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Conservation Assessment for the Siskiyou Mountains Salamander and Scott Bar Salamander in Northern California

Environmental Science Division

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Conservation Assessment for the Siskiyou Mountains Salamander and Scott Bar Salamander in Northern California

by
W.S. Vinikour, K.E. LaGory, and J.J. Adduci
Environmental Science Division, Argonne National Laboratory

for
Klamath National Forest
U.S. Forest Service
Yreka, California

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CONTENTS

TABLES

FIGURES

FIGURES (Cont.)

NOTATION

The following is a list of the acronyms, initialisms, and abbreviations (including units of measure) used in this report.

Abbreviations

BLM	Bureau of Land Management
CBD	Center for Biological Diversity
CDFG	California Department of Fish and Game
Commission	California Fish and Game Commission
EPIC	Environmental Protection Information Center
ESA	Endangered Species Act
Forest	National Forest
GIS	Geographic Information System
REO	Regional Ecosystem Office
ROD	Record of Decision
SVL	snout-to-vent length
USDA	U.S. Department of Agriculture
USDI	U.S. Department of Interior
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service

Units of Measure

ac	acre(s)
cm	centimeter(s)
ha	hectare(s)
in.	inch(es)
ft	foot (feet)
m	meter(s)
mm	millimeter(s)
yr	year(s)

EXECUTIVE SUMMARY

Species: Siskiyou Mountains salamander (*Plethodon stormi*) and Scott Bar salamander (*Plethodon asupak*)

Taxonomic Group: Amphibian, Family: Plethodontidae

Purpose: The purpose of this conservation assessment is to summarize existing knowledge regarding the biology and ecology of the Siskiyou Mountains salamander and Scott Bar salamander, identify threats to the two species, and identify conservation considerations to aid federal management for persistence of the species. The conservation assessment will serve as the basis for a conservation strategy for the species.

Range and Habitat: The Siskiyou Mountains salamander occurs in northern Siskiyou County, California; southern Jackson County, Oregon; and southeastern Josephine County, Oregon, at elevations between 488 and 1,830 m (1,600 and 6,000 ft). Its documented range is about 136,400 ha (337,000 ac) occurring within the Applegate River drainage of southern Oregon south to the Klamath River watershed of northern California. Its range is bounded by the Indian Creek drainage to the west and the Horse Creek drainage to the east. There are two genetically distinct groups of the Siskiyou Mountains salamander (Applegate and Grider groups) that are separated by the crest of the Siskiyou Mountains. The Scott Bar salamander occurs in northern Siskiyou County, California, near the confluence of the Klamath and Scott Rivers at an elevation of about 460 to 1,190 m (1,500 to 3,900 ft). The Scott Bar salamander may have the most restricted range of any western plethodontid species (e.g., estimated at between 27,700 ha [68,400ac] and 32,630 ha [80,640 ac]), occurring from just east of the Seiad Valley to Scott Bar Mountain with its range extending north and south of the Klamath River and east and west of the Scott River. Both species have been found in a variety of forest habitats primarily within areas of rock talus and rocky outcrops.

Threats: Habitat loss, modification, and fragmentation are the main threats to these species. Any activity that alters microclimatic conditions such as the removal of forest canopy or disturbance of talus has the potential to adversely impact these species. Timber harvest is the most prevalent activity within the area that has the potential to affect the species. Recreational developments, mining, road construction, and prescribed and wildland fires can also affect them.

Conservation Elements: Conservation elements, or strategies recommended to conserve the species, include: (1) habitat conservation actions; (2) research, inventory, and monitoring activities; and (3) adaptive management. Objectives are identified to guide development of a land management strategy that has a low risk of adversely affecting the species. The identified strategy would meet these objectives by (1) maintaining the species' existing ranges, (2) providing suitable habitat patches within a matrix of habitat types, (3) providing for redundancy of subpopulations, and (4) providing connectivity between occupied patches for gene exchange and recolonization after disturbance. Although this conservation strategy has been developed for Region 5, the objectives are consistent with the recent conservation strategy prepared for the Siskiyou Mountains salamander in southern Oregon. Coordination with activities in adjacent

Region 6 would maximize the effectiveness of both strategies while still allowing for other uses of the forests on federal lands.

CONSERVATION ASSESSMENT FOR THE SISKIYOU MOUNTAINS SALAMANDER AND SCOTT BAR SALAMANDER IN NORTHERN CALIFORNIA

Prepared by

William S. Vinikour, Kirk E. LaGory, and Joseph J. Adduci
Environmental Science Division
Argonne National Laboratory

1 INTRODUCTION

The Siskiyou Mountains salamander (*Plethodon stormi*) and Scott Bar salamander (*Plethodon asupak*) are closely related terrestrial salamanders whose ranges are restricted to mostly federal lands in northern California, and, in the case of the Siskiyou Mountains salamander, in adjacent lands of southern Oregon. This conservation assessment has been prepared to identify those conservation considerations needed to ensure protection of these species in Region 5 of the U.S. Forest Service (USFS), specifically within the Klamath National Forest.

1.1 GOAL OF THE CONSERVATION ASSESSMENT

The goal of this conservation assessment is to summarize existing knowledge regarding the biology and ecology of the Siskiyou Mountains salamander and Scott Bar salamander, identify threats to the species, and identify conservation considerations to aid federal management for persistence of the two species. The conservation assessment will serve as the basis for a conservation strategy for the species.

These salamander species are of concern because their limited distribution and restricted microhabitat and microclimatic requirements make them particularly vulnerable to disturbance effects. USFS management for these species within northern California currently follows the survey and manage and protection buffer provisions of the Northwest Forest Plan, as amended (U.S. Department of Agriculture [USDA] and U.S. Department of Interior [USDI] 2001), and USFS Sensitive Species objectives and policies (USFS Manual Sections 2670.22 and 2670.32, respectively).

The survey and manage program requires surveys for rare and isolated species that are listed as “survey and manage species” before allowing any ground-disturbing activities, and management of all known sites within which the species occur. The protection buffer standards and guidelines include protective measures for occupied sites and the delineation of protected buffer areas around known sites (Olson 1999).

USFS objectives for sensitive species include:

- Develop and implement management practices to ensure that the species do not become threatened or endangered because of USFS actions;

- Maintain viable populations of all native and desired nonnative species in habitats distributed throughout their geographic range on National Forest (Forest) lands; and
- Develop and implement management objectives for populations and/or habitat of sensitive species.

USFS policies for sensitive species include:

- Assist states in achieving their goals for conservation of endemic species;
- Review potential effects of programs and activities to sensitive species through biological evaluations, as part of the National Environmental Policy Act process;
- Avoid or minimize impacts to species whose viability has been identified as a concern;
- If impacts cannot be avoided, analyze the significance of potential adverse effects on the population or its habitat within the area of concern and on the species as a whole; and
- Establish management objectives in cooperation with the state when projects on Forest lands may have a significant effect on sensitive species population numbers or distributions.

This conservation assessment is intended to: (1) contribute to the USFS Region 5's objectives to maintain well-distributed or secure populations of the Siskiyou Mountains salamander and Scott Bar salamander across their known ranges on Forest lands; (2) avoid a trend that could contribute to the listing of these species under the Endangered Species Act (ESA), while still allowing for other uses of Forest lands; and (3) complement the conservation strategy prepared for the Siskiyou Mountains salamander within southern Oregon by Olson et al. (2004).

1.2 SCOPE OF THE CONSERVATION ASSESSMENT

The geographic scope of this conservation assessment includes the ranges of the Siskiyou Mountains salamander and Scott Bar salamander that occur within the Klamath National Forest in northern California (Figure 1). However, some background information is included for the entire range of the Siskiyou Mountains salamander, which extends into USFS Region 6 (Rogue and Siskiyou National Forests) and U.S. Bureau of Land Management (BLM) lands (Medford District) in southern Oregon. The conservation assessment emphasizes species considerations on federal lands; however, information gathered on or pertinent to nonfederal lands is included, as it is relevant to the overall conservation of the salamanders.

This conservation assessment summarizes the currently known or suspected threats to the species. Conservation considerations apply to specific localities; however, some larger scale issues such as population connectivity and rangewide concerns are listed. Uncertainty and inference are acknowledged where appropriate.

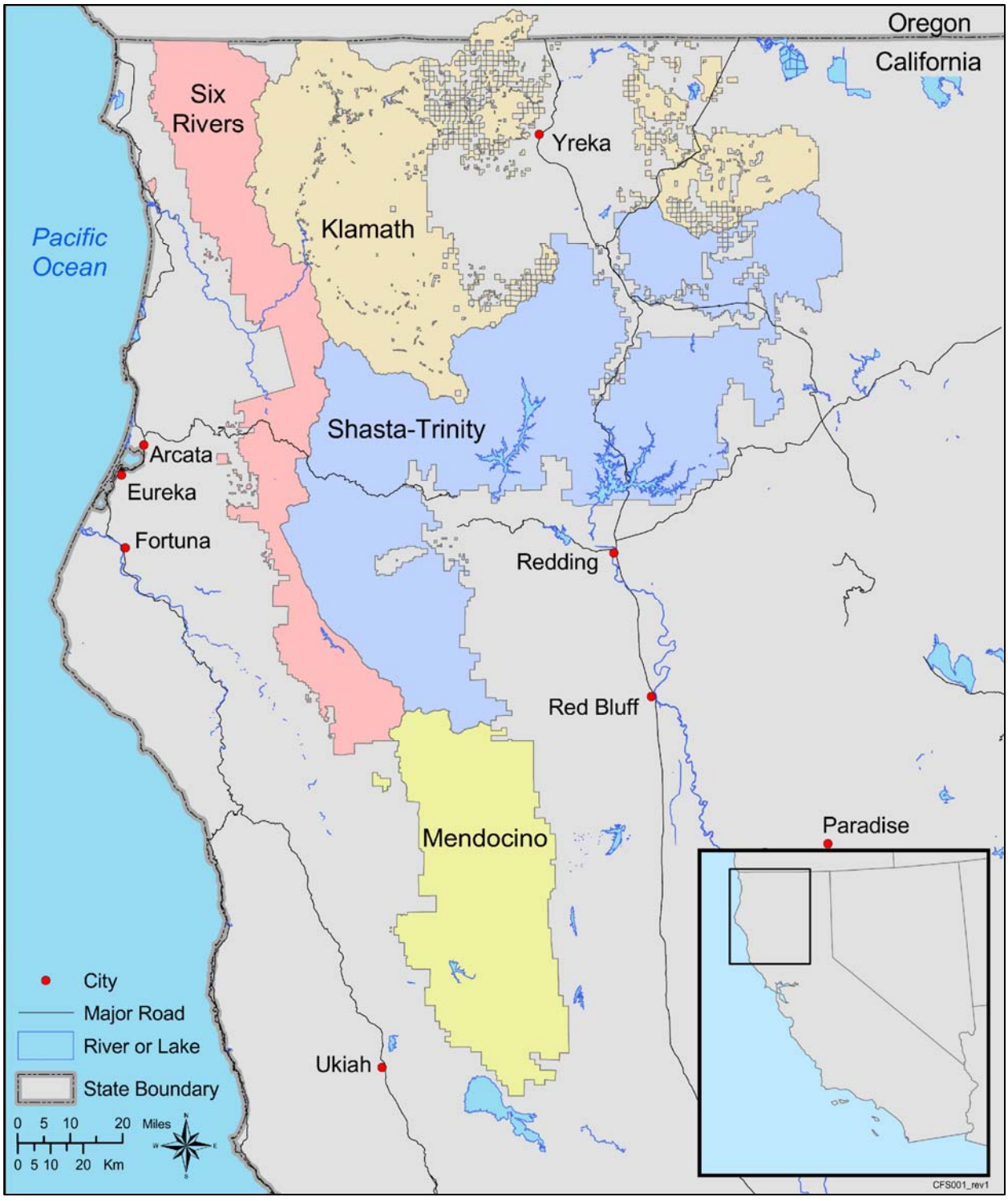

FIGURE 1 National Forests within U.S. Forest Service Region 5 (Source: LaGory et al. 2003)

The Siskiyou Mountains salamander and Scott Bar salamander are relatively little known. Within the past few years, information on distribution, habitat, and genetic structure has been gathered, but it is expected that updates of this conservation assessment will be necessary as a more complete understanding of the species' biology and ecology emerges.

1.3 MANAGEMENT STATUS OF THE SPECIES

The following summarizes the federal and state protection status of the Siskiyou Mountains salamander and Scott Bar salamander.[1]

- U.S. Fish and Wildlife Service (USFWS) Status: Not listed.

  The Center for Biological Diversity (CBD) et al. (2004) petitioned for an emergency listing of the Siskiyou Mountains salamander and Scott Bar salamander under the ESA, but the USFWS (2004) rejected the petition based on their determination that there was no imminent threat to the species that would necessitate an emergency listing for these two species. On August 23, 2005, several environmental groups filed suit, stating that the USFWS failed to make either a 90-day or 12-month determination on the petition filed by the CBD et al. (2004). As part of the settlement of this suit, a 90-day finding was published in the *Federal Register* on April 25, 2006. The finding of the USFWS was that neither species warranted listing as threatened or endangered under the ESA (USFWS 2006a).

- State Status:
  - California: The Siskiyou Mountains salamander is listed as threatened, but the Scott Bar salamander is not listed.
  - Oregon: The Siskiyou Mountains salamander is not listed as threatened or endangered. The Scott Bar salamander does not occur in Oregon.

- USFS Status: Survey and manage and sensitive species.

  The Siskiyou Mountains salamander was one of a number of survey and manage species added to the Sensitive Species Program after the Record of Decision [ROD] to remove the survey and manage mitigation and management guidelines from the Northwest Forest Plan (see discussion below).

- BLM Status:
  - California: No status because neither species is expected to occur on BLM lands (Olson et al. 2004).
  - Oregon: Survey and manage and sensitive species (Siskiyou Mountains salamander only, the Scott Bar salamander does not occur in Oregon).

[1] Because the status of the Scott Bar salamander as a distinct species was uncertain until recently, it has generally been considered as the Siskiyou Mountains salamander by land management and regulatory agencies (Olson et al. 2004). However, the recognition of the Scott Bar salamander as a distinct species, without concurrent agency classification of the species within a protected category, potentially places the species at risk. As an example, several environmental organizations filed suit on March 17, 2006, against the California Department of Forestry and California Department of Fish and Game related to their approval of logging within Scott Bar salamander habitat.

The Siskiyou Mountains salamander is a Category A species under the survey and manage standards and guidelines. For Category A species, all known locations are to be managed to avoid adverse impacts and to minimize indirect loss of undiscovered sites (e.g., prior to ground-disturbing activities, sites are surveyed and management standards developed for those sites where the species is found) (USDA and USDI 2001). The Scott Bar salamander has not been reviewed to determine if it meets the survey and manage species criteria. However, the Klamath National Forest has a policy that it will apply survey and manage standards and guidelines to the species because: (1) its range has not been fully mapped, and (2) it is difficult to distinguish the Scott Bar salamander from the Siskiyou Mountains salamander in the field.

The USDA and USDI published a ROD (USDA and USDI 2001) on standards and guidelines for amendments to the survey and manage, protection buffer, and other mitigation measures in USFS and BLM planning documents within the range of the northern spotted owl (*Strix occidentalis*) (i.e., the area covered by the Northwest Forest Plan). Generally, these amendments did not change the way the USFS would manage the Siskiyou Mountains salamander. In a subsequent ROD (USDI and USDA 2004), the survey and manage mitigation and management guidelines were removed from the Northwest Forest Plan, essentially leaving the Siskiyou Mountains salamander to be protected on Forest lands through application of guidelines set forth in USFS Manual Section 2670 and on BLM lands in BLM Manual 6840 (*Special Status Species Management*, particularly Section 6840.22 that covers the conservation of special status species other than those protected under the ESA). However, in a judgment dated January 9, 2006, the 2004 ROD was set aside and the 2001 ROD was reinstated (REO 2006).

A revised supplement to the 2004 Supplemental Environmental Impact Statement and ROD (USDA and USDI 2004) is planned. It is anticipated that the ROD for the revised supplement will be published on or before March 30, 2007, and would again call for the removal of the survey and manage mitigation and management guidelines. Therefore, the adequacy of regulations to protect the two salamander species may need to be reevaluated at that time (USFWS 2006a).

In Oregon, the Siskiyou Mountains salamander is not provided any regulatory protection on private lands, which comprise about 10% of the species' range (USFWS 2006a). The state threatened status in California provides protection for the species. Thus, for all timber harvest plans within the California range of the Siskiyou Mountains salamander, timber companies have to consult with the California Department of Fish and Game (CDFG). To proceed with logging, timber operators must either (1) conduct surveys that determine the species is not present; (2) obtain an incidental take permit; or (3) protect all suitable habitat from logging, including limiting logging in 15 to 30 m (50 to 100 ft) buffers around suitable habitat (the CDFG considers all areas with talus covering 25% of the area to be suitable habitat) to periods when the species is not active on the surface (CDFG 2005).

The CDFG (2005) has recommended that the Siskiyou Mountains salamander be removed from the state list of threatened and endangered species because: (1) it is not as rare as originally thought when it was listed by the state; and (2) it is not likely to become endangered in the foreseeable future, nor is it in serious danger of becoming extinct throughout all or a

significant portion of its range. Consequently, the CDFG has proposed to enter into an initial five-year program in collaboration with private landowners to document and report on the response of the Siskiyou Mountains salamander to timber operations. This program may be extended beyond the initial five years to document longer term response of Siskiyou Mountains salamander to disturbance (CDFG 2005).

In their petition for federal listing of the Siskiyou Mountains salamander and Scott Bar salamander, the CBD et al. (2004) stated their opinion that if the Siskiyou Mountains salamander is removed from state listing, it would leave the species with no formal protection on private lands, and it is uncertain what the long-term status of the species would be on nonfederal lands. About 31% of the Siskiyou Mountains salamander range in California occurs on private lands (see Section 4.2).

The Scott Bar salamander receives no regulatory protection on private lands in California, which comprises between 18% (USFWS 2006a) to 36% (see Section 4.2) of its range. On April 6, 2006, the CBD, Environmental Protection Information Center (EPIC), and Klamath-Siskiyou Wildlands Center filed a joint petition to protect the Scott Bar salamander as a threatened species under the California Endangered Species Act (CBD 2006).[2] These groups also filed suit on March 16, 2006, against the California Departments of Forestry and Fish and Game for their approval of logging on Scott Bar salamander habitat (EPIC 2006). The outcome of this suit is still pending.

In their 90-day finding (issued April 25, 2006) on the petition for an emergency listing under the ESA of the Siskiyou Mountains salamander and Scott Bar salamander, the USFWS concluded that neither species warranted additional protection under the ESA because:

- Both species occur to some extent in clearcuts and naturally open habitats;
- The demography of populations subjected to timber harvest is poorly known;
- The rate and extent of timber harvest has declined dramatically on federal lands;
- Habitat loss has not been quantified nor demonstrated to have impacted the species;
- The Survey and Manage Program of the Northwest Forest Plan was reinstated in January 2006 by court order;
- The Klamath National Forest has formally extended survey and manage protections to the newly described Scott Bar salamander;
- The Siskiyou Mountains salamander is currently protected as a threatened species under the California ESA, and is afforded protection on private timberlands;
- The USFWS does not have appropriate information to evaluate the risk of global warming or stochastic events; and

[2] The petition was returned to the petitioners by the California Fish and Game Commission (Commission) on April 19, 2006. In returning the document, the Commission noted that the petition had not been submitted on Form FGC-670 as required by Title 14, Section 670.1(d)(1) of the California Code of Regulations. The Commission also stated that it was not immediately apparent that the petition contained information in each of the required categories specified in Title 14, Section 670.1(d)(1) of the California Code of Regulations.

- A considerable amount of Scott Bar salamander habitat has yet to be surveyed, suggesting that the population may be larger than currently described (USFWS 2006b).

2. CLASSIFICATION AND DESCRIPTION

2.1 SYSTEMATICS

Both the Siskiyou Mountains salamander and Scott Bar salamander are members of the Plethodontidae, the lungless salamanders. They are included within the *elongatus* species group of salamanders that also includes the more common and widespread Del Norte salamander (*Plethodon elongatus*). The three species are immediate descendants of a common ancestral species (CDFG 2005).

The Siskiyou Mountains salamander was first discovered in 1963 and was described as a distinct species in 1965 (Highton and Brahme 1965). However, some researchers reported the Siskiyou Mountains salamander to be one of two subspecies of the Del Norte salamander (i.e., striped Del Norte salamander [*P. e. elongatus*] and Siskiyou Mountains salamander [*P. elongatus stormi*]) (Stebbins 2003). Pfrender and Titus (2001) identified four genetically distinct population segments within the *elongatus* species group. These are now considered the Del Norte salamander, two groups of Siskiyou Mountains salamander (the Applegate Group in the north and the Grider Group in the south that are separated by the Siskiyou Mountains crest), and the Scott Bar salamander. The Siskiyou Mountains crest, that roughly follows the California-Oregon border, may provide a significant barrier to gene flow between the two groups of Siskiyou Mountains salamander (Ollivier et al. 2001). Molecular and morphological variation reported by Mead et al. (2005) supported these findings, and also identified the Scott Bar salamander as a new species. It has been suggested that each of these species or population groups should be treated as separate units for management considerations (Pfrender and Titus 2001).

Pfrender and Titus (2001) reported an almost complete lack of genetic variation within and among populations of the Siskiyou Mountains salamander in the Applegate River drainage, which contains the majority of the known populations of the salamander. While lack of genetic variation is often considered to be a risk to the persistence of a species, the species' genetic makeup may provide high fitness within its environment (CDFG 2005). The genetic divergences noted between the Del Norte salamander and the Siskiyou Mountains salamander ranges from about 7.7 to 9.5%, which is similar to values reported for other Pacific Northwest amphibians (Mahoney 2004). There is a sharp contact zone with no evidence of intergradations between the Siskiyou Mountains salamander and Del Norte salamander in the Thompson Creek drainage within Oregon. This is a likely zone of secondary contact between the two species that may be maintained by competitive exclusion (Pfrender and Titus 2001).

Within Siskiyou County, California, the separation between the Del Norte salamander and Siskiyou Mountains salamander occurs at Indian Creek, west of Thompson Creek (Mead 2006), and there is a suggestion of limited hybridization between the Siskiyou Mountains

salamander and the Del Norte salamander in this area (CDFG 2005). Just east of Upper Walker Creek, the Del Norte salamander is apparently replaced by the Scott Bar salamander. Data are insufficient to determine if any gene flow occurs between the Del Norte salamander and Scott Bar salamander in this area (Mead 2006). There may be some gene flow between the Siskiyou Mountains salamander and Scott Bar salamander in the Horse Creek area (Mead 2006). Apparently, reproductive and/or ecological barriers to broad scale hybridization have evolved among the three salamander species (Mead 2006). Recorded locations of the three species (including locations of individuals recorded as Siskiyou Mountains salamander prior to recognition of the Scott Bar salamander) are presented in Figure 2.

2.2 SPECIES DESCRIPTION

Adult Siskiyou Mountains salamanders typically have 17 costal grooves and 5 intercostal folds between adpressed legs (Mead et al. 2005). Adults may reach a total length of about 14 cm (5.5 in.) (CDFG 2005). Sexual dimorphism is apparent. Mean snout-to-vent length (SVL) for 62 mature males was 58.9 mm (2.3 in.), while 41 mature females averaged 61.9 mm (2.4 in.). A specimen with a SVL of 76 mm (3.0 in.) has been reported. Siskiyou Mountains salamander hatchlings measure 17 to 18 mm (0.67 to 0.71 in.) SVL (Blaustein et al. 1995). Males average 43.5 maxillary and pre-maxillary teeth, while females have a mean of 54.8 teeth (Mead et al. 2005). Males also have a mental gland (a round gland under the chin), and sometimes poorly developed vent lobes (Brodie 1976).

Siskiyou Mountains salamander juveniles typically have an even-edged, olive-tan dorsal stripe. In adults, the stripe is faint and is comprised of pinkish or golden-tan dots (Nussbaum et al. 1983). Ground and ventral coloration is black in small juveniles, but lighter in adults, where it appears purplish-brown in dorsal ground color and lavender to light purplish-gray on the ventrum. The gular region is cream-colored, copper-colored iridiphores are present beneath the stripe, and heavy iridiphore flecking is present along the dorsal stripe and the gular area. Iridiphores are absent or very sparse along the midventral line. Rarely, some individuals may have a few gold iridiphores on the eye above the pupil (Brodie 1971).

The Scott Bar salamander is more robust and has a wider head and longer limbs than the Siskiyou Mountains salamander. It has a mean of 16 to 17 costal grooves in males and females, respectively, with 3 intercostal folds between adpressed legs. The tail length is about 83% to 86% of the SVL in males and females, respectively, compared to 86% to 91% for the Siskiyou Mountains salamander (Mead et al. 2005). The sides of the body are chocolate brown, with brown and black pigmentation. The upper back and head have a brown and bronze dorsal stripe, which extends to the tip of the tail. White and yellow flecks cover most of the body. However, the flecks are more concentrated on the sides, legs, and throat. The ventrum is mottled with light gray patches on a dark gray to purplish background. Eyes are black with some gold flecking on the upper and lower surfaces (Mead et al. 2005). Juveniles have two orange to reddish-brown stripes on the dorsum extending from just behind the eyes to the tail. Just behind the vent, the stripes fuse into a single stripe. The edges of the stripes are black, and the sides of the body dark brown (Mead et al. 2005).

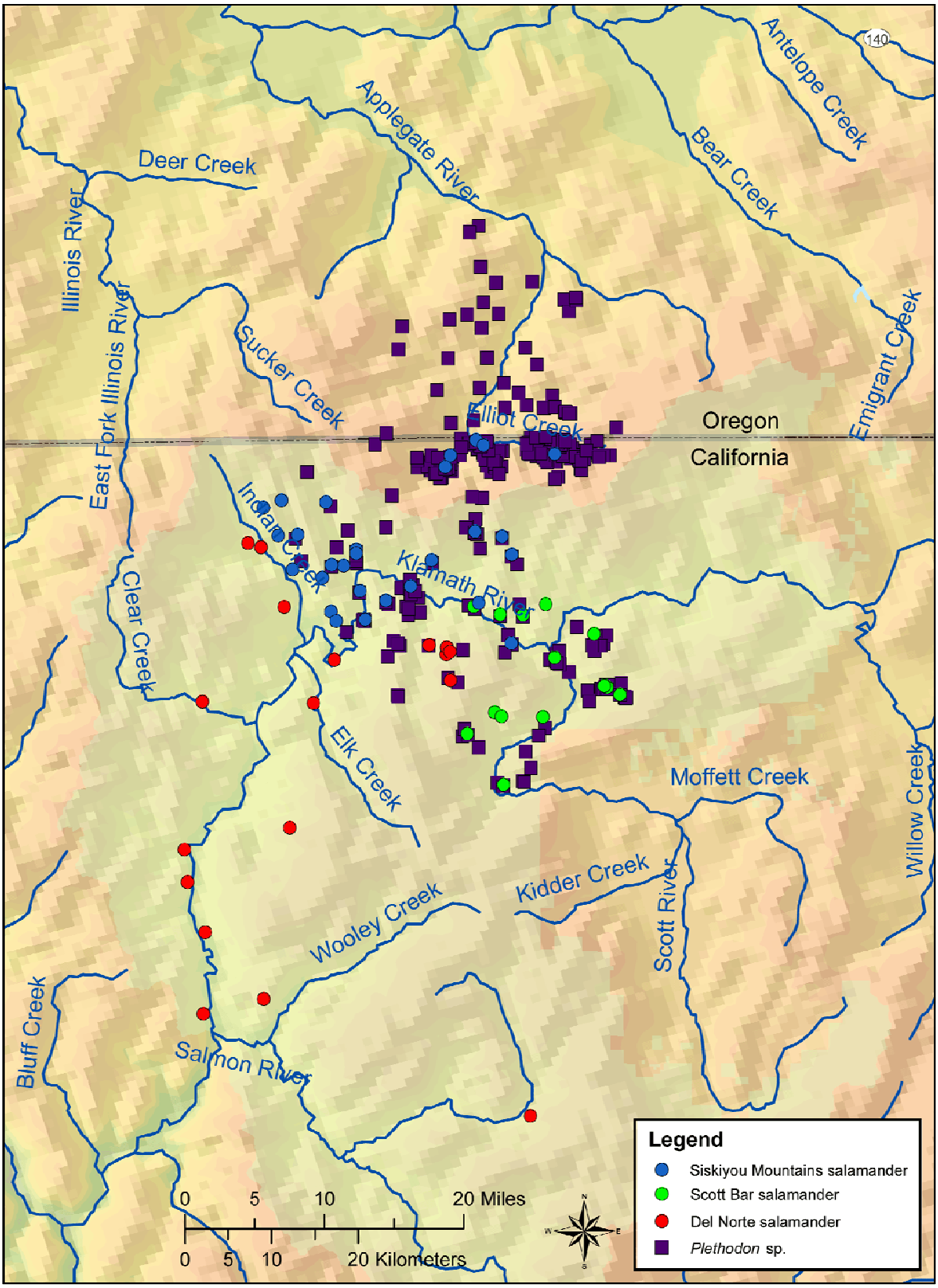

FIGURE 2 Locations of Siskiyou Mountains Salamander, Scott Bar Salamander, and Del Norte Salamander in Northern California and Southern Oregon

Forelimb and hindlimb length, head width, and the number of intercostal folds between adpressed limbs provide reliable characteristics that can be used to distinguish between males of the two species. The number of intercostal folds and the internarial distance best discriminate between females of the two species (Mead et al. 2005). Table 1 provides measurements for various morphological features for the Siskiyou Mountains salamander and Scott Bar salamander.[3]

3 BIOLOGY AND ECOLOGY

This section provides information on the biology and ecology of the Siskiyou Mountains salamander and the Scott Bar salamander. For some topics, species-specific information is supplemented with information pertaining to plethodontid salamanders in general. More detailed species-specific information is provided for the Siskiyou Mountains salamander, because ecological information specific to the Scott Bar salamander is limited mostly to its distribution and range (USFWS 2006a). However, the biology and ecology of the Scott Bar salamander are thought to be similar to that of the Siskiyou Mountains salamander. This is largely due to studies having encompassed the range of both species when they were considered to be just the Siskiyou Mountains salamander.

3.1 REPRODUCTIVE BIOLOGY

The reproductive biology of the Siskiyou Mountains salamander and Scott Bar salamander are presumed to be similar. The Siskiyou Mountains salamander is sexually mature at a SVL of about 55 mm (2.2 in.) and an age of 5 to 6 years. Individuals can live as many as 15 years (Olson et al. 2004). Mating occurs in autumn or spring, and females breed every other year. Females must acquire sufficient body mass and develop large fat reserves in order to produce fully developed eggs. Ollivier et al. (2001) believed that where microhabitat conditions limit the duration of surface activities, a longer period of time could be needed to acquire reproductive status. Nests of these species have not been found, but indirect evidence indicates that females lay their eggs in the spring and brood them in underground nests deep within talus throughout the summer. The number of mature eggs in gravid females varies from 2 to 18 with an average of 9, but the number does not correlate with body size. Eggs probably hatch in fall, but hatchlings do not emerge on the surface until the following spring (Olson et al. 2004).

3.2 ACTIVITY PATTERNS AND MOVEMENTS

Terrestrial plethodontid salamanders have long periods of surface inactivity interspersed with brief periods of activity when temperature and humidity conditions are suitable (Feder 1983). For example, the Siskiyou Mountains salamander is most likely to be active on the surface during the spring rainy season (March to early June), but can be found on the surface any time microclimatic conditions are suitable (Clayton et al. 1999; Ollivier et al. 2001).

[3] Photographs of the Siskiyou Mountains salamander and Scott Bar salamander can be found at http://www.CaliforniaHerps.com.

TABLE 1 Comparison of Select Morphological Features for Adult Siskiyou Mountains Salamanders and Scott Bar Salamanders[a]

	Males		Females	
Variable	Siskiyou Mountains Salamander	Scott Bar Salamander	Siskiyou Mountains Salamander	Scott Bar Salamander
Sample size	6	7	13	8
Snout-vent length	62.9 (53.5-67.9)	60.7 (48.4-71.3)	58.2 (48.6-72.3)	67.2 (54.9-72.0)
Tail length	54.0 (46.3-59.3)	50.6 (34.9-58.9)	52.9 (37.0-48.0)	57.8 (48.8-51.5)
Head width	14.5 (12.4-15.3)	14.4 (11.7-17.4)	13.7 (11.3-15.8)	15.3 (11.4-17.9)
Internarial distance	2.6 (1.9-2.9)	2.9 (2.6-3.5)	2.4 (1.9-2.7)	2.9 (2.7-3.2)
Forelimb length	11.5 (9.7-12.5)	12.5 (10.7-14.3)	10.9 (9.7-13.3)	12.9 (11.6-13.7)
Hindlimb length	13.8 (12.3-14.8)	14.3 (11.7-16.0)	13.1 (11.6-15.1)	15.5 (13.1-16.4)
Costal grooves	17 (17-18)	16 (16-17)	17 (16-18)	17 (16-17)
Intercostal folds	5 (5-6)	3 (2-3)	5 (4-6)	3 (3-5)

[a] All measurements are in mm. Means (with the range of values in parentheses) are presented for most variables. Modes are presented for the number of costal grooves and intercostal folds between adpressed limbs (with ranges in parentheses).

Source: Mead et al. (2005).

In summer, the Siskiyou Mountains salamander is least likely to be active at the surface. However, during wet weather, they may emerge and move about freely on rock surfaces (Palazzo 1994). While mostly found in talus slopes and rock crevices, the Siskiyou Mountains salamander and Scott Bar salamander may occur beneath woody debris or leaf litter during very wet periods (e.g., Farber et al. 2001; Olson et al. 2004). However, terrestrial plethodontids risk dehydration during periods of surface activity and must periodically retreat to moist microhabitats to rehydrate before resuming activity (Feder 1983). Harsh and unfavorable conditions (e.g., hard freezes, inundation, or very dry conditions) may delay the response of the Siskiyou Mountains salamander to subsequent suitable surface conditions for two or three days (Clayton et al. 1999). Survivorship and recruitment can be affected if surface conditions appropriate for feeding and breeding are too short (Ollivier et al. 2001).

The activity periods of the Scott Bar salamander are presumed to be similar to those of the Siskiyou Mountains salamander, and the species may be active at the surface when suitable

microclimatic conditions exist. At higher elevations, the Scott Bar salamander may not be active on the surface during portions of the winter due to freezing nighttime temperatures or winter storm conditions.

The Siskiyou Mountains salamander typically completes its life cycle within an area less than 1.0 ha (2.5 ac) and has not been observed to migrate between subpopulations (Nussbaum 1974). However, because plethodontid salamanders are territorial, juveniles are probably forced to disperse away from natal sites (CDFG 2005).

3.3 FOOD HABITS

Plethodontid salamanders are primarily sit-and-wait predators, but they also actively search for food on damp soil and under objects when microclimatic conditions are favorable (CDFG 2005). Although invertebrate prey of salamanders are abundant on the forest floor, it is thought that such prey items are scarce or unavailable to salamanders underground (deMaynadier and Hunter 1995). Low metabolic rates, relatively large energy stores, and a resistance to starvation may enable individuals to survive extended periods between irregular periods of feeding (CDFG 2005). The Siskiyou Mountains salamander feeds on small invertebrates such as spiders, mites, ants, springtails, pseudoscorpions, and beetles (Nussbaum et al. 1983). It is assumed that the Scott Bar salamander has similar feeding habits.

3.4 RANGE AND DISTRIBUTION

The geographic range of the Siskiyou Mountains salamander and the Scott Bar salamander are contiguous, occur over a relatively small area (about 164,000 ha [405,000 ac]), and have similar environmental conditions (USFWS 2006a). The known range of the Siskiyou Mountains salamander is about five times greater than that of the Scott Bar salamander (USFWS 2006a). The Siskiyou Mountains salamander is currently known from Jackson and Josephine Counties in Oregon and northwestern Siskiyou County in California. Its range encompasses about 136,500 ha (337,037 ac) within the Applegate River drainage of southern Oregon south to the Klamath River watershed of northern California, and is bounded by the Indian Creek drainage to the west and the Horse Creek drainage to the east (USFWS 2006a). The geographic range of the Siskiyou Mountains salamander has been split between a northern (Applegate) and a southern (Grider) group, which approximately coincides with the crest of the Siskiyou Mountains (Oregon Natural Heritage Information Center 2005). The northern group's range includes BLM's Medford District and USFS's Rogue/Siskiyou National Forest north of the Siskiyou Mountains crest (USFS and BLM 2002). The Siskiyou Mountains salamander is known from sites ranging in elevation from 488 m (1,600 ft) to 1,800 m (6,000 ft) (USFWS 2006a).

The range of the Scott Bar salamander is now known to extend beyond the original three localities south of the Klamath River in the Scott River drainage that were used to describe the species (Mead et al. 2005). Its current range is estimated to be between 27,717 ha (68,438 ac) and 32,634 ha (80,640 ac) in Siskiyou County, California. It ranges from just east of the Seiad Valley to Scott Bar Mountain, with its range extending north and south of the Klamath River and

east and west of the Scott River (USFWS 2006a). However, this may still be the most restricted range of any species of western plethodontid salamander (Mead et al. 2005). The roadless north side of Scott Bar Mountain, that is nearly unexplored, may contain more populations of the Scott Bar salamander (Nauman 2005). The Scott Bar salamander is known from sites ranging up to 1,195 m (3,920 ft) in elevation (Farber et al. 2001).

Many of the known sites for the two salamander species are based on single survey efforts. Thus, their known distributions may be conservative (e.g., there may be greater occupancy and/or a larger distribution than currently known) (Olson et al. 2004). About 50% of the Siskiyou Mountains salamander's range and up to 80% of the Scott Bar salamander's range occur within the Klamath National Forest (USFWS 2006a).

The distributions of the Del Norte salamander, Siskiyou Mountains salamander, and Scott Bar salamander all converge within a small area just north and south of the Klamath River in Siskiyou County (Figure 2; Mead 2006). There are no major geographic barriers to dispersal in this area, but the species replace each other over very short distances, and any intergradations appear to be minimal (Mead 2006). The Del Norte salamander and Siskiyou Mountains salamander may be sympatric near Baker Gulch, east of Indian Creek (Mead 2006).

3.5 POPULATIONS AND ABUNDANCE

Individual populations (or subpopulations) of the Siskiyou Mountains salamander can consist of a few individuals to thousands of individuals (Nussbaum 1974; Welsh and Lind 1991). In optimum habitat, Siskiyou Mountains salamander may reach a density of 0.53 salamander/m^2 (0.09 salamander/ft^2) (Nussbaum 1974). Nussbaum (1974) estimated a population of just over 3 million Siskiyou Mountains salamander in Oregon and California, but stated that the actual abundance could be 10 times as high. However, that estimate was based on a range less than half of that known today (CDFG 2005). Population trends have not been evaluated for the Siskiyou Mountains salamander and Scott Bar salamander partly because the species spend so much time underground in steep talus slopes within remote mountainous terrain. The number of salamanders found at individual sites is highly variable with only a small percentage of the population likely to be active and accessible at any one time, even during optimal survey conditions (CDFG 2005).

3.6 HABITAT ASSOCIATIONS AND REQUIREMENTS

The Siskiyou Mountains salamander and Scott Bar salamander occur in areas underlain by metamorphosed marine sediment (chert, marble, slate), metamorphosed sub-marine lava, ultramafic rock (peridotite, serpentine), and granitic rock in areas consisting of very steep mountains and mountain valleys (CDFG 2005). Within the range of the two species, climatic conditions are characterized by warm dry summers and cold moist winters. Average daily air temperatures are about 32°C (90°F) during the summer and near 0°C (32°F) in the winter. Annual precipitation is about 50 to 190 cm (20 to 75 in.). During winter, precipitation is usually in the form of rain below 1,219 m (4,000 ft) and as snow above this elevation (CDFG 2005).

The Siskiyou Mountains salamander and Scott Bar salamander do not have lungs and consequently are limited to microclimates that provide a high relative humidity and relatively low temperatures. Their skin must be moist and permeable for gas exchange (Ollivier et al. 2001). Generally, rocky substrates, downed wood, and leaf litter are three important habitat features used by terrestrial plethodontid salamanders.

Bury et al. (1991) suggested that the occurrence and abundance of most species of woodland salamanders are more likely related to the presence of rocky outcrops or underlying talus than to forest development (stand age) or amounts of coarse woody debris. Talus slopes are unique habitats that represent the gradual accumulation of weathered rock fragments from cliff faces. Talus slopes can vary in terms of rock size, aspect, and the amount and type of vegetation; and, therefore, represent a broad range of thermal and moisture regimes (Herrington 1988). As a consequence, not all talus areas provide suitable habitat for salamanders.

Suitable microhabitats for the Siskiyou Mountains salamander have been described as forested, rocky substrates consisting of any rock type (e.g., chert, slate, shale, and schist) with at least some cobble-size pieces (smallest diameter >6.4 cm [2.5 in.]) on the surface that are large enough to provide cover to individual salamanders (Ollivier et al. 2001). The Siskiyou Mountains salamander has rarely been found far from talus deposits or fissured rock outcrops. However, in the wettest months of the year, it will move into surrounding forest where it occurs under bark, logs, and other debris. Occupied sites tend to have large amounts of rocks and little mineral soil and sand that can fill interstitial spaces thereby reducing salamander access to subterranean refugia (Ollivier et al. 2001). These habitats are common but have a patchy distribution throughout the range of the Siskiyou Mountains salamander (CDFG 2005).

Both the Siskiyou Mountains salamander and Scott Bar salamander have been found in talus habitats and rocky substrates in all forest age classes, on all slope aspects, and in various conditions of disturbance (Diller and Wallace 1994; Farber et al. 2001). Various alignments of mountains and valleys can cast deep shadows into ravines and canyons that supply the needed shade conditions for favorable microclimatic conditions regardless of forest age (Olson et al. 2004). Also, microclimatic differences between old-growth forests and managed stands may be less extreme on cooler, north-facing slopes (Dupuis et al. 1995). Although Siskiyou Mountains salamander may be less abundant in clearcuts, the full representation of size classes and the presence of gravid females in clearcuts suggest that Siskiyou Mountains salamander reproduce and persist in such areas (CDFG 2005).

The Siskiyou Mountains salamander inhabits an area of fragmented habitat that contains isolated regions of suitable moist habitat that is separated by inhospitable xeric areas (Pfrender and Titus 2001). It has been estimated that 18% or less of the known range of the Siskiyou Mountains salamander has suitable habitat, and that all suitable habitats are not equally occupied (USFWS 2006a).

It is assumed that the Scott Bar salamander has similar habitat requirements and that the descriptions for the Siskiyou Mountains salamander are applicable to this species as well. This assumption is based partly on studies that were conducted within the range of the Scott Bar salamander before it was considered a species distinct from the Siskiyou Mountains salamander

(e.g., Farber et al. 2001; Ollivier et al. 2001). Among 43 Scott Bar salamanders[4] that were observed, 82% were found under talus, 13% were found under downed woody debris located on top of talus, and 5% were found under forest floor litter (Farber et al. 2001). Canopy cover where Scott Bar salamanders were observed ranged from 20% to 100%. No significant differences between tree or vegetation species were associated with the presence or abundance of Scott Bar salamanders and there was a large variation in size of trees at occupied sites. Results of the survey indicated that the presence of large trees is not a prerequisite for presence or abundance of the Scott Bar salamander in talus rock habitat (Farber et al. 2001). Scott Bar salamanders were found on northwest through northeast aspects 88% of the time. Slope and elevation did not appear to directly influence the presence and absence of the species. They were observed on slopes ranging from 13% to 80% (Farber et al. 2001).

3.7 ECOLOGICAL RELATIONSHIPS

Davic and Welsh (2004) recently reviewed the ecological roles of salamanders. Those roles that apply to the Siskiyou Mountains salamander and Scott Bar salamander include:

- Furnishing an abundant source of energy and nutrients to consumers such as birds, reptiles, mammals, and decomposers;
- Modulating energy pathways and the release of essential minerals by eating invertebrates associated with the decomposition of organic matter;
- Decreasing the abundance of competitively dominant prey, thereby increasing diversity in lower trophic levels; and
- Enhancing forest resilience (or stability) throughout ecological succession by converting and storing large amounts of secondary production in the form of salamander biomass.

By regulating the composition and abundance of soil invertebrates, terrestrial salamanders play a key role in forest nutrient flow and are an excellent source of energy for their predators (Burton and Likens 1975; Pough et al. 1987). Predators of these species are largely unknown but may include snakes and shrews. Potential competitors may include the ensatina (*Ensatina eschscholtzii*) and black salamander (*Aneides flavipunctatus*), which also inhabit similar habitats (Olson et al. 2004). No specific information is available for the Siskiyou Mountains salamander and Scott Bar salamander regarding diseases, parasites, or symbiotic and mutualistic interactions (CDFG 2005; Olson et al. 2004).

[4] Farber et al. (2001) identified the salamander as the Siskiyou Mountains salamander. However, their study was conducted before the Scott Bar salamander was identified as a species distinct from the Siskiyou Mountains salamander. Their survey was located in the area that included the Klamath and Scott River confluence and Mill Creek, which is the core area for the Scott Bar salamander.

4 CONSERVATION

The Klamath National Forest encompasses an area of approximately 716,000 ha (1.77 million ac) and ranges from about 274 to 2,740 m (900 to 9,000 ft) above mean sea level. It supports a diverse mixture of vegetation types ranging from open, relatively dry ponderosa pine (*Pinus ponderosa*) forests in the southern Cascade Range to high-elevation mixed conifers near Russian Peak to grasslands on the eastern side of the Forest (USFS 1995b). Vegetation associations within the Klamath National Forest include westside mixed conifer (43%); Douglas-fir (*Pseudotsuga menziesii*) (20%); nonforest types including chaparral, shrublands, grasslands, and wetlands (16%); eastside mixed conifer (6%); ponderosa pine (6%); westside true fir (*Abies* spp., 5%); eastside true fir (2%); lodgepole pine (*Pinus contorta*, 1%); and hardwoods (1%) (USFS 1995b). Dominant plant communities (using the CalVeg community type classification; USFS 1981) include Pacific Douglas-fir (20%), mixed conifer pine (13%), white fir (*Abies concolor*, 9%), red fir (*Abies magnifica*, 6%), and upper montane mixed chaparral (5%) (LaGory et al. 2003).

Klamath National Forest lands are classified as (1) administratively withdrawn, (2) Congressionally withdrawn (Wilderness Areas and National Grasslands), (3) late-successional reserves, (4) riparian reserves, (5) adaptive management areas, and (6) matrix (USFS 1995a). Administratively withdrawn lands are lands where management emphasis precludes scheduled timber harvest. Included in this category are research natural areas, special habitat management areas, experimental forests, backcountry recreation sites, special habitat, wild rivers, winter range, and special interest areas. Within Congressionally designated Wilderness and National Grasslands, no timber harvest is allowed; and all lightning fires are managed as a prescribed natural fire, unless the fire would not meet the land allocation goals and objectives. Late-successional reserves are managed to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for a number of species including the northern spotted owl. Riparian reserves are areas along all streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent species receive primary emphasis. Timber harvests are permitted within late-successional reserves and riparian reserves only if they further land management objectives. Adaptive management areas are areas that are set aside and used to develop and test new management approaches that integrate and achieve ecological and economic health, and other social objectives. This land allocation is outside the range of the Siskiyou Mountains salamander and Scott Bar salamander within the Klamath National Forest. Matrix lands are those lands not in the above categories where most timber harvest takes place. These lands provide sustained timber yields. A map of Klamath National Forest showing various land allocations is provided in Figure 3. In this figure, riparian reserves and adaptive management areas are included in the administratively withdrawn category. Table 2 presents the area occupied, objectives, and descriptions for various land allocation categories in the Klamath National Forest.

The Klamath National Forest Plan (USFS 1995a) identifies an ecosystem management approach to forest management that is intended to maintain biodiversity and that is consistent with the Northwest Forest Plan (USFS and BLM 1994). With this approach, reserves are set aside within the Forests, according to the land allocations identified above, where timber harvest and other resource development or land-disturbing activities are prohibited or restricted. Timber-

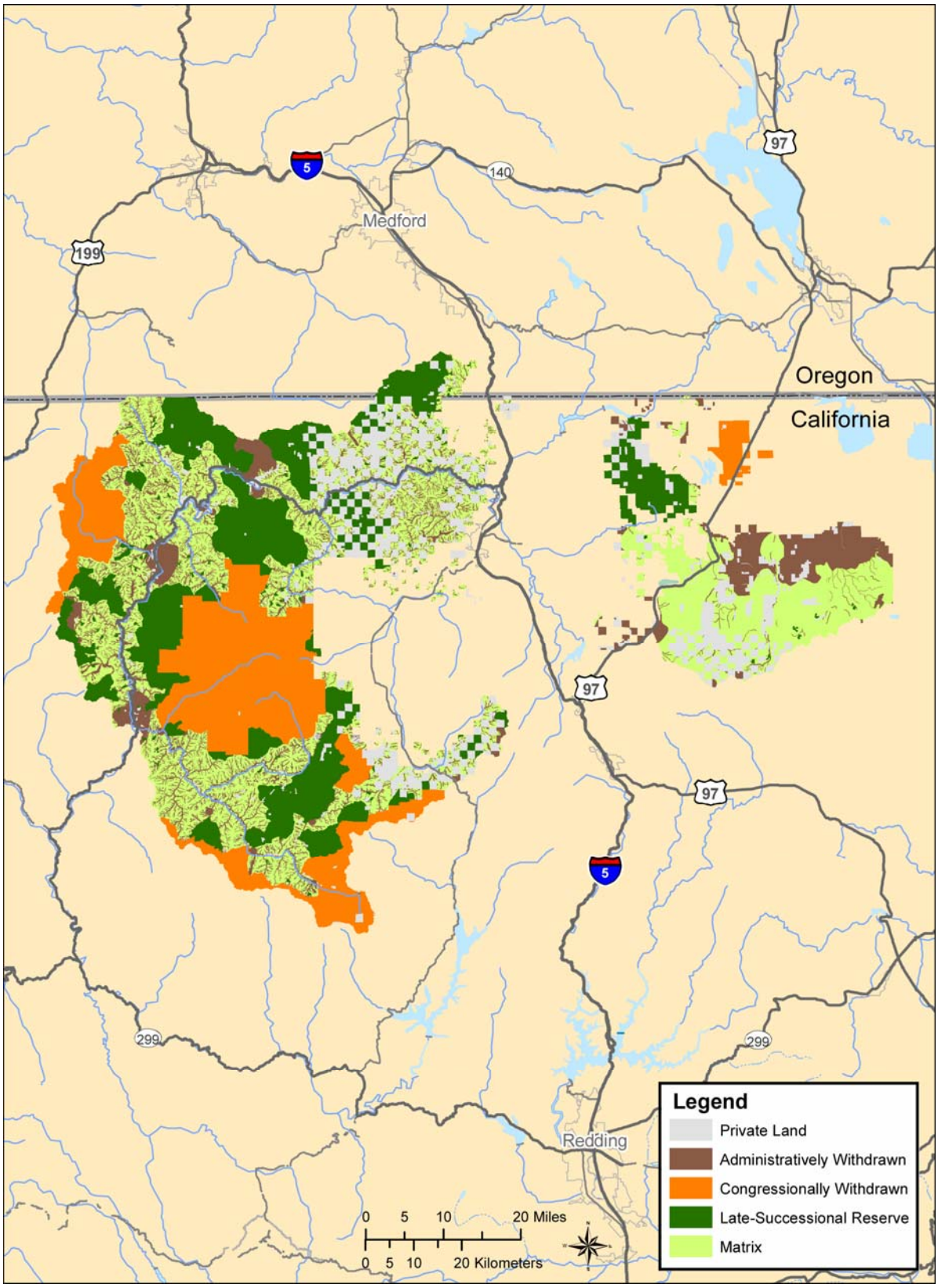

FIGURE 3 Land Allocations in Klamath National Forest

TABLE 2 Areas, Objectives, and Descriptions of Land Allocation Categories in the Klamath National Forest.

Primary Land Allocations	Area (ha)	Percent of Total	Allocation Objective and Description
Administratively withdrawn	125,857	17.6%	Areas withdrawn from timber harvest for a variety of reasons. Includes research natural areas, special interest areas, cultural sites, backcountry recreation sites, special habitat, wild rivers, and winter range.
Congressionally withdrawn	161,875	22.6%	Provide solitude and primitive recreation. Includes Wilderness Areas and National Grasslands. No timber harvest allowed. All lightning fires managed as prescribed natural fires unless the fire does not meet the goals and objectives.
Late-successional reserve	149,734	20.9%	Provide habitat for old-growth forest associated species. Manage vegetation to promote this objective. Timber harvest permitted only if it furthers land management objectives.
Riparian reserve	42,087	5.9%	Provide habitat for riparian-dependent resources. Manage vegetation to promote this objective. Timber harvest permitted only if it furthers land management objectives.
Adaptive management area	65,559	9.1%	Experiment with technical and social approaches to achieving desired ecological, economic, and other social objectives. This land allocation is entirely outside of the range of Siskiyou Mountains salamander and Scott Bar salamander.
Matrix	171,992	24.0%	Provide sustained yield of timber. Includes managed wildlife habitat, scenic rivers, forage, retention visual quality objectives, recreational rivers, partial retention visual quality objectives, and general forest lands.
Total	717,104	100.0%	

Source: Klamath National Forest Geographic Information System (GIS) data.

management practices are designed to mimic natural patterns and levels of stand replacement. A mix of even-aged and selective harvest is intended to provide the variety and distribution of habitats that are typical of natural systems (USFS 1995a).

4.1 THREATS

The following discusses the major potential threats to the Siskiyou Mountains salamander and Scott Bar salamander. These include: (1) timber harvests and management; (2) prescribed and wildland fires; and (3) other threats (e.g., recreational development, mining, and road development).

4.1.1 Timber Harvests and Management

Timber harvest operations may impact salamanders directly when they are active at the surface by killing them or indirectly by reducing habitat suitability. The long-term fate of amphibians after clear-cutting (mortality, dispersal off-site, and/or persistence onsite in subterranean habitats) is uncertain (deMaynadier and Hunter 1995), but species are expected to respond differently according to their particular habitat requirements.

Messere and Ducey (1998) found no difference in abundance of the northern redback salamander (*P. cinereus*) between forests and forest gaps resulting from harvest after one year in a mixed deciduous forest in New York. However, the authors indicated that this may have been due to the salamanders not having been able to move away from the gap or that the micro-environmental conditions of the gap were not immediately inhospitable to the species (e.g., soil moisture and leaf litter thickness were still adequate). It was concluded that the northern redback salamander would require a lengthy period to recolonize a clear-cut forested area in New York (e.g., up to 65 years) due to the length of time required to rebuild the organic matter in the forest floor (Pough et al.1987). Similar conclusions were reached for other this and other salamanders in the Appalachians (i.e., 50 to 70 years) (Petranka et al. 1993). Disappearance and return of terrestrial salamanders to clear-cuts in the southern Blue Ridge Mountains, North Carolina, were tied to the standing crop and moisture content of leaf litter. A return to pre-harvest salamander numbers was estimated at 20 to 24 years (Ash 1997).

In the Six Rivers National Forest in northwestern California, amphibian abundance was found to be nearly twice as high in forests and at forest edges than in clear-cuts. Clear-cutting appeared to have affected amphibian numbers up to 25 years post-harvest (Karraker and Welsh 2006). Nevertheless, detections of ensatina and Del Norte salamanders of all ages within clear-cuts, coupled with their short movement distances, indicate that reproduction, foraging, and aestivation by these species were occurring (Karraker and Welsh 2006). As breeding of western red-backed salamanders and ensatina salamanders still occurs in clear-cuts, these species may recover to pre-harvest abundance before the next harvest cycle (e.g., 50 to 55 years). Light thinning may cause a short-term decline in the abundance of some salamander species; populations of salamanders would probably start to increase as understory vegetation becomes established and starts to grow. However, the presence of all size classes and gravid females of western red-backed salamanders in clear-cuts implies that these areas can support reproducing populations, even though overall abundance of salamanders is reduced (Grialou et al. 2000). Diller and Wallace (1994) found that the occurrence of the Del Norte salamander showed no relationship to forest age or canopy cover in north coastal California. No studies have been found that reported that various silvicultural treatments would completely eliminate salamanders from occupied sites.

In their petition for listing, the CBD et al. (2004) suggested that Siskiyou Mountains salamander and Scott Bar salamander are eliminated by overstory removal, but may return as habitat recovers if there is adjacent habitat that can provide a source for recolonizing salamanders. However, as the Siskiyou Mountains salamander and Scott Bar salamander are not dependent on fallen woody debris, they would not be as affected by tree removal operations as would be other plethodontids such as ensatina, clouded salamanders, and Oregon slender

salamanders that are associated with wood debris. Farber et al. (2001) found that the Scott Bar salamander persisted after intensive forest management. Gravid Siskiyou Mountains salamanders have been collected from recently created clear-cuts and open canopy forests (CDFG 2005).

About 24% of the land within the Klamath National Forest is designated as matrix lands with programmed timber harvests (Table 2). The remainder of the land within the Forest is in land designations that are not managed for timber production. Nauman and Olson (2004a) found higher detection rates of Siskiyou Mountains salamander on matrix lands (41%) compared to reserve lands (16%). However, most known sites for both species are concentrated in areas that were expected to yield large numbers of salamanders; that occurred near roads; or were in areas where land management activities have been proposed, therefore, requiring status reviews prior to land disturbance activities (Ollivier et al. 2001; Nauman and Olson 2004b). The Scott Bar salamander occurs in an area where 18% of the surveyed sites are on lands that are privately held and logging is subject to the California Forest Practice Act.

Generally, both total area cut and the proportion that is clear-cut have decreased in the Forests of Region 5 (which includes the Klamath National Forest) and Region 6 (which includes the Rogue River and Siskiyou National Forests) between fiscal years 1984 and 2000, while commercial thinning has increased (USFS 2001). Figure 4 shows timber harvest activities on the Klamath National Forest from 1995 through 2002. Within the Klamath National Forest, 15.9 million board ft/yr of timber were removed between 2000 and 2005. This can be compared to 187.8 million board ft/yr from 1985 to 1990 and 238.2 million board ft/yr from 1979 to 1984 (USFWS 2006a). This decline in timber harvest reduces the likelihood that a high proportion of the species' populations would be impacted by logging (USFWS 2006a). The USFWS (2006a) has concluded that threats from timber harvest have declined dramatically in the past 30 years and do not pose a threat to the two salamander species. Both species have been found to exist in areas that have been clear-cut or that have naturally open habitats (USFWS 2006a).

4.1.2 Prescribed and Wildland Fires

Fires can affect amphibian populations directly (e.g., killing individuals) or indirectly (e.g., habitat alteration), and the effects will vary depending on time of year the fire occurs and on the time since the last burning (Pilliod et al. 2003). High-intensity wildfires (that can remove or significantly reduce forest cover; consume moss, duff, and forest litter; and sterilize surface soil layers) have not been evaluated for their impacts on the Siskiyou Mountains salamander and Scott Bar salamander, but the impacts of such fires may be greater than those of clear-cutting (USFWS 2006a). Generally, a wildfire is less severe, covers a smaller area, and is more easily suppressed in areas where prescribed burning has been conducted (Weatherspoon and Skinner 1995). Preliminary evidence has not demonstrated that wildfires have had a negative effect on terrestrial amphibians (Bury 2004). Prescribed fires and thinning to reduce fuel loads could remove large amounts of coarse woody material, which could reduce cover for some amphibian species (Bury 2004). However, because both the Siskiyou Mountains salamander and Scott Bar salamander use talus for cover rather than coarse woody debris, they are less likely to be affected by this loss.

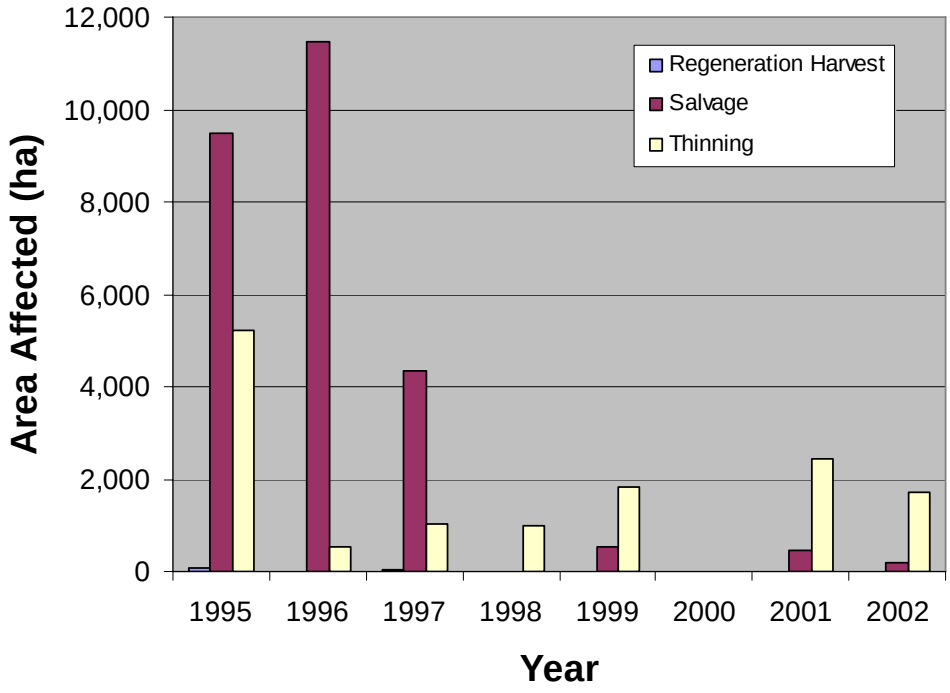

FIGURE 4 Timber Harvest Activities on the Klamath National Forest from 1995 through 2002 (Source: Klamath National Forest GIS data)

Most wildfires occur in summer when conditions are driest and most terrestrial amphibians are underground, whereas prescribed burns are often conducted in spring and late fall when conditions are moist and terrestrial amphibians are more likely to be active on the surface (Bury et al. 2002; Pilliod et al. 2003; Major 2005). However, direct mortality of amphibians due to fire is thought to rarely occur and to be of relatively minor importance to most populations (Pilliod et al. 2003). Smith (2000) speculated that the potential effects of fire on amphibians would be most severe on those species that have limited mobility, restricted home ranges, and specialized habitats. Del Norte salamanders have been found in areas that have burned under moderate to high severity, at one, two, and more than 10 years following the wildfire event (CDFG 2005).

Fire can influence forest structure, species composition, soil properties, wildlife habitat, landscape patterns, watershed hydrology, nutrient cycling, and many other ecosystem processes (Frost and Sweeney 2000). Few forested regions have experienced fires as frequently and with such high variability in severity as the Klamath Mountains (Taylor and Skinner 1998). Prescribed burning and wildfire can have significant effects on ecosystems including shifting species composition towards fire-adapted species, reducing the encroachment of woody or nonnative vegetation in grasslands, changing the age structure or seral state, reducing understory species and the density of overstory species, creating openings, and fragmenting habitats. Depending on their intensity, frequency, seasonal timing, and areal extent across the landscape, prescribed burns and wildfires can either restore and maintain ecosystems in a more natural state

or produce conditions that are atypical of the natural ecosystem. When appropriately used, prescribed fire and wildfire management are important tools for maintaining biodiversity in the National Forests.

There is very little forest area in northern California that has not been affected by fire suppression. Generally, fire suppression has resulted in a smaller size of forest openings and a greater distance between openings, resulting in a less diverse landscape mosaic (Skinner 1995). Where fire suppression has been practiced, forests may be more susceptible to outbreaks of budworms, tussock moths, and bark beetles, in addition to the strong potential for high-intensity crown fires (Rapp 2005). In addition to increasing the density of trees, fire suppression has favored species that are less fire resistant such as grand fir (*Albies grandis*), Douglas-fir, and subalpine fir (*A. lasiocarpa*). As a result, wildfires now typically burn hotter, faster, and higher than those of the past (USDA and USDI 2000). Wildfires and insect disturbances can spread quickly and easily through the dry forest because of the profusion of small to mid-sized, fire-intolerant trees in dense, multistoried arrangements (Rapp 2005).

In 2001, a National Fire Plan was approved by Congress to reduce fire risk and to restore healthy, fire-adapted ecosystems on federal lands through proactive fuel reduction (USDA and USDI 2001). The Klamath National Forest Fire Management Plan (USFS 2004) recognizes both fire use and fire protection as integral components of natural resource management, and includes a full range of fire management options consistent with its Land and Resource Management Plan (USFS 1995a). However, uncertainty exists regarding the effects of fuel-reduction practices (e.g., prescribed fires and mechanical fuel reduction) on biota (Pilliod et al. 2003). Prescribed burning can be used to reintroduce an important ecosystem process into forests, but has the disadvantage of smoke production; risk of fire escaping prescribed boundaries; and difficulty of implementation because of constraints from weather, access, and availability of field crews (Stephens and Moghaddas 2005). The advantages of using mechanical means to reduce fuels are increased precision, no smoke production, low risk of treatments leaving prescribed boundaries, and the ability to produce forest commodities. However, mechanical fuel reduction can produce negative ecosystem effects such as soil disturbance and compaction, disruption of nutrient cycling, damage to residual trees, and the enhancement of root pathogens (Stephens and Moghaddas 2005).

The general approach for addressing fuels management at known Siskiyou Mountains salamander sites within USFS Region 6 involves a hierarchical approach involving maintenance of canopy, limited ground disturbance, and seasonal restrictions. This approach allows management flexibility while maintaining a low risk to the species by retaining suitable microclimatic and substrate conditions and by reducing direct impacts to animals (USFS and BLM 2003). The amount of area within the Klamath National Forest that was subjected to fuels treatment from 1996 through 2002 is shown in Figure 5. Fuels treatment has included prescribed burning, chipping small trees and shrubs, and burning of piles of woody materials. The area of fuel treatments increased from 1996 to 1999, but decreased thereafter.

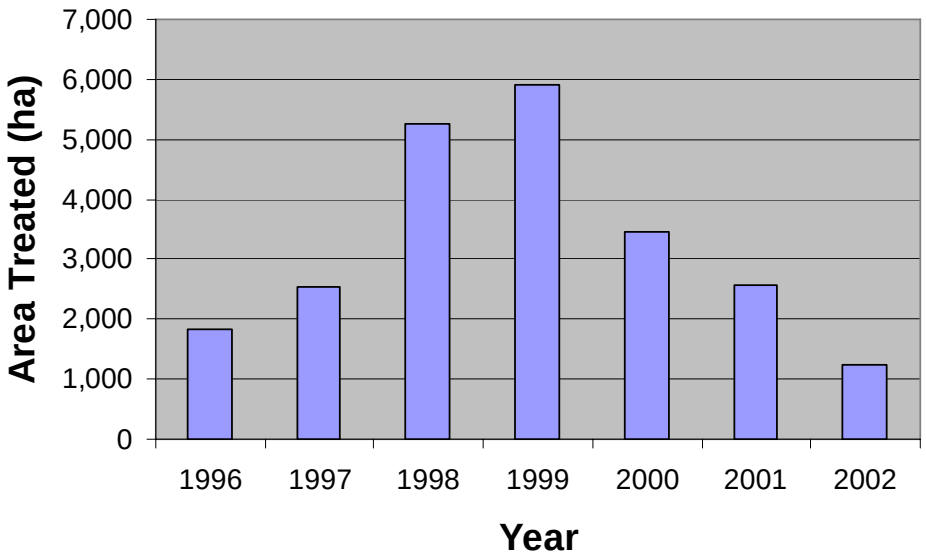

FIGURE 5 Fuels Treatment Area on Klamath National Forest from 1996 through 2002 (Source: Klamath National Forest GIS data)

The historic and continuing variability of fires in terms of frequency, severity, and spatial pattern is likely a critical aspect of long-term ecosystem dynamics and function that accounts for the vegetation mosaics that exist across the Klamath Mountains landscape, and an important factor contributing to the high biodiversity of the region (Frost and Sweeney 2000). As the Siskiyou Mountains salamander and Scott Bar salamander have existed for at least 3 to 4 million years, it is assumed that fires pose little risk to the species' viability (CDFG 2005). Native wildlife species at best are adapted to, and at worst persisted through, the fires and dynamics typical of the historical landscape. Therefore, the restoration of mixed-severity fire regimes in dry forests would likely benefit most native wildlife species (Rapp 2005).

4.1.3 Other Threats

Road construction, recreational development, and mineral extraction can affect Forest ecosystems by causing a loss or fragmentation of habitats, increasing human access and disturbance, and increasing rates of erosion and sedimentation. For example, the filling of the Applegate Reservoir in the mid-1970s flooded a small portion of the Siskiyou Mountains salamander's range within Oregon (Oregon Natural Heritage Information Center 2005). Also, construction of boat ramps around Applegate Reservoir has affected the Siskiyou Mountains salamander habitat (Olson et al. 2004). Sites near roads or recreation areas receive more human use, which can cause adverse effects on salamanders (Olson et al. 2004). The intensity of the effect would be a function of the location and nature of the area affected, the areal and temporal extent (duration) of the disturbance, the timing of the activity or development, and mitigation (e.g., erosion control, reclamation activities) associated with development.

The Siskiyou Mountains salamander and Scott Bar salamander do not dig burrows, but rather use the burrows of other animals (e.g., small mammals), root channels, interstices, and rock fissures to move between the surface and moister depths of the soil and talus. Compaction of soil and rock talus by heavy equipment can adversely affect these channels. This can lead to fewer hunting and hiding places and reduce foraging and reproduction access (Welsh and Droege 2001). Thus, limiting ground disturbance is important for maintaining access to subterranean refugia (Ollivier et al. 2001).

Talus removal (e.g., for road building materials) can result in the downward movement of both the surface and deeper layers of talus towards the slope base. The immediate effect would be to kill or injure amphibians inhabiting the slopes; the long-term consequence would be an increase in erosion. The latter can increase the amount of soil present in the talus that could eliminate access to or fill in microhabitats (Herrington 1988).

Roads and firebreaks can act as a barrier to migration or dispersal and thus influence population dynamics across a landscape (deMaynadier and Hunter 2000; Pilliod et al. 2003). A high density of roads can act to reduce dispersal and increase the degree of isolation among populations. This can lead to reduced gene flow and reduce long-term persistence of smaller, isolated populations (Marsh et al. 2005). The extent to which this factor can influence the two salamander species is currently unknown (USFWS 2006a) and, therefore, may warrant investigation. However, erosion and sedimentation from forest roads are more likely to cause detrimental effects on amphibians (deMaynadier and Hunter 1995; Welsh and Ollivier 1998).

4.1.4 Summary of Threats

As described above, the Siskiyou Mountains salamander and Scott Bar salamander can be affected by a number of factors including timber harvest and management, prescribed fires and wildfires, and a variety of other human activities. The currently known distribution of the Siskiyou Mountains salamander and Scott Bar salamander, the presence of all age classes, and the range-wide history of activities such as logging, fires, road building, and mining suggest that the species can persist in the face of local disturbances (Diller and Wallace 1994; Farber et al. 2001). A primary issue of interest is whether fuels management and current timber management practices impact the species (Olson et al. 2004). While analysis of disturbance over the range of Siskiyou Mountains salamander in California shows that at least 37% of the landscape has been disturbed by fire or timber harvesting, the species continues to be found in these areas and is reproducing (CDFG 2005). Metapopulation theory predicts that the characteristic of Siskiyou Mountains salamanders to occur in disjunct populations is likely to maintain its persistence within the larger landscape (CDFG 2005; Wiens 1996). Therefore, disturbances that may kill individual animals or impact local suitability (e.g., road building, fire, or timber harvest) would not ordinarily affect all disjunct populations (CDFG 2005). Disturbances from fires and various land management activities would likely be staggered spatially and temporally; therefore, risk to several populations would not occur at the same time (Olson et al. 2004). The current risk of extinction for the Siskiyou Mountains salamander is considered negligible, even when various resource management activities are considered (CDFG 2005). Additionally, consideration of

impacts to the Siskiyou Mountains salamander and Scott Bar salamander will be required for all timber harvest and fuel reduction projects within the Klamath National Forest.

The USFWS determines a species to be endangered or threatened due to one or more of the five factors described in Section 4(a)(1) of the ESA:

- Present or threatened destruction, modification, or curtailment of the species' habitat or range;
- Overutilization for commercial, recreational, scientific, or educational purposes;
- Disease or predation;
- Inadequacy of existing regulatory mechanisms; and
- Other natural and man-made factors affecting the species' continued existence.

In assessing these factors relative to the Siskiyou Mountains salamander and Scott Bar salamander, the USFWS did not substantiate the claims in the petition by CBD et al. (2004) that these species should receive emergency listing as threatened or endangered because:

- Both species occur to some extent in clear-cuts and naturally open habitats;
- The demography of populations subjected to timber harvest is poorly known;
- The rate and extent of timber harvest have declined dramatically on federal lands;
- Habitat losses have not been quantified nor demonstrated to have impacted the species;
- The survey and manage program of the Northwest Forest Plan was reinstated in January 2006 by court order;
- The Klamath National Forest has formally extended survey and manage protections to the newly described Scott Bar salamander;
- The Siskiyou Mountains salamander is currently protected as a threatened species under the California ESA, and is afforded protection on private timberlands;
- The USFWS does not have appropriate information to evaluate the risk of global warming or stochastic events; and
- A considerable amount of Scott Bar salamander habitat has yet to be surveyed, suggesting that the population may be larger than currently described (USFWS 2006b).

4.2 CONSERVATION STATUS OF THE SPECIES IN THE KLAMATH NATIONAL FOREST

The USFWS recently evaluated the conservation status of the Siskiyou Mountains salamander and Scott Bar salamander in response to a petition for emergency listing and subsequent lawsuits filed by several environmental organizations (CBD et al. 2004). In their 90-day finding, the USFWS concluded that neither the Siskiyou Mountains salamander nor Scott Bar salamander warrant additional protection under the ESA (USFWS 2006a). They determined that the rate and magnitude of timber harvest on the majority of the species' ranges are not

sufficient to cause them to be threatened or endangered in the foreseeable future (USFWS 2006a). Additional protection of these species is provided by the listing of the Siskiyou Mountains salamander as threatened in California, and both species being managed under the reinstated survey and manage provisions of the Northwest Forest Plan (Section 1.3).

Consideration of the threats to the Siskiyou Mountains salamander and Scott Bar salamander, together with important aspects of their population ecology and conservation biology, can be used to arrive at an understanding of the conservation status of the species. The preceding discussions on the ecology and threats to the species suggest that the following conclusions apply to their conservation status:

- The distribution (geographic range) and abundance of the species are not declining in all or part of their ranges in Region 5.
- Most habitats can support the species as long as talus and appropriate microclimatic conditions are present.
- Life history, ecology, and distribution of the species do not suggest that the populations are particularly vulnerable to habitat change or other changes in the environment.
- Habitats used by the species are not declining in Region 5.
- There is no strong evidence that populations in Region 5 or particular portions of the Region are at risk as a consequence of land management.

As discussed in Section 3.4, about 50% of the Siskiyou Mountains salamander's range and 80% of the Scott Bar salamander's range occur within the Klamath National Forest (USFWS 2006a). While the known ranges of the two species occur over a relatively small area, they are larger than those known when the species were first described. However, the Scott Bar salamander may still have the most restricted range of any species of western plethodontid salamander (Mead et al. 2005). Many of the known sites for the two salamander species are based on single survey efforts. Thus, their known distributions may be conservative (e.g., there may be greater occupancy and/or distribution than identified in surveys) (Olson et al. 2004).

Individual populations (or subpopulations) of the Siskiyou Mountains salamander consist of a few individuals to thousands of individuals (Nussbaum 1974; Welsh and Lind 1991). Nussbaum (1974) estimated a population of just over 3 million Siskiyou Mountains salamander in Oregon and California. This estimate was based on a range less than half of that known today (CDFG 2005). However, population trends have not been evaluated for the Siskiyou Mountains salamander and Scott Bar salamander, partly because the species spend so much time underground in steep talus slopes within remote mountainous terrain.

Salamanders are inherently difficult to sample because their surface activity varies with topography, season, humidity, climate, and other landscape variables, which further vary from species to species (Hyde and Simons 2001). Also, various physical, climatic, and biological conditions can make field monitoring difficult and dangerous (Nauman 2005). In any survey there is a chance that the salamander will not be detected, even when they are present in the survey area. This can occur when microclimatic conditions force the salamander further underground than inspection techniques can detect, the inexperience of the surveyor, inadequate

search period, or searching less carefully in areas that the surveyor believes are suboptimal (CDFG 2005). During opportunistic surveys, the CDFG (2005) documented the Siskiyou Mountains salamander in areas with little or no overstory that had been cleared, burned, or had no disturbance where Ollivier et al. (2001) failed to detect them. The observations by CDFG are at odds with the conclusions of Ollivier et al. (2001) that the Siskiyou Mountains salamander is more consistently found in late seral stages. The CDFG (2005) concluded that the Siskiyou Mountains salamander occupies a wide range of sites, including both disturbed and undisturbed sites with low canopy cover.

The Siskiyou Mountains salamander occupies a wide range of forest types with a varied range of overstory canopy cover and slope aspect. Talus and forested rocky substrate are likely the most important environmental factors affecting Siskiyou Mountains salamander (CDFG 2005). While common, these habitats have a patchy distribution throughout the range of the Siskiyou Mountains salamander. However, species such as the Siskiyou Mountains salamander and Scott Bar salamander that are subdivided into spatially discrete local populations will tend to persist despite the fragmentation of habitats. The persistence of a species that has subpopulations tends to increase with increasing number of subpopulations and the landscape scale over which the species is distributed (CDFG 2005). The occurrence of the Siskiyou Mountains salamander on both sides of the Siskiyou Mountains crest increases the resilience of this species to logging and wildfires (USFWS 2006a). A considerable amount of potentially suitable habitat capable of supporting the Scott Bar salamander has yet to be surveyed. Therefore, the Scott Bar salamander may be less susceptible to stochastic events than believed by some (e.g., CBD et al. 2004).

Within the Klamath National Forest and on adjacent private lands, sites occupied by the Siskiyou Mountains salamander and Scott Bar salamander are located in areas with a variety of management designations, and these designations can be used to evaluate the potential for adverse effect to the species (Figure 6). On the basis of our evaluation of Klamath National Forest GIS data, the percentages of the Siskiyou Mountains salamander range on various land allocation types include 46% late-successional reserve, 11% administratively withdrawn, 0% Congressionally withdrawn, 13% matrix, and 31% privately owned. The first three categories, which comprise areas where timber harvest and other ground-disturbing activities are greatly restricted, constitute a total of 57% of the species' range in California. Risks to the species in these areas are considered very low. Timber harvests that pose an increased risk of adverse impact to salamander populations and their habitat typically occur on Forest land designated as matrix land and on private land. For the Scott Bar salamander's range, approximately 36% is designated late-successional reserve, 12% is administratively withdrawn, 0% is Congressionally withdrawn, 16% is matrix, and 36% is privately owned. The greatest threat to both species may occur on private lands where harvest intensity may be greater. It should be noted that the estimated percentages of the Scott Bar salamander on private lands presented above is higher than the 18% listed by the USFWS (2006).

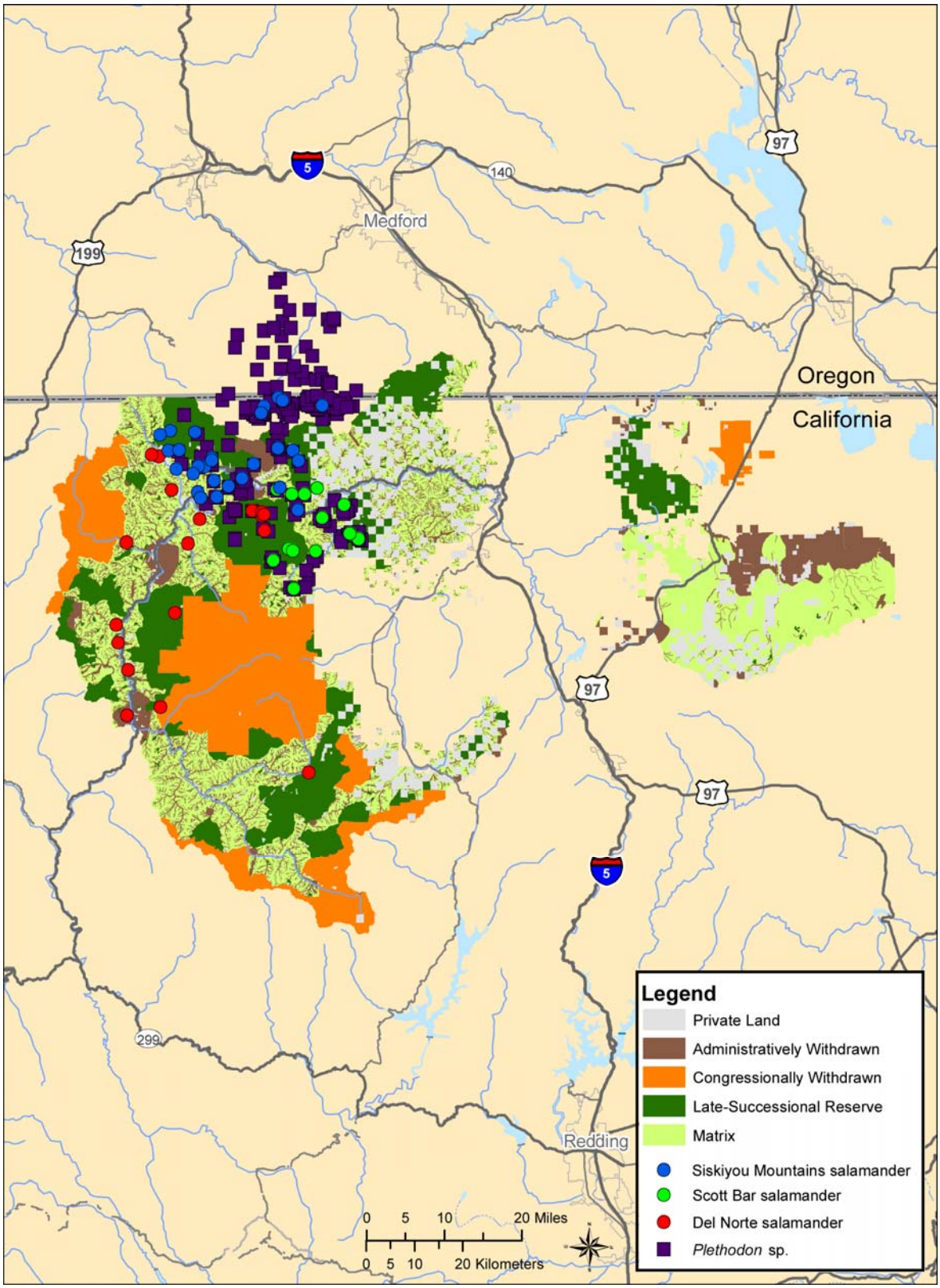

FIGURE 6 Locations of Siskiyou Mountains Salamander, Scott Bar Salamander, and Del Norte Salamander Relative to Land Allocation Types within the Klamath National Forest

4.3 CONSERVATION ELEMENTS

Conservation elements are those strategies recommended in this assessment to conserve the Siskiyou Mountains salamander and Scott Bar salamander in northern California. In this section, the following topics are addressed:

- Recommended conservation actions that identify (1) elements that address conditions that cause the species to be at risk; (2) the range of desired environmental conditions that address threats to the species; and (3) approaches to achieve desired conditions.
- Research, inventory, and monitoring recommendations that focus on practical and efficient approaches that are expected to provide reasonable power to detect important changes in population response to management.
- Adaptive management strategies including methods to determine success of conservation efforts, strategies for adapting to new information gathered during the course of research, inventory, and monitoring efforts and lessons learned elsewhere.

The recent conservation strategy prepared for the Siskiyou Mountains salamander in southern Oregon (Olson et al. 2004) identified a number of objectives to ensure conservation of the species, and these objectives are for the most part applicable to this species and the Scott Bar salamander in northern California. To ensure species persistence and avoid listing as an endangered or threatened species, that conservation strategy assumed the need to maintain the species over their known ranges.

The following objectives, modified from Olson et al. (2004), apply to conservation of the Siskiyou Mountains and Scott Bar salamanders in Region 5:

- Maintain viable populations of both species such that there are sufficient numbers of reproductive individuals distributed across the species ranges to insure their continued existence.
- Provide well-distributed habitat to support viable populations.
- Determine the need for restoration and protective actions in occupied sub-watersheds.
- Prioritize sites for management and protection of these species based on the known location of individuals, suitable habitat, risk factors, federal land allocations, and proximity to other sites.
- Consideration of fire ecology, stand conditions, current management designations, and the distribution of existing federal reserves when designing management recommendations for each high-priority site.

These objectives are intended to provide for a land management strategy that has an inherently low risk of adversely affecting these species. A strategy that meets these objectives would ensure viable populations by (1) maintaining their existing ranges, (2) providing suitable habitat patches within a matrix of habitat types, (3) providing for redundancy of subpopulations, and (4) providing connectivity between occupied patches for gene exchange and re-colonization after disturbance. Although this conservation strategy has been developed for Region 5,

coordination with the strategy and management actions in adjacent Region 6 is considered essential for success.

4.3.1 Recommended Conservation Actions

The habitat requirements of the Siskiyou Mountains salamander and Scott Bar salamander are fairly well understood, but this understanding has evolved as better distribution and habitat information has become available. Specifically, recent observations suggest there may be somewhat less reliance on late successional forest stands than originally thought. The overriding environmental variable that seems to influence distribution of these species is microclimate. A landscape-level habitat-suitability model for the Siskiyou Mountains salamander was developed by Reilly et al. (2004) to support management priorities in the conservation strategy for Region 6. This model used four variables to predict optimal habitats: rocky soil types with adequate interstitial spaces, forest canopy closures greater than 70%, conifer forest with average tree size greater than 43 cm (17 in.) diameter at breast height, and illumination index that serves as an indication of the amount and extent of solar insolation that reaches the ground surface. All of these variables are associated with moist microclimatic conditions. However, the bias toward high forest canopy closure with larger diameter trees may be due to a lack of surveys conducted in open sites. Both salamander species can also occur in areas with no vegetation and on south slopes where vegetation has been removed (Farber et al. 2001; CDFG 2005). For example, the Scott Bar salamander (including gravid females) is routinely found at undisturbed, open dry sites near Horse Creek.

Suzuki and Olson (2004) developed a risk assessment for the Siskiyou Mountains salamander in southern Oregon. This approach used logistic regression to determine the environmental factors affecting the distribution of occupied sites across the range of the species in Oregon and relative risk (based on land allocation type, road density, relative potential for stand replacement fire, and a wildland-urban interface boundary). The approach has the advantage of using data specific to occupied locations within the region of interest rather than using a predetermined conceptual model of suitability from published studies. Gustafson et al. (2001) also developed a GIS-based model to assess the response of terrestrial salamander populations to alternative forest management plans in the Hoosier National Forest in Indiana. Development of such models and performance of a risk assessment for northern California populations are recommended. Data collected in the future (see Section 4.3.2) can be used to refine the habitat and risk models. Until this is done, a number of recommendations are presented below that have been gleaned from the literature.

In general, harvesting forests without directly affecting amphibian populations is probably not possible; however, strategies can be developed to minimize long-term adverse effects. Those that could apply for the Siskiyou Mountains salamander and Scott Bar salamander include: (1) protecting special habitats, such as talus slopes; (2) providing microhabitat; and (3) minimizing compaction (Welsh and Lind 1991). As previously discussed, all age classes of both species have been found to persist in areas that have been subject to a wide range of activities (e.g., logging, fire, road construction, and mining). Therefore, these species can persist in the face of local disturbance. Nevertheless, to minimize adverse impacts, these activities

should be restricted to times when the salamanders are not active near the surface (USFS and BLM 2003). To minimize effects, ground-disturbing activity should be limited from October 1 to May 30. Some activities may be possible during winter when the salamanders have retreated to below-surface refuges. Also, if conditions remain dry in the fall, land-management activities could occur if surveys show that the salamanders are not active at the surface (Olson et al. 2004).

Canopy removal due to timber harvesting would have less impact if it occurred on north-facing aspects where microclimatic fluctuation would be less severe. Also, greater soil moisture on the northern sites would allow relatively quicker regeneration of the understory and shrub layer following timber harvest, further buffering microclimatic changes. Furthermore, the northern sites have greater quantities of deeply layered rock that help ameliorate microclimatic impacts that result from the loss of overstory canopy (Ollivier et al. 2001).

As terrestrial salamanders have evolved adaptations to natural disturbances, they should be able to tolerate harvesting and other timber management practices if they resemble natural disturbances. A conservative approach to maintain viable populations of terrestrial salamanders would be to ensure that a representative array of forest types remain in an unharvested state (deMaynadier and Hunter 1995).

Creation of a greater array of prescribed burn intensity levels, especially retention of some that preserve forest floor fuels, would provide a diverse array of forest floor characteristics amenable to terrestrial salamanders (Major 2005). Stand thinning, prescribed fires, natural fires (e.g., allowing these to burn), and other fuels management practices are increasingly used to reduce ground-layer fuel loads in western forests (Bury 2004). Russell et al. (1999) suggested that prescribed fire would benefit amphibians in fire-maintained ecosystems by restoring historical mosaics of successional stages, habitat structures, and vegetative species composition; and that this would outweigh any fire-induced mortality or decrease in diversity within a particular burned patch in the long term.

Maintaining known Siskiyou Mountains salamander sites would sustain a well-distributed population across the landscape. Preserving many protected areas within a wide range of elevational, geographical, and habitat conditions would allow subpopulations to be maintained throughout the range of the species despite potential large-scale disturbances (Olson et al. 2004). The size of a habitat patch needed to sustain a subpopulation is not known. However, larger habitats may be more resilient to disturbances and could have reduced edge effects. Larger areas may be particularly relevant to consider for isolated areas that may not have the potential for a "rescue effect" from adjacent salamander sites (Olson et al. 2004). Also within the California portion of the Siskiyou Mountains salamander's range, where precipitation is less dependable, those sites with greater amounts of rainfall would be important for maintaining populations (Ollivier et al. 2001).

Management of only withdrawn lands for Siskiyou Mountains salamander persistence could be a risky approach, given the high proportion of detections in matrix lands and the spatial distribution of matrix blocks that support populations (Nauman and Olson 2004a). Therefore, the goal of the conservation planning effort for the Siskiyou Mountains salamander and Scott Bar

salamander should be to maintain well distributed populations across the landscape by designating high priority sites regardless of land allocation status (Nauman and Olson 2004b).

4.3.2 Research, Inventory, and Monitoring

Reliable sampling methods for species and their habitats must be developed before establishing research, inventory, or monitoring programs. Recently, the Yreka, California Office of the USFWS developed a draft sampling protocol for the Siskiyou Mountains salamander and Scott Bar salamander in the Klamath River basin south of the Siskiyou Mountain Crest in northern California (West 2006). The objectives of this draft protocol are to:

- Determine if there are differences in abundance, condition, and population structure of Siskiyou Mountain salamanders and Scott Bar salamanders across a habitat gradient (open managed, naturally open, dense younger stands less than 100 years, and dense mature to old-growth stands).
- Identify the habitat variables that best explain the variation in abundance, condition, and population structure among strata.

The USFWS protocol is based on an existing survey protocol for the Siskiyou Mountains salamander (Clayton et al. 1999). Using the protocol, 30 sites for each species are sampled. A stratified sampling approach is used to sample an equal number of sites among four habitat types: (1) dense mature to old-growth forest, (2) dense younger (<100 years) stands, (3) open managed stands, and (4) naturally open sites (<40% canopy closure). Since both species require talus or rock substrate, all sampling sites must contain >25% rocky substrate. Target sample size is 30 sites for each species. At least one visit per year is made to each site.

Using the USFWS protocol, surveys are conducted only under weather conditions that favor above-ground activity of the salamanders (i.e., temperature 4 to 20°C [39 to 68°F], humidity $\geq$65%, and no temperatures <0°C [32°F] 48 hours prior to survey). Reference sites (historic sites that support a known population) within the same sub-watershed are checked to determine potential salamander activity at the survey site. Data collected for each individual salamander found include SVL, total length, and weight. Each individual is examined for indications of reproduction (gravid females), with tail autotomy and life stage noted. Ambient air temperature, soil temperature, and relative humidity are recorded onsite during each visit at the start and end of sampling. Digital photographs are taken at each site to document site habitat characteristics. Habitat characteristics are measured at each plot during the summer after salamander sampling has ceased.

Under the survey and manage program of the Northwest Forest Plan, surveys for the Siskiyou Mountains salamander (or other Component/Strategy 2 amphibian species) are triggered when: (1) a proposed project occurs within the likely range of the species; (2) habitat for the species is found within or adjacent to a proposed project site; and (3) the project would probably cause a significant negative effect on the species habitat or the persistence of the species at the site (USDA USDI 2001). Reference sites (i.e., known locations for a given species) are surveyed to determine whether animals are surface-active. This knowledge is useful for

decisions regarding survey timing and to reduce the risk of Type II errors (not finding the target species when it is in fact present at a site) (Olson 1999).

As of 2001, about 30% of sites where the Siskiyou Mountains salamander was previously found had not been surveyed since 1994. Therefore, it is not known if all of these sites still support the species. Additional surveys also may be relevant in areas where little knowledge of salamander occupancy exists, but that have the potential to support these species (Olson et al. 2004). Site-level assessments require an examination of fire hazard maps, optimal habitat maps, topography, aspect maps of known sites, distribution of Wildland-Urban Interface lands, land ownership and allocations, and aerial photographs (Olson et al. 2004). This information can be used to prioritize areas for survey based on habitat suitability. Well-maintained databases should be updated yearly showing areas where the species have and have not been detected (Olson et al. 2004).

Field studies using marked animals are recommended to determine if the behavior, movement, and survival of salamanders are consistent with the assumptions of abundance indices (Hyde and Simons 2001). In addition, mark-recapture techniques could be used to more accurately estimate population size. The rocky soils and talus that provide habitat occur in small pockets and patches. Therefore, for conservation planning, it is critical to understand how the animals move between these habitats (Nauman 2005). Caution should be used in interpretation of results for other plethodontid salamanders to the Siskiyou Mountains salamander or Scott Bar salamander because other species may not respond in the same way to management practices and their habitats may not be identical (e.g., in the eastern U.S., summer rains are common and many of the timber harvesting studies have been done in deciduous forests). Site-specific studies of individually marked Siskiyou Mountains salamander and Scott Bar salamanders in northern California could provide the information needed to more fully understand the effects of forest management practices on salamander populations (CDFG 2005).

Further research is needed that investigates the effects of forest canopy removal on the abundance and demographics of the species following logging (USFWS 2006a). Messere and Ducey (1998) believed that additional studies are needed that compare selectively logged forests over time before conclusions can be drawn about the full impact of this forestry technique on salamander distributions. Similar studies are also needed on the effects of fire on the species. Pilliod et al. (2003) suggested that research should be conducted that emphasizes the following topics:

- Population-level studies in fire-adapted forests where large, catastrophic fires have recently occurred or in forests where fuel reduction is being implemented; and
- Development and testing of predictive models for predicting the range of responses that might be expected from short-, mid-, and long-term habitat changes associated with fire suppression, wildland fires, and fuel-reduction practices.

Fire suppression and logging are the major activities that have likely affected natural fire regimes in the Klamath Mountains (Frost and Sweeney 2000). Prescribed burning, prescribed wildland fires, and other fuels management practices are being used to reduce fuels loadings, but little is known about their effects on forest biota (Bury et al. 2002). Timely scientific research is needed that can provide information regarding the effects of fire, fire suppression, and fuel-

reducing activities on federal lands (Pilliod et al. 2003). Future prescribed fire research should use more rigorous experimental designs, including larger sample sizes, pre-fire baseline data, more carefully selected controls, and better replication (Pilliod et al. 2003; Russell et al. 1999).

While microclimatic conditions are considered of great importance in determining the distribution of the Siskiyou Mountains salamander and Scott Bar salamander, there are limited data to demonstrate that this is an important limiting factor in a managed forest landscape. There is also little information on how various management practices affect microclimates or subpopulations of these species (Olson et al. 2004). Data gaps in the knowledge of the species and their habitats needed to refine microhabitat and microclimatic conditions suitable for the species include:

- The microclimatic changes that occur with vegetation management, including edge effects;
- Response of the species to timber harvest activities (density management and regeneration harvest) and natural and prescribed fires;
- Species reproduction, movement, dispersal, and foraging;
- Geographic boundaries of discrete subpopulations and connectivity among subpopulations;
- Effects of multiple hazards or risks across landscapes and subpopulations; and
- The role of the species in community and ecosystem processes (Olson et al. 2004).

4.3.3 Adaptive Management

An adaptive management approach could be used to identify and refine forest management practices and activities that would minimize adverse effects and ensure persistence of the Siskiyou Mountains salamander and Scott Bar salamander within the Klamath National Forest. A focused approach to adaptive management is required in which monitoring and research addresses topics of greatest uncertainty, with management practices refined in response to the findings (Bunnell et al. 1998). Adaptive management will need to focus on the following: (1) determining the features of forest structure necessary to maintain the salamander species and how these features can be maintained in managed forests; and (2) how forest practices should be distributed across large areas to prevent isolation of populations and sustain the species (Bunnell et al. 1998). Adaptive management strategies would be primarily required for timber and fire management, as these are the primary land management activities that can impact terrestrial salamanders. However, artificially created talus areas (e.g., banks of road cuts with riprap and rock piles associated with mining activities), which were found to have a depauperate amphibian fauna compared to natural talus areas, could be constructed in such a manner to benefit amphibian species (Herrington 1988).

The Goosenest Adaptive Management Area is the only designated adaptive management area within the Klamath National Forest. This area is dedicated to the development and testing of new approaches for integrating and achieving both ecological and economic objectives, but it is outside the range of both salamander species. However, the Land and Resource Management

Plan for the Klamath National Forest (USFS 1995) requires the use of an adaptive management approach throughout the Forest. This approach consists of a continuing process of action-based planning, monitoring, research, evaluation, and adjustments to improve the implementation and achievement of Forest Plan goals. The overall goal of the Forest Plan is the integration of a mix of management activities that allow for the use, management, and protection of Forest resources.

This overall framework should be used to address uncertainties regarding the effects of timber management actions in matrix lands on the Siskiyou Mountains salamander and Scott Bar salamander. As new information becomes available, forest management practices would be refined to minimize adverse effects on habitats and populations. An evaluation of forest management activities (particularly timber harvests and prescribed fires) on the salamanders in matrix lands would be closely evaluated and decisions made as to whether to make adjustments or changes in forest management activities. A more complete understanding could be gained through cooperative programs with various federal, state, and local agencies and other stakeholders (e.g., timber companies and private landowners) that would allow the evaluation of larger scale activities that would encompass salamander habitats within private lands that are subject to timber harvests. Similarly, cooperative efforts with Region 6 could afford the opportunity to conduct more detailed or complex research on the effects of varying land management activities the Applegate Adaptive Management Area.

Most of the northern Applegate group of the Siskiyou Mountains salamander occurs in the Applegate Adaptive Management Area. Thus any adaptive management activities should be tried in this large, genetically uniform group rather than in the Klamath National Forest where the more spatially restricted Grider group of the Siskiyou Mountains salamander and the Scott Bar salamander occur. The Applegate Adaptive Management Area is one of ten adaptive management areas established in the Northwest Forest Plan to test alternative landscape-level management approaches to achieve ecological, economic, and social objectives for National Forest lands. Pertinent research and monitoring projects that have been initiated in the Applegate Adaptive Management Area include investigations on the effects of commercial thinning on the Del Norte salamander and impact of timber harvest on microclimate (Regional Ecosystem Office 2002).

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Environmental Science Division
Argonne National Laboratory
9700 South Cass Avenue, Bldg. 900
Argonne, IL 60439-4832

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