Conservation Assessment for the

California Slender Salamander in Oregon

(*Batrachoseps attenuatus*)

Version 1.0

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Interagency Special Status and Sensitive Species Program

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Executive Summary

Species: California slender salamander (*Batrachoseps attenuatus*)

Taxonomic Group: Amphibian

Other Management Status: U.S.D.A. Forest Service, Region 6 – Oregon Sensitive; U.S.D.I. Bureau of Land Management, Oregon – Oregon Sensitive; Oregon Department of Fish and Wildlife State Sensitive – Peripheral; NatureServe ranks this species as Globally widespread, abundant and secure (G5), Oregon State imperiled (S2); Oregon Natural Heritage Information Center - List 2 – taxa that are threatened with extirpation or presumed to be extirpated from the state of Oregon. Management of the species follows Forest Service 2670 Manual policy and BLM 6840 Manual direction.

Range: The species occurs in the Coast Ranges from the southwestern corner of Oregon to northwestern California. In Oregon, it is currently known from near the Rogue River to Highway 199 in Curry County. The Oregon range is about 52,000 ha (~128,400 ac). There are 28 site records total, with 8 on federal lands (Rogue River-Siskiyou National Forest).

Specific Habitat: This is a terrestrial salamander that does not need standing or flowing water for any part of its life cycle. This species can be found in a wide variety of habitats across its range including coniferous forests, oak woodlands, grasslands, chaparral, urban areas, and coastal scrublands. In Oregon, it is typically found in humid coastal evergreen forests, under surface cover including down wood, rocks and litter. In northwestern California, this species was reported to be more abundant in older forests compared to young forests, and abundance decreased with elevation and distance from the coast.

Threats: This species is little studied, so the threats listed here are based on expert opinion and information known about other terrestrial salamanders in the same general area. Land-use activities that affect surface microhabitats and microclimates may impact individuals or populations at occupied sites. In Oregon, forest management effects are the greatest concern. These salamanders are also likely adversely affected by chemicals, such as herbicides, pesticides and fertilizers. Stand replacement fire, disease, global climate change and population fragmentation may be additional concerns.

Management Considerations: Considerations for maintaining local populations include maintaining surface refugia and microclimates at occupied sites. Reducing the impact of forest management is a key consideration; canopy retention, down wood management and reduced substrate disturbance would benefit this species. The timing of activities to outside of the wet season when animals are surface-active is also a consideration for this species' management.

Inventory, Monitoring, and Research Opportunities: Information gaps include delineation of the north-eastern distribution of the species, habitat associations, understanding threats to the species, and distribution of risk factors throughout the species range. Many of these gaps can be answered by using various techniques of inventory, monitoring and research.

TABLE OF CONTENTS

INTRODUCTION

Goal

The primary goal of this conservation assessment is to provide the most up to date information known about this species including life history, habitat, and potential threats, and to describe habitat and site conditions that may be desirable to maintain if management of a particular site or locality for the species is proposed. This species is an endemic vertebrate to Oregon and California, with a known range in Oregon restricted to the southwest portion of the state. In Oregon, it is recognized as a potentially vulnerable species by various Federal agencies and by the State of Oregon because of its restricted range and its potential susceptibility to land management activities that occur within this portion of its range. The goals and management considerations of this assessment are specific to BLM and Forest Service lands in Oregon. The information presented here is compiled to help manage the species in accordance with Forest Service Region 6 Sensitive Species (SS) policy and Oregon/Washington Bureau of Land Management Special Status Species (SSS) policy. Additional information for Region 6 SS and Oregon BLM SSS is available on the Interagency Special Status Species website (www.fs.fed.us/r6/sfspnw/ISSSSP).

For lands administered by the Oregon/Washington Bureau of Land Management (OR/WA BLM), SSS policy (6840 manual and IM OR-91-57) details the need to manage for species conservation.

For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

Scope

While the synthesis of biological and ecological information for the species focuses on information from Oregon, range-wide references also are highly relevant and included. This Conservation Assessment relies on published accounts, reports, locality data from individuals and databases, and expert opinion, each noted as appropriate. Although information compiled here is not restricted to that coming from federal sources, the scope of the management considerations of this assessment are specific to BLM and Forest Service lands in Oregon. The range of the California slender salamander on federal lands in Oregon includes the westernmost part of the Rogue River-Siskiyou National Forest. It also may occur on lands administered by the Coos Bay District of the Bureau of Land Management.

Management Status

It is listed by the: U.S.D.A. Forest Service, Region 6, as Oregon Sensitive; U.S.D.I. Bureau of Land Management, Oregon, as Oregon Sensitive; Oregon Department of Fish and Wildlife State as Sensitive-Peripheral; NatureServe as Globally widespread, abundant and secure (G5), Oregon State imperiled (S2); and Oregon Natural Heritage Information Center - List 2 – taxa that are

threatened with extirpation or presumed to be extirpated from the state of Oregon. In California, it is not a State or Federal species of concern. Management of the species in Oregon follows Forest Service 2670 Manual policy and BLM 6840 Manual direction.

II. CLASSIFICATION AND DESCRIPTION

Systematics

The California slender salamander (*Batrachoseps attenuatus*) is a lungless terrestrial salamander of the family Plethodontidae. Members of the genus *Batrachoseps* are known as the slender salamanders or "worm salamanders." They are found only along the Pacific coast of North America, where 19 species have been described in California, Oregon, and Baja California, Mexico (Jockusch and Wake 2002, Wake and Devitt 2007). Only 2 *Batrachoseps* species occur in Oregon, and these have geographically separated ranges: southwest coast and northwest Cascade Range.

Genetic studies have discovered that the genus *Batrachoseps* is the most diverse group of salamanders in western North America (Jockusch and Wake 2002). Five species groups of *Batrachoseps* salamanders have been delineated (i.e., lineages, Jockusch and Wake 2002), and *B. attenuatus* has been placed alone within its own lineage or species-group (Wake and Devitt 2007, Jockusch et al. 2001, Jockusch and Wake 2002).

Within the *attenuatus* group, four groups were distinguished using mitochondrial DNA sequencing of the cytochrome b gene by Jockusch and Wake (2002): 1) a southern clade ranging from Monterey Bay to Marin Co., California; 2) an eastern clade ranging to the Sierra Nevada foothills in north-central California; 3) a northern clade extending from Sonoma County, California, into Oregon; and 4) a sister lineage discovered from a single locality at Bodega Bay, California (Jockusch and Wake 2002). This study found the northern clade differed by 9.6% from the southern clade, and by 7.6% from the eastern clade. For reference, they suggested that no genetic exchange occurs when mtDNA divergence exceeds 14%. They postulated that the northern and southern clades were geographically separated by the historic location and historically larger size of the Russian River, or a seaway associated with this region. Similarly, the Rogue River in Oregon may have served as a dispersal barrier to the north. Within the northern clade, this study showed populations ranging from Humboldt County, California, to Oregon were very similar, with generally up to only 1.3% divergence.

Species Description

In Oregon, *Batrachoseps* salamanders can be distinguished by their elongate body and short limbs, with only four toes on their hind feet. California slender salamanders have a dark gray, brown or black ground color dorsally, and a dorsal stripe that can be reddish brown, tan, to yellow, and may be faint or absent (Nussbaum et al. 1983, Wake and Kuchta 2005). The ventral surface is gray with fine white stippling. When intact, the tail is longer than the head and body, but the end of the tail can be missing. Adults may reach 55 mm snout-vent length, and 138 mm total length. Maslin (1939) reported average size of female specimens from the San Francisco area was 99 mm total length (n = 74, no tail breaks) and 41.6 mm body length (snout-vent,

behind hind legs; n = 76). These salamanders have 20-21 costal grooves, and 11-13 intercostal folds between adpressed limbs (Wake and Kuchta 2005). Juveniles have relatively longer limbs and shorter tails.

Eggs are laid subsurface, in depressions under cover objects or deep in soil. Eggs are unpigmented, with the ova being ~4 mm diameter and a capsule surrounding each ova that adds ~2 mm to the egg diameter, and are deposited in a continuous gelatinous chain which may break (Maslin 1939, Storer 1925). Clutch sizes up to 25 eggs are reported (Wake and Kuchta 2005) with 13.4 to 18.3 eggs/clutch for coastal sites and 6.8 eggs/clutch for a Sierra Nevada site (Jockusch and Mahoney 1997). Maslin (1939) found an average of 11.8 eggs in the ovaries of 79 specimens examined from the San Francisco area. Communal clutches have been found with up to 74 eggs (Maslin 1939). Hatchlings are 16-17 mm in total length (Nussbaum et al. 1983).

III. BIOLOGY AND ECOLOGY

Life History

This is a terrestrial salamander that does not need standing or flowing water for breeding or any other part of its life cycle (Stebbins 1985). Eggs are oviposited in clutches underground in October and November. Eggs may take about 79 days to hatch, based on laboratory-kept clutches (Wake and Kuchta 2005). There is direct development of eggs into juveniles that resemble miniature adults. Hatching occurs in the spring (Maiorana 1976, Maslin 1939). Females seem to mature in about 3.5 years in forest habitat. This animal can live to at least 8 years in nature, based on skeletochronology studies (Wake and Castanet 1995), and while 10 years also has been estimated (Hendrickson 1954), most animals may live 2-6 years as adults in forests (Maiorana 1976). Longevity has been proposed to be related to unpredictable juvenile survivorship and a high juvenile mortality relative to adult mortality, due to a variable climatic regime (i.e., rainfall, dry season length; Maiorana 1976).

California slender salamanders are most active on the ground surface during moist conditions during the fall through spring (Maiorana 1976), and are less active when temperatures are below about 10°C (Hendrickson 1954).

Movements

Movements of ~1.5-2.0 m have been reported by several studies (Hendrickson 1954, Anderson 1960, Maiorana 1978). However, Anderson (1960) also reported gravid females moving during a fall rain event distances of at least 9 m. Henrickson (1954) thought that greater movement distances would occur when surface cover objects were close together, such that an animal would encounter another refuge within its normal cruising radius of 1-2 m from its “home” cover. This species also has been found 2 m above ground between the bark and trunk of dead oak trees in California (Cunningham 1955). Genetic studies supporting the recognition of numerous *Batrachoseps* species along the Pacific Coast support the low gene flow and hence extreme sedentary nature of members of this genus of salamanders (Jockusch et al. 2001).

Breeding Biology

Courtship is not described. Eggs are oviposited in the fall under surface cover objects or underground (Morey and Basey 2005). Maslin (1939) found one female laying eggs in November in Berkeley, California, and there were 3 other females and 74 eggs discovered at this communal oviposition site. Females may not always stay with eggs. Females can breed every year.

Range, Distribution, and Abundance

The California slender salamander ranges from southwestern Oregon to near Monterey Bay, California. They occur predominantly along the coastal ranges, but the distribution extends eastward to the Sierra Nevada foothills near Chico and Davis, California. There are isolated sites reported in California. It occurs from sea level to 4,600 ft (1,400 m) (Morey and Basey 2005).

In Oregon, this salamander is currently known from the Rogue River to the California border in Curry County (Figure 1). The Oregon range is about 52,000 ha (~128,400 ac). There are 28 unique site records in Oregon, with 8 sites on federal lands (Rogue River-Siskiyou National Forest).

Oregon sites (Figure 1) were compiled from searches of: 1) University of California, Berkeley, Museum of Vertebrate Zoology data; 2) Oregon Natural Heritage Information Center data; 3) data provided by D. Clayton, Rogue River-Siskiyou National Forest; 4) US Forest Service Natural Resource Information System (NRIS) Fauna database; 5) US Bureau of Land Management Geographic Biotic Observation (GeoBOB) database; and 6) Survey and Manage Strategic Survey data. Although 94 total records were found, most of these were duplicate sites and upon inspection were determined to represent 28 unique localities. These 28 unique sites have different levels of spatial resolution and accuracy because the original data ranged from coordinates to general descriptions. Locations in Figure 1 represent the central points of general descriptive locations. California sites are generally considered to be abundant and are not depicted on this map, because site compilation has not been conducted in that state.

Gaps in both distribution and knowledge may be apparent by inspecting the distribution map (Figure 1). Lack of observations on this map likely reflects a lack of surveys. The eastern and northern extents of this species in Oregon are unknown.

Patterns of abundance in Oregon are unknown. In northwestern California, Bury (1983) reported capturing from 18 to 61 California slender salamanders in 0.125-ha plots in old-growth redwood forests (i.e., 144-488 salamanders/ha). In matched sites logged 6-14 years previously, these salamanders ranged from 1 to 9 animals per 0.125 ha plot (8-72 salamanders/ha). In the redwood forests, Cooperrider et al. (2000) reported California slender salamanders as the most common of six upland amphibians they regularly sampled using time-constrained searches. Similarly, Hodgson and Welsh (2007) reported the species to be the most common terrestrial salamander in sites in the Mill Creek watershed, Del Norte County, California. Further south, Anderson (1960) estimated 4,470 salamanders/ha in Contra Costa County and 17,290 salamanders/ha on Red Rock Island in San Francisco Bay. Another estimate of a Contra Costa County population was 2,939-3,459 animals/ha (1,190-1,400/acre) (Hansen and Wake 2005 from Stebbins 1954). Recent

fieldwork by Hansen and Wake (2005) suggest coastal California populations of this species remain high.

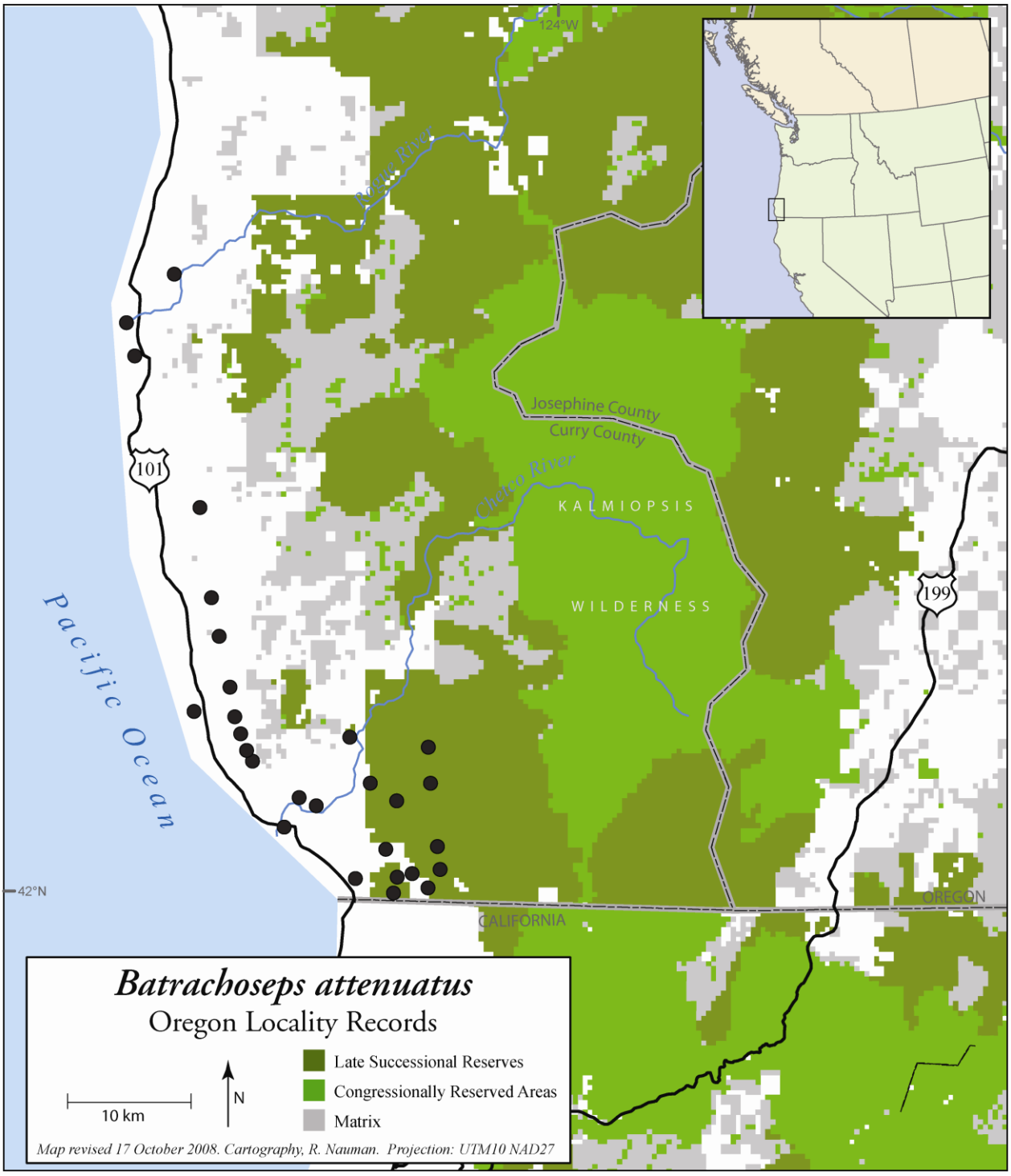

Figure 1. Oregon known sites of *Batrachoseps attenuatus*, the California slender salamander, showing distribution relative to federal land allocations of the Northwest Forest Plan.

Population Trends

Little is known about population trends in this species in Oregon. While several studies have found it to be associated with older forest conditions, it occurs in a variety of habitat conditions (see Habitat, below) and it has not been included in viability assessments associated with timber harvest activities (review in Blaustein et al. 1995). In California, habitat loss is a known threat, with much of the historic range being converted to agriculture or urban developments (Hansen and Wake 2005). However, this species persists in some urban areas, for example along narrow riparian buffer strips of oak woodland habitat (Hansen and Wake 2005).

Habitat

This species can be found in a wide variety of habitats across its entire range including coniferous forests, oak woodlands, grasslands, chaparral, urban areas, and coastal scrublands. They have also been found in riparian corridors in the Central Valley (Wake and Kuchta 2005). In southwestern Oregon and northwestern California, California slender salamanders occur in low-elevation, moist coniferous forests, including coastal redwood and mixed evergreen forests (Bury and Martin 1973, Bury 1983, Welsh and Lind 1988, Nussbaum et al. 1983).

During the wet season, this salamander can be near the surface. Microhabitat includes surface cover such as down wood (in or under logs, under bark or boards), rocks, and litter; during the dry season, they are thought to retreat to subsurface refugia, largely existing cracks, crevices or burrows because they are unable to dig (e.g., Storer 1925, Hendrickson 1954, Maiorana 1976). In their coastal forest study in northwestern California, Welsh and Lind (1991) found 89% of captures were associated with logs, snags and bark and 11% of captures were found with rocks or litter.

While they are in no way restricted to older forests, several studies report associations of California slender salamanders with older forest stands. Welsh and Lind (1991) found them to be significantly less abundant in forest stands <99 years old compared to mature (100-200 years) and old (>200 years) stands. They found elevation and distance from the coast were negatively related to salamander abundances. Cooperrider et al. (2000) found they were more abundant in both old-growth and mature redwood stands compared with young (post-harvest) redwood stands. Bury and Martin (1973) found them in old-growth and second-growth redwood forests, but found only a few in cleared redwood forest areas. Hodgson and Welsh (2007) also found them to be more abundant in old-growth compared to early seral redwood stands. Bury (1983) found these salamanders were 10 times more abundant in old-growth redwood forest than 6-14 year-old clearcuts with abundant surface cover. He suggested that timber harvest effects on microclimate or other attributes of forest habitat conditions (rather than surface cover) likely have adverse effects on this animal. Hendrickson (1954) also thought this species would be particularly vulnerable to changes in microclimate.

Wisely and Golightly (2003) examined site selection relative to microclimate conditions with this species and Ensatina (*Ensatina eschscholtzii*) in Humboldt County, California. They found sites with these two salamander species had higher humidity than sites without salamanders. California slender salamanders were closer to the surface in leaf litter (mean depth 6.6 cm) than

Ensatina (9.1 cm). The authors suggested that a slender body form reduces constraints on the animal from dry conditions. Additionally, a slender body form likely allows these salamanders to use a variety of subsurface cracks, crevices and burrows (e.g., Storer 1925).

Ecological Considerations

The northern limit of the distribution of the California slender salamander in southwestern Oregon has been proposed to be related to climate and interspecific interactions with ecologically similar *Plethodon* salamanders. The species' distribution in Oregon suggests that winter cold weather conditions may be a factor. This is consistent with the animal being more of a warm-adapted species, supported by the heart of its range occurring further south. There are few records in the Coast Range mountains, where colder conditions would be expected at higher elevations, although sampling bias may also result in this distribution pattern, with fewer roads and less access inland. Weather becomes colder as you go north in Oregon which may limit the northern extent of the species. In favor of the role of interspecific interactions in bounding this species' range, such as predation or competition, is the complementary range of the western red-backed salamanders, that have their southern boundary extending to about the Rogue River. The range of Dunn's salamanders extends south through western Oregon to just over the California border, hence overlaps with California slender salamanders in this region, but may contribute to a cumulative effect of interspecific interactions on this animal in Oregon.

Also, there may be synergistic effects of climate and interspecific interactions. Maiorana (1976) suggested that the relatively late egg deposition times of *Batrachoseps attenuatus* (November) and the colder winters at the more northerly latitudes would increase egg developmental time, consequently shortening juvenile growth time before summer dry conditions. Late-hatching and then smaller juveniles would be at a disadvantage for summer survival, and might be out-competed by sympatric larger *Plethodon* (that often hatch in the fall, attaining larger sizes by the following summer). Alternatively for the northward extent of this species, the Rogue River may have been an effective geographic barrier to dispersal in this species which has apparently limited movements on the ground surface and no aquatic phase.

Chemical communication in this species is possible. Gillette (2002) found these salamanders could differentiate between moss from their own enclosure and moss from that of another individual's enclosure, apparently by scent. This suggests there may be intra- or inter-specific interactions mediated by scent marking.

This species may be found in pairs under the same cover object (Nussbaum et al. 1983). It is unknown if this apparent social interaction has a function or biological context.

This species has a high frequency of tail loss (28-48% of salamanders lost tails annually in Berkeley, CA; Maiorana 1977). About half of the tail breaks observed exceeded 30% of the tail (Maiorana 1977). Tail loss may be an antipredator strategy, and high rates of loss may indicate high predation rates. Tail loss has a cost to the salamander because tails are fat deposition sites. For example, tail loss may affect time to maturity and whether or not a female reproduces in a year, with ova being absorbed if tails are too short (Maiorana 1976). Tails are regenerated.

As an additional defense strategy to tail autonomy, animals remain motionless or coil tightly; in some cases, they may rapidly coil and uncoil which may confuse predators. Predators are not well known but include ring-necked snakes (*Diadophis punctatus*, Cunningham 1960), sharp-tailed snakes (*Contia tenuis*), garter snakes (*Thamnophis atratus*), California giant salamanders (*Dicamptodon ensatus*), and scrub jays (*Aphelocoma coerulescens*) (see Hansen and Wake 2005). In captivity, they were eaten by alligator lizards (Cunningham 1956). Also, they may have poisonous secretions rendering them distasteful, and it has been reported that garter snakes, king snakes and a mockingbird died after eating slender salamanders in captivity (see Cunningham 1960). Across the range of the genus, other predators on *Batrachoseps* salamanders may include Jerusalem crickets (*Stenopelmatus*), arboreal salamanders (*Aneides lugubris*), and the white-footed mouse (*Peromyscus*) (Stebbins 1954).

This salamander forages on the surface of the ground (e.g., Stebbins 1951). Their prey are small invertebrates, including mites, flies, springtails, spiders, and snails (e.g., Adams 1968, Bury and Martin 1973, Lynch 1985, Maiorana 1978). Larger individual salamanders appear to eat larger prey (Maiorana 1978)

Biological Considerations

This species appears to have a high tolerance for saline conditions. In 1966, they were found under boards and in seaweed in salt marsh habitat along Monterey Bay, California (R.B. Bury, pers. commun.). In laboratory experiments, coastal populations have survived a 40% salt water solution, whereas inland populations can survive a 30% salt water solution (Licht et al. 1975).

Erythrocytes (red blood cells) of this salamander are 95% non-nucleated, in contrast to other amphibians which have nucleated erythrocytes. This condition may be associated with lungless species (Emmel 1924) with derived, diminutive body features and large cells (Villolobos et al. 1988). It is unclear if this condition has other significance relevant to this assessment.

IV. CONSERVATION

Land Use Allocations

Relationship of the species' distribution to lands managed under the federal Northwest Forest Plan is a key consideration for conservation. Of the 28 known sites in Oregon, 8 (28.6%) occur on federal lands. These 8 federal sites are in the Late-Successional Reserve (LSR) land-use allocation of the Rogue River-Siskiyou National Forest, and receive a high level of protection.

Threats

Threats to this species are not well studied. Suspected threats across the species' entire range include disease and activities that may change habitat, microhabitat, and microclimate conditions. In Oregon, timber harvest activities appear to be the main threat, with past harvest practices altering microhabitats and microclimates by disturbing substrates and removing canopy closure. However, this species has been detected in second growth, so it may be resilient to some harvest practices. Natural disturbances such as fire also may adversely affect this salamander, especially if it were a stand replacement fire such that microhabitats and microclimates were

altered. Due to their apparently small home ranges, this salamander may persist in a fragmented landscape in patches of retained habitats, however that is only conjecture at this time and size of patches needed for persistence is not known. Loss of connectivity among habitat patches would be a concern due to the likely limited mobility of these animals across the landscape and consequent population isolation. Chemical applications and global climate change are additional potential threats.

Disease

The amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) has recently been detected in California slender salamanders in Berkeley, California (Weinstein 2007; S. Weinstein, unpubl. data, Univ. California at Berkeley). During early observations of collected animals, 100% mortality was noted among 18 infected animals, compared to the death of only 1 of 9 uninfected animals. This disease detection is particularly notable because *Bd* is an aquatic fungus and primarily has been found in aquatic amphibians up to this point. The only other instance of *Bd* in a plethodontid salamander to date was reported by Cummer et al. (2005), in *Plethodon neomexicanus* in New Mexico. *Bd* is thought to be the cause of local extirpations of montane frogs in the Washington Cascade Range and the California Sierra Nevada Range. However, some amphibian species are thought to be carriers of *Bd*, and do not show symptoms of the disease; Bd has been detected more broadly in the northwestern US (Olson and Ronnenberg 2008: http://www.parcplace.org/images/BD_Map4.jpg). *Bd* in California slender salamanders warrants additional study, and in particular the prevalence and consequence of *Bd* in wild populations needs to be investigated.

Disease warrants mention here to alert biologists to be aware of and report observations of ill or dead animals. "Abnormal dark patches of skin, excessive shedding, and tail autotomy are frequently signs of infection and are fairly easy to see in the field" (S. Weinstein, pers. commun.). Individuals or tissues collected can be analyzed at regional or national laboratories. *Bd* may be spread from field gear such as boots or nets, wildlife, translocated animals (including fishes), or movement of water (e.g., during fires).

Timber Harvest

Timber harvest is a primary land management practice in forested ecosystems in the geographic region of this species' range in Oregon and could have several effects on the species and its habitat. Harvest of standing green trees reduces the future potential for down wood recruitment on the forest floor, microhabitat for this species. However, there is uncertainty relative to this species regarding the amounts and types of down wood that may be needed for salamander persistence, and these down wood provisions likely differ with site condition.

There is also uncertainty as to the threat that timber harvest on federal lands within the species' range in Oregon may pose for the salamander. While it warrants further study, it bears acknowledgement at this time to recognize that not all timber harvest practices are equal. Some harvest practices, including selective harvest or thinning, and protected areas such as owl cores, species-specific set-asides, and riparian reserves may result in a reduced impact on salamanders and their habitats. Salamanders may persist at sites, or recolonization may be accelerated, with

retention of standing trees that ameliorates microclimate alteration, and offers recruitment of future down wood. Furthermore, green tree retention can reduce ground disturbance. Standing trees may be dispersed (i.e., via thinning) and/or aggregated (i.e., leave islands, patch reserves or riparian reserves). Green tree retention may retain connectivity among suitable habitat patches, either via providing continuous habitat or by providing "stepping stones" of habitat patches through which animals may traverse to larger habitat blocks. In the Late-Successional Reserve (LSR) federal land allocation, harvest practices are designed to accelerate the development of habitat for late-successional and old-growth forest dependent species, hence harvest practices using green-tree retention may predominate. With much of the California slender salamander's range on federal lands in Oregon occurring in LSRs, the threat of adverse effects on this salamander of timber harvest activities on these Oregon federal lands appear to be mitigated. However, the effect on this species of habitat fragmentation across various land ownerships with different timber harvest practices remains a concern across the range in Oregon.

Fire

The effects of fire on these salamanders are unknown. Low intensity fires including prescribed fire for fuels reduction treatments in forested uplands likely have no adverse effect on this species, especially if those treatments occur when the animals are not surface active. Fires in cool, moist times of surface activity, such as in spring or fall, might affect these salamanders. The effects of a more intense level of fire disturbance due to fire exclusion and fuel loading may be a concern in that stand replacement fire represents a more catastrophic disturbance to flora and fauna. In particular, relative to salamander habitat, it removes overstory canopy that serves to moderate surface microclimates from extremes (e.g., high temperatures), reduces standing green trees that may supply future down wood, and consumes current down woody material. However, this species can occur in grasslands or oak woodland habitats that have higher summer extreme temperatures. Given the frequency and intensity of fires in recent years in this species' range in Oregon, the potential positive and negative effects of fire on the animal and its habitat is an identified research need.

Chemical Applications

Chemicals such as herbicides, pesticides, fungicides, fertilizers and fire retardants may have a direct impact on these salamanders. These animals' skin is moist and permeable for gas exchange, and can readily uptake lethal chemical doses. No data exists, however, specific to chemical effects on this species to understand the scope of this potential threat. However, given the location and allocation of federal lands within this species' range in Oregon, the threat of chemical applications to this salamander is likely low. For example, aerial drift of agricultural chemicals is unlikely due to the few agricultural lands in this area, and the federal reserve allocation likely reduces risk of use of many of these applications. The threat of fire retardants and scope of their use on reserved lands is uncertain, however.

Global Climate Change

Oregon represents the northern margin of the range of the California slender salamander, and includes habitats that are particularly vulnerable to predicted patterns of global climate change. In particular, a change in storm patterns that alters precipitation, either annual accumulation or seasonal pattern, could affect this species. Warming trends could increase the elevational or latitudinal extent of the species range and increase occupancy of north-facing slopes. Warming trends could alter fire regimes and vegetation conditions, further restricting habitats. Indirect effects from changes of prey or predator communities are likely, but are difficult to predict. Interactions of warming trends with reduced cover from timber harvest are likely. Amelioration of climate changes may be possible by retaining canopy cover and large down wood, which moderate temperature extremes in their forested habitats.

Fragmentation of Populations

Dispersal may be inherently low in this sedentary salamander, and in the northernmost extent of its distribution in Oregon, dispersal could be further hindered by topography, rivers, climate, or interspecific interactions (competition or predation). Additional disturbances to habitat quality, including all of the potential threat factors cited above, can increase the isolation of populations. The genus *Batrachoseps* appears to have an evolutionary history of population isolation that has resulted in considerable genetic differentiation along the Pacific coast (e.g., Jockusch et al. 2001, Jockusch and Wake 2002). This group of species may be particularly sensitive to isolating factors.

Conservation Status

The California slender salamander is of concern in Oregon due to its extremely limited distribution and potential vulnerability to several threats.

Known Management Approaches

Habitat protections offered by the Late-Successional Reserves of the federal Northwest Forest Plan provide protection for the California slender salamander on federal lands. On federal and non-federal forest lands in Oregon, species or habitat mitigations such as owl cores and riparian reserves would likely provide some benefits to this species, but it is unknown to what extent. It is uncertain how much of the Oregon range coincides with federal lands because the distribution of California slender salamanders in Oregon is poorly known.

In Oregon, the US Forest Service 2670 sensitive species policy, and the BLM 6840 spatial status species policy dictate management of this species. It is a requirement of the 2670 and 6840 policies to assess the effects of proposed activities on this species in National Environmental Policy Act (NEPA) analyses and documentation. The federal Interagency Special Status and Sensitive Species Program helps provide tools to address these policy requirements.

Management Considerations

The conservation goal for California slender salamanders is to contribute to a reasonable likelihood of long-term persistence within the range of the species in Forest Service Region 6 and Oregon BLM, including the maintenance of well-distributed populations, and to avoid a trend toward federal listing under the Endangered Species Act.

Specific Objectives

- Assess and prioritize areas of the species occurrence and geographic range on federal lands relative to species management needs.

- As projects are proposed on federal lands, identify occupied sites to be managed for species persistence (FS) or to not contribute to the need to list under the ESA (BLM and FS).

- At sites that are managed for species persistence, maintain the integrity of microhabitat and microclimate conditions.

Although recommendations can be developed for the entire range of the species, the variety of site conditions, historical and ongoing site-specific impacts, and population-specific issues warrant consideration of each site with regard to the extent of both habitat protection and possible restoration measures. Methods to identify occupied sites for management to meet agency specific policy goals may involve surveys in areas of high conservation concern or locations with limited knowledge of species distribution or abundance patterns. General threats known are listed above, and should be considered during development of site-level and basin-level management approaches.

Specific Considerations

Specific considerations for the California slender salamander take into account knowledge of this species, and knowledge from closely related species that occur in similar habitat types that likely also pertains to California slender salamanders.

The following should be considered as habitats with California slender salamanders are proposed for management, and the Land Management unit determines that salamander persistence is a priority:

- Consider conducting surveys to determine if the species is present. See the Inventory section below for potential protocols to use.

At locations where salamanders have been found:

- Maintain the integrity of substrates for subsurface refugia and retain cool, moist microclimates during timber harvest activities by considering:
  - Thinning or aggregated green tree retention to reduce ground disturbance, retain canopy closure, ameliorate microclimate shifts, and provide standing trees to provide future down wood.

- Maintaining patch set-asides or riparian reserves in salamander-occupied areas (including ephemeral and intermittent streams).
    - Manage to reduce likelihood of stand replacement fires.
    - Restrict chemical applications.
- Assess the short- vs. long-term impact and the spatial scale of the impact of the proposed activity to identify the potential hazards specific to the salamander.
    - The hazards and exposure to salamanders of some activities relative to substrate disturbance, microclimate shifts, and incidental mortality may be minimal. A minimal or short-term risk may be inappropriate at a small, isolated population, whereas it may be possible in part of a large occupied habitat. Restoration activities can be assessed, in addition to other disturbances. Thus, both current and predicted future conditions of the site and its habitat can be considered during risk assessment procedures. If the risk, hazards, or exposure to actions are unknown or cannot be assessed, conservative measures are recommended.
- Disinfect field gear between sites if disease agents become known. Disinfection guidelines to reduce risk of transmission of *Bd* by field gear are under development and at this time include bleaching equipment between uses in different aquatic locations (20% bleach solution, 30 seconds, e.g., 22 ounces of liquid Clorox per gallon water; 7% bleach solution, 10 minutes, e.g., 9 ounces of liquid Clorox per gallon water).
- Seasonally restrict activities to summer conditions. For disturbances proposed at salamander sites, take the seasonal activity patterns of this species into consideration. Disturbance of animals and their habitats during their seasons of surface activity could result in direct mortality of individuals. A seasonal restriction may be implemented during wet conditions to reduce direct mortality of animals. Exact dates of a seasonal restriction can vary, based on local conditions.
- Consider proximity of sites to reserve areas, maintain habitat connectivity to such areas.
- Consider monitoring the effects of land management on this species.
- Consider delineating the spatial extent of the area occupied by this species.

V. INVENTORY, MONITORING, AND RESEARCH OPPORTUNITIES

Data and Information Gaps

Additional data are needed to understand the Oregon distribution of this species, its habitat associations, and effects of various disturbances on the species, including disease. Of primary importance is determining how far east does this species range. Regarding habitat in Oregon, is this species: 1) riparian-associated; 2) talus-associated; 3) associated with aspect (or hill-shading, illumination, or heat index from Geographic Information Service coverages); 4) associated with lower elevations or climate conditions; or 5) associated with certain vegetation conditions or forest stand structure? Once information has been collected on these attributes, can a map of optimal habitat be developed? What is the prevalence and consequence of the amphibian chytrid fungus, *Bd*, on California slender salamanders in Oregon?

There are no studies addressing the effects of land management activities on this species in Oregon. What is the effect of timber harvest on this animal, particularly with varying degrees of green tree and down wood retention? What is the effect of fuels treatments to reduce risk of stand

replacement fires? What is the effect of prescribed fire? Do riparian buffers protect this species (what riparian management options should be considered, how wide should buffers be)?

Lastly, there is little understanding of populations or the species life history and general ecology. What is the spatial extent of a stable population, or rather the range of areas for population persistence? At what abundances are these animals found in Oregon? Would disjunct habitats of about 100-500 m functionally segregate populations? Their ecological role is poorly understood. Are these salamanders a critical cog in the trophic structure of the ecosystem? Are food webs altered by forest management practices?

Inventory

Very little survey effort has been devoted to this species in Oregon, and hence there is a poor understanding of its occurrence. Inventories could help delineate this species' range. While a full geographic inventory is of prime importance, if these surveys were designed carefully, then associations with habitat conditions and land management practices could also be addressed, and *Bd* occurrence could be censused. A habitat map would be a useful asset to federal land managers within the species' range.

Time-constrained searches have been particularly effective for assessing the occurrence of terrestrial salamanders in the region (e.g., Nauman and Olson 2004, 2008; Olson 1999, Rundio and Olson 2007, Corn and Bury 1990). This survey approach is optimal for inventories or other types of sampling that involve a limited number of site visits to a location.

If other sampling techniques are considered for long-term monitoring objectives, they would need pilot testing for the species before full implementation. Pitfall traps may be a useful monitoring tool, however, they have fallen into disfavor with many animal use and care committees due to mortality of both amphibians and small mammals captured. McDade and Maguire (2005) found them to be highly effective for amphibians in the Umpqua National Forest. Artificial cover objects have been successful for salamander monitoring in some areas (Davis 1997), yet in one study in the Umpqua River basin the method did not appear to be effective due to the relatively xeric forest conditions (McDade and Maguire 2005). The effectiveness of artificial cover objects for sampling these salamanders has not been assessed.

An emerging topic in the literature is that detectability of surface-dwelling salamanders by any of these methods is not known, and would be needed to more accurately assess capture probability per method. Mark-recapture methods may be effective approaches for long-term site or population studies (Heyer et al.1994).

Voucher specimens or photographs are needed to validate new site locations. These should be sent to an archive such as the Museum of Vertebrate Zoology, Berkeley, California. Alternatively, confirmation of species identification by known species experts is recommended.

Monitoring

It appears that little to no monitoring of specific sites has occurred for this species in Oregon.

Knowledge of land management activities at sensitive species' sites can enable monitoring and adaptive management relative to species management objectives. If impacts to sites occur, annual accomplishment reporting could be considered, and electronic data entry in GeoBOB/NRIS provides a standard format for documentation. Complete all applicable GeoBOB/NRIS data fields (e.g., site management status, non-standard conservation action; threat type; and threat description). With later monitoring, impacts to habitats or species can be recorded into GeoBOB/NRIS or other local or regional sensitive species databases in order to facilitate site persistence assessments.

Ongoing monitoring of current-populations and the implementation and effectiveness monitoring of currently-imposed protective measures are needed. What are the recognized hazards, exposure to hazards, and risks to animals or habitats at each locality and for each population? How is management addressing each identified scenario of hazards, exposures, and risks per site or population? How can hazards be reduced over the long term in highly sensitive areas? Rather than always focusing on site-specific management, can the results of compiled risk analysis be used to generate long-term area management goals?

Research

The data gaps discussed above each relate to needed research on this animal. In particular, there is little information on how various forest management practices may affect microhabitats or populations of these salamanders. Also, the effects of *Bd* on this species are poorly known.

The use of the federal GeoBOB/NRIS databases will allow several questions of the spatial distribution of this species to be addressed for the development of landscape-level design questions and the further assessment of habitat associations. Field units are encouraged to enter areas surveyed with no detections in these databases; relationships in salamander distributions relative to the spatial distribution of vegetation types, slope, aspect, topography, elevation, riparian areas, land allocation, land ownership, historical disturbances, and current disturbances could begin to be assessed. Development of strategies to address these questions of conservation biology is a critical research need.

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VII. DEFINITIONS

Persistence

The likelihood that a species will continue to exist, or occur, within a geographic area of interest over a defined period of time. Includes the concept that the species is a

functioning member of the ecological community of the area.

Site (Occupied)

The location where an individual or population of the target species (taxonomic entity) was located, observed, or presumed to exist and represents individual detections, reproductive sites or local populations. Specific definitions and dimensions may differ depending on the species in question and may be the area (polygon) described by connecting nearby or functionally contiguous detections in the same geographic location. This term also refers to those located in the future. (USDA, USDI 1994)

Oregon and California Natural Heritage Program Definitions

Globally Imperiled

G4– Not rare and apparently secure, but with cause for long-term concern, usually with more than 100 occurrences.

State Imperiled

S2 –Imperiled because of rarity or because of other factors demonstrably making it very vulnerable to extinction throughout its range.

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