent fisher habitat loss as a result of vegetation management treatments in the Sierra Nevada.

To develop coefficients of vegetation management activities on non-Federal lands, we replicated the above approach using a database of approved Timber Harvest Plans (THP) submitted to the California Department of Forestry and Fire Protection (CAL FIRE) from 2003 to 2011 (The THP Tracking Center 2013, spreadsheet document). This database reports acreages by county of submitted timber harvest plans in California. We organized counties in California that would overlap with the Northern California-Southwestern Oregon sub-region and those in the Sierra Nevada sub-region (Table 6). We calculated a coefficient of vegetation management for each region by dividing the sum of the THP acres from 2003 to 2012 by the sum of non-Federal timberland acres over the same region. We acknowledge these are submitted plans over a 10-year period and may not represent actual on-the-ground harvests. Furthermore, activities described in some plans may not be occurring in or degrading or removing fisher habitat and some of the THP's may not overlap with the current or historical range of fishers. We determine that this approach used the best available data to approximate harvest over a 10-year period. We used a value mid-way between the two California regions as the coefficient of vegetation management for sub-regions within these states. We consider this to be an adequate proxy for Washington because stand-replacing timber harvest in the range of the northern spotted owl between 1992 and 2002 in Washington State was previously estimated (for the Washington State Forest Practices HCP and Biological Opinion) to occur at a rate of 1.1 to 1.3 percent per year on private lands (Service 2006, p. 392). Private timber harvest makes up the majority of non-Federal timber harvest in California, but Oregon and Washington have a much larger proportion of timber lands managed by State natural resource agencies. The significance of this difference is discussed later in this section.

Assuming these coefficients of vegetation management approximate harvest rates over the recent past, and can provide reasonable projections of ongoing and future vegetation management activities, we multiplied each coefficient by the appropriate constant to represent a future 40 year projection of management activity. That is, we divided the seven-year Federal ownership coefficient by 7, then multiplied by 40; and we multiplied the 10-year non-Federal coefficient by 4 to derive the values presented in Table 7 for use in the calculations of scope.

Table 6. Summary of habitat acres of approved Timber Harvest Plans submitted to the CAL FIRE from 2003 to 2012 (The THP Tracking Center 2013, spreadsheet document) used to derive a coefficient of vegetation management for non-Federal owned lands.

By County	Sum THP Acres 2003 to 2012	Non-Fed Timberland Acres	%Non-Fed Timberland Harvested
Northwestern CA			
Del Norte	9,338	106,023	8.8
Humboldt	126,676	1,234,885	10.3
Lake	1,450	100,104	1.4
Mendocino	131,541	1,408,582	9.3
Napa	132	108,598	0.1
Shasta	207,818	832,702	25.0
Siskiyou	167,130	836,828	20.0
Sonoma	10,585	433,352	2.4
Tehama	56,215	259,027	21.7
Trinity	51,409	428,952	12.0
	762,296	5,749,053	
			Coeff 0.133

By County	Sum THP Acres 2003 to 2012	Non-Fed Timberland Acres	%Non-Fed Timberland Harvested
Sierra Nevada			
Alpine	19	11,678	0.2
Amador	6,600	120,344	5.5
Butte	24,791	265,310	9.3
Calaveras	17,973	210,304	8.5
El Dorado	42,257	369,048	11.5
Fresno	18,969	95,663	19.8
Kern	3,483	149,044	2.3
Lassen	94,203	369,109	25.5
Madera	81	88,006	0.1
Mariposa	3,279	29,382	11.2
Nevada	37,407	288,256	13.0
Placer	38,094	239,259	15.9
Plumas	76,548	309,628	24.7
Sierra	24,529	110,625	22.2
Tulare	970	94,992	1.0
Tuolumne	16,354	159,905	10.2
Yuba	16,005	85,066	18.8
	421,562	2,995,619	
			Coeff 0.141

Table 7. Coefficient of Management Activity for Federal lands (excluding National Park Service Lands) and Non-Federal lands in the foreseeable future (approximately 40 years) across the analysis area used to calculate potential scope of vegetation management.

Analysis area sub-region	Coefficient of Management Activity – % Federal Ownership (40 years)	Coefficient of Management Activity – % Non- Federal Ownership (40 years)
Sierra Nevada	0.3	56.3
Northern California-Southwest Oregon	1.8	53.0
Coastal Oregon[A]	1.0	54.7
Eastern Oregon Cascades[B]	14.5	54.7
Western Oregon Cascades[B]	6.2	54.7
Washington Coast Ranges[B]	0.0	54.7
Eastern Washington Cascades[A]	4.4	54.7
Western Washington Cascades[A]	0.6	54.7

[A]Sub-region where fisher populations are considered likely extirpated.
[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

To calculate scope (potential area of habitat loss as a result of vegetation management), we used GIS to derive the area of modeled fisher habitat (intermediate and high quality) within each Federal and non-Federal ownership category for each of the analysis area sub-regions. By multiplying the appropriate 40-year coefficient of vegetation management (Federal or non-Federal within each sub-region) with the corresponding area values, we calculated the area within fisher habitat projected to receive vegetation management treatments with the potential to remove that habitat. We derived the scope of this stressor by dividing the projected area treated by the total amount of intermediate and high quality modeled fisher habitat in each sub-region (Table 8). Given the differences between Federal and non-Federal ownerships in the coefficients of vegetation management, as well as their inherent management differences, we divided the scopes between these ownerships rather than combining them to aid in qualifying our interpretation of effects. The sum of the ownership-specific scopes represents the total scope for the vegetation management stressor. Using only intermediate and high quality habitat in this calculation likely underestimates the scope on Federal lands because the values were derived only from alterations to northern spotted owl nesting and roosting habitat (which are likely to be higher quality fisher habitat) and does not represent actions that occurred in areas not identified as owl habitat that could provide fisher habitat. On non-Federal lands, this approach may underestimate the area managed for the opposite reason. We derived the coefficient of vegetation management for non-Federal lands from all submitted THPs, which do not characterize timber harvest effects on northern spotted owl habitat (remove or downgrade of habitat), thus non-Federal management as represented in our available data may occur more readily across a greater diversity of habitat types. We are making the assumption that lower quality habitats are generally going to be less desirable from a vegetation management perspective, therefore are represented less frequently in timber harvest plans. This assumption may be more accurate for ownerships such as private industrial timber lands, where intensive timber management is a goal (for example, Spies *et al.* 2007, pp. 8-12 for the Oregon Coast Range). However, it may be less accurate for some other non-Federal ownerships. For example, Oregon State Forest Lands in the Coast Range have a goal of developing from 30 to 60 percent of their ownership into forest structural conditions that could provide fisher habitat (ODF undated, pp. 4-7), which would require treatments in lower quality habitat to develop the desired conditions. Similarly, Washington Department of Natural Resources (WDNR) manages timber lands for a variety of purposes, including maintaining adequate quantity and quality of fisher habitat. WDNR operates under an HCP that includes fisher (See Regulatory Mechanisms Section). For both the Federal and non-Federal estimates, we note that the data sets used represent only planned activities and it is not known what proportion of projects were ultimately implemented.

As with the scope, we divided severity between Federal and non-Federal ownerships. Because we derived the scope of vegetation management by identifying the removal or downgrading of habitat, we ascribe high severity values (60 to 80 percent) for most regions and ownerships within the scope. However, we were able to ascribe lower severity values for certain regions and ownerships where we had additional data available to do so. Federal lands (USFS) in Washington State are managing their forests with almost entirely restoration thinning techniques that maintain the largest trees and all legacy structures. These projects have effects that are included in the northern spotted owl Section 7 database because they result in temporary downgrades from loss of canopy cover. Since the stands being managed are primarily second growth plantations or ~80 year-old stands regenerated from forest fires, and we predict that fisher use of these stands would not significantly change, we ascribed low severity values to vegetation management in these areas. As an example, consultation on the North Fork Thin Timber Sale on the Gifford Pinchot National Forest (USDI 2011(FWS Ref. No. 01EWFW00-2012-I-0028)), where 709 acres of northern spotted owl foraging habitat will be downgraded to dispersal habitat for 9 years, at which point canopy re-growth would return the stands to foraging habitat conditions. We did not estimate severity for the Washington Coast Ranges because vegetation management in that area is not removing fisher habitat. We estimated a higher range of severity in the Eastern Washington Cascades than the Western Washington Cascades because of more aggressive vegetation management designed to reduce fuel loading and the risk of catastrophic wildfires.

The available databases can include a variety of treatments, some of which may be outside the scope. Per the data from Federal lands in Table 5, downgrades to northern spotted owl habitat are likely to involve reductions in canopy cover, removal of snags, and simplifications of stand structure, but in some cases the treated stand may still provide some habitat value to fishers. Removal of northern spotted owl habitat generally involves substantial reductions in canopy cover, and most likely also equates to removal of fisher habitat as well. Still other activities recorded in Table 5 may be detrimental to fisher habitat at the local scale in the short term, but benefit development or retention of fisher habitat in the long term (for example, habitat restoration activities or risk reduction treatments). Data limitations prevent us from quantifying what proportion of the treatments in the data sets we used may be outside the scope of habitat loss or downgrade, so the severity score represents our best estimate and is a relatively broad range based on the diversity of potential effects inherent in management objectives between Federal and non-Federal lands, differences in regulatory mechanisms between the three states, and a moderate amount of uncertainty of site-specific effects of various vegetation management techniques. Site-specific vegetation management depends in part on topography and productivity, and is influenced by numerous regulatory mechanisms (see regulatory factors below) affecting the types and amounts of reserve (for example water course protections) and non-operational areas (for example unstable slopes).

Table 8. Scope and severity values for current vegetation management activities over approximately 40 years. Scope represents the proportion of intermediate and high quality fisher habitat within the sub-region affected by Federal and non-Federal habitat removal or downgrade. The sum of the Federal and Non-Federal scope values within a sub-region represents the estimated total amount of intermediate and high quality fisher habitat affected by habitat removal or downgrade (total scope). The Federal and Non-Federal severity values for each sub-region are not additive.

Analysis area sub-region	% Federal Ownership	Scope %			Severity %	
		Federal	Non-Federal	Total (Federal + Non-Federal)	Federal	Non-Federal
Sierra Nevada	55	<1	15	15	60 to 80	60 to 80
Northern California - Southwest Oregon	47	1	22	23	60 to 80	60 to 80
Western Oregon Cascades[B]	74	5	14	19	60 to 80	60 to 80
Eastern Oregon Cascades[B]	60	10	16	26	60 to 80	60 to 80
Coastal Oregon[A]	25	<1	37	37	60 to 80	60 to 80
Western Washington Cascades[A]	65	<1	30	30	25	60 to 80
Eastern Washington Cascades[A]	53	2	25	27	25 to 50	60 to 80
Coastal Washington[B]	33	0	34	34	N/A	60 to 80

* Note that the methodologies for estimating severity for Federal lands varied by sub-region based on the best available information for each sub-region (see description on p. 94 for details).

[A]Sub-region where fisher populations are considered likely extirpated.

[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

As noted earlier, vegetation management, as implemented, is a broad category of activities that can have a wide range of effects on fisher habitat; treatments can range from complete habitat removal to altering aspects of fisher habitat without completely removing the ability of the habitat to continue to meet at least some if not all of fisher life history requirements. In this analysis we tried to focus on those activities that removed or substantially degraded fisher habitat through the removal of large structures and overstory cover. However, the best available scientific and commercial information does not allow us to determine what portion of the activities in the available data result in habitat removal or a substantial reduction in quality, versus what proportion may be outside this scope and still reasonably function as fisher habitat. The data sets also likely include activities that may be detrimental to fisher habitat at the site scale in the short term, but benefit development or retention of fisher habitat in the long term (for example, risk reduction treatments or habitat restoration activities). Although these activities do result in a short-term loss of habitat, they are designed to retain or improve habitat over the long term, yet we cannot quantify that effect in our scope and severity estimates. Given the range in management activities and the general nature of the data used there is an unquantifiable error in the scope and severities estimated.

Not only do harvest rates differ among ownerships, but general types of treatments differ, which would influence interpretation of the assigned scope and severity scores. For instance, projects that tend to be restoration focused and thus, more consistent with fisher habitat retention or development over the long term when appropriately implemented, tend to be more prevalent on Federal lands and some other public lands given their agency missions and regulations. Such activities are less likely to occur on those non-Federal lands where the primary management objectives are typically for forest products. Thus, scope values for Federal ownerships do not account for potential future habitat development or retention that may occur as a result of current or past treatments that reduced habitat value in the short term. For non-Federal lands, harvest rates were derived from California data and represent primarily harvest plans from private owners. While California has relatively little State Forest land (excluding State parks), Oregon and Washington have substantially more. These public lands, while managed to provide timber products, also have additional restrictions and management objectives to provide for other resources (See Regulatory Mechanism Section). Thus, harvest rates derived from the submission of Timber Harvest Plans from private managed lands in California may overestimate the severity in Oregon and Washington on non-Federal lands managed by the state by some unquantifiable amount given the management objectives of State-managed forest land.

Although we have not explicitly calculated regrowth of fisher habitat in this assessment of scope and severity, ingrowth of intermediate and high quality fisher habitat on Federal lands is anticipated. Specific to northern spotted owl habitat development over the course of the Northwest Forest Plan, Davis *et al.* (2011, p. iii) concluded, "Not enough time has yet elapsed for us to accurately detect or estimate any significant recruitment of [northern spotted owl] nesting/roosting habitat; however, increases were observed in "marginal" (younger) forests indicating that future recruitment of nesting/roosting habitat is on track to occur, as anticipated, within the next few decades." When considering recruitment of late-successional forest over the course of the Northwest Forest Plan, Moeur *et al.* (2011, pp. i, 15) found a net loss of 1.9 percent of old-forest from Federal lands, though the net change was small relative to uncertainties and error rates in the estimates. Of the 217,000 ac (87,800 ha) of older forest lost on Federal lands, most of it was due to fire, with 15 percent a result of timber harvest, which might be a slight overestimate (Moeur *et al.* 2011, pp. 17, 21). The authors did determine that losses were roughly balanced by recruitment, though recruitment was much more difficult to estimate, and most likely through incremental stand growth into the lower end of the size and structural definition of older forests (Moeur *et al.* 2011, p. 31). The biggest change in forest diameter class distributions on Federal lands was an increase in the 25.4 to 50.5 cm (10- to 19.9 in) diameter classes, representing potential recruitment acres into the older forest category (Moeur *et al.* 2011, p. 21). Over our 40 year analysis window, the majority of these Federal acres would be expected to develop into habitat suitable for fishers, which may offset some of the loss that is expected to occur from vegetation management, wildfire, and other disturbances.

Development

Human developments associated with population growth will have an increasing impact on fisher habitat into the foreseeable future. The timing of development across the analysis area is ongoing.

Within much of the analysis area, human development is generally considered to be of relatively low concern for fishers, and occurs at relatively small spatial scales in forested landscapes (Naney *et al.* 2012, p. 53). For Northern California-Southwestern Oregon, Coastal Oregon, Eastern Oregon Cascades, Western Oregon Cascades, and Eastern Washington Cascades, we therefore considered the scope of human development to be less than 10 percent. In particular, the scope of habitat loss from urbanization in these sub-regions is less than 5 percent (Table 9) (Bradley *et al.* 2007, p. 260; ODF 2010a, p. 10; FRAP 2010, p. 53).

In other sub-regions, we estimated a higher scope; that is, development is likely to affect a larger proportion of fisher habitat. In western Washington (encompassing Coastal Washington and Western Washington Cascades), Bradley *et al.* (2007, pp. 268-269) estimated that from 1988 through 2004, 1.04% of privately-owned forest land was lost per year to agriculture, residential, or urban land uses. In these two sub-regions, private land accounts for 46 and 35 percent of fisher habitat, respectively, and if the same rate of land conversion continues over 40 years, it will cause a loss of 19 percent of all fisher habitat in Coastal Washington and 15 percent in the Western Washington Cascades. In addition, our estimate of scope should account for development of campgrounds, trailhead parking lots, and other recreation-related development, which is likely to increase as the population increases in and near these sub-regions. Because individual recreation-related development projects are likely to be small, we estimated that they would likely not exceed 5 percent. In the Sierra Nevada, high population growth is expected in the northern and central Sierra Nevada, and a significant ecotype making up fisher habitat, Montane Hardwood-Conifer forest, is identified as one of the ecotypes most at-risk due to development (FRAP 2010, p. 46). Estimates of past land conversion equate to approximately 21 to 38 percent of land devoted to private forestry lost over 40 years (Wacker *et al.* 2002, p. 842;

Walker 2003, p. 5), and one research group gives the estimate that 20 percent of the Sierra Nevada's private forests and rangelands could be subjected to development between 2008 and 2040 (Natural Capital Project 2008, p. 1). If these same rates of change are applied to fisher habitat on private lands, the result is 5 to 10 percent of fisher habitat in the Sierra Nevada potentially affected by development. As in the western Washington sub-regions, we must also include a measure of recreation-related development on public lands, which we estimate as less than 5 percent. It is not certain whether the rate of conversion of fisher habitat is higher or lower than conversion of forest and rangelands in these reports.

Severity varies depending on the type of development. We consider recreational development to be of low severity (approximately 5 percent) and urbanization to be of very high severity (90 percent). Other types of development, such as conversion to farmland or low-density rural housing, fall in between the two extremes. In Western Washington, approximately two thirds of the converted land shifted to agriculture and mixed-rural land uses, and approximately one third was developed for residential or urban use. Combined with our assumption that there will also be some low-severity recreational development, we therefore estimate severity to be approximately 50 percent for Coastal Washington and the Western Washington Cascades. For the Sierra Nevada, where most of the converted forested land is used for residential areas, we estimated severity to be approximately 60 percent. In the other sub-regions, we assume that development is as or more likely to consist of low-severity recreational use than higher-severity residential use, and estimate severity between 30 and 40 percent (Table 9).

Table 9. Scope and severity of human development as stressor on fisher habitat

Analysis area sub-region	Scope (%)	Severity (%)
Sierra Nevada	10-15	60
Northern California - Southwestern Oregon	<10	30-40
Western Oregon Cascades[B]	<10	30-40
Eastern Oregon Cascades[B]	<10	30-40
Coastal Oregon[A]	<10	30-40
Western Washington Cascades[A]	20	50
Eastern Washington Cascades[A]	<10	30-40
Coastal Washington[B]	25	50

[A]Sub-region where fisher populations are considered likely extirpated.
[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

Linear Infrastructure

As we calculate the scope and severity of habitat loss from linear features, the timing of the habitat loss is mainly in the past. However, this stressor still affects fisher populations currently and will continue to do so for the foreseeable future. New road construction in fisher habitat is likely to be associated with human development (see previous section addressing Human development as stressor on fisher habitat) and is not included in the scope and severity calculations for linear features. Regardless of new construction, we expect that habitat previously lost due to linear features will remain as non-habitat for the foreseeable future.

We roughly approximated the scope of habitat loss due to linear features by conducting a geographic information system (GIS) exercise to ascertain the number of potential fisher home ranges that could have a road occur within them. A consistent road layer (ESRI STREETSCARTO, published 2009, Tele Atlas StreetMap Premium v. 7.2) was available for the entire analysis area allowing for a comparative analysis across sub-region, although we acknowledge we are underestimating the impact because we are not including the other potential linear features. Roads are substantially more prevalent on the landscape that are other linear features, thus were determined to be an appropriate metric to evaluate this stressor.

We calculated the scope of habitat loss from linear features as the percentage of potential home ranges that contained a road. We created a grid with cells sized to approximate the size of female fisher's home range (10 km^2), and superimposed this grid on our fisher habitat model. Each grid cell was assigned a low quality, intermediate quality, or high quality habitat ranking defined by the majority habitat type within the grid cell. We counted the number of cells within "intermediate" or "selected for" habitats that contained a road to approximate "exposure" to a hypothetical individual (Figure Roads). We calculated the scope of habitat loss from linear features as the percentage of hypothetical home ranges that contained a road. Among analysis area sub-regions, the scope ranged from 82 percent in the Coastal Washington sub-region to 100 percent of all hypothetical home ranges having a road in the Coastal Oregon sub-region (Table 10, Figure 17).

Severity was evaluated as the area intersected by roads within the hypothetical home ranges identified as being within the scope. The length of the road was multiplied by the road width, which varied by road type. The Federal Interstate Highway System uses a 3.6 m (12 ft) standard for lane width, while local and collector roadways vary from 2.7 to 3.6 m (9 to 12 ft) (USDOT FHWA 2007, pp. 26-27). Most roads are two lanes, so we multiplied 7.2 m (24 ft) times the length of roads within intermediate or high quality hypothetical home ranges that contained a road to approximate lost habitat. This is a very conservative estimate because shoulder and median widths vary greatly depending on location, and because ecological edge effects due to roads can extend into the otherwise undisturbed land next to the road. These factors are not accounted for in the following calculations. Additionally, a consistent road layer that portrayed forest roads across this analysis area was not available; thus these estimates could underestimate the severity by 10 to 20 percent (based on visual examination of two road layers) in regions with high forest road densities.

Table 10. Scope and severity of habitat loss attributed to linear features.

Analysis area sub-region	Scope (%)	Severity (%)
Sierra Nevada	84	1
Northern California-Southwestern Oregon	89	1
Western Oregon Cascades[B]	96	1
Eastern Oregon Cascades[B]	99	1
Coastal Oregon[A]	100	1

Western Washington Cascades[A]	91	1
Eastern Washington Cascades[A]	99	1
Coastal Washington[B]	82	1

[A]Sub-region where fisher populations are considered likely extirpated.
[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

Trapping and Incidental Capture

This stressor is ongoing, although the effects of current trapping, which are limited to incidental capture and an unknown amount of poaching, are significantly reduced compared to the previous effects of widespread unregulated legal trapping of fishers. Without spatial data of areas frequented by current day trappers, we evaluate the scope of trapping and incidental capture for fishers based upon road access that could allow trapper access to fisher habitat (see Table 10). Specific data to quantify the severity of trapping in each sub-region is not available, but we determined severity to be very low (close to zero) in Washington and California, and infrequent (less than one percent) in Oregon (Table 11).

Table 11. Scope and severity of stressors associated with trapping and incidental capture

Analysis area sub-region	Scope %	Severity %
Sierra Nevada	84	<1
Northern California - Southwestern Oregon	89	<1
Western Oregon Cascades[B]	96	<1
Eastern Oregon Cascades[B]	99	<1
Coastal Oregon[A]	00	<1
Western Washington Cascades[A]	91	<1
Eastern Washington Cascades[A]	99	<1
Coastal Washington[B]	82	<1

[A]Sub-region where fisher populations are considered likely extirpated.
[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

Research Activities

Scope and severity of stressors related to research

Current research and monitoring study efforts vary greatly by sub-region. Because of these differences, we used different methods to estimate the scope for each sub-region.

In the Southern Sierra Nevada, two relatively robust monitoring efforts are ongoing, and there are often as many as 60 collared fishers within these study areas (Thompson *et al.* 2010, p. 16; SNAMP 2013, p. 9). Most of the NSN reintroduced population also falls within this sub-region; many of these animals are collared and all may be subjected to ongoing research-related live-trapping. We consider that animals that are not currently collared, but that may be subjected to research-related live-trapping within their home ranges, also fall within the scope of the stressor. Given population estimates of 300 for the SSN population, and somewhere between 30 and 45 for the NSN reintroduced population, we estimate that the research-related stressors may affect 25-30% of all animals within this sub-region (Table 11).

For the Northern California-Southwestern Oregon sub-region, we estimated scope by dividing the areas within research areas by the area currently occupied by native and reintroduced fisher populations in the sub-region (Table 12). As in the Sierra Nevada, there are two ongoing studies in the native NCSO population, and the reintroduced NSN population extends partly into this sub-region as well. However, the research areas in this sub-region are considerably smaller than those in the Sierra Nevada sub-region, and the area occupied by the native population is much larger. Therefore, the scope is much lower in this sub-region.

In Coastal Washington, there is no ongoing research-related live-trapping, but some animals in this reintroduced population are radio-collared, and thus are exposed to research-related stressors. All 90 animals released as part of the reintroduction were radio-collared. Information is available about the survival of these animals through 2010 (Lewis *et al.* 2012b, p. 7). If we assume subsequent annual survival rates in the range of 60 to 90 percent, then the expected number of collared fishers remaining alive in 2014 is between 3 and 30. Meanwhile, if we assume a population growth rate between 1 and 1.1, the expected population size of this reintroduced population is between 90 and 142 animals. We consider that the scope of this stressor is equivalent to the percentage of animals within the ONP reintroduced population that are collared.

There are no research study areas currently within the SOC reintroduced population or in any of the sub-regions where fishers are likely extirpated. This may change in the future if new reintroductions take place or previously unknown populations are discovered, but these events cannot be predicted.

In order to calculate severity for research-related stressors, we used preliminary results from two datasets reporting the sources of fisher mortality associated with ongoing fisher research projects conducted both in the SSN and NCSO populations from 2007 to 2012 (Gabriel 2013b, pers. comm.; Sweitzer 2013a, pers. comm.). From these datasets, we calculated the proportion of all mortality that could be attributed to research-related causes (Table 12). We combined the proportion of mortality attributable to research with overall annual mortality rates as measured for study areas in the NCSO and SSN populations. Our information about sources of mortality comes from research study areas, and all of the animals within the study area are within the scope of the research stressor. Therefore, we calculated the severity of this stressor as the proportion of deaths due to research multiplied by the overall annual mortality rate. We report a range of severity values. In part, the range reflects the range of overall mortality rates, which affects the severity calculation. In addition, in some cases, more than one possible cause was listed for a given death, so we calculated low and high numbers. The low number includes only those deaths that were attributed to research-related human error and had no other potential cause. The high number includes all those deaths in which research-related human error was either confirmed, or initially suspected, as a cause.

Table 12. Scope and severity related to stressors associated with research efforts. The severity percentages reported here give the proportion of the population that dies annually from this stressor.

Analysis area sub-region	Scope %	Severity %
Sierra Nevada	25-30	<1 to 2
Northern California - Southwestern Oregon	1-2	<1 to 5
Western Oregon Cascades[B]	0	n/a
Eastern Oregon Cascades[B]	0	n/a
Coastal Oregon[A]	0	n/a
Western Washington Cascades[A]	0	n/a
Eastern Washington Cascades[A]	0	n/a
Coastal Washington[B]	2 to 34	<1 to 5

[A]Sub-region where fisher populations are considered likely extirpated.
[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

Disease or Predation

These stressors are ongoing. Previously considered to be of minimal impact to fisher populations throughout their range, predation and disease now appear to be the most significant causes of mortality for California fishers. If disease affects fisher populations in patterns similar to disease outbreaks in other mustelids, there is the potential for disease to greatly reduce the size and extent of current fisher populations.

We used preliminary results from two datasets reporting the sources of fisher mortality associated with ongoing fisher research projects conducted for both the SSN and NCSO populations from 2007 to 2012 (Gabriel 2013b, pers. comm.; Sweitzer 2013a, pers. comm.). From these datasets, we calculated the proportion of all mortality that could be attributed to disease or predation (Tables 13, 14). We combined the proportion of mortality attributable to each stressor with overall annual mortality rates as measured for study areas in the NCSO and SSN populations. We assumed that all fishers could potentially be exposed to the risk of disease or predation; therefore, the scope is 100%. We calculated the severity by multiplying the proportion of deaths attributed to disease or predation by the total annual mortality rate. We report a range of severity values. The range reflects three sources of variation. First, the range reflects the range of overall mortality rates, which affects the severity calculation. Second, we had preliminary data on disease mortalities from two different ongoing studies, which differed in the proportions of deaths due to disease (Gabriel 2013b, pers. comm.; Sweitzer 2013a, pers. comm.). Third, in some cases, more than one possible cause was listed for a given death. In sub-regions where we lacked data to calculate a specific sub-regional severity range, we assumed that the severity fell within the range of the severity values calculated for sub-regions for which we did have data.

Table 13. Scope and severity related to mortality associated with disease. The severity percentages reported here give the proportion of the population that dies annually from each stressor.

Analysis area sub-region	Scope %	Severity %
Sierra Nevada	100	<1 to 5
Northern California - Southwestern Oregon	100	1 to 8
Western Oregon Cascades[B]	100	<1 to 8
Eastern Oregon Cascades[B]	100	<1 to 8
Coastal Oregon[A]	100	<1 to 8
Western Washington Cascades[A]	100	<1 to 8
Eastern Washington Cascades[A]	100	<1 to 8
Coastal Washington[B]	100	<1 to 8

[A]Sub-region where fisher populations are considered likely extirpated.
[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

Table 14. Scope and severity related to mortality associated with predation. The severity percentages reported here give the proportion of the population that dies annually from each stressor.

Analysis Area Sub-Region	Scope %	Severity %
Sierra Nevada	100	15 to 20
Northern California - Southwestern Oregon	100	5 to 23
Western Oregon Cascades[B]	100	5 to 23
Eastern Oregon Cascades[B]	100	5 to 23
Coastal Oregon[A]	100	5 to 23
Western Washington Cascades[A]	100	5 to 23
Eastern Washington Cascades[A]	100	5 to 23
Coastal Washington[B]	100	5 to 23

[A]Sub-region where fisher populations are considered likely extirpated.

[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

Small Population Size and Isolation

No quantitative analysis was provided in the draft Species Report for this stressor (Service 2014).

Other Anthropogenic Factors

No quantitative analysis was provided in the draft Species Report for this stressor (Service 2014).

Collision with Vehicles

See above section on Habitat loss attributable to linear features for description of scope. For severity, we used preliminary results from two datasets reporting the sources of fisher mortality associated with ongoing fisher research projects conducted for both the SSN and NCSO populations report from 2007 to 2012 (Gabriel 2013b, pers. comm.; Sweitzer 2013a, pers. comm.). From these datasets, we calculated the proportion of all mortality that could be attributed to individual vehicle strikes. We combined the proportion of mortality attributable to collisions with overall annual mortality rates as measured for study areas in the NCSO and SSN populations. We adjusted the mortality and survival rates to reflect the fact that mortality from collisions only affected animals within the scope; that is, animals with a road within their home range. For animals without a road in the home range, the proportion of deaths due to vehicle strikes must be 0, and the reported proportion of mortality due to collisions is a weighted average of this 0 with the higher proportion of mortalities due to collisions for animals within the scope. We used algebra to calculate the proportion of deaths due to vehicle strikes for those animals with the scope. We assume that animals die of other causes at the same rates, regardless of the presence of roads in their home ranges. Therefore, animals with no roads in their home ranges have, on average, lower mortality rates than animals with roads in their home ranges. The weighted average of the mortality rates within the scope and outside of the scope is equal to the overall mortality rate. We used algebra to calculate the overall mortality rate of animals with roads in the home range. We calculated the severity by multiplying the overall mortality rate for animals within the scope with the proportion of mortality attributable to collisions for animals within the scope (Table 15).

We report a range of severity values. The range reflects three sources of variation. First, the range reflects the range of overall mortality rates, which affects the severity calculation. Second, we had preliminary data on roadkill mortalities from two different ongoing studies, which differed in the proportions of deaths due to collisions (Gabriel 2013b, pers. comm.; Sweitzer 2013a, pers. comm.). Third, in some cases, more than one possible cause was listed for a given death, so we calculated low and high numbers to determine the minimum and maximum number of deaths in which a vehicle strike may have been involved. In sub-regions where we lacked data to calculate a specific sub-regional severity range, we assumed that the severity fell within the range of the severity values calculated for sub-regions for which we did have data.

Table 15. Scope and severity related to mortality associated with roads. The severity percentages reported here give the proportion of the population that dies annually from each stressor.

Analysis area sub-region	Scope %	Severity %
Sierra Nevada	84	2 to 3
Northern California - Southwestern Oregon	89	<1 to 4

Western Oregon Cascades[B]	96	<1 to 4
Eastern Oregon Cascades[B]	99	<1 to 4
Coastal Oregon[A]	100	<1 to 4
Western Washington Cascades[A]	91	<1 to 4
Eastern Washington Cascades[A]	99	<1 to 4
Coastal Washington[B]	82	<1 to 4

[A]Sub-region where fisher populations are considered likely extirpated.
[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

Direct Climate Change

The stressor of direct climate effects to fishers is ongoing, since climate warming has begun, and is likely to become more pronounced in the future as warming increases. All fisher populations are affected by direct climate effects to fishers (scope is 100 percent). The severity ranges we report are based on data described earlier (see Climate Change Effects to Fisher Habitat) that compare late 21st century climate projections with the climate conditions historically present in the range of the fisher (Lawler *et al.* 2012, p. 380; Lawler 2013, pers. comm.). The severity estimate for the mid-21st century was interpolated from the late 21st century projection; we assumed it to be approximately half of the later estimate (Table 16). We report the approximate percentages of each sub-region in which climate is expected to shift away from climatic suitability for fishers. The range reflects disagreements among the 10 different climate models used to make these projections (Lawler 2013, pers. comm.). Unlike other severity calculations we report, these numbers do not necessarily represent mortality or loss of habitat, but rather the portion of the range where fishers may lose fitness, alter behavior patterns, or perhaps die or migrate because the climate is no longer suitable.

Note that in the northernmost sub-regions of the analysis area, especially Coastal Washington, and Western Washington Cascades, there is likely to be expansion in the area of suitable climate for fishers (Figure 18). The severity value for these regions only reflects how much of the region is projected to show contractions in areas of suitable climate, not the net change in area of suitable climate. Fishers living in areas where suitable climate disappears may not be able to migrate easily into areas where suitable habitat is appearing.

Table 16. Scope and severity of direct effects to fishers from climate change

Analysis area sub-region	Scope %	Severity % (mid-21st century)	Severity % (late 21st century)
Sierra Nevada	100	44-50	89-100
Northern California - Southwestern Oregon	100	23-40	47-81
Western Oregon Cascades[B]	100	3-26	7-53
Eastern Oregon Cascades[B]	100	3-28	6-56
Coastal Oregon[A]	100	4-46	8-92
Western Washington Cascades[A]	100	0-7	0-15

Eastern Washington Cascades[A]	100	5-14	11-28
Coastal Washington[B]	100	0	0

[A]Sub-region where fisher populations are considered likely extirpated.
[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

Exposure to Toxicants

**This section updated with new information since the timing of the draft Species Report (Service 2014).
The timing of this stressor is ongoing. To calculate the scope of this stressor, we focused on illegal marijuana cultivation sites in California and legal uses in rural areas in Washington. Thompson *et al.* (2014, p. 98), found a significant relationship between AR exposure and female fisher survival but also noted that the association between illegal marijuana cultivation sites, ARs and other pesticide exposure, and fisher mortality, although strong, is still speculative and will continue to be logistically and potentially dangerous to determine a cause and effect relationship. On the Olympic Peninsula where fishers have been detected in close proximity to suburban and rural areas, fishers may be more likely to consume ARs from legal uses given that illegal marijuana grows on the Olympic Peninsula appear to be uncommon relative to other locations within the analysis area (Figure 21). The number and distribution of cultivation sites within suitable fisher habitat is unknown, but the activity is prevalent in forested regions within the range of fishers in the Pacific States. The only available information for the growth, stability, or decline of illegal marijuana cultivation sites is from eradication efforts, which are sensitive data not readily available for public use, highly variable year-to-year, between National Forests (and other land ownerships), and between States.

For California, our estimate of scope ranges from 23 to 95 percent based on several lines of reasoning. The data displayed in Figure 19 are illegal cultivation sites eradicated by law enforcement over two years (2010 and 2011) (Higley *et al.* 2013a, entire). Buffering these locations by 4 km (approximating the area that a male fisher may encompass as a home range) results in 23 percent of the fishers' current range in California exposed over these two years (Higley 2013, pers. comm.), giving us the minimum scope for this stressor. The number of sites annually eradicated is estimated to be 15 to 50 percent of active sites (Higley 2013, pers. comm.). If the eradicated sites represent any less than 25 percent of active sites, and if those sites are distributed evenly throughout the fishers' current range in California, nearly all California fishers could potentially have a source of these toxicants in their home ranges in a given year. Additionally, as new sites become active, there will be an increase in the cumulative proportion of fishers that are exposed, especially since many eradicated sites have not been remediated (toxicants removed). Also noted in Thompson *et al.* (2014, p. 95) many of the illegal grow sites in the study area were clustered in proximity to water sources. We were unable to determine, due to lack of site specific data, the extent to which the tendency of grow site location proximity to water overlapping with fisher home range locations may increase the potential of fishers exposure to ARs. We did adjust the scope to less than 100%, because some wilderness areas are not used for marijuana cultivation sites (Higley 2013, pers. comm.).

To calculate scope in Oregon, we obtained spatial data representing illegal cultivation sites eradicated between 2004 and 2012 (Figure 20) (OR HIDTA 2013, shapefiles). Following the method used by Higley *et al.* (2013a, p. 1), we buffered each site by 4 km. We then calculated how much of the modeled high quality and intermediate fisher habitat in each sub-region fell within one of these buffers. The resulting percentage was our minimum scope. We did not have information indicating what proportion of active sites this dataset represents, so we assumed that it might be similar to the 15 to 50 percent that are included in the California data. We calculated our maximum scope by assuming that the sites identified represent 15 percent of all illegal cultivation sites. We note that both the maximum and minimum scope would be even higher if we had restricted our calculations to high quality modeled habitat, as this is where the majority of eradicated cultivation sites are located. The Northern California-Southwestern Oregon sub-region spans both California and Oregon. The range for scope calculated for the Oregon portion of the Northern California-Southwestern Oregon sub-region was very similar to the range calculated using the California dataset: 14 to 92 percent for Oregon (18 to 100 percent in high quality habitat) versus 23 to 95 percent for California. The scope for the rest of Oregon ranged from 2 to 44 percent, depending on sub-region.

Regarding the severity, we used results reported by Gabriel *et al.* (2012a, p. 5), who autopsied fishers that died in and near two study areas, one in Northern California and one in the Southern Sierra Nevada. We removed from consideration all animals recovered outside of study areas (as displayed in Gabriel *et al.* 2012a, pp. 7-8), since the inclusion of these animals could potentially bias the dataset. This dataset also provides an estimate for the scope of the rodenticide stressor among the animals they tested, as they report numbers of animals that showed exposure to rodenticides, whether they died of rodenticide toxicosis or other causes: 69% within their Northern California study area and 82% within their Southern Sierra Nevada study area (Gabriel *et al.* 2012a, pp. 5, 7-8). For the animals that had been exposed to rodenticides, we calculated the proportion of all mortality that could be attributed to anticoagulant rodenticides.

We combined the proportion of mortality attributable to rodenticides with overall annual mortality rates as measured for study areas in the NCSO and SSN populations (Table 17). We adjusted the mortality and survival rates to reflect the fact that mortality from rodenticides only affected animals within the scope, and we assumed that the scope within these study areas was the same as the exposure rate reported by Gabriel *et al.* (2012a, pp. 5, 7-8) for their study areas. We assume that animals die of other causes at the same rates, regardless of the presence of rodenticides in their home ranges (although this assumption may not be accurate; see discussion of sublethal effects below). Therefore, since we did not consider the effects of toxicant exposure beyond direct acute mortality for this analysis, we assumed that animals with no rodenticide exposure have, on average, lower mortality rates than animals with rodenticides in their home ranges. The weighted average of the mortality rates within the scope and outside of the scope is equal to the overall mortality rate. We used algebra to calculate the overall mortality rate of animals within the scope. We calculated the severity by multiplying the overall mortality rate for animals within the scope with the proportion of mortality attributable to rodenticides for animals within the scope (Table 17).

We report a range of severity values. This range mainly reflects variation in estimates of overall mortality rates, which affects the severity calculation. For sub-regions for which we did not have data to calculate the severity, we assumed that the range of possible severity values fell within the range of severity values calculated for the populations for which we did have data.

Table 17. Scope and severity related to mortality attributed to toxicants associated with illegal activities. The severity percentages reported here give the proportion of the population that dies annually from each stressor.

Analysis area sub-region	Scope %	Severity %
Sierra Nevada	23 to 95	1 to 2
Northern California - Southwestern Oregon	23 to 95	2 to 8
Western Oregon Cascades[B]	2 to 11	1 to 8
Eastern Oregon Cascades[B]	2 to 13	1 to 8
Coastal Oregon[A]	7 to 44	1 to 8
Western Washington Cascades[A]	2 to 95	1 to 8
Eastern Washington Cascades[A]	2 to 95	1 to 8
Coastal Washington[B]	75	1 to 8

[A]Sub-region where fisher populations are considered likely extirpated.
[B]Sub-region where fisher populations are considered likely extirpated outside of reintroduction areas.

We based our severity estimates on mortality rates alone but acknowledge these values likely strongly underrepresent the population level effects when considering research conclusions indicating sublethal levels of rodenticides and other toxicants. Sublethal levels of rodenticides and other toxicants likely predispose individuals to death from other causes (for example, collisions with automobiles, disease, predation, or starvation) or may reduce the chance of recovery from accidents (Gabriel *et al.* 2012a, p. 10, Golden *et al.* 2012, entire). Secondary exposure through the consumption of AR-exposed prey is considered more likely than primary exposure from direct consumption. The physical and physiological manifestations of lethal AR exposure in rodents are fairly well known, but the minimum amount of AR required for sublethal or lethal poisoning in fishers is currently unknown. Fishers exposed to ARs likely become physically compromised, potentially leading to lower survivorship and reproductive success, and ultimately to negative population growth and a reduced geographic distribution.

Appendix C, continued. SUMMARY TABLES—QUANTITATIVE ANALYSIS AS PRESENTED IN DRAFT SPECIES REPORT (Service 2014).

Tables 18 through 25 are stressor summary tables and are intended to provide a holistic summary of potential stressors acting on fisher habitat and fishers within each sub-region (Washington; Eastern Cascades, Western Cascades, Coastal: Oregon; Eastern Cascades, Western Cascades, Coastal: Northern California-Southwestern Oregon: and Sierra Nevada). For each stressor we provide a detailed description and identify any associated uncertainty factors for scope and severity values. In order to provide a more comprehensive way to interpret their combined effects within and between sub-regions we multiplied the scope times the severity and provide the results in the Discussion columns. Due to the large number and complexity of potential synergistic interactions between and among stressors, these summary tables do not attempt to quantify synergistic interactions.

In sub-regions where there is no direct information about the scope or severity of a particular stressor, we used the best available data from other sub-regions to extrapolate and noted this in our assessment. We acknowledge that if we had data on fishers in sub-regions without fisher studies, the range of values we extrapolated from another sub-region may not be representative, and therefore, may be another source of uncertainty. Other areas of uncertainty that we accounted for and expressed as a range in values include: differences reported in the literature and severity of potential effects to fisher habitat from specific sources of habitat alteration.

The scope and severity of all habitat stressors are reported using our habitat model as the baseline for the analysis, and timeframes used to correspond with our definition of the foreseeable future (40 or 100 years depending on the stressor). The habitat model was used as a reference point from which to evaluate current habitat conditions and estimate future losses of habitat. We expect that over the next century, recruitment of some fisher habitat will occur as forests that are currently in mid- and early-seral stages continue to develop (for example, Moeur *et al.* 2011, p. 31). However, the amount of fisher habitat that will be recruited is difficult to predict, given stochastic events and anthropogenic changes to habitat, and therefore we were unable to factor habitat recruitment into our projections related to changes and loss in fisher habitat. Therefore, there is a degree of uncertainty related to cumulative amount of reduction in fisher habitat over the time periods assessed. To provide the context for the current habitat condition within each sub-region, please refer to Figure 2.

For stressors affecting fishers directly, the severity value is reported in terms of annual mortality rate attributable to each stressor, with the exception of the direct effects of climate change to fishers. The mortality values were calculated based on mortality data collected as part of ongoing research studies tracking radio-collared fishers. Direct effects of climate change were estimated using comparisons of a range of projected future climate values to the historical variation found throughout the fishers North American historical range.

Table 18a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Eastern Washington Cascades analysis area [A], as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors Related to Habitat: Scope values in the discussion section below represent the proportion of the fisher analysis area sub-region that can be reasonably expected to be affected by the stressor within the appropriate time period. Severity values in the discussion below represent the proportion of habitat within the scope that we expect to be lost or rendered significantly less suitable for fisher use due to the stressor.				
1. Wildfire, emergency suppression, post-fire management: The smaller severity value includes only areas burned by high severity fire, and the larger value includes all areas burned at moderate or high severity. Range of severity values represent the uncertainty related to functional effects of moderate severity fires on fisher habitat.				
Wildfire over 40 years	Ongoing	15	20-48	Results in a reduction of 3-7% in modeled existing high and intermediate quality fisher habitat.
Wildfire over 100 years	Long-term	38	20-48	Results in a cumulative reduction of 6-13% in modeled existing high and intermediate quality fisher habitat.
2. Changes in landscape patterns and ecosystems; Climate Change: Forested area may increase, but due to drier conditions forests will likely experience slower growth as compared with current forests, and some conifer forest may shift to woodlands that will not provide suitable fisher habitat. The ranges of Douglas fir and some pine species are likely to contract. It is uncertain how these changes in tree species distribution may affect the distribution of fisher habitat. Range of severity values represents variation in models.				
2040-2060	Ongoing	100	1-10	Results in a reduction of 1-10% in forests that support habitat conditions for fishers.
2080-2100	Long-term	100	1-20	Results in a cumulative reduction of 1-20% in forests that support habitat conditions for fishers.
3. Vegetation management: Scope estimates for Federal land used a summary of northern spotted owl (NSO) suitable habitat removed or downgraded. The range of severity values reflects the changes to NSO habitat from primarily reductions in canopy cover, but may include removal of snags and simplification of stand structure where those elements conflicted with managing for forest health (i.e., fuels reduction and forest pest management). Removal of NSO habitat generally involves significant reductions in habitat components that we considered important in fisher habitat, therefore we equated NSO habitat removal to removal of fisher habitat. Downgrading of NSO habitat does not remove NSO habitat but includes some or all of the following effects: reduction in canopy cover, loss of some snags or large trees, and/or simplifies stand structure. We considered that downgrading of NSO habitat changes habitat quality for fishers for a variable amount of time, but we considered that it may still provide some habitat value to fishers. We used an acre value for non-Federal harvest levels mid-way between the two California sub- regions as the coefficient of acres of harvest in Washington. Estimates of potential removal of fisher habitat are for those areas currently modeled as intermediate and high quality fisher habitat. Scope and severity were divided between Federal and non-Federal activities.				
Current vegetation management over 40 years	Ongoing	2 Fed 25 non-Fed	25-50 Fed 60-80 non-Fed	Results in a total reduction of 16-22% in forests that support habitat conditions for fishers on both public and private land.
4. Human development	Ongoing	<10	30-40	Results in a reduction of 3-4% due to small scale, localized recreational development.

[A] Sub-region where fisher populations are considered likely extirpated.

Table 18b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Eastern Washington Cascades analysis area [A], as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors With Direct Effects to Fishers: Values in the discussion section below represent the potential percent of the population in the analysis area experiencing direct annual mortality, and does not include any potential sublethal effects that may result in reduced fitness.				
1. Trapping and Incidental Captures	Ongoing	99	<1	<1% annual mortality. Spatial data for trapping not available so assume roads provide access for trappers into areas modeled to provide fisher habitat. Body-gripping traps are not legal in Washington, so we estimate severity to be near zero.
2. Research Activities	Ongoing	0	n/a	n/a. Research is not currently being conducted in this analysis area.
3. Disease	Ongoing	100	<1-8	<1-8% annual mortality. Values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
4. Predation	Ongoing	100	5-23	5-23% annual mortality. Values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
5. Collision with vehicles	Ongoing	99	<1-4	<1-4% annual mortality. Severity values extrapolated from analysis areas with previous and on-going fisher research. Range in severity values reflects 3 sources of variation within and between studies. Scope is calculated on likelihood of roads occurring within a potential fisher home range.
6. Exposure to Toxicants	Ongoing	2-95	1-8	<1%-8% annual mortality. Scope and severity values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
Direct Climate Effects to fishers: These projections do not necessarily represent mortality or loss of habitat, but rather the portion of the range where fishers may lose fitness, alter behavior patterns, or perhaps die or migrate because the climate is no longer suitable. The range of values reflects disagreements among the 10 different climate models evaluated.				
2040-2060	Ongoing	100	5-14	5-14%
2080-2100	Long-term	100	11-28	11-28%

[A]Sub-region where fisher populations are considered likely extirpated.

Table 19a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Western Washington Cascades analysis area[A], as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors Related to Habitat: Scope values in the discussion section below represent the proportion of the fisher analysis area sub-region that can be reasonably expected to be affected by the stressor within the appropriate time period. Severity values in the discussion below represent the proportion of habitat within the scope that we expect to be lost or rendered significantly less suitable for fisher use due to the stressor.				
1. Wildfire, emergency suppression, post-fire management: The smaller severity value includes only areas burned by high severity fire, and the larger value includes all areas burned at moderate or high severity. Range of severity values represent the uncertainty related to functional effects of moderate severity fires on fisher habitat. There is additional uncertainty in the scope and severity values reported here, as they are based on a recent 28-year dataset, whereas the historical fire regime in this sub-region consisted of high-severity fires and a fire return interval longer than 200 years. Therefore, scope and severity reported here may be underestimates.				
Wildfire over 40 years	Ongoing	<1	5-27	Results in a reduction of <1% in modeled existing high and intermediate quality fisher habitat.
Wildfire over 100 years	Long-term	<1	5-27	Results in a cumulative reduction of <1% in modeled existing high and intermediate quality fisher habitat.
2. Changes in landscape patterns and ecosystems; Climate Change: Some conifer forest may shift to woodlands that will not provide suitable fisher habitat. Maritime conifer forests may shift to drier temperate conifer forest types. The ranges of Douglas fir and some pine species are likely to contract. It is uncertain how these changes in tree species distribution may affect the distribution of fisher habitat. Range of severity values represents variation in models.				
2040-2060	Ongoing	100	1-7	Results in a reduction of 1-7% in forests that support habitat conditions for fishers.
2080-2100	Long-term	100	1-15	Results in a cumulative reduction of 1-15% in forests that support habitat conditions for fishers.
3. Vegetation management: Scope estimates for Federal land used a summary of northern spotted owl (NSO) suitable habitat removed or downgraded. The range of severity values reflects the changes to NSO habitat from primarily reductions in canopy cover. Removal of NSO habitat generally involves significant reductions in habitat components that we considered important in fisher habitat, therefore we equated NSO habitat removal to removal of fisher habitat. Downgrading of NSO habitat does not remove NSO habitat but canopy cover is reduced. We considered that downgrading of NSO habitat changes habitat quality for fishers for a variable amount of time, but we considered that it may still provide some habitat value to fishers. We used an acre value for non-Federal harvest levels mid-way between the two California sub- regions as the coefficient of acres of harvest in Washington. Estimates of potential removal of fisher habitat are for those areas currently modeled as intermediate and high quality fisher habitat. Scope and severity were divided between Federal and non-Federal activities.				
Current vegetation management over 40 years	Ongoing	<1 Fed 30 non-Fed	25 Fed 60-80 non-Fed	Results in a total reduction of 18-24% in forests that support habitat conditions for fishers on both public and private land.
4. Human development	Ongoing	20	50	Results in a total reduction of 10% due to conversion of forested land to agricultural, residential, or urban uses, in addition to recreational development within fisher habitat.

[A]Sub-region where fisher populations are considered likely extirpated.

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Table 19b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Western Washington Cascades analysis area[A], as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors With Direct Effects to Fishers: Values in the discussion section below represent the potential percent of the population in the analysis area experiencing direct annual mortality, and does not include any potential sub-lethal effects that may result in reduced fitness.				
1. Trapping and Incidental Captures	Ongoing	91	<1	<1% annual mortality. Spatial data for trapping not available so assume roads provide access for trappers into areas modeled to provide fisher habitat. Body-gripping traps are not legal in Washington, so we estimate severity to be near zero.
2. Research Activities	Ongoing	0	n/a	n/a. Research is not currently being conducted in this analysis area.
3. Disease	Ongoing	100	<1-8	<1-8% annual mortality. Values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
4. Predation	Ongoing	100	5-23	5-23% annual mortality. Values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
5. Collision with vehicles	Ongoing	91	<1-4	<1-4% annual mortality. Severity values extrapolated from analysis areas with previous and on-going fisher research. Range in severity values reflects 3 sources of variation within and between studies. Scope is calculated on likelihood of roads occurring within a potential fisher home range.
6. Exposure to Toxicants	Ongoing	2-95	1-8	<1%-8% annual mortality. Scope and severity values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
Direct Climate Effects to fishers: These projections do not necessarily represent mortality or loss of habitat, but rather the portion of the range where fishers may lose fitness, alter behavior patterns, or perhaps die or migrate because the climate is no longer suitable. The range of values reflects disagreements among the 10 different climate models evaluated.				
2040-2060	Ongoing	100	0-7	0-7%
2080-2100	Long-term	100	0-15	0-15%

[A]Sub-region where fisher populations are considered likely extirpated.

Table 20a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Coastal Washington analysis area[A], as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors Related to Habitat: Scope values in the discussion section below represent the proportion of the fisher analysis area sub-region that can be reasonably expected to be affected by the stressor within the appropriate time period. Severity values in the discussion below represent the proportion of habitat within the scope that we expect to be lost or rendered significantly less suitable for fisher use due to the stressor.				
1. Wildfire, emergency suppression, post-fire management: The smaller severity value includes only areas burned by high severity fire, and the larger value includes all areas burned at moderate or high severity. Range of severity values represent the uncertainty related to functional effects of moderate severity fires on fisher habitat. There is additional uncertainty in the scope and severity values reported here, as they are based on a recent 28-year dataset, whereas the historical fire regime in this sub-region consisted of high-severity fires and a fire return interval longer than 200 years. Therefore, scope and severity reported here may be underestimates.				
Wildfire over 40 years	Ongoing	<1	10-34	Results in a reduction of <1% in modeled existing high and intermediate quality fisher habitat.
Wildfire over 100 years	Long-term	<1	10-34	Results in a cumulative reduction of <1% in modeled existing high intermediate quality fisher habitat.
2. Changes in landscape patterns and ecosystems; Climate Change: Maritime conifer forests may shift toward mixed conifer-hardwood forest along the coast and to drier forest types on the eastern side of the sub-region. The ranges of Douglas fir and some pine species are likely to contract. It is uncertain how these changes in tree species distribution may affect the distribution of fisher habitat. Range of severity values represents variation in models.				
2040-2060	Ongoing	100	1-5	Results in a reduction of 1-5% in forests that support habitat conditions for fishers.
2080-2100	Long-term	100	1-10	Results in a cumulative reduction of 1-10% in forests that support habitat conditions for fishers.
3. Vegetation management: Scope estimates for Federal land used a summary of northern spotted owl (NSO) suitable habitat removed or downgraded. We did not estimate a severity score for Federal land in this sub-region because the spotted owl Section 7 database did not indicate that suitable habitat for spotted owls is being removed or downgraded. We used an acre value for non-Federal harvest levels mid-way between the two California sub- regions as the coefficient of acres of harvest in Washington. Estimates of potential removal of fisher habitat are for those areas currently modeled as intermediate and high quality fisher habitat. Scope and severity were divided between Federal and non-Federal activities.				
Current vegetation management over 40 years	Ongoing	0 Fed 34 non-Fed	0 Fed 60-80 non-Fed	Results in a total reduction of 20-27% in forests that support habitat conditions for fishers on both public and private land.
4. Human development	Ongoing	25	50	Results in a total reduction of 13% due to conversion of forested land to agricultural, residential, or urban uses, in addition to recreational development within fisher habitat.

[A]Sub-region where fisher populations are considered likely extirpated outside of reintroduction area.

Table 20b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Coastal Washington analysis area [A], as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors With Direct Effects to Fishers: Values in the discussion section below represent the potential percent of the population in the analysis area experiencing direct annual mortality, and does not include any potential sublethal effects that may result in reduced fitness.				
1. Trapping and Incidental Captures	Ongoing	82	<1	<1% annual mortality. Spatial data for trapping not available so assume roads provide access for trappers into areas modeled to provide fisher habitat. Body-gripping traps are not legal in Washington, so we estimate severity to be near zero.
2. Research Activities	Ongoing	2-34	<1-5	<1-2% annual mortality. Scope reflects the approximate percentage of the reintroduced population that may retain collars, as researchers are not currently trapping and collaring any additional fishers. Researchers did not provide mortality data for this sub-region, so severity values are extrapolated from sub-regions where researchers did provide mortality data for fishers within their study area.
3. Disease	Ongoing	100	<1-8	<1-8% annual mortality. Values extrapolated from sub-regions for which researchers provided mortality data. Range reflects 3 sources of variation within and between studies.
4. Predation	Ongoing	100	5-23	5-23% annual mortality. Values extrapolated from sub-regions for which researchers provided mortality data. Range reflects 3 sources of variation within and between studies.
5. Collision with vehicles	Ongoing	82	<1-4	<1-3% annual mortality. Values extrapolated from sub-regions for which researchers provided mortality data. Range in severity values reflects 3 sources of variation within and between studies. Scope is calculated on likelihood of roads occurring within a potential fisher home range.
6. Exposure to Toxicants	Ongoing	75	1-8	<1%-6% annual mortality. Scope based on exposure rate among fisher carcasses tested for toxicant exposure. Severity values extrapolated from sub-regions for which researchers provided mortality data. Range reflects 3 sources of variation within and between studies.
Direct Climate Effects to fishers: These projections do not necessarily represent mortality or loss of habitat, but rather the portion of the range where fishers may lose fitness, alter behavior patterns, or perhaps die or migrate because the climate is no longer suitable. Climate models did not project this degree of climate change in any portion of the range within this sub-region, and some models projected that formerly unsuitable climates in parts of this sub-region may be altered to become suitable.				
2040-2060	Ongoing	100	0	0%
2080-2100	Long-term	100	0	0%

[A]Sub-region where fisher populations are considered likely extirpated outside of reintroduction area.

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Table 21a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Eastern Oregon Cascades analysis area [A], as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors Related to Habitat: Scope values in the discussion section below represent the proportion of the fisher analysis area sub-region that can be reasonably expected to be affected by the stressor within the appropriate time period. Severity values in the discussion below represent the proportion of habitat within the scope that we expect to be lost or rendered significantly less suitable for fisher use due to the stressor.				
1. Wildfire, emergency suppression, post-fire management: The smaller severity value includes only areas burned by high severity fire, and the larger value includes all areas burned at moderate or high severity. Range of severity values represent the uncertainty related to functional effects of moderate severity fires on fisher habitat.				
Wildfire over 40 years	Ongoing	13	18-41	Results in a reduction of 2-5% in modeled existing high and intermediate quality fisher habitat.
Wildfire over 100 years	Long-term	33	18-41	Results in a cumulative reduction of 6-14% in modeled existing high intermediate quality fisher habitat.
2. Changes in landscape patterns and ecosystems; Climate Change: Forested area may increase, but due to drier conditions forests will likely experience slower growth as compared with current forests. Range of severity values represents variation in models.				
2040-2060	Ongoing	100	1-5	Results in a reduction of 1-5% in forests that support habitat conditions for fishers.
2080-2100	Long-term	100	1-10	Results in a cumulative reduction of 1-10% in forests that support habitat conditions for fishers.
3. Vegetation management: Scope estimates for Federal land used a summary of northern spotted owl (NSO) suitable habitat removed or downgraded. The range of severity values reflects the changes to NSO habitat from reductions in canopy cover, removal of snags, and simplification of stand structure from management. Removal of NSO habitat generally involves significant reductions in habitat components that we considered important in fisher habitat, therefore we equated NSO habitat removal to removal of fisher habitat. Downgrading of NSO habitat does not remove NSO habitat but includes some or all of the following effects: reduction in canopy cover, loss of some snags or large trees, and/or simplifies stand structure. We considered that downgrading of NSO habitat changes habitat quality for fishers but we considered that it may still provide some habitat value to fishers. Uncertainty related to Non-Federal vegetation management in Oregon as harvest is not reported in terms of acres. We therefore used an acre value for non-Federal harvest levels mid-way between the two California sub-regions as the coefficient of acres of harvest in Oregon. Estimates of potential reduction in fisher habitat are for those areas currently modeled as intermediate and high quality fisher habitat. Scope and severity were divided between Federal and non-Federal activities.				
Current vegetation management over 40 years	Ongoing	10 Fed, 16 non-Fed	60-80 Fed 60-80 non-Fed	Results in a total reduction of 16-21% in forests that support habitat conditions for fishers on both public and private land.
4. Human development	Ongoing	<10	30-40	Results in a total reduction of 3-4% due to small scale, localized recreational development.

[A]Sub-region where fisher populations are considered likely extirpated outside of reintroduction area.

Table 21b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Eastern Oregon Cascades analysis area[A], as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors With Direct Effects to Fishers: Values in the discussion section below represent the potential percent of the population in the analysis area experiencing direct annual mortality, and does not include any potential sublethal effects that may result in reduced fitness.				
1. Trapping and Incidental Captures	Ongoing	99	<1	<1% annual mortality. Spatial data for trapping not available so assume roads provide access for trappers into areas modeled to provide fisher habitat. Body-gripping traps are legal in Oregon, but fishers are infrequently trapped, resulting in a low severity estimate.
2. Research Activities	Ongoing	0	n/a	n/a. Research is not currently being conducted in this analysis area.
3. Disease	Ongoing	100	<1-8	<1-8% annual mortality. Values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
4. Predation	Ongoing	100	5-23	5-23% annual mortality . Values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
5. Collision with vehicles	Ongoing	99	<1-4	<1-4% annual mortality. Severity values extrapolated from analysis areas with previous and on-going fisher research. Range in severity values reflects 3 sources of variation within and between studies. Scope is calculated on likelihood of roads occurring within a potential fisher home range.
6. Exposure to Toxicants	Ongoing	2-13	1-8	≤1% annual mortality. Scope calculated based on likelihood of known marijuana grow sites occurring within a potential fisher home range. Severity values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
Direct Climate Effects to fishers: These projections do not necessarily represent mortality or loss of habitat, but rather the portion of the range where fishers may lose fitness, alter behavior patterns, or perhaps die or migrate because the climate is no longer suitable. The range of values reflects disagreements among the 10 different climate models evaluated.				
2040-2060	Ongoing	100	3-28	3-28%
2080-2100	Long-term	100	6-56	6-56%

[A]Sub-region where fisher populations are considered likely extirpated outside of reintroduction area.

022922

Table 22a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Western Oregon Cascades analysis area[A], as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors Related to Habitat: Scope values in the discussion section below represent the proportion of the fisher analysis area sub-region that can be reasonably expected to be affected by the stressor within the appropriate time period. Severity values in the discussion below represent the proportion of habitat within the scope that we expect to be lost or rendered significantly less suitable for fisher use due to the stressor.				
1. Wildfire, emergency suppression, post-fire management: The smaller severity value includes only areas burned by high severity fire, and the larger value includes all areas burned at moderate or high severity. Range of severity values represent the uncertainty related to functional effects of moderate severity fires on fisher habitat. There is additional uncertainty in the scope and severity values reported here, as they are based on a recent 28-year dataset, whereas the historical fire regime in parts of this sub-region consisted of high-severity fires and a fire return interval longer than 200 years. Therefore, scope and severity reported here may be underestimates.				
Wildfire over 40 years	Ongoing	6	18-37	Results in a reduction of 1-2% in modeled existing high and intermediate quality fisher habitat.
Wildfire over 100 years	Long-term	17	18-37	Results in a cumulative reduction of 3-6% in modeled existing high intermediate quality fisher habitat.
2. Changes in landscape patterns and ecosystems; Climate Change: Forest types are projected to shift from moist conifer forests toward drier conifer forest, mixed conifer-hardwood forest, and hardwood forest; and some conifer forest may shift to woodlands that will not provide suitable fisher habitat. The range of Douglas fir is likely to contract. It is uncertain how changes in tree species distribution may affect the distribution of fisher habitat. Range of severity values represents variation in models.				
2040-2060	Ongoing	100	1-4	Results in a total reduction of 1-4% in forests that support habitat conditions for fishers.
2080-2100	Long-term	100	3-55	Results in a cumulative reduction of 3-55% in forests that support habitat conditions for fishers.
3. Vegetation management: Scope estimates for Federal land used a summary of northern spotted owl (NSO) suitable habitat removed or downgraded. The range of severity values reflects the changes to NSO habitat from reductions in canopy cover, removal of snags, and simplification of stand structure from management. Removal of NSO habitat generally involves significant reductions in habitat components that we considered important in fisher habitat, therefore we equated NSO habitat removal to removal of fisher habitat. Downgrading of NSO habitat does not remove NSO habitat but includes some or all of the following effects: reduction in canopy cover, loss of some snags or large trees and/or simplifies stand structure. We considered that downgrading of NSO habitat changes habitat quality for fishers but we considered that it may still provide some habitat value to fishers. Uncertainty related to Non-Federal vegetation management in Oregon as harvest is not reported in terms of acres. We therefore used an acre value for non-Federal harvest levels mid-way between the two California sub-regions as the coefficient of acres of harvest in Oregon. Estimates of potential reduction in fisher habitat are for those areas currently modeled as intermediate and high quality fisher habitat. Scope and severity were divided between Federal and non-Federal activities.				
Current vegetation management over 40 years	Ongoing	5 Fed 14 non-Fed	60-80 Fed 60-80 non-Fed	Results in a total reduction of 11-15% in forests that support habitat conditions for fishers on both public and private land.
4. Human development	Ongoing	<10	30-40	Results in a reduction of 3-4% due to small scale, localized recreational development.

[A]Sub-region where fisher populations are considered likely extirpated outside of reintroduction area.

022923

Table 22b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Western Oregon Cascades analysis area [A], as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors With Direct Effects to Fishers: Values in the discussion section below represent the potential percent of the population in the analysis area experiencing direct annual mortality, and does not include any potential sublethal effects that may result in reduced fitness.				
1. Trapping and Incidental Captures	Ongoing	96	<1	<1% annual mortality. Spatial data for trapping not available so assume roads provide access for trappers into areas modeled to provide fisher habitat. Body-gripping traps are legal in Oregon, but fishers are infrequently trapped, resulting in a low severity estimate.
2. Research Activities	Ongoing	0	n/a	n/a. Research is not currently being conducted in this analysis area.
3. Disease	Ongoing	100	<1-8	<1-8% annual mortality. Values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
4. Predation	Ongoing	100	5-23	5-23% annual mortality. Values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
5. Collision with vehicles	Ongoing	96	<1-4	<1-4% annual mortality. Severity values extrapolated from analysis areas with previous and on-going fisher research. Range in severity values reflects 3 sources of variation within and between studies. Scope is calculated on likelihood of roads occurring within a potential fisher home range.
6. Exposure to Toxicants	Ongoing	2-11	1-8	<1% annual mortality. Scope calculated based on likelihood of known marijuana grow sites occurring within a potential fisher home range. Severity values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
Direct Climate Effects to fishers: These projections do not necessarily represent mortality or loss of habitat, but rather the portion of the range where fishers may lose fitness, alter behavior patterns, or perhaps die or migrate because the climate is no longer suitable. The range of values reflects disagreements among the 10 different climate models evaluated.				
2040-2060	Ongoing	100	3-26	3-26%
2080-2100	Long-term	100	7-53	7-53%

[A] Sub-region where fisher populations are considered likely extirpated outside of reintroduction area.

022924

Table 23a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Coastal Oregon analysis area[A], as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors Related to Habitat: Scope values in the discussion section below represent the proportion of the fisher analysis area sub-region that can be reasonably expected to be affected by the stressor within the appropriate time period. Severity values in the discussion below represent the proportion of habitat within the scope that we expect to be lost or rendered significantly less suitable for fisher use due to the stressor.				
1. Wildfire, emergency suppression, post-fire management: The smaller severity value includes only areas burned by high severity fire, and the larger value includes all areas burned at moderate or high severity. Range of severity values represent the uncertainty related to functional effects of moderate severity fires on fisher habitat. There is additional uncertainty in the scope and severity values reported here, as they are based on a recent 28-year dataset, whereas the historical fire regime in this sub-region consisted of high-severity fires and a fire return interval longer than 200 years. Therefore, scope and severity reported here may be underestimates.				
Wildfire over 40 years	Ongoing	<1	11-35	Results in a reduction of <1% in modeled existing high and intermediate quality fisher habitat.
Wildfire over 100 years	Long-term	<1	11-35	Results in a cumulative reduction of <1% in modeled existing high and intermediate quality fisher habitat.
2. Changes in landscape patterns and ecosystems; Climate Change: There will likely be a shift from maritime conifer forest toward mixed conifer forest, and there may also be a shift toward drier conifer forest types in parts of the sub-region. There will be an increase in forest disturbances, in particular those caused by fungal diseases. It is uncertain how these changes in forest composition may affect the distribution of fisher habitat. Range of severity values represents variation in models.				
2040-2060	Ongoing	100	1-5	Results in a reduction of 1-5% in forests that support habitat conditions for fishers.
2080-2100	Long-term	100	1-10	Results in a cumulative reduction of 1-10% in forests that support habitat conditions for fishers.
3. Vegetation management: Scope estimates for Federal land used a summary of northern spotted owl (NSO) suitable habitat removed or downgraded. The range of severity values reflects the changes to NSO habitat from reductions in canopy cover, removal of snags, and simplification of stand structure from management. Removal of NSO habitat generally involves significant reductions in habitat components that we considered important in fisher habitat, therefore we equated NSO habitat removal to removal of fisher habitat. Downgrading of NSO habitat does not remove NSO habitat but includes some or all of the following effects: reduction in canopy cover, loss of some snags or large trees, and/or simplifies stand structure. We considered that downgrading of NSO habitat changes habitat quality for fishers but we considered that it may still provide some habitat value to fishers. Uncertainty related to Non-Federal vegetation management in Oregon as harvest is not reported in terms of acres. We therefore used an acre value for non-Federal harvest levels mid-way between the two California sub- regions as the coefficient of acres of harvest in Oregon. Estimates of potential reduction in fisher habitat are for those areas currently modeled as intermediate and high quality fisher habitat. Scope and severity were divided between Federal and non-Federal activities.				
Current vegetation management over 40 years	Ongoing	<1 Fed 37 non-Fed	60-80 Fed 60-80 non-Fed	Results in a total reduction of 22-30% in forests that support habitat conditions for fishers on both public and private land.
4. Human development	Ongoing	<10	30-40	Results in a reduction of 3-4% due to small scale, localized recreational development.

[A]Sub-region where fisher populations are considered likely extirpated.

022925

Table 23b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Coastal Oregon analysis area[A], as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors With Direct Effects to Fishers: Values in the discussion section below represent the potential percent of the population in the analysis area experiencing direct annual mortality, and does not include any potential sublethal effects that may result in reduced fitness.				
1. Trapping and Incidental Captures	Ongoing	100	<1	<1% annual mortality. Spatial data for trapping not available so assume roads provide access for trappers into areas modeled to provide fisher habitat. Body-gripping traps are legal in Oregon, but fishers are infrequently trapped, resulting in a low severity estimate.
2. Research Activities	Ongoing	0	n/a	n/a. Research is not currently being conducted in this analysis area.
3. Disease	Ongoing	100	<1-8	<1-8% annual mortality. Values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
4. Predation	Ongoing	100	5-23	5-23% annual mortality. Values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
5. Collision with vehicles	Ongoing	100	<1-4	<1-4% annual mortality. Severity values extrapolated from analysis areas with previous and on-going fisher research. Range in severity values reflects 3 sources of variation within and between studies. Scope is calculated on likelihood of roads occurring within a potential fisher home range.
6. Exposure to Toxicants	Ongoing	7-44	1-8	<1%-4% annual mortality. Scope calculated based on likelihood of known marijuana grow sites occurring within a potential fisher home range. Severity values extrapolated from analysis areas with previous and on-going fisher research. Range reflects 3 sources of variation within and between studies.
Direct Climate Effects to fishers: These projections do not necessarily represent mortality or loss of habitat, but rather the portion of the range where fishers may lose fitness, alter behavior patterns, or perhaps die or migrate because the climate is no longer suitable. The range of values reflects disagreements among the 10 different climate models evaluated.				
2040-2060	Ongoing	100	4-46	4-46%
2080-2100	Long-term	100	8-92	8-92%

[A]Sub-region where fisher populations are considered likely extirpated.

022926

Table 24a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Northern California – Southwestern Oregon analysis area, as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors Related to Habitat: Scope values in the discussion section below represent the proportion of the fisher analysis area sub-region that can be reasonably expected to be affected by the stressor within the appropriate time period. Severity values in the discussion below represent the proportion of habitat within the scope that we expect to be lost or rendered significantly less suitable for fisher use due to the stressor.				
1. Wildfire, emergency suppression, post-fire management: The smaller severity value includes only areas burned by high severity fire, and the larger value includes all areas burned at moderate or high severity. Range of severity values represent the uncertainty related to functional effects of moderate severity fires on fisher habitat.				
Wildfire over 40 years	Ongoing	22	17-37	Results in a reduction of 4-8% in modeled existing high and intermediate quality fisher habitat.
Wildfire over 100 years	Long-term	56	17-37	Results in a cumulative reduction of 10-21% in modeled existing high intermediate quality fisher habitat.
2. Changes in landscape patterns and ecosystems; Climate Change: Nearly all models project shifts from conifer forest to mixed conifer-hardwood forest. It is uncertain how these changes in forest composition may affect the distribution of fisher habitat. Many models also show shifts from forest to woodland and chaparral that do not provide suitable fisher habitat. Range of severity values represents variation in models.				
2040-2060	Ongoing	100	4-14	Results in a reduction of 4-14% in forests that support habitat conditions for fishers.
2080-2100	Long-term	100	9-28	Results in a cumulative reduction of 9-28% in forests that support habitat conditions for fishers.
3. Vegetation management: Scope estimates for Federal land used a summary of northern spotted owl (NSO) suitable habitat removed or downgraded. The range of severity values reflects the changes to NSO habitat from reductions in canopy cover, removal of snags, and simplification of stand structure from management. Removal of NSO habitat generally involves significant reductions in habitat components that we considered important in fisher habitat, therefore we equated NSO habitat removal to removal of fisher habitat. Downgrading of NSO habitat does not remove NSO habitat but includes some or all of the following effects: reduction in canopy cover, loss of some snags or large trees, and/or simplifies stand structure. We considered that downgrading of NSO habitat changes habitat quality for fishers but we considered that it may still provide some habitat value to fishers. Estimates of potential reduction in fisher habitat are for those areas currently modeled as intermediate and high quality fisher habitat. Scope and severity were divided between Federal and non-Federal activities.				
Current vegetation management over 40 years	Ongoing	0-3 Fed 22 non-Fed	60-80 Fed 60-80 non-Fed	Results in a total reduction of 13-19% in forests that support habitat conditions for fishers on both public and private land.
4. Human development	Ongoing	<10	30-40	Results in a reduction of 3-4% due to small scale, localized recreational development.

Table 24b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Northern California – Southwestern Oregon analysis area, as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors With Direct Effects to Fishers: Values in the discussion section below represent the potential percent of the population in the analysis area experiencing direct annual mortality, and does not include any potential sublethal effects that may result in reduced fitness.				
1. Trapping and Incidental Captures	Ongoing	89	<1	<1% annual mortality. Spatial data for trapping not available so assume roads provide access for trappers into areas modeled to provide fisher habitat. Body-gripping traps are legal in Oregon, but not in California, so we estimate severity to be well below 1%.
2. Research Activities	Ongoing	1-2	<1-5	<1% annual mortality. Current research affects only a small proportion of fishers within Northern California and Southwestern Oregon and infrequently results in mortality.
3. Disease	Ongoing	100	1-8	1-8% annual mortality. Range reflects 3 sources of variation within and between studies.
4. Predation	Ongoing	100	5-23	5-23% annual mortality. Range reflects 3 sources of variation within and between studies.
5. Collision with vehicles	Ongoing	89	<1-4	1-4% annual mortality. Range in severity values reflects 3 sources of variation within and between studies. Scope is calculated on likelihood of roads occurring within a potential fisher home range.
6. Exposure to Toxicants	Ongoing	23-95	2-8	<1%-8% annual mortality. Range reflects 3 sources of variation within and between studies.
Direct Climate Effects to fishers: These projections do not necessarily represent mortality or loss of habitat, but rather the portion of the range where fishers may lose fitness, alter behavior patterns, or perhaps die or migrate because the climate is no longer suitable. The range of values reflects disagreements among the 10 different climate models evaluated.				
2040-2060	Ongoing	100	23-40	23-40%
2080-2100	Long-term	100	47-81	47-81%

Table 25a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Sierra Nevada analysis area, as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors Related to Habitat: Scope values in the discussion section below represent the proportion of the fisher analysis area sub-region that can be reasonably expected to be affected by the stressor within the appropriate time period. Severity values in the discussion below represent the proportion of habitat within the scope that we expect to be lost or rendered significantly less suitable for fisher use due to the stressor.				
1. Wildfire, emergency suppression, post-fire management: The smaller severity value includes only areas burned by high severity fire, and the larger value includes all areas burned at moderate or high severity. Range of severity values represent the uncertainty related to functional effects of moderate severity fires on fisher habitat. There is additional uncertainty in the severity estimate because there is conflicting research as to whether there is an increase in the proportion of high severity fire in this sub-region; if so this would increase the severity of wildfire-related stressors. This possible increase in severity is not accounted for in the severity estimates below.				
Wildfire over 40 years	Ongoing	24	21-44	Results in a reduction of 5-11% in modeled existing high and intermediate quality fisher habitat.
Wildfire over 100 years	Long-term	60	21-44	Results in a cumulative reduction of 13-26% in modeled existing high intermediate quality fisher habitat.
2. Changes in landscape patterns and ecosystems; Climate Change: Several models show shift from forested habitat to woodland and grassland that do not provide suitable fisher habitat. Many models also show a shift from conifer forest to mixed conifer-hardwood forest. It is uncertain how these changes in forest composition may affect the distribution of fisher habitat. Range of severity values represents variation in models.				
2040-2060	Ongoing	100	1-31	Results in a reduction of 1-31% in forests that support habitat conditions for fishers.
2080-2100	Long-term	100	1-62	Results in a cumulative reduction of 1-62% in forests that support habitat conditions for fishers.
3. Vegetation management: Scope estimates for Federal land used a summary of northern spotted owl (NSO) suitable habitat removed or downgraded. The range of severity values reflects the changes to NSO habitat from reductions in canopy cover, removal of snags, and simplification of stand structure from management. Removal of NSO habitat generally involves significant reductions in habitat components that we considered important in fisher habitat, therefore we equated NSO habitat removal to removal of fisher habitat. Downgrading of NSO habitat does not remove NSO habitat but includes some or all of the following effects: reduction in canopy cover, loss of some snags or large trees, and/or simplifies stand structure. We considered that downgrading of NSO habitat changes habitat quality for fishers but we considered that it may still provide some habitat value to fishers. Estimates of potential reduction in fisher habitat are for those areas currently modeled as intermediate and high quality fisher habitat. Scope and severity were divided between Federal and non-Federal activities.				
Current vegetation management over 40 years	Ongoing	0-<1 Fed 15 non-Fed	60-80 Fed 60-80 non-Fed	Results in a total reduction of 9-12% in forests that support habitat conditions for fishers on both public and private land.
4. Human development	Ongoing	10-15	60	Results in a total reduction of 6-9% due to land conversion and development related to high human population growth in this sub-region, as well as development of recreational sites.

022929

Table25b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Sierra Nevada analysis area, as presented in the draft Species Report (Service 2014).

Stressors	Timing	Scope	Severity	Discussion
Stressors With Direct Effects to Fishers: Values in the discussion section below represent the potential percent of the population in the analysis area experiencing direct annual mortality, and does not include any potential sublethal effects that may result in reduced fitness.				
1. Trapping and Incidental Captures	Ongoing	84	<1	<1% annual mortality. Spatial data for trapping not available so assume roads provide access for trappers into areas modeled to provide fisher habitat. Body-gripping traps are not legal in California, so we estimate severity to be near zero.
2. Research Activities	Ongoing	25-30	<1-2	<1% annual mortality. Current research affects a substantial proportion of fishers in the Sierra Nevada, but infrequently results in mortality.
3. Disease	Ongoing	100	<1-5	<1-5% annual mortality. Range reflects 3 sources of variation within and between studies.
4. Predation	Ongoing	100	15-20	15-20% annual mortality. Range reflects 3 sources of variation within and between studies.
5. Collision with vehicles	Ongoing	84	2-3	2-3% annual mortality. Range in severity values reflects 3 sources of variation within and between studies. Scope is calculated on likelihood of roads occurring within a potential fisher home range.
6. Exposure to Toxicants	Ongoing	23-95	1-2	<1%-2% annual mortality. Range reflects 3 sources of variation within and between studies.
Direct Climate Effects to fishers: These projections do not necessarily represent mortality or loss of habitat, but rather the portion of the range where fishers may lose fitness, alter behavior patterns, or perhaps die or migrate because the climate is no longer suitable. The range of values reflects disagreements among the 10 different climate models evaluated.				
2040-2060	Ongoing	100	44-50	44-50%
2080-2100	Long-term	100	89-100	89-100%