DRAFT 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 April 8, 2004, the U.S. Fish and Wildlife Service (Service) published a 12-month finding in the Federal Register 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 2004, 12-month finding (69 FR 18770, p. 18775) 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.

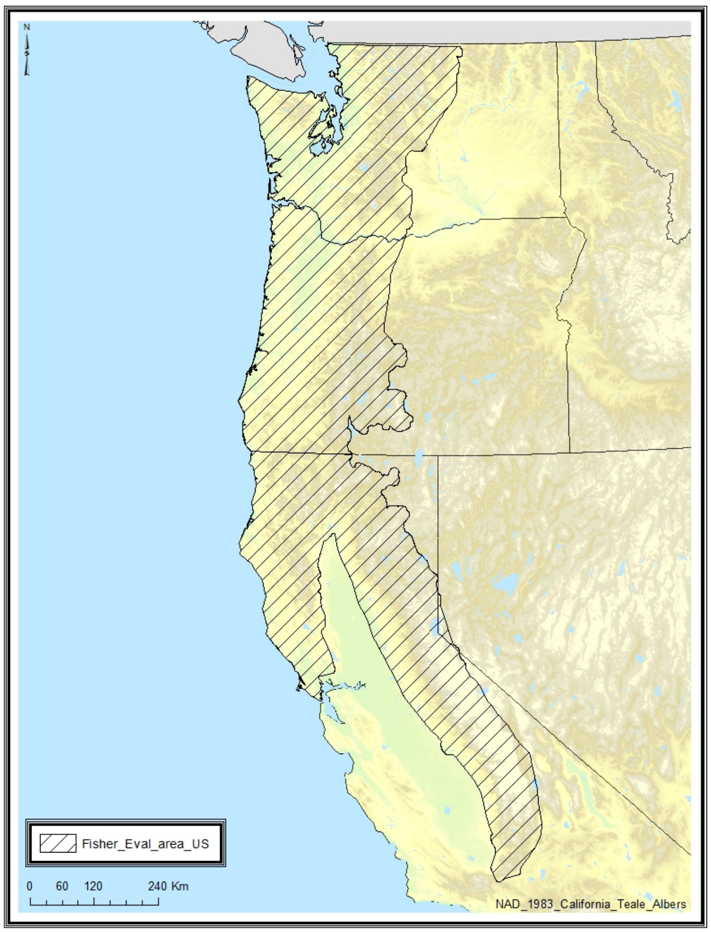

Figure 1. Analysis area for west coast population of fishers (*Pekania pennanti*).

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
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
USEPA	U.S. Environmental Protection Agency
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, a family that 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 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* is 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 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 all descendants, and separate from the branches of the other subspecies.

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). 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). 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) 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 (Wier 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.

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). Higley and Matthews (2009, pp. 15, 62) documented a mean annual female survival rate of 58.9 percent–94.4 percent from 2005–2009 for all female fishers marked on the Hoopa Valley Reservation, in California. Swiers (2013, p. 19) estimated that the annual survival rate of 64% did not vary from 2007 to 2011 and did not vary by sex on the eastern Klamath study area. 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–88 percent) in the north and 74 percent (95 percent confidence interval of 60 percent–87 percent) in the south.

Recruitment

The estimated recruitment rate we used for this analysis is defined as the number of juveniles alive per adult female during the fall of the year at the time of juvenile dispersal. Very little is known about fisher recruitment and often data are derived by piecing together various sources of information (e.g., 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. Matthews *et al.* (2013, p. 104) reported a recruitment rate of 0.19 (0.16 juvenile females and 0.02 juvenile males) per adult female on the Hoopa Valley Indian Reservation in California.

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). 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 females. 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). 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). Home range size most likely increases with increasing latitude (Lofroth *et al.* 2010, p. 69) and home range size increases 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).

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-foldor 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*. 1989a, 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).

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) –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).

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 (e.g., tree squirrels and other rodents that cache or hoard seeds) (e.g., Roemer *et al.* 2009, p. 170). Carrion and plant material (e.g., 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 (e.g., mice (*Peromyscus maniculatus*) or western fence lizard, *Sceloporus occidentalis*) per day to meet their energetic needs (Golightly *et al.* 2006, pp. 40–41).

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.* 1989a, 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). 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 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; 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 (e.g., 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). 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, as well as foraging opportunities at forest stand and larger scales, that provide for 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 >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, 1.4–3.4 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, pg. 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, pg. 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 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 >2260 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 (i.e., 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 >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).

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). 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 reproduce in managed forest landscapes and forest stands not classified as mature or late-successional, if those managed forest landscapes provide sufficient amounts 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). 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, p. 5; 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 (Lindstrand 2006, pp. 50-51).

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 (Scuiridae 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), forest type, 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 (USDI FWS 2004, p. 18773; USDA FS and USDI BLM 1994a, pp. J2-54, J2-56–J2-57, J2-79). However more recent analysis of information across the west indicates that the fishers patterns of use of riparian areas is 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 facing slopes and ridges early in the denning season (Thompson 2013, pers. comm.; Chatel *et al.* 2013, pers. comm.). 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 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).

Habitat Models

Numerous large scale habitat models have been developed for various regions within the west coast evaluation 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 evaluation area. We developed a model (hereafter "fisher analysis area habitat model") of potential habitat quality for fishers across the west coast evaluation 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 evaluation area (Figure 4) and selected points for model development that were verified detections (i.e., they had physical evidence to verify fisher identification; see distribution section) and the detections occurring 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 (e.g., vegetation, climate, elevation, terrain) and did not consider urban and open water areas as having the potential to provide fisher habitat conditions. Three regions of the analysis area, Washington, northern two-thirds of Oregon, and the central Sierra Nevada, currently had insufficient numbers and distribution of fisher detections to calibrate the models.

To portray potential fisher habitat for areas with insufficient verified detection data (Washington and 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 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.

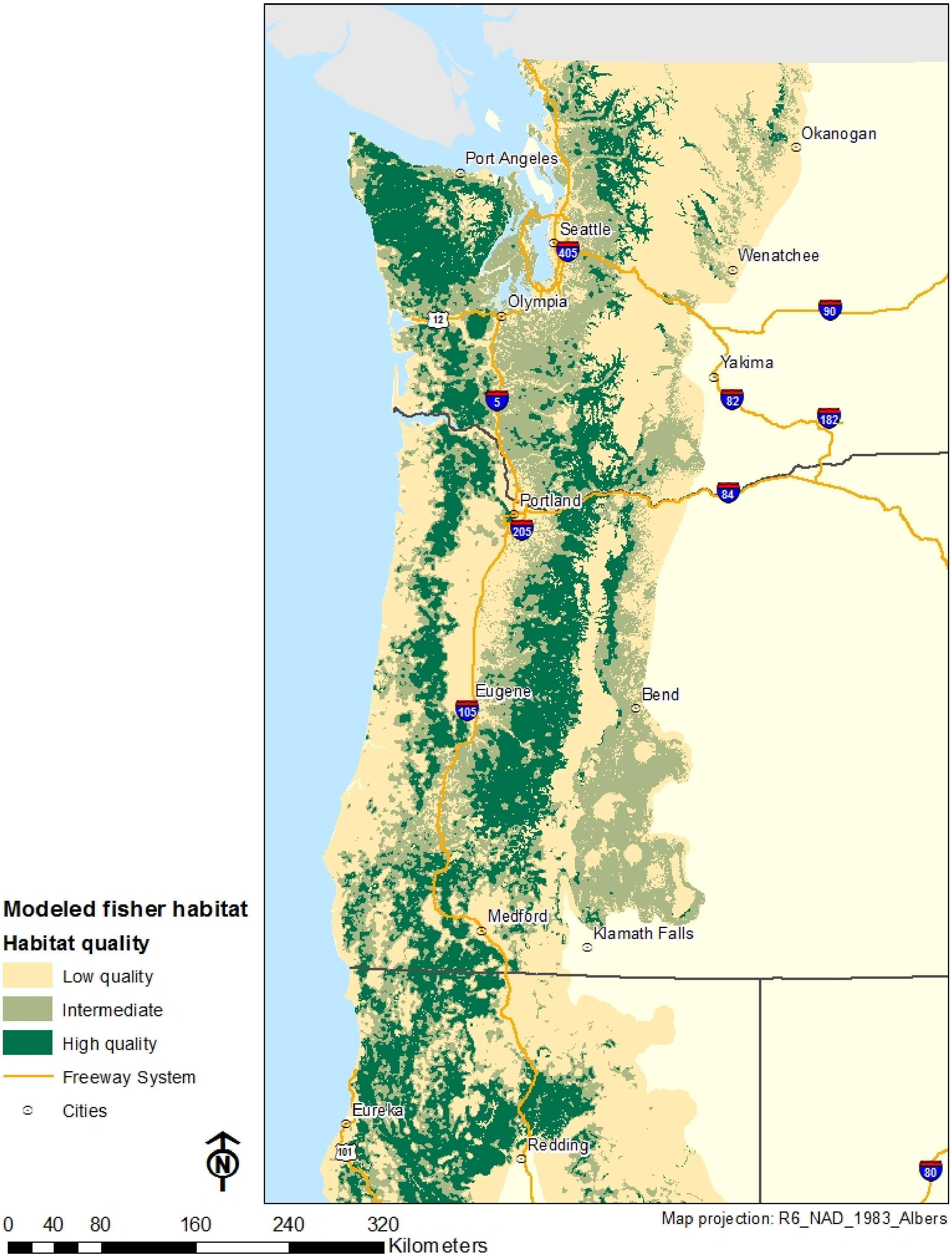

Figure 2. Fisher analysis area habitat model (north half).

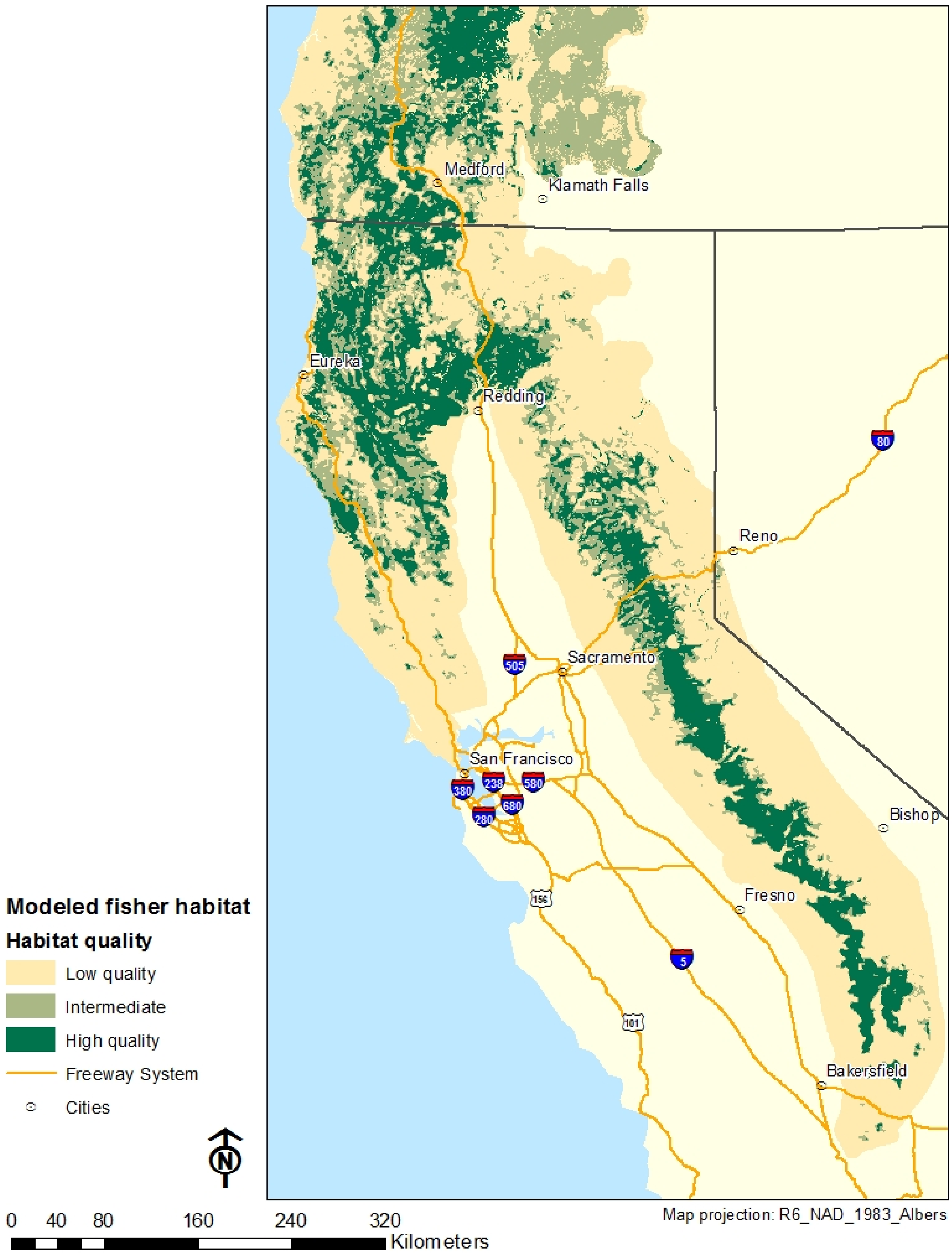

Figure 3. Fisher analysis area habitat model (south half).

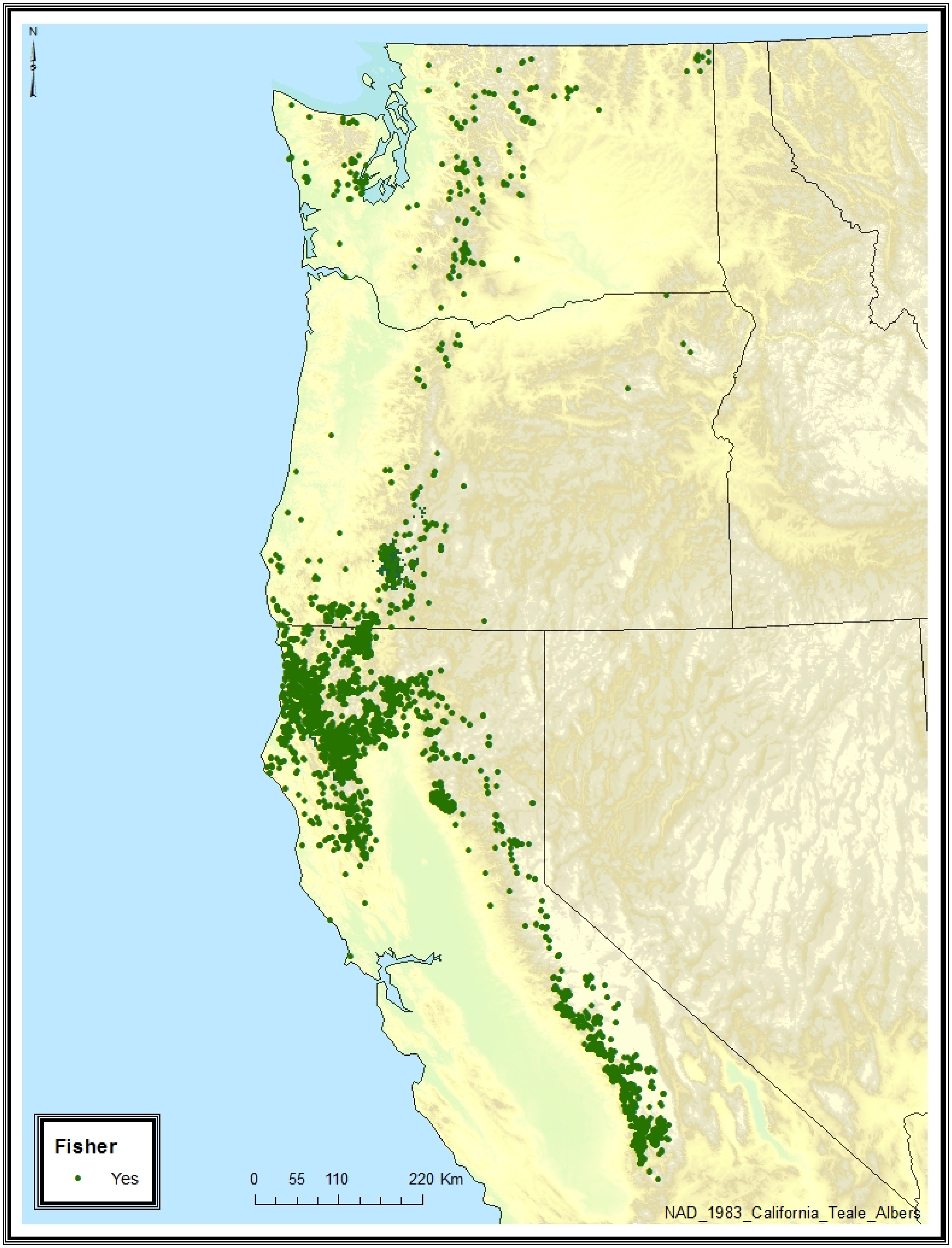

Figure 4. Fisher locality data for the analysis area. Reports from 1896 to the present.

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 (Giblisco 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.

Probably as a result of unregulated trapping, predator-control efforts, habitat loss and fragmentation, and climatic changes in eastern North America, a reduction in range and distribution of fishers occurred in the late 1800s and early 1900s. As a result, the extent of the range shrank 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 and 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 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.

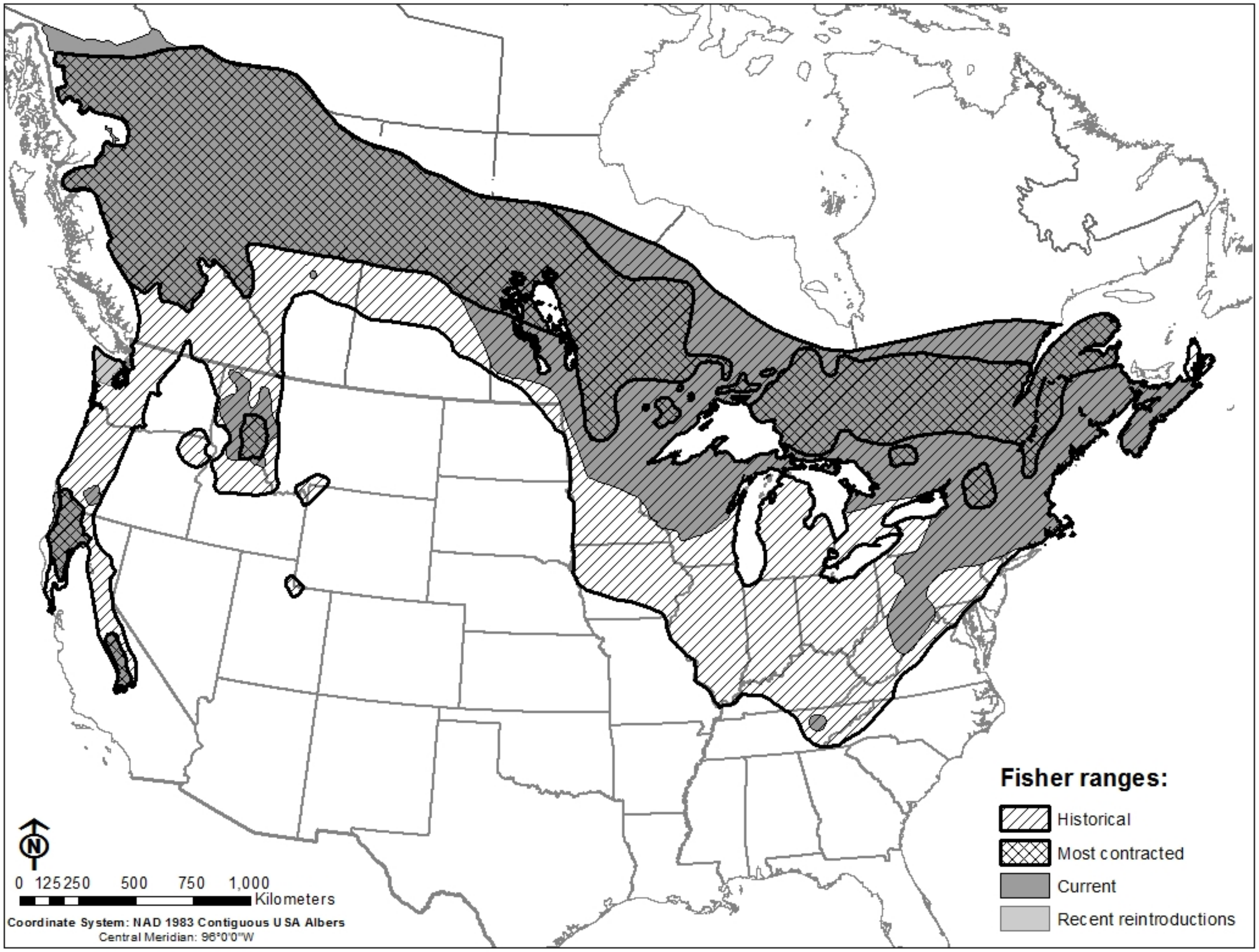

Figure 5. The fisher's historical, most-contracted, and current ranges. (Adapted from Lewis *et al.* 2012a, Figure 8.)

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 and 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 Grinnell *et al.* (1937, p. 216)'s 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; 2010, pp. 41,47; Slauson and Zielinski 2001, p. 12; Hamm *et al.* 2003, p. 203; Slauson *et al.* 2003, p. 20–21; Farber and Criss 2006, p. 11; Thompson 2008, entire; Lindstrand 2006, p. 49, 2010, p. 18; Spencer *et al.*2008, p. 44; 2011), 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'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 to the present.

In compiling the location information to describe the 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.* 1989a, 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). 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 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 the likelihood of detecting them. 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.

Because fishers are difficult to detect and it is difficult to determine whether they occupy an area or not, precisely determining their present range, or past trends in range expansion or contraction is also difficult. 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 over the last 20 years in this 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 present) 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).

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). 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), 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; 2005, p. 1394), 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.

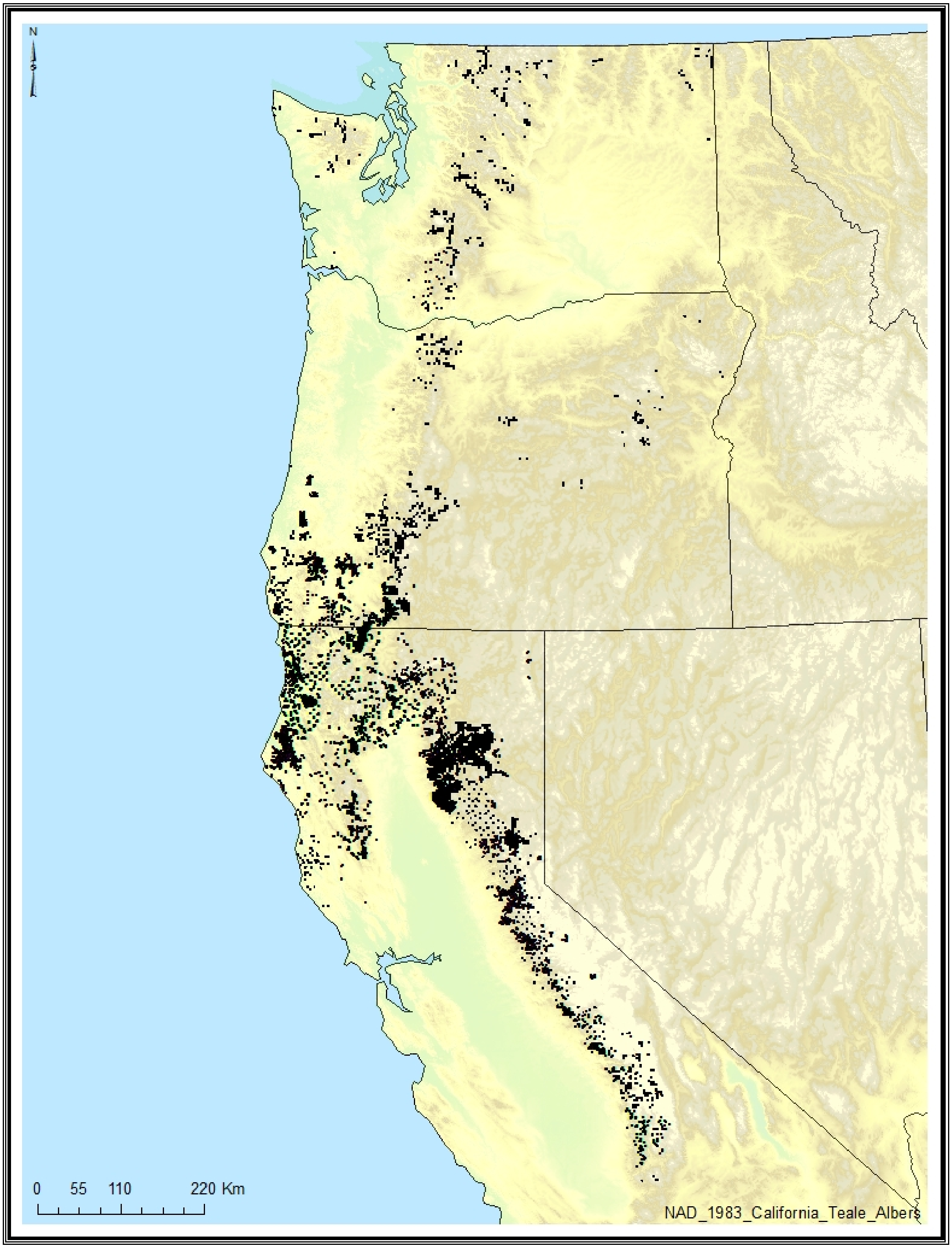

Figure 6. Opportunistic and systematic survey, trapping efforts, and other verifiable reports since 1993.

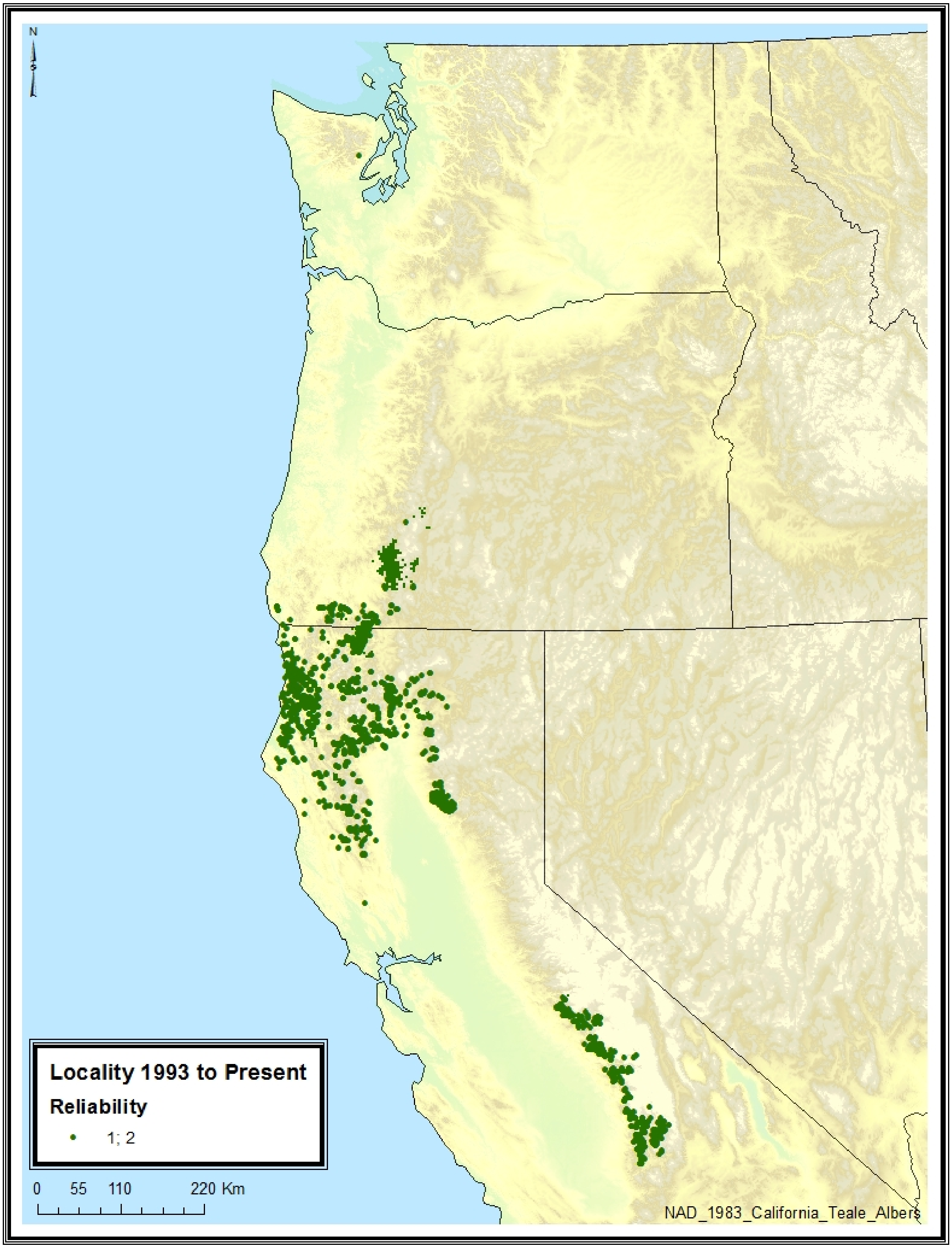

Figure 7. Locality records 1993 to present for reliability ratings 1 and 2. Please note that the ONP population here is represented by a single dot, and this representation is based on the information we received from WA Department of Fish and Wildlife.

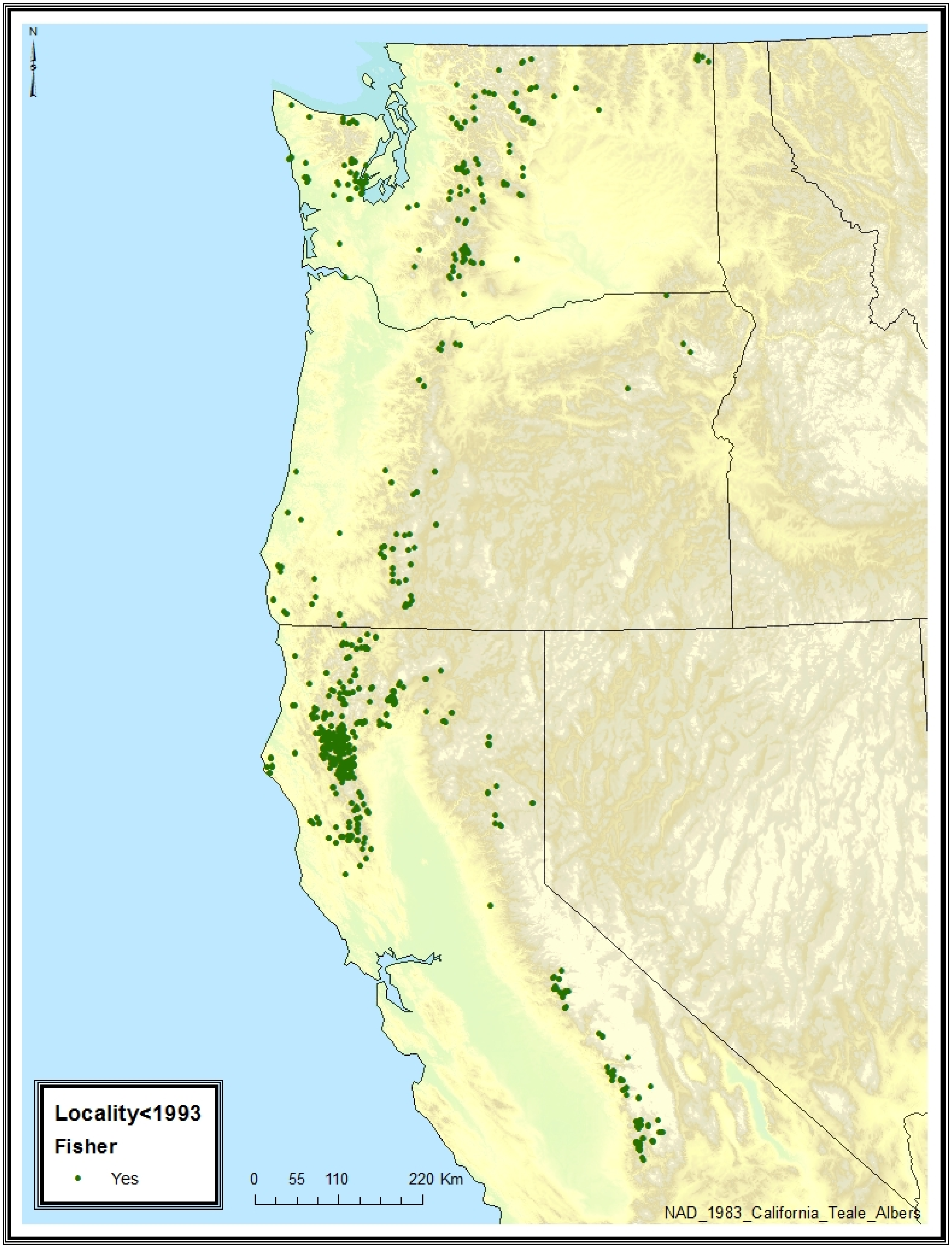

Figure 8. All records prior to 1993. Note: reliability ratings 1 through 6.

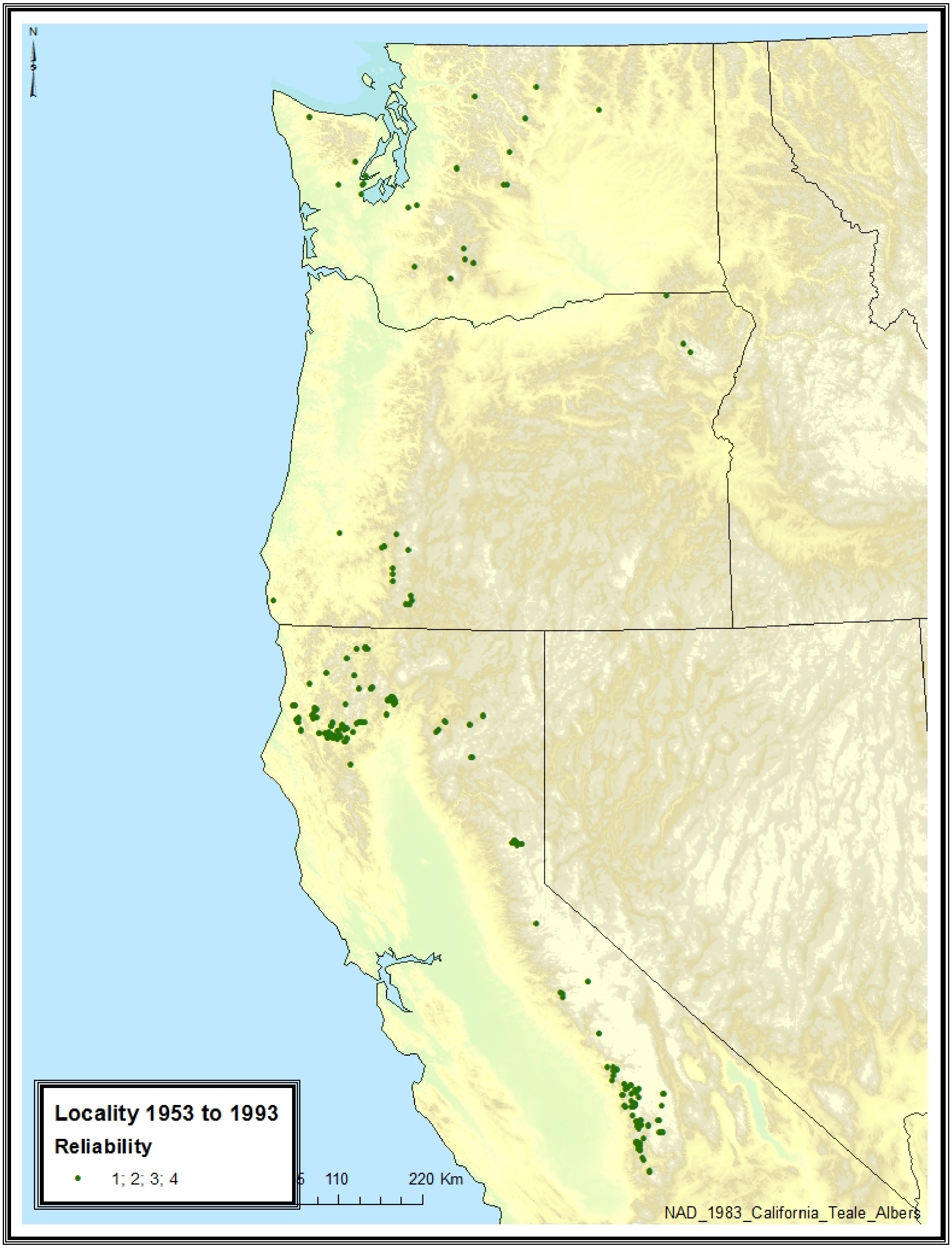

Figure 9. Fisher records 1953 to 1993 with reliability ratings 1 to 4

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 below in the section on Recently Introduced Populations, 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 on the Olympic Peninsula (3 years) and in the northern Sierra Nevada (2 years) after the last year of fisher releases, that fishers are persisting and reproducing.

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%

Current Distribution of Naturally Occurring Populations (1993 to Present)

The current extent of occurrence of the Southern Sierra Nevada Population in California includes portions of Mariposa, Madera, Fresno, Tulare, and Kern Counties. 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.

The Northern California-Southwestern Oregon Population occurs in the Klamath Mountains of southwestern Oregon in Josephine, Jackson, and Curry Counties in Oregon and extends south 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.

A scarcity of verifiable sightings in Washington, northern Oregon, and central Oregon suggests populations appear to be likely extirpated, as described below, except on the Olympic Peninsula, where they have been recently reintroduced (see Introduced Populations 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). 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, as has happened before with a small fisher population outside of the analysis area.

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 a total of 188 fishers originating from central British Columbia, Minnesota, and Wisconsin being released 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 the presence of a remnant native population of fishers in the USNRM that escaped 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 genetic legacy of this remnant native population, with unique genetic identity found nowhere else in the range of the fisher in addition to the genetic contributions from fishers introduced from British Columbia and the Midwest.

Introduced 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). Below, the status of the three reintroduction efforts in the analysis area is discussed further.

Southern Oregon Cascades Reintroduced Population

The fishers in the Southern Oregon Cascades Population 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; however, it does not appear to be expanding its range despite the presence of apparently unoccupied suitable habitat in the vicinity (Lofroth *et al.* 2010, p. 48).

The Southern Oregon Cascades Population is relatively close (within 40 km (25 mi)) to the Northern California-Southwestern Oregon Population, but is separated by a relatively narrow band of forested habitat and 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).   Therefore, the Oregon Cascades and Northern California-Southwestern Populations may be interconnected by dispersing fishers.

Olympic Peninsula Reintroduced Population

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.

Northern Sierra Nevada Reintroduced Population

In California, in 2009 the reintroduction of fishers into the northern Sierra Nevada was implemented 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 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 (USDI FWS 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).

Population Status

Native populations

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 (e.g., 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), reveal that the extant fisher populations are reduced in size relative to our understanding of their historical distribution.

Northern California-Southwestern Oregon Population

No published population or density estimates are available for the entire Northern California-Southwestern Oregon 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 0.18 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 one, which indicates a declining population if less than one and a stable to slightly increasing population if equal to one 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 Northern California-Southwestern Oregon 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 Northern California-Southwestern Oregon 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 Northern California-Southwestern Oregon population as a whole is increasing, decreasing, or stable.

There have been several approaches used to estimate the Northern California-Southwestern Oregon 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 Northern California-Southwestern Oregon 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 2790 to 3990 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 2850. 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 Northern California-Southwestern Oregon population estimates range from a population size of 258 to 4,018.

Additional insight into the status of the Northern California-Southwestern Oregon population comes from occupancy modeling and 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. 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% of these sites (Furnas 2014, pers. comm.). Using occupancy modeling, Furnas (2014, pers. comm.) estimated that fishers were present at 65% (90% CI 53-79%) of the survey sites.

We mapped our database of fisher surveys (Figure 6) onto a hexagonal, 1000-ha grid depicting hypothetical fisher home ranges within the area occupied by the Northern California-Southwestern Oregon population (Figure 10). There were 1274 hexagons that contained at least one survey location between 2003 and 2013; 34% of these hexagons contained at least one positive survey, whereas 66% included only negative surveys. Within high-value modeled habitat, the percentage of hexagons with at least one positive survey was higher, 47%. If we assume a detection probability of 60%, we estimate that fishers may have been present within approximately 56% of all surveyed hexagons and within 78% 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% 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 Northern California-Southwestern Oregon 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.). Also 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	0.07 males 0.11 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

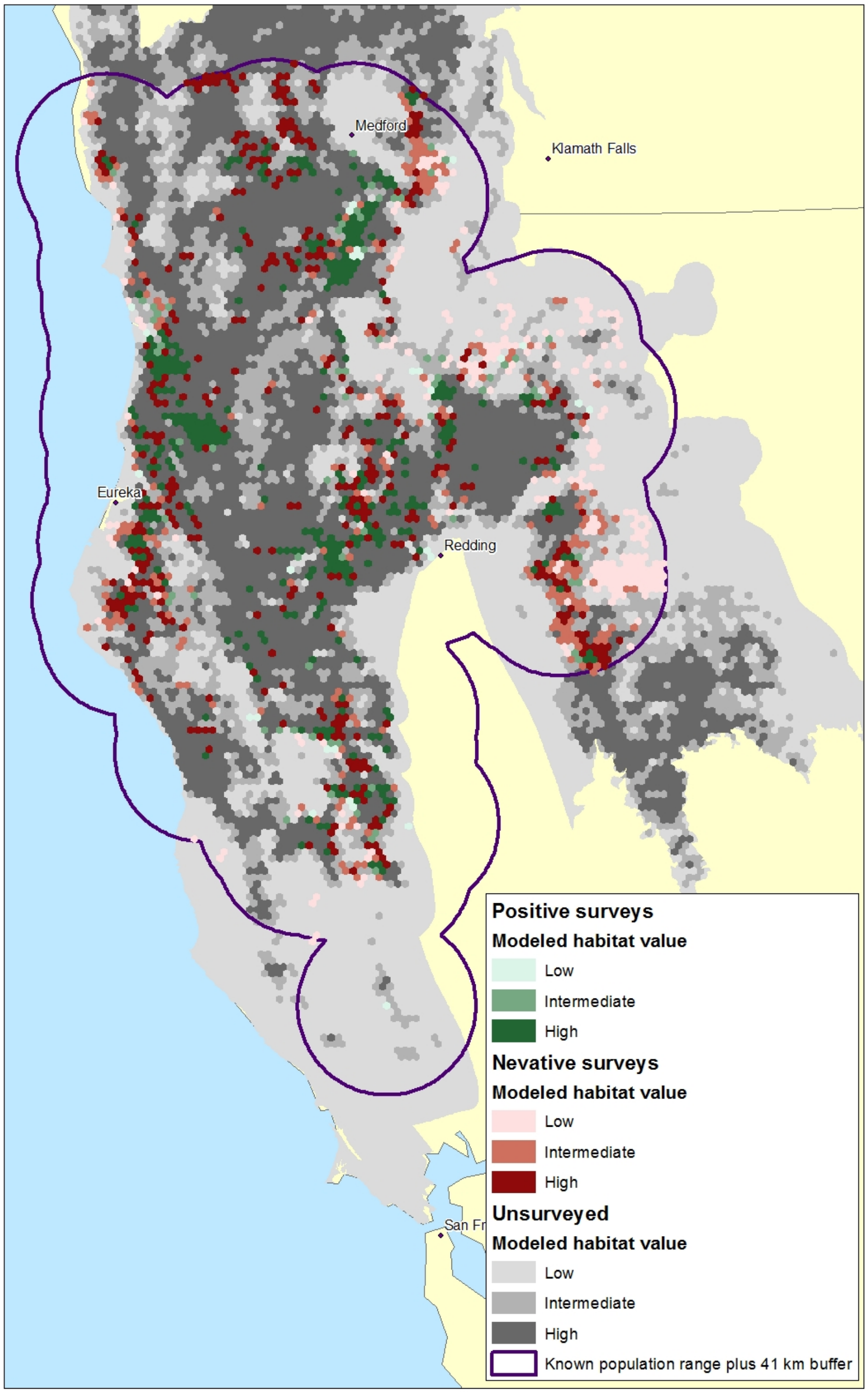

Figure 10. Hypothetical 1000-ha fisher home ranges that contain positive survey results since 2003 (green); that were surveyed since 2003 but contain only negative survey sites (red and pink); or that were not surveyed between 2003 and 2013 (gray). The purple outline buffers all positive detections of 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.

Southern Sierra Nevada Population

Several approaches have been taken to understanding the population status of the Southern Sierra Nevada Population. Density estimates are available from two study sites (Zielinski *et al.* 2004b, p. 654; Jordan 2007, pp. 12–44; listed in 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 one study area over a period of eight years (Zielinski *et al.* 2013, entire). By all estimates, the isolated Southern Sierra Nevada 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 Southern Sierra Nevada Population. They then used a deterministic, Leslie stage-based matrix model to gauge risk of extinction for the Southern Sierra Nevada 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 they 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% CI 1.04-1.19), which indicates a stable or slightly increasing population (Sweitzer 2013a, pers. comm.; Sweitzer 2013b, pers. comm.). 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 Northern California-Southwestern Oregon 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, the USDA Forest Service (USFS) initiated a regional monitoring program to track occupancy trends of fishers in the Southern Sierra Nevada 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.* 2013, 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.* 2013, p. 8) and concluded the Southern Sierra Nevada 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.* 2013, 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). Re-creating 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 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 Southern Sierra Nevada Population.

Reintroductions

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 re-establish 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 (i.e., fishers persisted >10 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, five 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 two most recent reintroductions (Olympic Peninsula and Northern Sierra Nevada) have not reported that they have met their criteria for success.

Unsuccessful reintroductions into Oregon

During the 1950s, the USDA Forest Service and Weyerhaeuser Corporation asked the Oregon State Game Commission to reintroduce fishers to Oregon as a means of controlling porcupine (*Erethizon dorsatum*) 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).

Southern Oregon Cascades Reintroduced Population

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 Northern California-Southwestern Oregon 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 Northern California-Southwestern 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.).

Olympic Peninsula Reintroduced Population

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). 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 (i.e., photos of radio-collared individuals) and of reproduction (e.g., one road-killed female was lactating and had four placental scars) (Happe 2013b, pers. comm.).

Northern Sierra Nevada Reintroduced Population

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).

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, both photographs DNA evidence, north, south, and east of the Aubry and Raley (2006) study area. These recent ageny surveys, while not systematic in design, do not indicate evidence of broad-scale population expansion.

For both the Olympic Peninsula Reintroduced Population 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 two new reintroductions.

REVIEW OF STRESSORS

In the following section, we will review and evaluate potential past, current, and future stressors that may be affecting fishers in the analysis area. At the conclusion of each section, we indicate the timing, scope, and severity of the potential stressor, noting where stressors may differ regionally. 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. 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). Two geographic areas encompassed extant native fisher populations: 1) Northern California-Southwestern Oregon, and 2) Sierra Nevada. In addition, the reintroduced Olympic Peninsula population is present in Coastal Washington; the reintroduced Northern Sierra Nevada population spans the Sierra Nevada and Northern California-Southwestern Oregon sub-regions; and the reintroduced Southern Oregon Cascades population is located at the conjunction three sub-regions: Northern California-Southwestern Oregon, Western Oregon Cascades, and Eastern Oregon Cascades.

Definition of Terms

Stressors

Stressors are the activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, or impairment of west coast fisher populations or their habitat. 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. For each identified stressor, the timing, scope, and severity are determined.

Past Stressors

Effects of past stressors (if not continuing) are taken into consideration when determining long-term and short-term trends.

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.

Table 3. Analysis area sub-regions

Analysis Area Sub-Region	State/ Province	Geographic Description	General Occupancy	Reintroduced 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.	Likely extirpated outside of reintroduction areas	The Olympic Peninsula Reintroduced Population 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.	Likely extirpated		0.66	0.34
Eastern WA Cascades	Washington	East side of the Cascade Range from the Canadian border south to the Columbia River.	Likely extirpated		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.	Likely extirpated		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	Likely extirpated outside of reintroduction areas	The Southern Oregon Cascades Reintroduced 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.	Likely extirpated outside of reintroduction areas	The Southern Oregon Cascades Reintroduced 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.	Extant Native	The Southern Oregon Cascades Reintroduced Population occurs in northern portion of this sub-region. The Northern Sierra Nevada Reintroduced Population occurs in southern portion of 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.	Extant Native	The Northern Sierra Nevada Reintroduced Population occurs in northern portion of this sub-region.	0.57	0.43

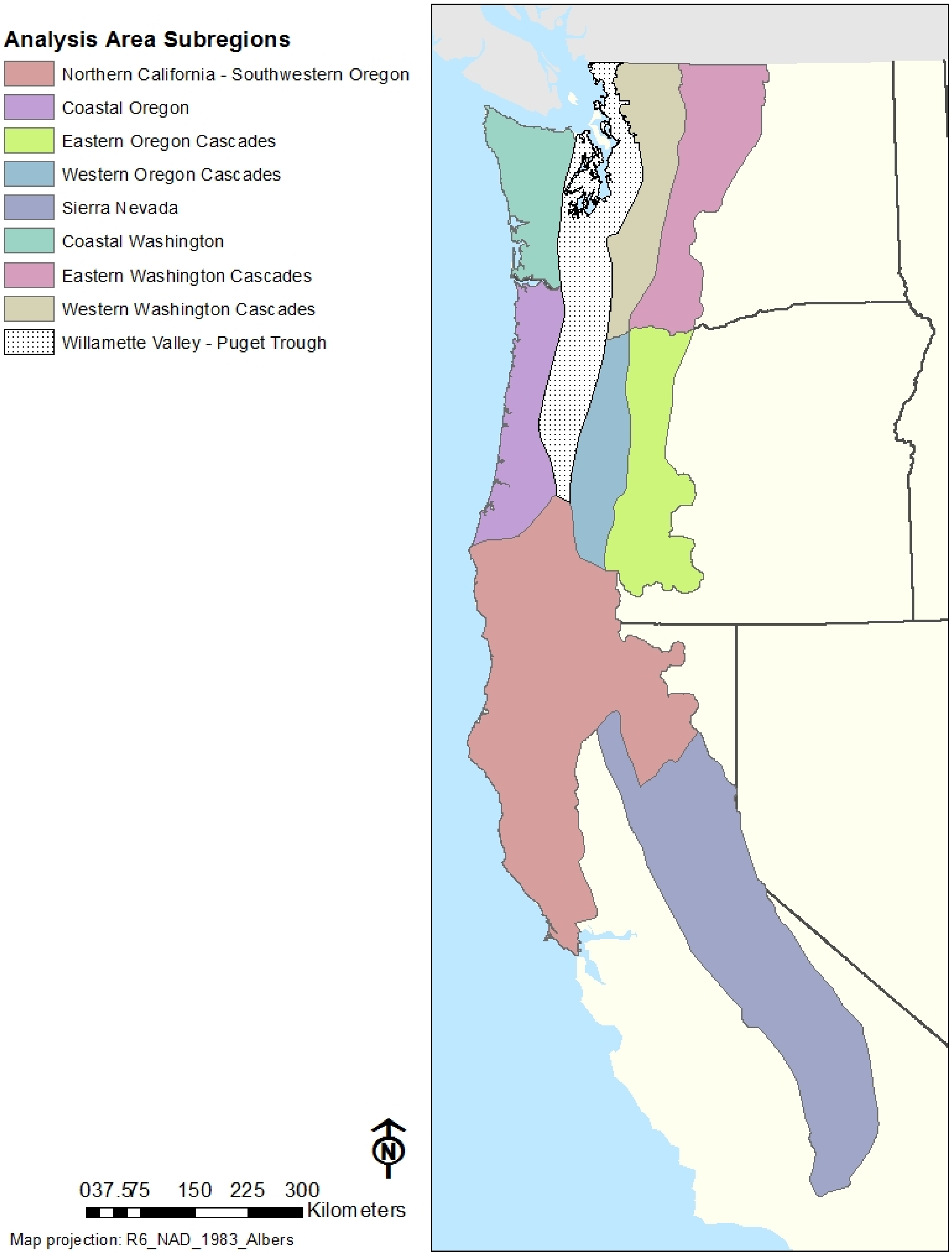

Figure 11. Graphical representation of analysis area sub-regions used to evaluate potential stressors.

Stressors that 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 for the foreseeable future.

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 into 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 U.S. Forest Service Land and Resource Management Plans were developed between 1983 and 1993 (USDA 2012, p. 21164); and 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). Similarly, climate change is underway, but its effects are likely to be long-lasting, and moreover are likely to accelerate into 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 (Mote and Salathé 2010, p. 39; Cayan *et al.* 2009, p. 7). However, many climate studies report results only for the late 21st century, and not for intermediate time points; we report these results as well but clearly identify the relevant time frame. Effects of fire are reported as an annual average of the amount of habitat affected, and these annual amounts are summed to give the amount of habitat likely to be affected over 40 years.

Timing (immediacy) Categories:

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

Ongoing—continuing (a stressor now).

Long-term future—in the future beyond the timeframe of the foreseeable future. The effects of some ongoing stressors have been projected for the late 21st century, which is outside of the forseeable future as defined above; therefore, we report them as the long-term future effects.

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 12). 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.

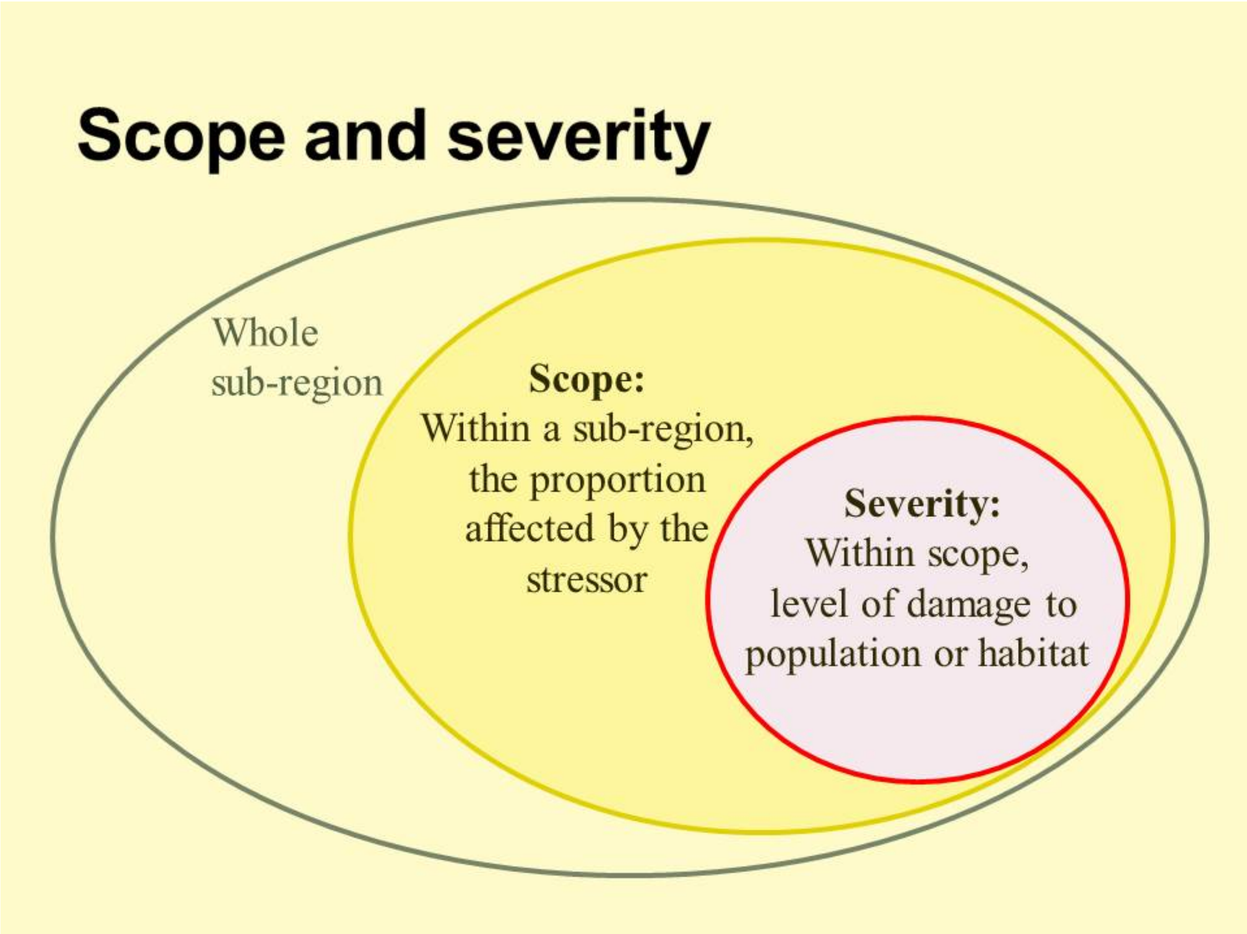

Figure 12. Relationship between a population, and the scope and severity of a stressor acting within that population.

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 12). 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 1000 fishers living in Northern California-Southwestern Oregon (Table 4). (A population size of 1000 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.

Table 4. 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]

Stressors related to habitat

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, 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). Also, 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 resulting in the removal and limits future recruitment of rest and den trees. Fuels reduction and fire suppression techniques that focus on the removal or salvage of snags and fire damaged trees may 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 and ongoing loss and fragmentation of fisher habitat may contribute to the decline of fisher populations (Aubry and Lewis 2003, p.82). 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, to more than 80 years in the in the drier areas of California and southern Oregon (Agee 1991, p. 32; Franklin and Spies 1991b, 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 Although there is no published work evaluating the direct effects of 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, providing 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).

Below we address stressors that affect forest vegetation and 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 powerlines. All of these changes in habitat may affect the landscape's overall ability to support fishers and may also act as barriers to 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.

While we attempt to quantify habitat loss, we were unable to quantify habitat recruitment through either ingrowth or silvicultural treatments that may offset some habitat loss over our 40-year analysis window. We discuss this in more detail in the Current Vegetation Management section.

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 speceis) 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 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 (USDA FS 2000, p. 5).

Scope and severity of loss of late-successional forest from past activities and disturbances

As stated earlier in this stressor, a reduction in the amount of late-successional forests occurred in Washington, Oregon, and California has been implicated as a primary cause of fisher declines across the analysis area. The reduction and fragmentation of forests that provide dense and multi-layered overstory canopy and structural elements used for denning and resting, and obstructing movement and dispersal capabilities of fishers have degraded regional habitat quality. Our evaluation of the timing, scope, and severity of the loss of late-successional forest due to vegetation management (primarily via timber harvest) was based on reporting of late-successional forest trends.

The timing of our consideration of this stressor is prior to the early 1990s. We assigned values for scope assuming that within each sub-region timber harvest was occurred ubiquitously on both public and private land; and estimating that a few areas such as national parks, high elevation, and more remote inaccessible areas were not as available for timber harvest during the time period being considered (Table 5). As a baseline for percentages of total productive forest land that contained old-growth forest we used Bolsinger and Waddell's (1993, p.3) values for California (56%; excluding the Cascade mountains and Sierra Nevada), Oregon (53%), and Washington (40%) for the time period 1933 to 1945; and values in the Sierra Nevada (45%) were derived from Beardsley *et al*, 1999 (p. 21) for the time period from 1945 to 1993. It should be noted that the values in both the Bolsinger and Waddell (1993) and Beardsley et al (1999) papers are presumed to under-represent the amount of late successional forests regionally available in the early 1800s because many decades of harvest had already been occurring in some areas. Severity values reflect the change in amounts of baseline old-growth forest from the 1930s and 1940s to the 1990s as reported by Bolsinger and Waddell (1993, p.3) and Beardsley *et al.* 1999, p. 21) (Table 5).

Table 5. Scope and severity values for loss of late-successional forest from past activities and disturbances

Analysis Area Sub-regions	Scope %	Severity %
Sierra Nevada	50 to 70	76
Northern California - Southwestern Oregon	50 to 70	64
Western Oregon Cascades[B]	50 to 80	60
Eastern Oregon Cascades[B]	50 to 80	60
Coastal Oregon [A]	90 to 95	60
Western Washington Cascades [A]	50 to 80	63
Eastern Washington Cascades [A]	50 to 80	63
Coastal Washington[B]	90 to 95	63

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

Wildfire, emergency fire suppression actions, and post-fire management actions

<u>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 is often expressed in categories of high, medium, 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). Moderate severity fire refers to fire that is intermediate in its effects between high-severity and low-severity fire; for example, a fire may kill scattered clumps of overstory trees within a stand. Mixed severity fire includes patches of low-severity fire and patches of high-severity fire (Jain *et al.* 2012, p. 47).

Fire frequency is generally expressed in terms of the fire return interval, or average time between fires at the same location. Historical fire return intervals in the analysis area vary from 6-9 years in some areas of northern California to 1000 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).

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). Both low-severity fire and high-severity fire can cause changes to fisher habitat elements. 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.

Low-severity fires decrease the density, diversity, and abundance of understory vegetation. 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). However, the recovery of understory, especially on productive sites, can occur within one fisher lifetime (Naney *et al.* 2012, p. 6). 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). However, 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 fires, especially stand-replacing fires. Mixed- and high-severity fires often 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. Even 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).

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 unfavourable 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). Due to the loss of suitable habitat, large stand replacing fires may reduce the number of fisher home ranges that can be supported by the habitat for several decades until forest regrows. 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). In some areas dominated by mixed-severity fire regimes, past fire severity is the best predictor of future fire severity, and the parts of the landscape that receive regular high-severity fire are dominated by shrublands, while the rest of the landscape is dominated by coniferous forests. 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 (Perry *et al.* 2011, pp. 707, 709). This conversion may present a long-term barrier to dispersing fishers, causing populations to become fragmented or preventing migration between populations.

Fisher use of burned landscapes

Only one research study has been conducted on the degree to which fishers use post-fire landscapes, although other researchers have reported hypotheses and incidental observations. In the southern Sierra Nevada, Hanson (2013, entire) observed that fisher scat could be found within areas that had burned 10-12 years previously, even areas where the fires had caused over 50% mortality. Hanson (2013, p. 26) further noted that within burned areas, fishers selected stands that had been categorized as dense, mature or old forest prior to the fire. 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.

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).

As described below in the section on Current Vegetation Management, spotted owls (*Strix occidentalis*) use similar habitat elements and forest conditions as fishers; 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, p. 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, p. 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 (see 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 than spotted owls, fishers may be more sensitive to barriers to dispersal created by large patches of stand replacing fire.

<u>Emergency fire suppression activities</u>

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.

There has been a recent paradigm shift in wildland firefighting policy, with increased attention to the impacts of fire suppression techniques. However, this concern is not universal among fire managers and crews, and many fire personnel may benefit from more education and training on minimum impact suppression tactics.

<u>Post-fire management activities</u>

Salvage logging (harvest of dead or soon to be dead trees with commercial value) also occurs on the vast majority of private timberlands in the analysis area. Of large fires that burned U.S. Forest Service lands, salvage logging is ongoing on the Chips Fire and was completed on portions of the Biscuit, B and B, and Tripod Fires. 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 (USDI FWS 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).

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.

Timing, scope, and severity of wildfire, fire suppression, and post-fire management

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 6), 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 6. 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 7), 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 (USDA FS 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 (USDI FWS 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 fuelbreaks 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 7. 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.

Additional information about the scope and severity of stressors related to wildfire in each of the analysis area sub-regions:

Sierra Nevada

Because there is evidence of increasing fire severity in yellow pine-mixed conifer forests, which include the majority of fisher habitat in the Sierra Nevada (Miller and Safford 2012, p. 46), the estimate of the severity of stressors related to wildfire given in Table 7 is likely to be an underestimate. Also, 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 severely disrupt north-south connectivity of habitat within the Sierra Nevada. The estimate given in Table 7 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 Southern Sierra Nevada Population of fishers. If habitat connectivity is lost to the north of the area currently used by the Southern Sierra Nevada Population, this loss could prevent the population from expanding. See the 2013 Fire Season section below for examples. In addition, forest burned at high severity in this region may be replaced by chaparral or grasslands (Climate Change section), and may therefore represent a permanent loss of habitat.

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, and even temporary losses of habitat may impede dispersal and increase fragmentation of the resident fisher population.

Western Oregon Cascades
Most of the Western Oregon Cascades have an 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. Therefore, the 28-year MTBS dataset may not be long enough to adequately extrapolate the scope of wildfire-related stressors over the next 40-100 years. However, our estimates for scope and severity in the Oregon Western Cascades are likely relatively accurate, as compared with our estimates for Coastal Oregon and Washington and the Western Washington Cascades (see below). Most of the Western Oregon Cascades contain large blocks of contiguous habitat, so habitat connectivity is only a major concern in a few areas at the northern and southern ends of this sub-region.

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 even more.

Coastal Oregon
By our calculations, the scope of stressors related to wildfire in Coastal Oregon is relatively low. However, the historical fire-return interval in this sub-region is generally greater than 200 years, and the 28-year MTBS dataset is likely not adequate to calculate an accurate estimate of area burned in Coastal Oregon over the next 40 or 100 years. Historically, most fires here have burned at high intensity. Therefore, both the scope and severity of wildfire-related stressors may be underestimated in this region, if such a fire occurs within the next 40-100 years. In addition, fisher habitat in Coastal Oregon occurs in a narrow strip, similar to the band of fisher habitat in Sierra Nevada, but 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. Therefore, the scope and severity of wildfire-related stressors in this sub-region may be higher than we can calculate using the 28-year MTBS dataset. In addition, the total area burned in this region is projected to increase to approximately eight times its present extent over the next 60 years, though this extent will still be relatively small compared with the area burned in other sub-regions (Littell *et al.* 2010, pp. 14-15). Fisher habitat is relatively sparse and fragmented in this sub-region (see Figure 2). If large, stand replacing fires occur, habitat connectivity may become impaired.

Eastern Washington Cascades
Our habitat model for the Eastern Washington Cascades (see Figure 2) shows very little high quality habitat available in this sub-region, and even the intermediate habitat is highly 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 likelihood that our scope and severity estimates are underestimates are the same in this area as in Coastal Oregon, as is the potential for disruption of habitat connectivity. 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 over the next 40-100 years.

<u>Examples: 2013 Fire Season</u>
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 Northern California – Southwestern Oregon, 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 Northern California – Southwestern Oregon 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 8. 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, just to the north of the current range of the Southern Sierra Nevada fisher 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 Southern Sierra Nevada fisher 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.

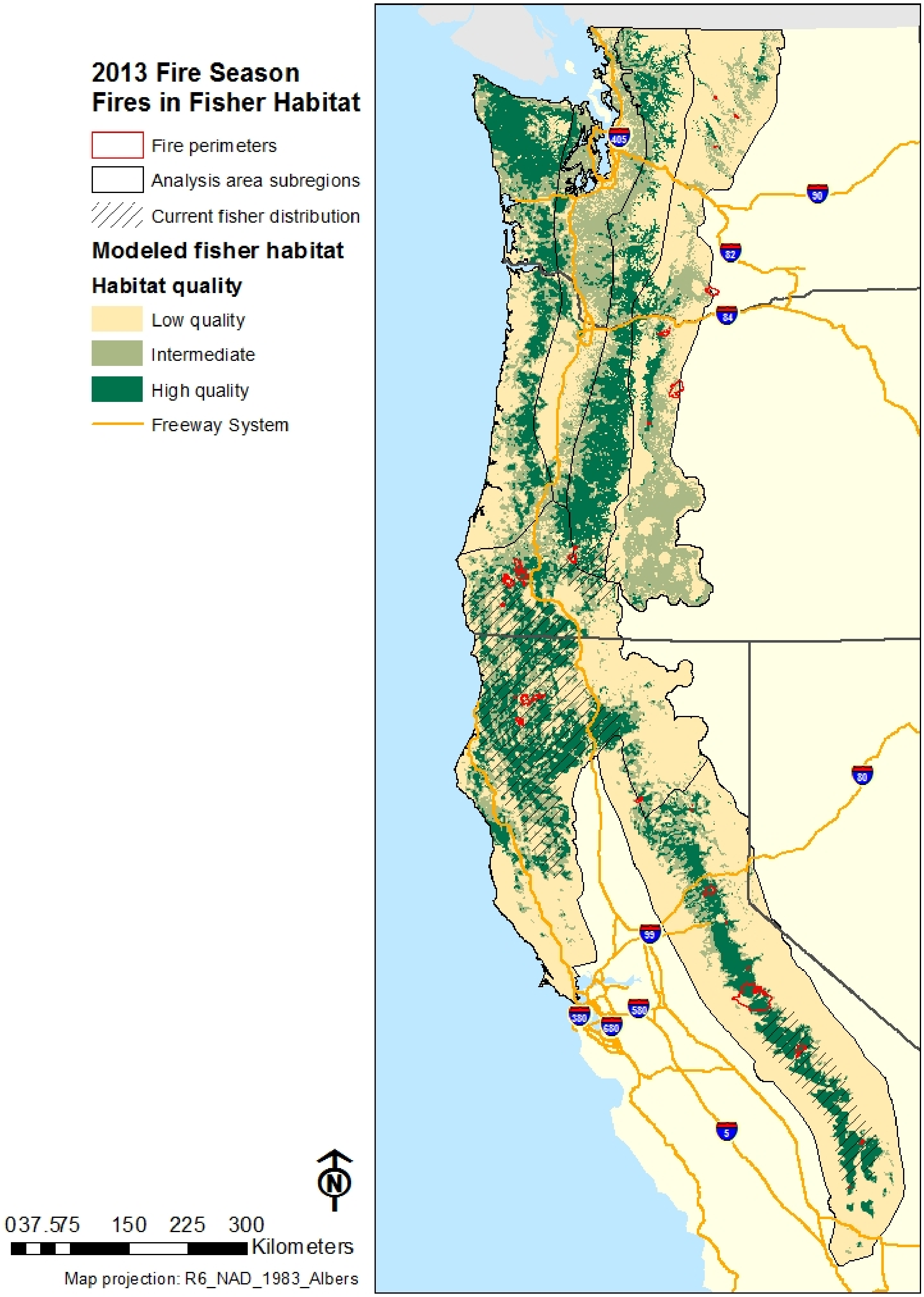

Figure 13. Fire perimeters within the analysis area for fire season 2013.

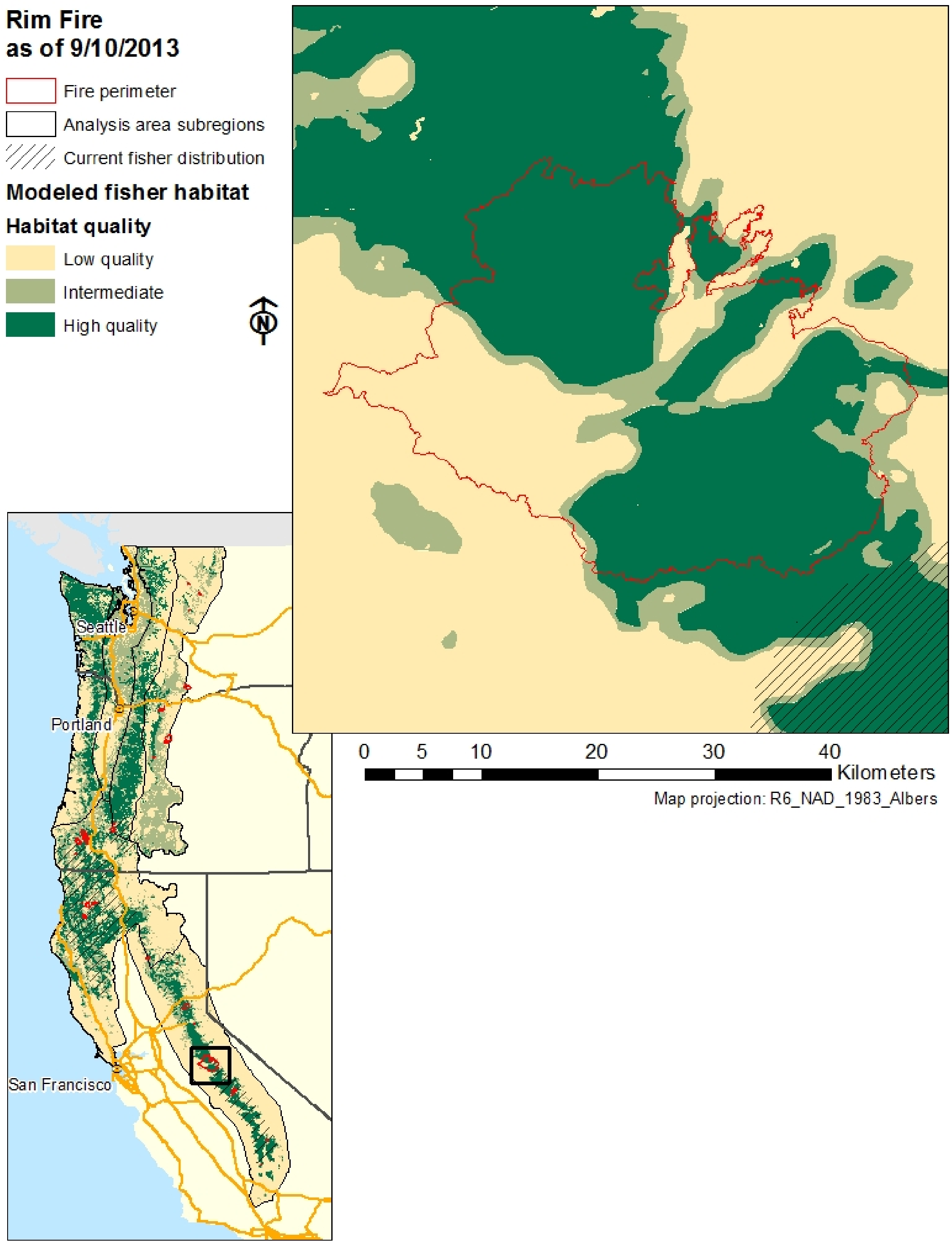

Figure 14. Inset depicts perimeter of the 2013 Rim fire as of 11 September 2013 in the Sierra Nevada. Hatch marks southeast of fire perimeter depict current distribution of the Southern Sierra Nevada fisher Population.

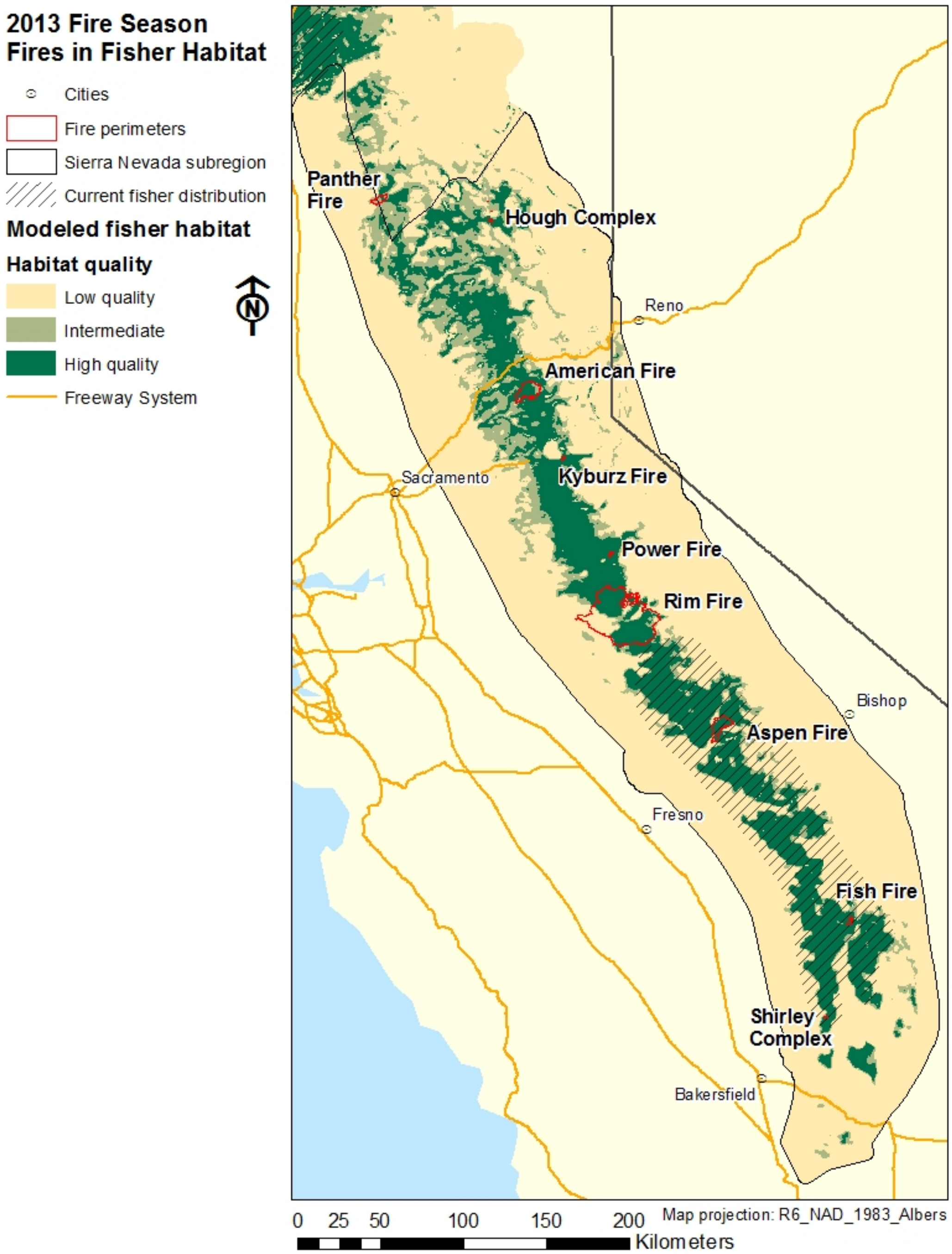

Figure 15. Sierra Nevada sub-region depicting 2013 fire perimeters as of 10 September 2013 to exemplify that the location of a fire may have impacts on habitat connectivity.

Table 8. 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

Habitat loss and fragmentation due to anthropogenic influences, insects, and disease

In most cases, the usual pattern of localized outbreaks and low density of insect and disease damaged trees are beneficial, providing structures conducive to rest and den site use by fishers or their prey. 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, pp. 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 they state that wide-scale salvage operation may substantially reduce the availability and suitability of remaining forests for fishers. Sudden Oak Death (*Phytophthora ramorum)* in southwestern Oregon and northwestern California is potentially a significant 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.

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 2007a, p. 78). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., 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 2007a, p. 78).

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 2007a, p. 30; and Solomon *et al.* 2007, pp. 35–54, 82–85.) 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 is “very likely” (defined by the IPCC as 90 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (IPCC 2007a, pp. 5–6 and figures SPM.3 and SPM.4; 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 (e.g., 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 2030. Although projections of the magnitude and rate of warming differ after about 2030, 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 (IPCC 2007a, pp. 44–45; Meehl *et al.* 2007, pp. 760–764 and 797–811; Ganguly *et al.* 2009, pp. 15555–15558; Prinn *et al.* 2011, pp. 527, 529). (See IPCC 2007b, p. 8, for a summary of other global projections of climate-related changes, such as frequency of heat waves and changes in precipitation. Also see IPCC 2011 (entire) for a summary of observations and projections of extreme climate events.)

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 (e.g., habitat fragmentation) (IPCC 2007a, 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 2007a, 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 (e.g., IPCC 2007a, pp. 8-12). Therefore, we 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, 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 (Mote and Salathé 2010, p. 39; Cayan *et al.* 2009, p. 7). 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. 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.

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 9).

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 Southern Sierra Nevada Population is likely to experience greater warming than the Northern California-Southwestern Oregon 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 section below on Direct climate effects to fishers for information on how temperature increases are likely to affect fisher.

Table 9: Projected increases in average seasonal temperature due to global climate change (winter and summer).

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)

Precipitation

Historical precipitation trends are mixed (Mote *et al.* 2010, p. 17). In the Northwest, annual precipitation has been 16% 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). 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). 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 season, 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). However, fishers in California appear to be limited to areas with low snowfall, so a decrease in snowpack could make more habitat available to fishers in the winter, as long as the habitat remains otherwise suitable (Krohn *et al.* 1997, entire).

Climate change effects on fisher habitat

Climate change is likely to affect fisher habitat by altering the structure and tree species composition of fisher habitat, and also through the changes to habitat of prey communities. These effects may cause mortality, decrease reproductive rates, alter behavioral patterns, or lead to range shifts. Although predictions of vegetation changes as a result of climate change abound, it is less clear how or at what rate that transition will occur. However, Littell *et al*. (2010, p. 147) projected that the transition will be driven more by disturbance (e.g. fire, forest insects, and pathogens) than by gradual changes in vegetation populations as a result of life-history characteristics and phenology. 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 factores (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 and 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), 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 below in the section on Other Stressors. Climate change may also affect infection rates and susceptibility to diseases; this effect is discussed below in the section on Cumulative and Synergistic Effects.

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 evergreen hardwood forests, a shift toward this forest type is unlikely to be harmful; although 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. However, an overall shift toward woodland represents 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 compositions 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, Figs. 2 & 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% 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; and in parts of the Western Oregon Cascades, conifer forest may decrease in favor of woodland or 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 it is not clear whether hardwood forest will provide suitable fisher habitat, as fishers are not known to use hardwood forests within the analysis area.

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, or even lead to a decrease in the late-successional habitat preferred by fishers (Lofroth *et al.* 2010, pp. 98-103). 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, p. 12-13), and is increasingly becoming the primary driver of fire regimes (Miller *et al.* 2012, p. 194; Miller *et al.* 2009, p. 30). Recent climate change has already caused an increase in wildfire activity (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). Within the analysis area, the fire regime is predicted to show the most sensitivity to changes in the timing 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, and the projected increase in the Sierra Nevada is comparable (Westerling and Bryant 2008, p. S244 and Fig. 7). 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 1100 to 9100 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 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).

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 (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% of the current range of pines in Washington (Littell *et al.* 2013, p. 114; Littell *et al.* 2010, pp. 15-19). 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.

Summary of the Effects of Climate Change on Fisher Habitat

Climate throughout the analysis area will become warmer over the next century, and in particular 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. 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. It is uncertain how these habitat shifts will affect fisher populations. 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. Insect and disease outbreaks will also increase. These changes will alter the structure of forested stands within fisher habitat, 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.

Timing, Scope, and Severity of the Effects of Climate Change on Fisher Habitat

Climate change is ongoing and its effects on fisher habitat are likely to increase and become more readily perceptible in the future. We evaluate climate-related stressors using two timeframes, one approximating a 40-year "foreseeable future" (2040-2060), and the late twenty-first century (2070-2100). We chose this later time frame because many of the relevant studies report results only for this later timeframe, and therefore there is even more uncertainty involved in interpolating results for a 40-year timeframe. 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 13) 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 10, and beyond what is described in the stressor assessment for fire individually.

Table 10. 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.

Summary of effects of stressors related to climate change in each of the analysis area sub-regions:

Sierra Nevada

Most projections indicate a widespread loss of suitable habitat in the Sierra Nevada due to 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% of currently forested habitat by the late 21st century. We assume that this translates into losses of up to 31% of currently forested habitat within 40 years. Other projections do not show a loss of forested habitat and it is possible that 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.

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 the climate and habitat will be able to support the fisher population. However, nearly all models show shifts in future vegetation type from conifer forest to mixed-conifer hardwood forest, as well as shifts toward unsuitable habitat types such as woodland and chaparral. 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, starting with approximately 1% of current forest converting during the next 30 years, with losses accelerating thereafter. Conifer forest is also projected to convert to hardwood forest, which is not known to provide fisher habitat in the western United States. This conversion may affect 1-4% of current conifer forest by 2045, accelerating to affect up to 55% by 2085 (Table 10). 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. 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. One climate-driven fire model projects an 8-fold increase in area burned per year by the 2080s, which we assume may translate to a 4-fold increase by the 2050s, but fire is currently so infrequent in this sub-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. One climate-driven fire model projects a doubling in area burned per year by the 2080s, which we assume may translate to a 50% increase by the 2050s. 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 within the next 40 years. (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.

Current vegetation management

Within the range of the northern spotted owl (*Strix occidentalis caurina*) we used various data sources associated with the monitoring of effects to their habitat. Since the listing of the northern spotted owl in 1990 a substantial effort has occurred to monitor habitat changes in the amount of northern spotted owl habitat, due to both natural and human caused disturbance events. We acknowledge that within individual fisher and northern spotted owl home ranges there are differences in how the two species spatially use habitat for activities such as foraging and daily movements, and there have been no formal comparisons of habitat use patterns of both species at the landscape or home range scales (Zielinski *et al.* 2006, pg. 410). However there are similarities of habitat conditions at the fisher den and rest site and northern spotted owl nest and roost site scales which are exemplified by both species associations for large live and dead trees, forest decadence, forest stand structural and vegetative diversity, and moderate to dense canopies (USDI FWS 2011, pp. A-9–A-12); Raley *et al.* 2012 pp. 237-241, 245-250; Zielinski *et al.* 2006, pp. 422-423; Habitat Associations section of this document). In addition, many of the Service's Habitat Conservation Plans for northern spotted owls and our own review of exisiting regulatory mechanisms for northern spotted owls have often used the similarities between fisher and northern spotted owl habitat as a mechanism for assessing habitat conditions and trends for fishers (see Regulatory Mechanisms section of this document). We have therefore concluded that an important source of data to assist with our analysis of trends associated with stressors to fisher habitat within the range of the northern spotted owl is the monitoring data associated with habitat changes being tracked for northern spotted owls.

Data sources we used to assess current vegetation management and potential changes in habitat for fishers within the range of the northern spotted owl included the modeling efforts developed to monitor changes in northern spotted owl habitat in the area managed under the Northwest Forest Plan (NWFP) that have been completed for the first 15 years of the plan, 1994 to 2008 (Davis *et al.* 2011, entire; Kennedy *et al.* 2012, entire). The Davis *et al.* 15-year monitoring report estimates a range-wide gross loss of 3.4 percent of northern spotted owl nesting/roosting habitat that was present on Federal lands in 1994/96. The 15-year monitoring report identified that 79 percent of the habitat loss occurred within the reserved land allocations and that wildfires accounted for about 90 percent of the habitat loss within these reserves. Habitat losses in non-reserved land allocation were due to timber harvesting (45 percent) and wildfire (about 50 percent). We provide these statistics as an indication of how fisher habitat may have been similarly affected.

The Kennedy *et al.* (2012, entire) modeling effort assessed spatial and temporal changes in forest disturbance (both natural and human caused) and regrowth within the entire NWFP area, including all non-Federal land and Federal lands. This effort was not limited to modeling changes on Federal land only, but rather tracked changes in forest conditions resulting from disturbance on Federal, state, private, and tribal forests. Percent changes in forest area disturbed between 1985 and 2008 range from a low of 9 percent on federally protected lands (all lands where harvest is not among the management goals) in Washington to a high of approximately 39 percent on private lands in both Oregon and Washington and tribal lands in Oregon. Beginning in the mid-1990s, around the time of the NWFP implementation, the magnitude of disturbances on federal lands declined substantially and has remained lower than that occurring on private lands (Kennedy *et al*. 2012, p. 128). As an indication of potential for future fisher habitat conditions on private timberlands, more than 75 percent of the future tree harvest is expected to come from private timberlands (Johnson *et al.* 2007, p. 37; Spies *et al.* 2007b, p. 50) and modeling of future timber harvests over the next 50 years indicates that current harvest levels on private lands in western Oregon can be maintained at that rate (Adams and Latta 2007, p. 13).

In addition to modeling disturbance, Kennedy *et al.* (2012) modeled patterns of vegetation regrowth across the regions. Their modeling results indicated that the drier ecoregions, particularly those in California, exhibit a slower post-harvest establishment of forest. This slower rate of vegetation regrowth in the drier areas of the Northern California-Southwestern Oregon fisher Population may have long term effects on the growth and recruitment of fisher habitat and forest structures important to fishers. It is however important to note the high degree of uncertainty with modeling changes in forest conditions and when forest stands develop from non-habitat to a condition that supports suitable habitat for owls (USDI FWS 2011, pp. B7-B8). Therefore, as we have already discussed the similarities in stand conditions used by fishers and northern spotted owls, assessing the potential amount and spatial arrangement for the ingrowth of fisher habitat is not appropriate at this time.

Also part of the 15-year monitoring effort for the northwest forest plan, changes to late-successional and old-growth (LSOG) habitat were also tracked on Federal and non-Federal lands in the northwest forest plan area (Moeur *et al*. 2011, entire). The report accounted for loss and recruitment of LSOG from 1994 to 2007 in California and 1996 to 2006 in Washington and Oregon, finding an overall net loss of LSOG of 1.9 percent. Amounts varied by province, but net changes were small relative to the sources of error and uncertainty in the estimates, limiting precise estimates of LSOG change (Moeur *et al*. 2011, p. i). Approximatley two-thirds of the total LSOG in the NWFP area is found on federal lands. The vast majority of LSOG loss on federal lands was from fire, with only 0.5 percent (approximately 32,000 acres) of LSOG on federal lands being harvested. In contrast, 13 percent (approximately 491,000 acres) of LSOG on nonfederal lands was harvested during the same time frame (Moeur et al. 2011, p. 31). Although the definition of LSOG in this report likely does not encapsulate all forest conditions that comprise fisher habitat, the vast majority (94 percent) of its harvest in the NWFP area occurred on non-federal lands.

Scope and severity for current vegetation management activities

Vegetation management activities (for example fuels reduction and timber production) that reduce large structures and overstory cover can negatively affect fisher reproduction, survival, recruitment, 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, silvicutural 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 11). 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 11, 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 11 includes not only northern spotted owl habitat that is removed (i.e. habitat that is treated to the point where canopy cover drops below 40 percent), but also includes 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 11 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 11 the removal or downgrading of foraging habitat in California is not specifically included in Table 11, 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 11. 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 11 Notes:

1. Defined in the Revised Recovery Plan for the Northern Spotted Owl (USDI FWS 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.
2. 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.
3. 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.
4. 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.
5. 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 Reservered Area. Non-reserve allocations under the NWFP intended to provide dispersal connectivity between

reserves include Administratively Withdrawn Area, Adaptive Management Area, and Matrix.

6. 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 12). 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 (USDI FWS 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 13 for use in the calculations of scope.

Table 12. 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
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 13. 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 14). 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 (*e.g.* 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 (Forest Service) 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 11, 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 11 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 (e.g., 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 14. 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 (e.g., 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.

Human development as stressor on fisher habitat

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, US 50 and Interstate 80; see Figure 16) (FRAP 2010, p. 58).

Timing, scope, and severity for human development as stressor on fisher habitat

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 15) (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 habiat 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 15).

Table 15. 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.

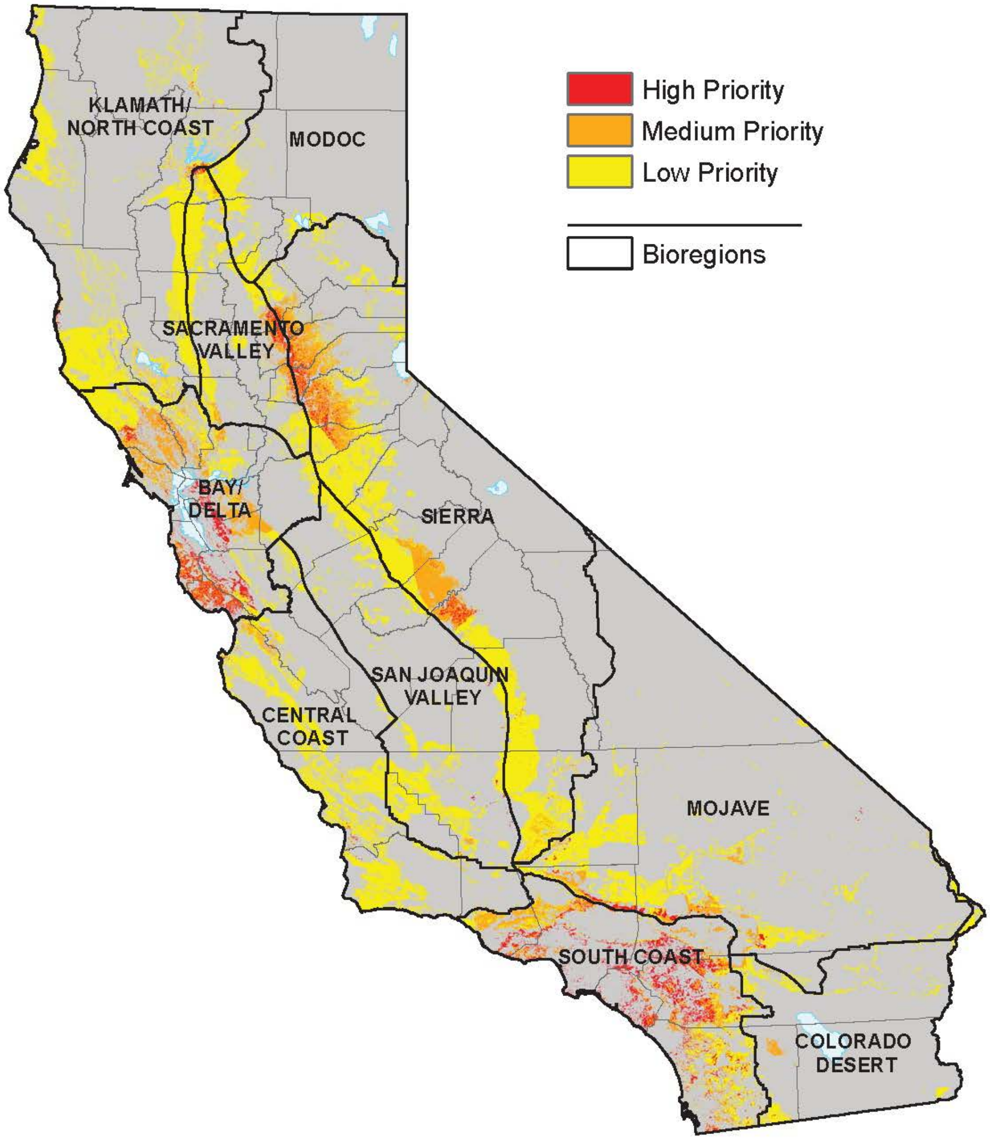

Figure 1.1.4.
Population growth and development impacts priority landscape.
Data Sources: Commission on Local Governance for the 21st Century (2000); California Tree Seed Zones, Buck, et al. (1970); Statewide Land Use / Land Cover Mosaic, FRAP (2006); ICLUS, U.S. Environmental Protection Agency (2009)

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% of the landscape as well as at a localized level. Medium priority areas are threatened over 10-25% of the landscape.

Habitat loss attributed to linear features (highways and other 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 section on Collisions with Vehicles), 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 (e.g., home range establishment, juvenile dispersal, breeding season movements by males), thereby affecting population connectivity.

A single linear feature may have a small effect on fisher movements, but multiple linear features (e.g., 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 there is information indicating that fishers cross the combined features of the Klamath River and a two line paved highway enough to maintain genetically homogenous populations on either side of these features (Farber and Schwartz 2007, Tab 6).

The adverse impacts of roads on movement patterns are more severe on low-density carnivores like fishers than on many wildlife species due to the fisher's large home ranges, 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. 93–94). Adverse effects of roads and other linear features also include displacement due to noise and human activity, secondary loss of habitat due to the spread of human development, increased exotic species invasion, increased wildfire starts, and increased vulnerability to predators (Naney *et al.* 2012, pp. 16, 22, 26, 36).

Timing, scope, and severity of habitat loss from linear features.

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 16, 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 16. 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.

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

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 (i.e., 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 six 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 18 HCPs and Safe Harbor Agreements with private, city, county, and state entities in Washington State. Of those plans, 15 pertain to forested areas within the range of the fisher, and five 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, and Murray Pacific Corporation. Cumulatively, the five HCPs cover 2,428,137 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 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 six 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 (one that does not cover fisher, and one that does). Five 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 (e.g., 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.

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 Forest Service is using this conservation strategy as the basis for the development of a southern Sierra Nevada conservation strategy for the Forest Service (USDA FS 2013). Region 6 of the Forest Service, along with Oregon/Washington region of the Bureau of Land Management (BLM), has chosen not to implement the strategy at this time (Chatel 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. Currently the state is in the planning phase to move to the next location for a reintroduction in the north Cascade Mountains. The recovery plan identifies the southwestern and northwestern Cascades as the next reintroduction location following the recent Olympic reintroduction. 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.

Critical Habitat for Northern Spotted Owl

On December 2, 2012, the Service designated revised critical habitat for the northern spotted owl (USDI FWS 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 17).

Table 17. 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 (USDI FWS 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) (USDI FWS 2012a,77 FR 71875, December 4, 2012, pp. 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 (e.g., 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 (e.g., large cavities, broken tops, mistletoe infections, and other evidence of decadence), large snags and large accumulations of woody debris on the ground (USDI FWS 2012a, 77 FR 71875, December 4, 2012, pp. 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 effects of habitat stressors

In conclusion, habitat loss, modification, and fragmentation appear to be significant stressors to fishers. Forested habitat in the Pacific coast region decreased by about 3.4 million ha (8.5 million ac) between 1953 and 1997 (Smith *et al.* 2001, p. 65; Alig *et al.* 2003, p. 57). Forest cover along the Pacific coast is projected to continue to decline through 2050 in Washington, Oregon, and California, with timberland area projected to be about 6 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, 57). As described in the preceding paragraphs, we used late-successional forest and northern spotted owl habitat as a surrogate for historical and current trends in modification and loss of fisher habitat. 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. 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 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.

Vegetation management techniques of the past (primarily timber harvest) and current vegetation management techniques have, and can, substantially modify both the numbers and distribution of structural elements and the overstory canopy. Once these key components of fisher habitat are modified or removed, it takes many decades to replace the snags and trees with cavities as well as the complexity of multi-layered overstory canopies (Franklin and Spies 1991a, p. 71–76; Franklin and Fites-Kaufmann 1996, p. 634–636). Reduction in understory complexity and plant species diversity can result from silvicultural and fuels reduction treatments (for example, single species tree plantations, removal of hardwoods, pre-commercial thinning, herbicide application); and as a result may affect prey species abundance and diversity. However, the effects of understory treatment to fishers can vary greatly by the ecosystem type, the intensity and scale of treatments (Naney *et al.* 2012, pp. 29–37), and the response of the prey communities being affected by the treatments. Some treatments to reduce fire risk or restore ecological resilience may be consistent with maintaining landscapes that support fishers in the long term and sometimes even the short term, providing 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).

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). 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.

Fisher habitat may decrease in areas, especially in the southern Sierra Nevada, 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 addition, disturbance regimes will change with many areas seeing an increase in frequency and area burned, and possibly also in severity. Insect and disease outbreaks will also increase. Changes in disturbance regimes 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.

The scope and severity of habitat loss has and will vary widely between public and private land, and between States. 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). The loss of intermediate and high quality fisher habitat on federal lands due to management actions, at least within the NWFP area, has declined substantially since its implementation (Kennedy *et al*. 2012, p. 128). The vast majority of the loss has been on private lands, while the loss on NWFP lands has been relatively small, with most of the loss being attributed to wildfires (Moeur *et al*., 2011, p. 31). 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 activites meet these characteristics State forest lands are managed for various purposes including wildlife, recreation purposes and for timber production (See Existing Regulatory Mechanisms Section). Climate change, and the associated increase in extent and severity of changes in forest composition and location, wildfire, and forest insect and disease, is likely to cause the greatest long-term loss of fisher habitat. These effects will also vary between states and this is reflected in the differences in scope and severity in the sub-regions.

We were unable to quantify recruitment of fisher habitat over our 40 year analysis window. On NWFP lands where late-successional and old-growth forest was monitored, losses over the 15 years since its implementation were roughly balanced by recruitment, although recruitment was most likely incremental stand growth into the lower end of the size and structural classes of older forest (Moeur *et al*. 2011, p. 31). Yet given some of the land management objectives of Federal and some State lands, and the number of reserves on NWFP lands, there is a reasonable expectation of a substantial amount of habitat that will be suitable for fishers, offsetting some of the loss that is expected to occur from other disturbances.

Stressors Related to Direct Mortality of Fishers

Stressors related to trapping and scientific purposes

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, 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) state 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).

It is currently 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.

Incidental captures in body-gripping or leg-hold traps often result in crippling injury or mortality (Strickland and Douglas 1984, p. 3; Cole and Proulx 1994, pp. 14–15). However, most uses of these trap types are now illegal in Washington and California [Washington Adminstrative Code (WAC) 323-12-141(4), California Fish and Game Code § 3003.1, 4004)]. Although data are not available from these states 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.

In Oregon, leg-hold and body-gripping traps remain legal. Annual harvest reporting is mandatory for trappers in Oregon. 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. Fishers are classified as a Sensitive Species in Oregon. Any captured fisher must be reported to ODFW. Five known incidental captures of fishers have been reported since 1975, two of these resulting in mortality. 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 (ODFW 2007, p. 1). In December 1997, a fisher was found by someone other than a trapper in a foot hold trap near the town of Williams in Josephine County. The animal was rehabilitated and released with a radio collar (ODFW 1998, entire). An ODFW document from 1982 reports three other instances of fishers caught in traps: a fisher was caught and escaped from in a marten trap in Klamath County in 1980 near O'Dell Lake; a fisher was trapped and killed in Douglas County in December 1979 on Clarks Branch Road.; and a fisher was trapped and released in Klamath County in 1975 on the west side of Crater Lake National Park (Robart 1982, pp. 3, 8). Incidental fisher captures in Oregon are expected to remain infrequent into the foreseeable future assuming current trends continue. Hiller (2011, p. 31) reports the 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 (see, e.g., 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

Fishers are readily trapped (Lewis and Stinson 1998, p. 23) and unregulated 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 the 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. Fishers in Oregon are occasionally captured incidental to pursuits for other species, resulting in occasional reporting of mortalities in that state. It appears that current mortalities and injuries from legal incidental capture of fishers in body gripping or leg-hold traps are infrequent in the analysis area and that trapping closures and other furbearer management methods that have been in place now for many decades have reduced, but not eliminated, deleterious population effects due to trapping. If not adequately regulated, low levels of harvest-related mortality, added to natural mortality, have the potential to negatively impact small, local populations.

Timing, scope, and severity of stressors related to trapping

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 (seeTable 16). 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 18).

Table 18. 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.

Stressors Associated with Research Activities

Although 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 animal including injury and mortality. 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, p. 308-310) identifies three primary ways that radio-collars can negatively influence animal safety including: radio-collars can get caught on external objects (e.g., sticks, wire fencing) or wedged in confined spaces (e.g., rock crevices, tree cavities); radio-collar fit may change over time causing lesions that can become infected; and collar attachment can alter behavior of the animal and limit habitat-related choices (e.g., 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 Southern Sierra Nevada and Northern California-Southwestern Oregon 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, 3 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.

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 Northern Sierra Nevada 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 Southern Sierra Nevada Population, and somewhere between 30 and 45 for the Northern Sierra Nevada Reintroduced Population, we estimate that the research-related stressors may affect 25-30% of all animals within this sub-region (Table 18).

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 19). As in the Sierra Nevada, there are two ongoing studies in the native Northern California-Southwestern Oregon Population, and the reintroduced Northern Sierra Nevada 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 Olympic Peninsula Reintroduced Population that are collared.

There are no research study areas currently within the Southern Oregon Cascades 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 Southern Sierra Nevada and Northern California-Southwestern Oregon 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 19). We combined the proportion of mortality attributable to research with overall annual mortality rates as measured for study areas in the Northwestern California – Southwestern Oregon and Southern Sierra Nevada 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. Also, 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 19. 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.

Conservation measures to reduce stressors related to trapping and research activities

Aside from state laws mentioned above, there are no known conservation measures related to trapping.

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.

Stressors related to disease or predation.

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 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). It is unclear how these diseases affect wild populations of fishers; however, information exists that show serious effects of disease outbreaks in populations of other species of mustelids: black-footed ferret

(*Mustela nigripes*), marten, and the sea otter (*Enhydra lutris*), as well as other carnivores such as the Santa Catalina island fox (*Urocyon littoralis catalinae*). These examples show the potential adverse impact of diseases on fisher populations. 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. 385-398). The disease is considered a major barrier to the reintroduction and recovery for the ferret. 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. In a sea otter population, it was determined that 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). 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).

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). Recently, in the insular southern Sierra Nevada 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 does 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 a number of other canine viruses have been isolated from fishers in northwest California (Brown *et al.* 2008, p. 2), and ongoing work in the analysis area and British Columbia (Gabriel *et al.* 2010, pp. 966-970) reported that in addition to canine distemper virus, viruses that infect fishers included rabies virus (Family *Rhabdoviridae*), parvoviruses, canine adenovirus (the cause of canine infectious hepatitis), and West Nile virus. 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). Parvovius 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). 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 and many other susceptible mustelids (Gabriel *et al.* 2010, pp. 966-970).

Brown *et al.* (2007, pp. 5–6) and Gabriel *et al*. (2010, pp. 966-970) also documented the bacterial diseases, *Anaplasma phagocytophilum* and *Borrelia burgdorferi* sensu lato, that infect fishers. 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 cause illness and death in fishers, it is not known whether they have a negative effect on fisher populations.

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. 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 2010, pp. 966-970). 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 2010, pp. 966-970). In addition, it is important to determine the prevalence of disease factors in fishers and how they may affect fisher population levels and their ability to re-colonize currently unoccupied habitat within their range.

Predation

Mortality from predation could be a significant stressor to fisher populations in the analysis area. 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 be more vulnerable to predation. The population levels of generalist predators such as bobcats and mountain lions in dense mixed coniferous and evergreen forests in the west are poorly known. Both species do inhabit various forest types including areas that have been altered (thinning and regeneration harvesting) from forest management. Two ongoing studies in the southern Sierra Nevada 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). A bobcat was also identified as the predator on a fisher in the Olympic Peninsula Reintroduced Population (Wengert 2010). Nine fisher mortalities recorded by Truex *et al.* (1998, pp. 80–82), were suspected to be from predation. Four fishers out of 7 that died during a study by Buck *et al.* (1994, p. 373) were killed by predators while the death of one juvenile was suspected to have been caused by another fisher. 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.

Timing, scope, and severity of stressors related to 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 Southern Sierra Nevada and Northern California-Southwestern Oregon 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 20, 21). We combined the proportion of mortality attributable to each stressor with overall annual mortality rates as measured for study areas in the Northwestern California – Southwestern Oregon and Southern Sierra Nevada 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 20. 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 21. 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.

Conservation measures to reduce the stressors related to disease or predation.

There are no known conservation measures to ameliorate stressors related to disease or predation.

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 doesn't 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.

Forest Service and BLM

Over 13.1 million ha (32.2 million ac) of Forest Service 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 Forest Service 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 Forest Service 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, p. 43037-43052), which required the Forest Service 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, p. 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 (USDA FS 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 (USDA FS 2007 and USDA FS 2011, unpublished data). The Sensitive Species Policy is contained in the USFS Manual, section 2670.32 (USDA FS 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 (USDA FS 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 (USDA FS 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 (USDI BLM 2008a and USDI BLM 2010, unpublished data). The special status species policy contained in the BLM Manual section 6840.02B (USDI 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 (USDI 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 Forest Service 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.

Northwest Forest Plan

The Northwest Forest Plan (USDA and USDI 1994a, entire; USDA and USDI 1994b, entire) was adopted by the Forest Service 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.

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 1994, 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% of the NWFP area comprises high to intermediate quality fisher habitat, and of that 33% is in a reserve land allocation that promotes retention and recruitment of forest structures and habitat important for fishers.

Implementation of the NWFP is intended over time (100 years or so) to provide a network of large block reserves of late successional forest habitat connected through riparian reserves surrounded by a matrix of younger more intensively managed forest. As the forests within reserved land allocations mature, current habitat conditions for fishers are expected to improve on Federal lands. In assessing the effects of the draft NWFP on fishers, the Forest Ecosystem Management Assessment Team (FEMAT) (1993, pp. IV-172 – IV-175) projected a 63 percent likelihood of achieving an outcome in which habitat is of sufficient quality, distribution, and abundance to allow the fisher population to stabilize and be well distributed across Federal lands.

FEMAT further concluded that there was a 37 percent likelihood that habitat was sufficient to allow fishers populations to stabilize, but that there would be significant gaps in the species distribution on Federal lands and the ratings for fisher reflected a general "uncertainty about the future welfare of this species regardless of option" (FEMAT 1993, p. IV-173). Additional mitigation measures were added to the final NWFP to increase the overall outcome for fishers from the selection of Option 9 (Appendix J2, p. J2-471) down wood amounts in Matrix allocations, riparian reserves and retention of dispersed patches of late-successional forest; increased the likelihood ratings of fishers being well distributed across Federal lands from 63 to over 80 percent (USDA and USDI 1994a Appendix J2, pp. J2-52 – J2-54, J2-471). In conclusion however, the species analysis team stated that due to cumulative effects, fisher populations are likely to "continue to be rare and have disjunct distributions" (Appendix J2, p. J2-471).

Substantially more information on fishers and fisher habitat is available today than was available for biologists evaluating species relative to the FEMAT report and the selection of Option 9 of the NWFP. 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). 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).

<u>Non-NWFP</u>

Additional management incorporated by the Forest Service 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 (USDA FS 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 (USDA FS 1995b, entire; USDA FS 1995c, entire; USDA FS 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 (USDA FS 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.

Forest Service 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 (USDA FS 2000, volume 3, chapter 3, part 4.4.1, pp 2-18; USDA FS2001, entire; USDA FS 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 US Forest Service 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, Forest Service 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 Forest Service 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" (USDI 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 (16 U.S.C. § 127). Park Service policy allows these activities on Park Service lands if the actions do not unacceptably impact park resources or natural processes (USDI 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, which make up from 67 to 85 percent of National Parks in the analysis area, are classified as alpine and are 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 Forest Service 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 Forest Service 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, with careful implementation it may 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 Forest Service 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. 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% 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 (i.e., 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 Forest Service have signed a memorandum of agreement (MOA) describing the process for government-to-government relations regarding management of the former reservation (Klamath Tribes and USDA FS 2005, entire). In the MOA, the Forest Service 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. Forest Service 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 (e.g., 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 (e.g., 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 is currently in the process of monitoring that population and planning further re-introductions in the North and South 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). Because fishers were effectively extirpated from Washington, the potential for incidental captures in Washington (if fishers are currently extant) is unknown (Lewis and Stinson 1998, p. 31). 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.

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 their proximity to National Forests and National Parks. However, current regulatory mechanisms (principally, Washington Forest Practices Rules and tribal forest management plans) may not protect and provide for fisher habitat on private land and tribal reservations in places where an insufficient quantity of mature forest with suitable denning structures is available and protected from harvest and land conversion.

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). The Oregon Conservation Strategy is a non-regulatory, overarching state strategy for conserving fish and wildlife and recommends voluntary actions to improve the efficiency and effectiveness of conservation in Oregon (ODFW 2006, p. i.).

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 2010b, 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 (i.e., 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. 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). Also, 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, with the exception of the no-cut riparian buffer, 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 2010c, entire; ODF 2010d, 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 2010e, p. 9). Only ODF districts in northwest Oregon have identified their sensitive species so far, and the fisher is not on these lists (ODF 2010e, 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 landbase 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" (e.g. ODF 2010c, 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 2010c, pp. 4-82 – 4-83; Dent 2013, pers. comm.). Spotted owl nest sites are protected by a 250-ac (101-ha) core, 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 2008, entire; ODF 2010f, entire). Marbled murrelet management areas (MMMAs) are established around marbled murrelet occupied sites (ODF 2010g, entire); management activities within MMMAs need to maintain habitat suitable for nesting and minimize disturbance of reproductive activities (ODF 2010h, p. 16). 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.

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 2010c, 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 (e.g. ODF 2010d, 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.

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 den or 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 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 landbase, 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

California Endangered Species Act (CESA)

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). This case affirmed that fishers are a Candidate Species in California, and take, under the CESA definition, is prohibited during the candidacy period. The California Department of Fish and Wildlife (CDFW) is evaluating the status of the species for possible listing as a Threatened or Endangered Species under the CESA. Thus, protection measures for fishers are in effect in California at this time, but the duration of that protection is uncertain.

California Trapping Regulations

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. Also, 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 California as long as the fisher remains a candidate for listing.

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.

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

Fishers are currently Candidate species under the CESA and take is prohibited while the State completes a status review. If the fisher is listed by the State the take prohibitions would continue to be enforced. If the State finds that listing is not warranted, the current take prohibitions would be lifted but trapping regulations would not be affected. 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 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 (e.g., USDI FWS 1993, entire; USDI

FWS 2012b, entire; USDI FWS 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 (USEPA 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…" (USEPA 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)." (USEPA 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).

Summary of stressors related to the inadequacy of existing regulatory mechanisms.

Trapping of fishers is currently illegal under State laws throughout the analysis area, although fishers may be incidentally captured in traps set for other species. Incidental capture of fishers in Washington and California, where body-gripping traps are banned, is expected to result in minimal to no physical injury to the animal. In Oregon, any fisher incidentally captured in body-gripping traps may be permanently injured or killed. However, known incidental capture in Oregon is rare (5 since 1975, with 2 resulting in mortality). Trapping occurs on tribal lands within the analysis area, and trapping for fishers, as well as the use of body-gripping traps, is legal under some tribal codes within the range of existing fisher populations. However, trapping on tribal lands is not known to be a common occurrence. In conclusion, trapping regulations have substantially reduced fisher mortality throughout the analysis area, although occasional injury or mortality may occur through incidental captures or on tribal lands where fisher trapping is not illegal under tribal code.

There are few places in the analysis area where forest management practices are explicitly applied to conserve or benefit fishers. The fisher is a sensitive species on all BLM and Forest Service units in the analysis area (and will likely become a species of conservation concern under revisions to the National Forest Management Act); however, protections afforded the fisher as a sensitive species largely depend on RMPs or LRMPs and on site-specific project analyses and implementation. Except for Federal units encompassing the Southern Sierra Nevada Population of fishers, Federal land management units have not developed fisher-specific guidelines in their management plans. The largest and most protective of these areas is the Southern Sierra Fisher Conservation Area. The Hoopa and Makah Tribes have fisher-specific guidelines in their forest management plans, providing some protection of specific fisher sites. Other tribes may manage habitat in ways that benefit fisher without specifically mentioning them in their management plans. Some fisher den sites may be protected as part of the Washington DNR HCP. The fisher is a candidate species under the California Endangered Species Act, where take is prohibited, at least until the CDFW makes a final determination on the listing status of fishers. Take of fishers in Oregon is also prohibited through its listing as a protected non-game species. The fisher is State listed as endangered in Washington, where poaching is prohibited and project analyses need to occur, but habitat protection and pre-project surveys are not required.

Retention of some level of snags and green trees in harvest units is a ubiquitous requirement in managed forests throughout the analysis area, regardless of ownership. In many areas managed for commercial timber production however, these structures do not meet the minimum sizes typically used by fishers. Where they are large enough, they may provide future denning and resting sites provided they have the appropriate structural attributes (e.g. cavities, large limbs) and the surrounding forest is allowed to develop the necessary canopy cover and prey base to support fishers' long term. However, the short rotations of industrial forest management rarely allow this to happen. Conversely, where management is for longer rotations or designed to develop older stands (e.g., old-forest structure management on Oregon State Forests), retention of these legacy structures may facilitate fisher habitat development.

Protection measures for riparian areas are also a widespread standard in managed forests lands, with larger buffers and more stringent retention requirements typically associated with Federal and State lands than on other ownerships. Retention areas to meet other management goals are also found across ownerships (e.g., spotted owl special emphasis areas under Washington Forest Practice Rules, anchor habitats on Oregon State Forests, occupied site buffers on multiple ownerships, Watercourse and Lake Protection Zones (WLPZ) on private land in California). Many of these retained areas are not large enough to support a fisher home range, but they may provide habitat patches that allow fisher to move across the landscape, providing connectivity to and facilitating dispersal between larger blocks of fisher habitat either within existing ownerships among neighboring ownerships.

Much of the Federal ownership in the analysis area is managed for interconnected blocks of late-successional forests that are likely to benefit fishers. Timber harvest has been substantially reduced on Forest Service and BLM lands within the NWFP area, and existing management in both the NWFP and SNFP area is designed to increase the development of older forests. Just over half of Forest Service and BLM lands in the analysis area contain fisher habitat of either intermediate or high quality, and this amount is expected to increase with current management plans.

In short, State and Federal regulatory mechanisms have abated the large-scale loss of fishers to trapping and habitat loss. Although fisher trapping has been banned since the mid-20th century, substantial reductions in the scale and amount of habitat loss has only come into play within the past decade or two, and has been limited primarily to Federal lands. Timber harvest occurs on non-Federal lands with fewer protections for fishers. However, management on State lands for older-forest or for retention of habitat blocks for other species may facilitate fisher movements across the landscape or provide future habitat as some areas are allowed to develop into older stands. Forest practice rules vary greatly among the three states, with no explicitly stated fisher protections specified in California, Oregon, or Washington. Fishers may not be intentionally harvested for fur or otherwise killed in any of these states, but incidental injury or destruction of habitat via forest management may occur. However, the species status as listed in Washington and a Candidate in California invokes additional requirements to reduce project effects on fishers.

Rodenticides are regulated under federal and state laws. However, it is not clear how well those regulations prevent fishers from exposure to legal uses of these rodenticides. Fishers are also exposed to rodenticides used illegally.

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

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 (random) environmental, genetic, or demographic events (Brewer 1994, p. 616). 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).

A scarcity of verifiable sightings in the Western and Eastern Cascades in Washington and Oregon, Coastal Oregon, and the north and central sections of the Sierra Nevada indicates that populations of fishers in southwestern Oregon and California are isolated from fishers elsewhere in North America. This isolation precludes both immigration and associated genetic interchange, increasing the vulnerability of the Northern California-Southwestern Oregon and Southern Sierra

Nevada Populations to the adverse effects of deterministic and stochastic factors. Wisely *et al.* (2004, p. 644) documented that fishers in northern California already have lower genetic diversity than other populations in North America. Drew *et al.* (2003, p. 57) cite evidence of genetic divergence between the California and British Columbia fisher populations since becoming isolated. Likewise, the Northern California-Southwestern Oregon fisher Population exhibits high genetic divergence from the Southern Sierra Nevada Population (Wisely *et al.* 2004, p. 644, Knaus *et al*. 2011, p. 11). The genetic divergence of California populations (Northern California-Southwestern Oregon and Southern Sierra Populations) from each other and from British Columbia fishers could be associated with either adaptation to local conditions, an ancient timeline for isolation, or both (Tucker *et al,*. 2012, p. 3).

It is difficult for populations to interchange individuals or provide colonists, when the populations are distributed in such a narrow, 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, it is more difficult to locate and occupy distant yet suitable habitat, and fishers may become aggregated into smaller interrelated groups on the landscape (Carroll *et al.* 2001, p. 974).

At the southernmost extent of the species' distribution, the Southern Sierra Nevada Population may be at greater inherent risk because it already exists at the edge of environmental tolerances as well as the edge of the geographic range. Additional 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 (2012, pp. 3, 11), however, cautions that conservation actions attempting to increase genetic diversity in the Southern Sierra Nevada Population by restoring connectivity with the Northern California-Southwestern Oregon Population should consider the potential for outbreeding depression 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.

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). Demographic changes can reduce the effective population size (number of breeding individuals). 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). Both the Northern California-Southwestern Oregon and Southern Sierra Nevada populations have small effective population sizes: 129 and 167, respectively (Tucker *et al.* 2012, p. 7).

Habitat specificity coupled with habitat fragmentation may also contribute to the exceptionally low levels of gene flow (migrants per generation) estimated among populations of fisher (Wisely *et al.* 2004, p. 644). Wisely *et al.* (2004, p. 644) found that populations of fisher exhibit high genetic structure (FST = 0.45, SE = 0.07) and limited gene flow (Nm less than 1) within their 1,600 km (994 mi) long peninsular distribution down through Washington, Oregon, and California. They state concerns about the future viability of the western fisher: "...we found that genetic diversity decreases from the base [British Columbia] to the tip [southern Sierra Nevada] of the peninsula, and that populations do not show an equilibrium pattern of isolation-by-distance. The reduced dimensionality of the distribution of fishers in the West appears to have contributed to the high levels of structure and decreasing diversity from north to south. The low genetic diversity and high genetic structure of populations in the southern Sierra Nevada suggest that populations in this part of the geographic range are vulnerable to extinction."

Fishers 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. Extremely 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, 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 10–20 percent reduction in survivorship interfered with population expansion in their modeling exercise for the Southern Sierra Nevada 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.

Other Anthropogenic Factors

Other 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, 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). Lofroth *et al.* (2010, p. 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).

Collision with Vehicles

Roads, in addition to their disruption of habitat continuity, are sources of vehicle-collision mortality (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 (Slausen 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 ten fishers killed by automobiles between 1993 and 2012 (Cline 2013, p. 32). Between 2007 and 2012, 4 of 73 (5 percent) radio collared fishers in analysis area studies were determined to have been killed by vehicular strike (Clifford *et al.* 2012, p. 5.). However, the type of road and its use level likely affects a fisher's susceptibility to collision mortality. Low use secondary roads seem to pose little direct effects (mortality due to vehicle collision only) to fishers (Slausen et al. 2003, p. 12). Washington Department of Fish and Wildlife and the National Park Service staff have recovered 11 fishers killed by vehicle collisions on the the Olympic Peninsula from 2008 to 2013, as part of the Olympic National Park reintroduction effort (Lewis 2014, pers. comm.).

Timing, scope, and severity of 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 Southern Sierra Nevada and Northern California-Southwestern Oregon 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 Northern California – Southwestern Oregon and Southern Sierra Nevada 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 22).

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 22. 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.

Conservation measures to reduce collisions with vehicles

There are few known conservation measures presently in place, 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 U.S. Forest Service, 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).

Direct climate effects to fishers

In addition to the climate change effects to fisher habitat and disease transmission, discussed respectively in the sections above on Stressors Related to Habitat and below on Synergistic Effects, climate change may cause direct effects to fishers, leading to increased mortality, decreased reproductive rates, or alterations in behavioral patterns, in addition to range shifts. Safford (2006, pp. 1, 11) has postulated that there will "undoubtedly" be significant direct climate effects to fishers, and that these effects may even be more important than climate effects mediated by alterations to habitat. Fishers may be especially sensitive, physiologically, to warming summer temperatures. In California, fishers choose rest sites in areas of cooler microclimate (Zielinski *et al.* 2004a, p. 488), and they 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). These observations suggest 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 (see paragraph on climate envelope models in the section discussing climate change effects to habitat). 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, p. 8EV-13EV). The current fisher range likely 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).

Timing, scope, and severity of direct climate effects to fishers

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 23). 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 23. 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.

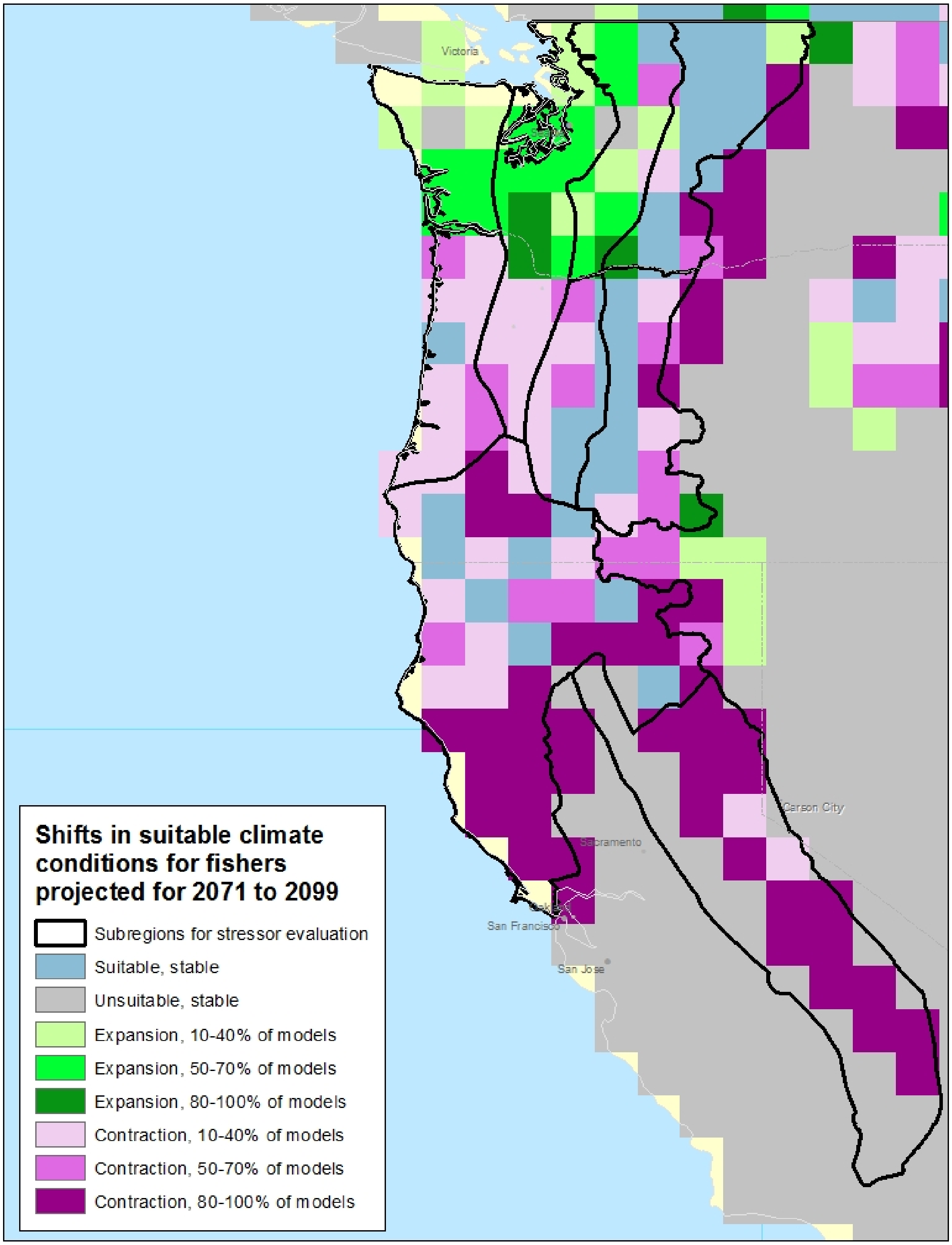

Figure 18. Changes in climate suitability for fishers, as defined by the climate envelope of the historical fisher range (see Figure 5). (Adapted from Lawler *et al.* 2012, Figure 16.3c, with additional data from Lawler 2013, pers. comm.)

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 cattus*)(Alterio 1996, entire); polecats (*Mustela putorius*; Shore *et al.* 1999, p. 202); American black bears (*Ursus americanus*; Schmidt 2014, pers. comm.); bobcats (*Lynx rufus*) 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); 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 (USEPA) ecological incident report documented AR residues in 27 avian species and 17 mammalian species (USEPA 2008, p. 8).

Within the Pacific States, AR exposure in fishers appears to be widespread, with residues found in 65 of 77 (84 percent) fisher carcasses tested from the two native populations in California (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. 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 widespread use of ARs across the landscape (Gabriel *et al.* 2012a, p. 5). 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.

Anticoagulant rodenticides were created to kill 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 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 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).] Further, because an exposed rodent may live several days after an initial feeding, and can become physically or behaviorally [for example, lethargic, hunched posture Litten *et al.*, p. 311-312; Swift 1998, pp. 42-44; Swift 2014, pers. comm.] compromised (Cox and Smith 1992, p. 169; Brakes and Smith 2005, p.121) by the ARs, a predator may have a better chance of locating and consuming an AR-exposed rodent over an unexposed rodent. The addition of "flavorizers" (for example, fish, bacon, cheese, or peanut butter flavored) to some products increase the likelihood that a mammalian predator would consume an AR directly if encountered within its home range. Anticoagulant rodenticides fall into two categories, first- and second-generation, based on toxicological characteristics and use patterns.

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 the SGARs (Fisher *et al.* 2003, pp. 7, 14, 16; Eason *et al.* 2010, pp. 176-177, 179; Crowell *et al.* 2013, entire).

Second-Generation ARs

In response to a developed resistance to FGARs by rodent populations in the US and Europe, development of second-generation ARs (SGARs), including brodifacoum, bromadialone, difethialone, and difenacoum, began in the 1970s (*e.g.*, 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 (for example, liver elimination half-life in mice of 307 days for brodifacoum [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.

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 deermice (*Peromyscus maniculatus*) to voles (*Microtus* spp.), pocket gophers (*Thomomys* spp.), and mountain beavers

(*Aplondontia rufa*), which utilize 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 apply very little if any AR on their ownerships (Standley 2013, pers. comm.; Bautista 2013, pers. comm.), 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). 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, pp. 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%, 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).

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 affects on fishers from the use of ARs.

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 fishers (Gabriel *et al.* 2012a, p. 12; Thompson *et al.* 2014, pp. 97-98).

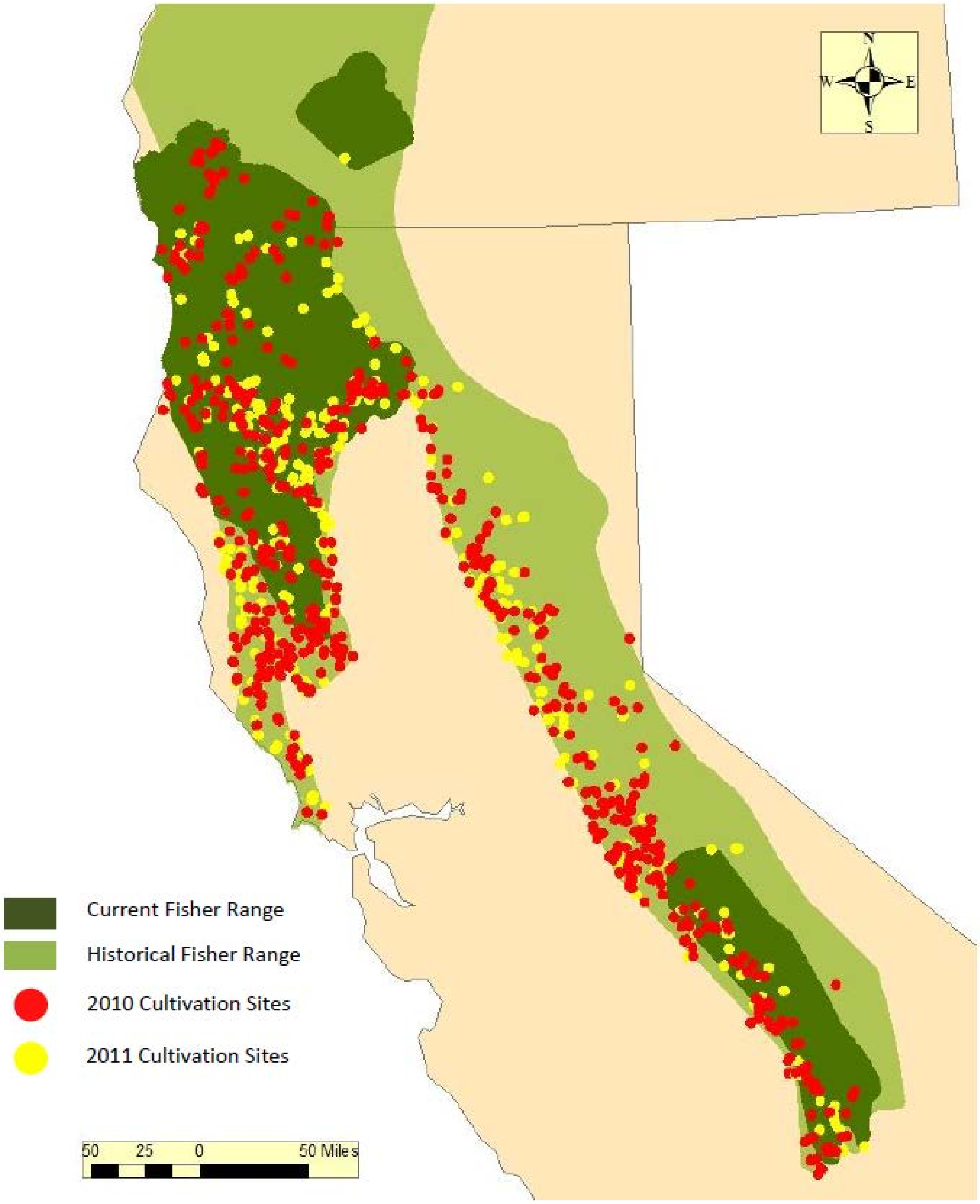

Figure 19. Cultivation sites eradicated on public, tribal or private lands during 2010 and 2011 within both historical and current ranges of the fisher in California and southwestern Oregon. The central location for each eradicated illegal cultivation location is buffered by 4000 meter radius which approximates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

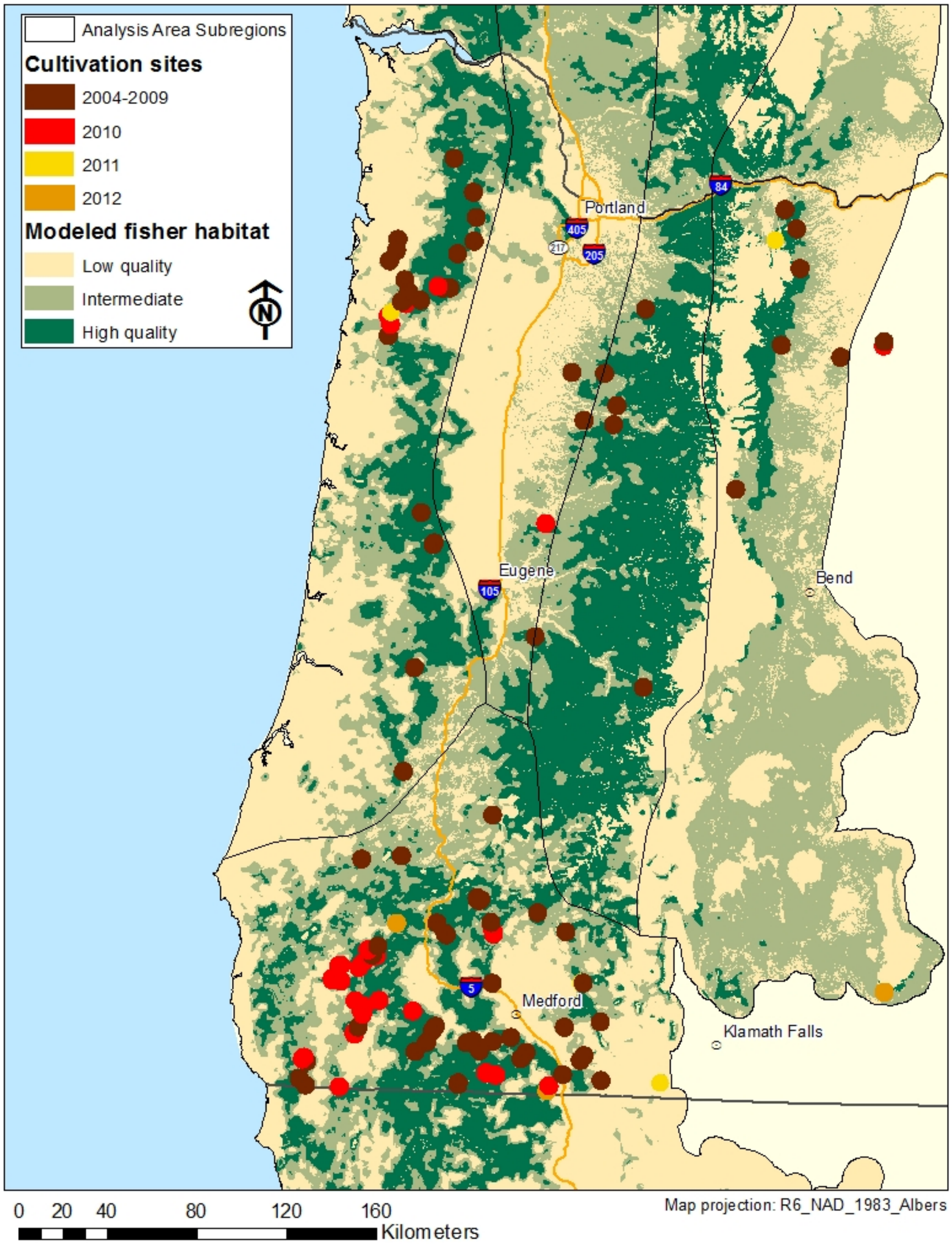

Figure 20. Marijuana cultivation sites eradicated between 2004 and 2012 in Oregon. The central location for each site is buffered by 4000 m to approximate the size of a male fisher home range. Cultivation site location data from ORHIDTA 2013.

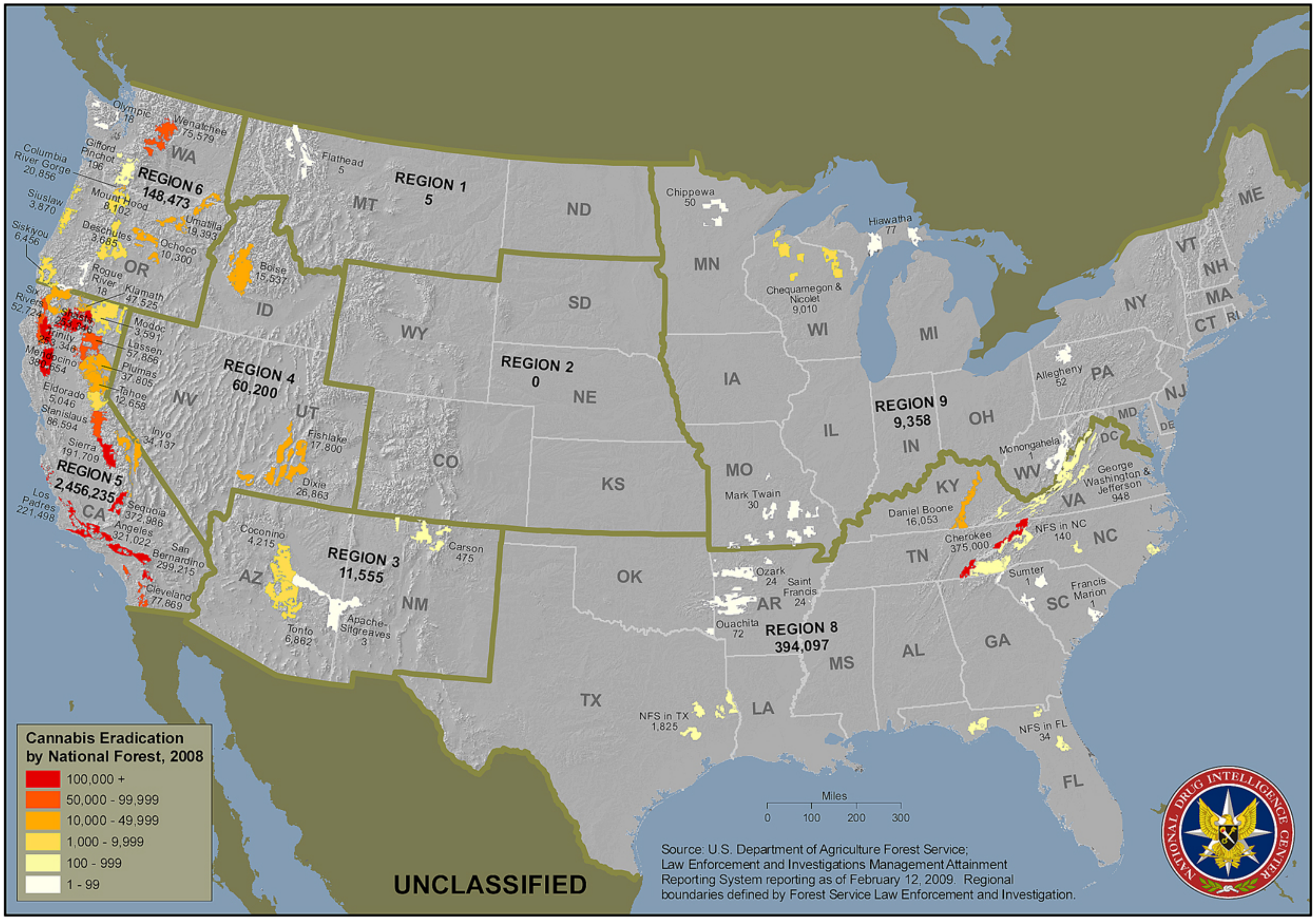

Figure 21. Cannabis eradication effort (number of plants) by national forest in 2008.

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, 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 (USEPA 2009, entire).

ARs Detected in Fishers

As mentioned above, first and second generation ARs have been detected in a majority of fishers tested in the Pacific States (Table 25; 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 fishers may consume ARs directly, especially if the AR baits contain flavorizers or are mixed with other foods that appeal to fishers (for example, chicken, wet cat food, tuna fish). 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 Northern California-Southwestern Oregon Population was suspected of succumbing to bromethalin 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.

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 USEPA (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% 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. Estimating the amount of brodifacoum contained within a prey item, such as a deermouse (*Peromyscus maniculatus*) or vole (*Microtus* spp.), is difficult. An animal can have undigested bait within its gastrointestinal tract, and liver residue values can approach the concentration of the bait itself (Ebbert and Burek-Huntington, 2010, p. 156). Whole body residue values are frequently used for small mammals that would be entirely consumed, but these vary widely. Merson *et al.* (1984, p. 213) sampled live-trapped voles in orchards broadcast-treated with a 0.005% brodifacoum bait, and found voles with whole body residues as high as 9.47 mg/kg. At this concentration, 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 (e.g., (e.g., 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

Class	Compound	Mammalian Toxicity Category[1]	Persistence in Tissue[2]	Illegal/Legal Use	Frequency on MJ sites	Documented exposure in fishers
Anticoagulant Rodenticide	Brodifacoum	Extremely toxic	High	Legal (21 products)	Many	Yes
	Bromadiolone	Extremely toxic	High	Legal (38 products)	Few	Yes
	Chlorophacinone	Extremely toxic	Medium	Legal (15 products)	Few	Yes
	Difenacoum	Extremely toxic	High	Legal (8 products)	None	Not tested
	Difethialone	Extremely toxic	High	Legal (12 products)	Few	Yes
	Diphacinone	Extremely toxic	Medium	Legal (47 products)	Few	Yes
	Warfarin	Extremely toxic	Medium	Legal (8 products)	Few	Yes
Acute Rodenticide	Aluminum Phosphide	Highly toxic	No residues expected	Legal (16 products)	Few	Not tested
	Bromethalin	Extremely toxic	Not available	Legal (48 products)	Few	Not tested
	Cholecalciferol	Extremely toxic	Low – Medium	Legal (6 products)	Few	Not tested
	Strychnine	Extremely toxic	Low	Legal (16 products)	Few	Not tested
	Zinc Phosphide	Highly toxic	No residues expected	Legal (25 products)	Moderate	Not tested
Organophosphate Insecticide	Malathion	Slightly toxic	Low	Legal (20 products)	Many	Not tested
	Azinphos Methyl	Extremely toxic	Low	Illegal	Few	Not tested
	Diazinon	Moderately toxic	Low	Legal (11 products)	Moderate	Not tested
	Methamidophos	Highly toxic	Low	Illegal	Few	Not tested
	Methyl Parathion	Extremely toxic	Low	Illegal	Few	Not tested
	Acephate	Moderately toxic	Low	Legal	Few	Not tested
Carbamate Insecticide	Carbaryl	Moderately toxic	Low	Legal (23 products)	Moderate	Not tested
	Carbofuran	Highly toxic	Low	Illegal	Many	Not tested
	Methomyl	Highly toxic	Low	Legal (11 products)	Few	Not tested
	Propoxur	Highly toxic	Low	Legal	Moderate	Not tested
Pyrethroid Insecticide	Bifenthrin	Slightly toxic	Medium	Legal (174 products)	Few	Not tested
	Deltamethrin	Slightly toxic	Low	Legal (99 products)	Few	Not tested
	Gamma Cyhalothrin	Slightly toxic	Low – Medium	Legal (133 products)	Many	Not tested

Class	Compound	Mammalian Toxicity Category[1]	Persistence in Tissue[2]	Illegal/Legal Use	Frequency on MJ sites	Documented exposure in fishers
	Beta Cyfluthrin	Slightly toxic	Low	Legal (23 products)	Few	Not tested
Organochlorine Insecticide	DDT	Moderately toxic	High	Illegal	Few	Not tested
Other Insecticides	Fipronil	Moderately toxic	Medium	Legal (75 products)	Few	Not tested
	Imidacloprid	Slightly toxic	Low	Legal	Few	Not tested
	Abamectin	Moderately toxic	Low	Legal (65 products)	Few	Not tested
Fungicide	Chlorothalonil	Slightly toxic	Low	Legal (89 products)	Moderate	Not tested
Molluscicide	Metaldehyde	Moderately toxic	Low	Legal (35 products)	Moderate	Not tested

[1]Mammalian and avian LD_{50} (USEPA): 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.

Table 25. Pesticides found on marijuana cultivation sites.

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, p. 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).

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, increased susceptibility to diseases and parasites, and reduced reproductive potential through exposure of ARs to fetuses *in utero* or to kits from tertiary exposure through tainted milk. 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.

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. Small, isolated fisher populations like the Southern Sierra Nevada Population, are already vulnerable to stochastic events (Shaffer 1981, entire), thus any additional reduction in survivorship may decrease the probability of population persistence. Although the Southern Sierra Nevada Population has shown stable occupancy rates for the past 8 years (Zielinski *et al.* 2013, 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 Southern Sierra Nevada 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 Southern Sierra Nevada 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. As a result, we lack direct evidence of AR-induced prey depletion and impacts to fisher populations.

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.

Timing, scope, and severity of exposure to toxicants

The timing of this stressor is ongoing. To calculate the scope of this stressor, we focused on illegal marijuana cultivation sites, where the ARs and other toxicants are used to control rodent populations, since fisher research suggests that these are the most likely source of the ARs and other toxicants found in fishers. 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. Association of ARs with illegal marijuana sites may not be true on the Olympic Peninsula where fishers have been detected in close proximity to suburban and rural areas and 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 locatons with 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 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.

We were unable to obtain data describing the prevalence or locations of marijuana cultivation sites in Washington. The best information we have about rodenticide exposure in Washington comes from the autopsies of 8 dead fishers from the reintroduced Olympic Peninsula population, 6 of which had been exposed to anticoagulant rodenticides. However, because this is a reintroduced population, we do not know if the animals were exposed to ARs prior to their translocation, after their arrival in Washington, or in both places. Also, some fishers in this population have been found near urban areas, and exposure may be from legal use in these areas rather than from marijuana cultivation (Lewis *et al.* 2012b, p. 9). Therefore, for Coastal Washington we estimate a scope of 75 percent. In western Washington, most marijuana is thought to be grown indoors, whereas most is grown outdoors in eastern Washington (NW HIDTA 2013, p. 16). However, this information does not offer insight into how much area within fisher habitat might be subject to AR exposure; however it may indicate that our scope for exposure may be an overestimate. 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. Conversely, the scopes for western Washington do not take into account possible exposure to legal uses in urban areas, which could affect fishers more than in other sub-regions. For regions of Washington other than the Coast Range, we assume that the scope falls within the broad range of scopes calculated for the other regions.

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 Northwestern California-Southwestern Oregon and Southern Sierra Nevada Populations (Table 26). 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, for this analysis since we did not consider sublethal affects as synergistic with exposure to toxicants we assumend 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 26).

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 26. 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 reproductive success, and ultimately to negative population growth and a reduced geographic distribution.

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 Southern Sierra Nevada 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% 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. Our severity estimates for stressors causing direct mortality are expressed in annual mortality rates, for ease of comparison with these numbers. Mortality related to research activities, collisions with vehicles, and anticoagulant rodenticide poisoning add, in aggregate, 3-17% annual mortality to naturally occurring mortality from disease and predation (collectively 6-32% 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. There is reason to expect increases in some mortality factors, e.g. rodenticide poisoning (see above), disease, and predation (see below).

In addition to these concerns, all native and reintroduced populations within the analysis are relatively small and isolated. This increases the vulnerability of these populations to stochastic changes in survival and reproductive rates. In combination with increasing mortality due to the stressors listed above, stochastic fluctuations in demographic parameters have the potential to cause sudden, sharp declines in the populations.

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 may increase fishers' vulnerability to predation; exposure to anticoagulant rodenticides may increase the death rates from predation, vehicle collisions, disease, or intraspecific conflict; it is projected that climate change, fire, forest disease, and environmental impacts of human development will interact to cause large-scale ecotype conversion; climate change is also projected to lead to increases in disease; and human development is likely to cause increases in vehicle collisions, 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, influenced 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). These results indicate that human development, linear features, and some types of vegetation management are likely to magnify the severity of stressors due to predation.

Anticoagulant rodenticide exposure appears to be widespread within the fisher populations in the Pacific States. Because 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.

In several sub-regions, changes in temperature and precipitation as a result of climate change are expected to cause reductions in habitat amounts due to shifts in vegetation types. These reductions will be cumulative with those due to fire, ongoing vegetation management, and human development. However, our scope and severity measures for these habitat-related stressors did not include the projected synergistic effects of climate change and fire: as the climate warms and summers become drier, fires are projected 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 (e.g., the Sierra Nevada), are expected to act in concert with climate change and fire to cause widespread ecotype conversions. Thus, the amount of habitat loss in some sub-regions may be greater than the scope and severity numbers reported here imply.

Climate change also is likely to 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 is likely to 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 is likely to 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 is likely 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, so human development is also likely to increase the severity of disease mortality.

Cumulative and Synergistic Effects Summary

Stressors operating at the population level include disjunct and small population size, past loss of late-successional habitat, on-going habitat changes from; vegetation management, human development, climate change (and the associated increase in wildfire), and sources of direct mortality such as consumption of ARs and collision with vehicles. Just as stressors, as evaluated, are not occurring in equal scope and severity across the analysis area, the cumulative and synergistic effects from these stressors are occurring more in some sub-regions than others. Historical, and on-going cumulative and synergistic stressors will be increasingly important in 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.

Tables 27 through 34 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 27a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Eastern Washington Cascades analysis area. [A]

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 27b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Eastern Washington Cascades analysis area. [A]

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 28a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Western Washington Cascades analysis area. [A]

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.

Table 28b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Western Washington Cascades analysis area. [A]

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 29a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Coastal Washington analysis area. [A]

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 29b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Coastal Washington analysis area. [A]

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.

Table 30a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Eastern Oregon Cascades analysis area. [A]

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 30b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Eastern Oregon Cascades analysis area.[A]

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.

Table 31a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Western Oregon Cascades analysis area. [A]

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.

Table 31b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Western Oregon Cascades analysis area. [A]

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.

Table 32a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Coastal Oregon analysis area. [A]

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.

Table 32b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Coastal Oregon analysis area. [A]

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.

Table 33a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Northern California – Southwestern Oregon analysis area.

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 no 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 33b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Northern California – Southwestern Oregon analysis area.

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 34a. Timing, scope, and severity of potential On-going and Long-term stressors on fisher habitat in the Sierra Nevada analysis area.

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.

Table 34b. Timing, scope, and severity of potential On-going and Long-term stressors on fishers in the Sierra Nevada analysis area.

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%

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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	1,526,924	4.31	1,309,525	177,934	39,465

National Forest					
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
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-Siskyou 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 Reserves	126,498	0.36	26,252	25,922	74,325
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, WA	35,075	0.1	10,281	24,793	0
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