

**Conservation Assessment for the  
Oregon Slender Salamander**

*(Batrachoseps wrighti)*

Version 1.0

March, 2007

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U.S.D.A. Forest Service Region 6 and U.S.D.I. Bureau of Land Management

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**Disclaimer**

*This Conservation Assessment was prepared to compile the published and unpublished information on the Oregon slender salamander (Batrachoseps wrighti). Although the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise and be included. If you have information that will assist in conserving this species or questions concerning this Conservation Assessment, please contact the interagency Conservation Planning Coordinator for Region 6 Forest Service, BLM OR/WA in Portland, Oregon, via the Interagency Special Status and Sensitive Species Program website.*

## Executive Summary

**Species:** Oregon Slender Salamander (*Batrachoseps wrighti*)

**Taxonomic Group:** Amphibian

**Other Management Status:** U.S.D.A. Forest Service, Region 6 - Sensitive; U.S.D.I. Bureau of Land Management, Oregon - Sensitive; Oregon State Sensitive-undetermined status; U.S. Fish and Wildlife Service proposed for listing in 2001; The Oregon Natural Heritage Information Center ranks this species as Globally imperiled (G2G3), Oregon State imperiled (S2S3) and it is List 1 (threatened with extinction or presumed to be extinct throughout their entire range). Management of the species follows Forest Service 2670 Manual policy and BLM 6840 Manual direction.

**Range:** The species is currently known from the north Oregon Cascade Range and foothills, occurring west of the crest from the Columbia River to Highway 58, and occurring east of the crest from the Columbia River to the Warm Springs Indian Reservation. It occurs across a north-south range of close to 233 km (145 miles), from around 25 meters in elevation (at the northern end of its range in the Columbia gorge) to around 1,700 meters at the southern end of its range on the west side of the Cascade Range crest. There are 740 site records, which collapse to 407 sites when locations within 200 m of each other are combined.

**Specific Habitat:** This terrestrial salamander is highly associated with down wood in forests. In the western Cascades, four habitat characteristics have a significant positive association with Oregon slender salamanders: canopy closure, west and east aspects, decayed logs in the 50 to 75 cm (20 to 30 in) diameter class, and snags. While it may be found in all seral stages when down wood is present, studies west of the Cascade Range have shown abundances are higher in late-successional forests. Habitat associations east of the Cascades are not well known; the species uses a variety of ground cover objects ranging from sloughed bark to down logs, and occur in younger and older forests.

**Threats:** Land-use activities that affect substrate, ground cover including down wood, forest condition, or microhabitat and microclimate regimes may impact individuals or populations at occupied sites (site). The primary potential threat to these salamanders and their habitat is short rotation clearcut timber harvest, which removes canopy closure, disturbs substrates, and can alter microhabitat refuges and microclimates. In particular, where there is limited large down wood volume and limited down wood recruitment, negative consequences for this terrestrial salamander are likely. However, there is uncertainty about the effect on these salamanders of partial harvest, or regeneration harvest with green tree and down wood retention.

**Management Considerations:** Considerations for maintaining local populations include maintaining undisturbed cool, moist surface and subsurface refuges. The timing of activities to outside of the season when animals are surface active is also a consideration for this species' management: some habitat disturbing activities that could harm the species at those times when the animals are surface active (i.e., winter/spring) may be relatively benign at other times when the animals are not surface active (e.g., fall prescribed fire). The geographic distribution of both sites and distinct populations (2 discrete populations are recognized within the range of the species) are considerations for determining sites to manage. At stand scales, a mosaic of riparian

reserves, upslope patch reserves and partial harvest areas may contribute to the retention of habitat for this species.

**Inventory, Monitoring, and Research Opportunities:** Information gaps identified by the interagency Oregon slender salamander work group as medium to high priority include:

- distribution of habitat throughout the species range
- delineation of the southern distribution of the species on both the east and west side of the Cascade Range,
- distribution on federal lands in current gaps within the range,;these may reflect lack of surveys,
- distribution of threats throughout the species range,
- the response of the species to alternative silviculture activities such as density management and fuels reduction treatments,
- the effect of fire on this species and habitat associations east of the Cascades,
- how much coarse woody debris should be recruited to retain salamanders at a site,
- distribution of the two discrete genetic populations on federal land allocations.

Many of these gaps can be answered by using various techniques of inventory, monitoring and research. Basic inventory techniques may assist in locating new populations or to monitor known sites over the long term to determine population trends.

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# **I. 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 with a known range restricted to the foothills of the Oregon Cascade Range in northern Oregon. It is recognized as a potentially vulnerable species by various Federal and State agencies because it is potentially susceptible to land management activities that occur within 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: <http://www.fs.fed.us/r6/sfpnw/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**

We synthesize biological and ecological information for the species range-wide, relying on published accounts, reports, locality data from individuals and databases, and expert opinion, each noted as appropriate. Although we did not restrict our information compilation to that coming from federal sources, our site data are largely compiled from federal lands and the scope of the management considerations of this assessment are specific to BLM and Forest Service lands in Oregon. Known sites are located on the Salem and Eugene BLM Districts, and the Mount Hood and Willamette National Forests.

## **Management Status**

State and federal agencies classify the Oregon slender salamander as a potentially vulnerable species due to its restricted distribution and vulnerability to a variety of anthropogenic disturbances. It is listed under U.S.D.A. Forest Service, Region 6 – Sensitive; U.S.D.I. Bureau of Land Management, Oregon - Sensitive; Oregon State Sensitive-undetermined status. The Oregon Natural Heritage Information Center ranks this species as Globally imperiled (G2G3), Oregon State imperiled (S2S3) and it is List 1 (threatened with extinction or presumed to be extinct throughout their entire range). Management of the species follows Forest Service 2670 Manual policy and BLM 6840 Manual direction.

## II. CLASSIFICATION AND DESCRIPTION

### Systematics

First described as *Plethopsis wrighti* (Bishop 1937), the Oregon slender salamander, *Batrachoseps wrighti* (also *B. writorum*), is one of 15 currently recognized species in the genus *Batrachoseps* (Jockusch et al. 1998). It is also one of two currently recognized species in the genus within the state of Oregon; the second species is the California slender salamander (*Batrachoseps attenuatus*). *Batrachoseps* is one of roughly 30 genera in a diverse family of salamanders, the Plethodontidae or lungless salamanders, which contain over half of all living salamander species. The family takes its name from the fact that most of its derived members lack lungs. Externally, the very slender shape and relatively small (often diminutive) limbs of individuals can distinguish *Batrachoseps* from most other plethodontid salamanders; this body morphology is the basis for the common name of the genus: slender salamander.

Wagner (2000) and Miller et al. (2005) demonstrated high levels of genetic divergence within this species. Mitochondrial DNA analysis showed that there is evidence of two major lineages, a northern and southern population, and random amplified polymorphic DNA (RAPD) analysis showed a pattern of isolation by distance. The northern population appears to include sites east of the crest and western sites from the Columbia River south to near Estacada, Oregon, in Multnomah, Clackamas, Hood River, and Wasco Counties. The southern population appears to include sites west of the Cascade crest, north to near Silver Creek Falls, in Marion and Linn Counties. Sampling was not conducted between Silver Creek Falls and Estacada to refine delineation of the boundary (Figure 1). These divergence patterns may be a result of limited gene flow between populations which could be reflective of limited dispersal capabilities, low reproductive rates, habitat requirements, and fragmented habitat. Miller et al. (2005) speculated that the boundary between these lineages may be coincident with the Pliocene-to-Pleistocene location of the Columbia River, which was deflected south during that time period. They suggested that there may have been a relatively recent northward range expansion, or the northern population may have been isolated during that time and diverged. Miller et al. (2005) also state that the genetic pattern may have resulted from a life history where males disperse and females do not.

### Species Description

*Batrachoseps wrighti* is relatively uniform in external morphology (Brame 1964). Dorsal ground color varies from deep brown to black, and rarely is lighter in color (Bishop 1937, Stebbins 1951). Except for an occasional black individual, a brick, chestnut, or reddish brown mottled and uneven-edged stripe extends over most of the back from head to tip of tail (Bishop 1937, Stebbins 1951, Leonard et al. 1993, Corkran and Thoms 1996). The lower sides and undersurfaces of the belly and tail are black with clusters of pale spots that are described as bluish white or silvery in color. Although a number of salamanders possess a fine flecking on lower surfaces, none have spots as large or as prominent as the Oregon slender salamander, which makes this among the best characters to distinguish the species (Stebbins 1985, Leonard et al. 1993, Corkran and Thoms 1996). Adults are known to reach 64 mm (2.5 in) in snout-vent length and 118 mm (4.6 in) in total length, and when unbroken, the tail can be 1.0 to 1.75 times

the body length (Jameson and Storm 1956, Leonard et al. 1993, Nussbaum et al. 1983, Stebbins 1985, Storm 2005). They have long bodies with 16-17 costal grooves, short legs (4.5-7.5 intercostal folds between adpressed limbs) and there are only four toes on the back feet (Storm 2005). Juveniles display adult coloration except that the dorsal stripe is less prominent and the flecking is more metal-flake in appearance. Hatchlings may be as small as 19 mm, total length, and have relatively longer legs and shorter tails than older animals (Storm 2005).

### **III. BIOLOGY AND ECOLOGY**

#### **Life History**

The Oregon slender salamander is among the least known salamanders in the Pacific Northwest. No focused life history studies have addressed this species. West of the Cascade crest, surface activity of these salamanders has been noted to occur at cool temperatures, 10-14°C (Nussbaum et al. 1983), and a high number have been found at 18°C (S. Dowlan, pers. commun.). Two or more individuals have been found under one cover object on the forest floor surface. When disturbed, this salamander may exhibit a flipping behavior, where it coils and uncoils its body. This is likely an antipredator response. Another potential antipredator adaptation is its propensity to lose its tail. One population was reported with a 13% incidence of tail loss, suggesting a high predation pressure (Blaustein et al. 1995).

#### **Movements**

Although mark-recapture studies of salamander movement have not been conducted with this species, its relative movement capability is indicated from genetic analyses. Wagner (2000) and Miller et al. (2005) found divergence patterns suggestive of two discrete populations, which could be retained through time only as a result of limited gene flow between populations, which could be reflective of limited dispersal capabilities, low reproductive rates, habitat requirements, and fragmented habitat. Their genetic data are consistent with the hypothesis that males disperse and females do not, however, this has not been documented by field studies. A mark-recapture study of a close relative to the south, the California slender salamander (*B. attenuatus*), found most animals remained in close proximity to the cover item at which they were initially found, having a cruising radius of only 1.5 m (Hendrickson 1954). The home range of the Oregon slender salamander could well be on the order of only tens of square-meters, but this is largely speculation. They have been detected recently in stands that were clearcut in the 1950's and 1960's, suggesting that they either persisted through the disturbance or dispersed into the area from nearby stands.

#### **Breeding Biology**

As with other plethodontid salamanders in this region, breeding likely occurs with mating via spermatophore transfer to females in the fall or spring. Gravid females have been found in the spring, with clutch sizes ranging from 3-11 eggs. Spring oviposition is likely. Nests have been found in subsurface retreats, such as under bark and within crevices in logs. Eggs hatch in 4-5 months (Storm 2005).

## Range, Distribution, and Abundance

The known range of the species is 1,289,840 ha (3,187,264 acres), which spans the northwest Oregon Cascade Range and its foothills, from the Columbia River Gorge to the southeast corner of Lane County, and the northeast Oregon Cascade Range foothills from the Gorge to the Warm Springs Indian Reservation (Figures 1 and 2). It occurs west of the crest across a north-south range of close to 233 km (145 miles), from around 25 meters (85 feet) in elevation (at the northern end of its range in the Columbia gorge) to around 1,700 meters (5,440 feet) at the southern end of its range. East of the crest, it occurs along a north-south span of 65 km (40 mi) and occurs to about 1,250 m (~4,000 ft) elevation. This range includes Clackamas, Linn, Lane, Marion, Multnomah, Hood River, and Wasco Counties in Oregon.

Table 1. Amount of acres within the range of Oregon slender salamander, by land allocation, and the proportion of range that represents. LSR = late-successional reserve; AMA = adaptive management area; CR = congressional reserve; AW = administratively withdrawn; AMR = adaptive management reserve; Unclassified = unknown classification; NA = not applicable.

Land Use Allocation (LUA)	Range (ha) [ac]	% LUA of Total Range	% LUA of Federal range
Matrix	316,166 [781,264]	24.5	39
LSR	225,511 [557,250]	17.5	28
AMA	63,656 [157,297]	5	8
CR	126,350 [312,218]	10	16
AW	43,407 [107,262]	3	5
AMR	3,692 [9,123]	0.3	1
Unclassified	23,178 [57,274]	2	3
(Nonfederal)	487,879 [1,205,574]	38	N/A

Table 2. Observations of Oregon slender salamander and percent distribution by land allocation.

Land Use Allocation	Number of Observations	% of federal observations within this LUA
Matrix	519	76
LSR	120	17.5
AMA	23	3
CR	11	2
AW	10	1
AMR	0	0
Unclassified	4	0.5
(Nonfederal)	53	N/A

Defining what is a “site”, or what is the scale of an area that defines a group of interacting

individuals is not a uniform, agreed-upon process. Sites can either be points on a map, or a collection of points that are in a certain proximity of one another. Often scientific research has not been done on the particular species to accurately define what this proximity may be; therefore biologists and managers often have to utilize what information may be known about that species, and complement it with information about other, similar species, drawing reasonable inferences. For the Oregon slender salamander there are 740 or 407 sites of this species, depending upon how one defines a “site”. At present, there are 740 observations (data records) of this animal across its range (Figure 2). These observations represent three types of data. First, these data include point sightings of individuals. In some cases, multiple individuals within a proposed project area or forest stand were reported independently as different site records. Second, some of these records are a single point representative of a larger area, study site, forest stand or habitat polygon in which this species was detected. Third, some data records are polygons. For analysis purposes in this Conservation Assessment, in order to consolidate records of individuals found in relatively close proximity to each other, site records of all three source data types were buffered by 200 m and those within this distance of another site record were combined into a single locality. A 200 m distance was chosen arbitrarily, but represents a distance other Plethodontid salamanders are known to disperse. Also, the area of a circle with a 200 m radius is 12.56 ha (31 acres) and may be of sufficient size to maintain a subpopulation (although there are currently no data available to estimate the spatial extent of stable populations for this species). Using this 200 m criterion, the 740 observations collapsed to 407 sites. Of 740 site records, 687 (93%) are on federal lands, occurring entirely within several land allocations of the Northwest Forest Plan, with most on Matrix (Table 1). Known sites are located on the Salem and Eugene BLM Districts, and the Mount Hood and Willamette National Forests.

Gaps in both distribution and knowledge may be apparent by inspecting the distribution map (Figure 2). Lack of observations on this map likely reflects both a lack of surveys in addition to a patchy occurrence of this animal across its range. At this time, surveys without detections of this species have not been compiled or mapped. In particular, the southern extent of the species’ range is not well delineated on either the east or west sides of the Cascade Range crest. The northwestern distribution is not well known, and the distribution in federal reserve land allocations is unclear. Also, the upper elevational extent of this species is not well known across its range.

Tables 1 and 2 show the distribution of sites and range by federal land use allocation of the Northwest Forest Plan. Matrix has most sites and the largest proportion of the federal range.

Only a few studies have reported occupancy rates at surveyed sites west of the Cascade crest. Larson and England (1994) found a 71% occupancy rate in mature stands (N=52). Vesely et al. (1999) reported this species to have the highest capture rate of salamanders he sampled, at 1 capture per person hour of sampling. Vesely et al. also (1999) found a 75% (9 of 12 sites) occupancy rate in old-growth stands. Salamanders were undetectable in recently harvested stands in Vesely’s study.

This salamander may occur in younger forest stands, especially those in which legacy down wood has been retained. Stands on the Cascades Resource Area that were clearcut prior to about 1960 may have tended to leave a fair amount of large down wood on the forest floor, typically high-grading the best-quality logs (S. Dowlan, pers. commun.). Dowlan reviewed aerial photos

from the 1950s and 60s and noticed current salamander presence in stands where much log retention occurred. Leaving this substrate likely either allowed for the salamanders to persist through harvest, or to pioneer into the stands more easily. In contrast, clearcuts since about 1960 have not left large down wood, with perhaps a negative effect on the occurrence or abundance of this species. Occupancy rates among younger stands are not well known, although much of the species' distribution overlaps this forest type. Vesely et al. (1999) found no salamanders in young (2-7 years) plantations.

Figure 1. Range map of the Oregon slender salamander, showing the two genetic populations that have been distinguished (estimated boundaries are shown by the darkest shading to the north and lightest shading to the south, with the intervening area [medium shading] where population status is not known).

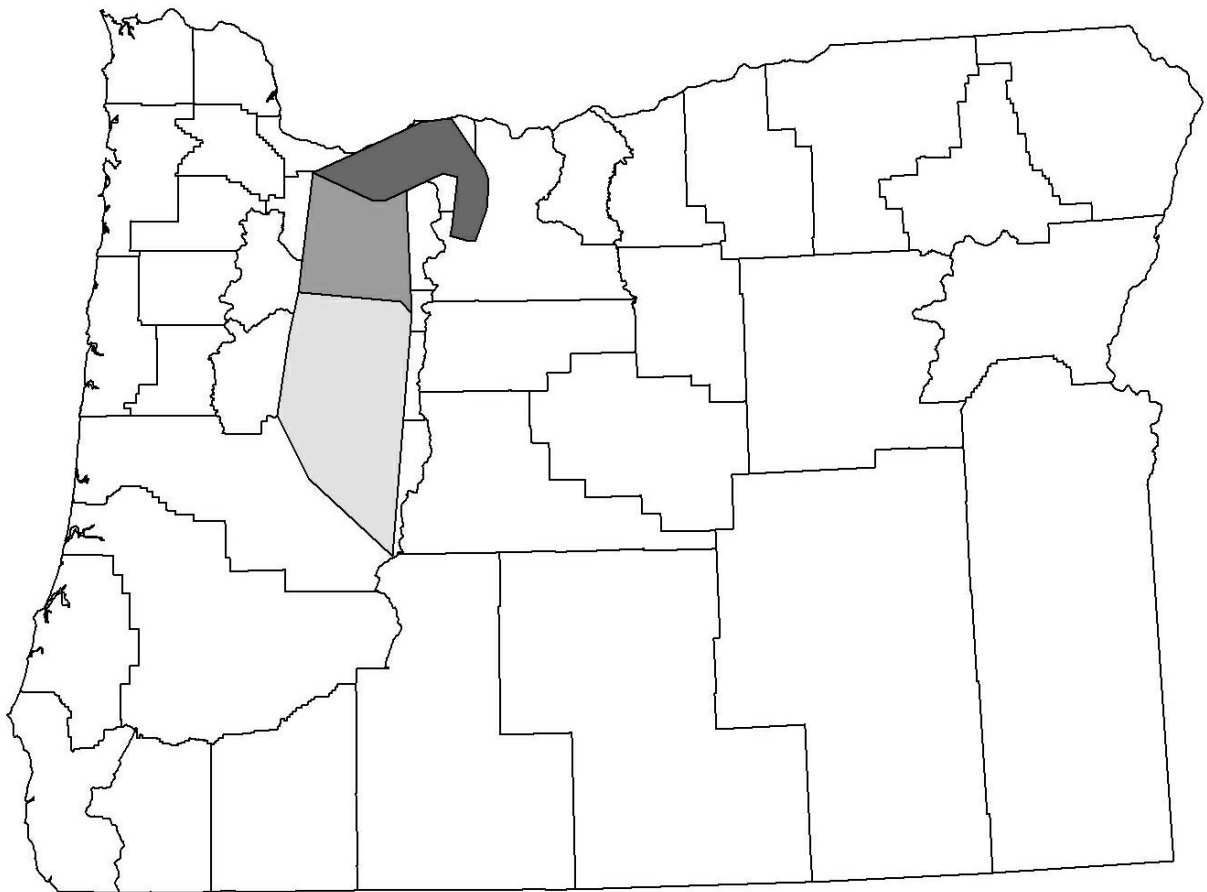
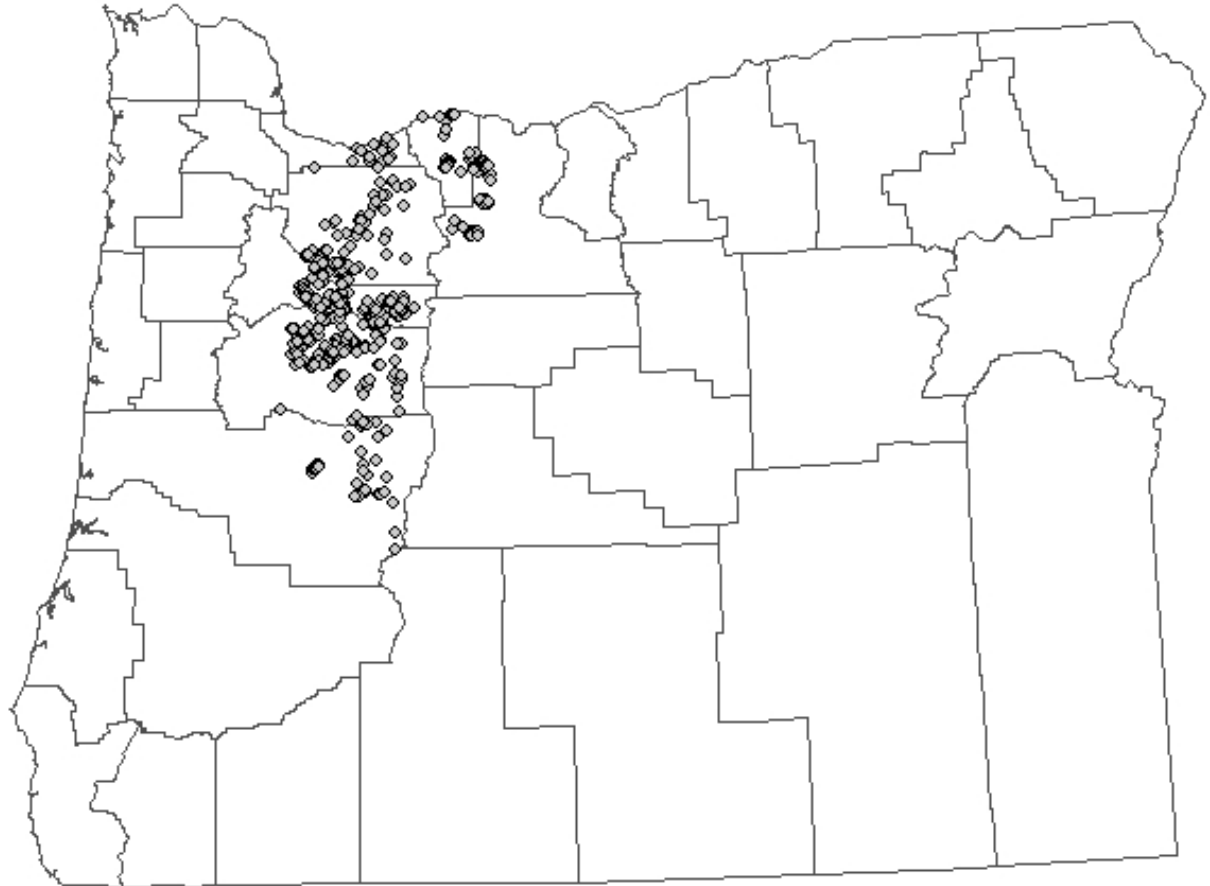


Figure 2. Sites (N = 740 observations) of the Oregon slender salamander. These observations collapse to 407 sites when observations within 200 m of each other are combined.



### **Population Trends**

There is no information about population trends in this species.

### **Habitat**

This species occurs in forested habitat. Three primary habitat conditions appear most important for this species west of the Cascade crest: moisture, dead wood, and older forests. First, *B. wrighti* occurs in stands with moist microhabitat conditions (Bury and Corn 1988, Gilbert and Allwine 1991). Second, there are numerous reports of associations of this species with large down wood, and some of the first publications on this species exemplify these cover associations. Jameson and Storm (1956) described an individual found under the moss of a decayed Douglas fir log and four *B. wrighti* were found under moss and bark of rotting stumps and logs of Douglas fir. Storm (1953) collected four individuals from beneath the bark of

decaying Douglas fir logs. Storm also described the collection of two *B. wrighti* from "well within" decaying fir logs and one from beneath the bark of an alder (*Alnus* sp.). Third, several more recent studies support an association of this species with large down wood and older forest stand conditions.

Bury and Corn (1988) reported that *B. wrighti* was significantly more abundant in old growth, than in 30 to 76 years old stands. Similarly, Gilbert and Allwine (1991) found these animals to be twice as abundant in mature and old-growth stands than in younger 30 to 80 year old stands. Vesely et al. (1999) further support an old-growth stand association of this species; of 56 stands of 13 forest types surveyed, *B. wrighti* was significantly more abundant in old growth (OG) than in second growth (SG) and no animals were found in clearcuts. The abundance of most classes of woody debris also was significantly lower in SG stands than in OG stands. Four habitat characteristics (canopy closure, aspect, logs in the 50 to 75 cm (20 to 30 in) diameter class, and snags) were found to have a significant positive association with Oregon slender salamanders. Canopy closure and aspect were best predictors of relative density among logged and unlogged stands. In this study, median canopy closures were 93% for old-growth stands (range = 24) and 92% for second growth stands (range = 34), precluding the development of a minimum or threshold value associated with species occupancy or abundance. However, salamander abundance was higher on west- and east-facing slopes, compared to north and south-facing areas. Vesely et al. (1999) suggested that south-facing slopes may become overly xeric in summer for persistence of this species, while north-facing slopes may be colder, retaining snow into the summer months, restricting the time interval for surface activity. Oregon slender salamander density was also positively correlated with large diameter (50 to 75 cm, 20 to 30 in) logs and snags, and negatively correlated with small (10 to 25 cm, 4 to 10 in) logs and logs in intermediate levels of decay (classes 2 and 3). This pattern is believed to reflect the Oregon slender salamander selection of microhabitats that have a greater abundance of snags and large down logs in advanced decay stages. The absence of Oregon slender salamanders in recent clearcuts was attributed to the combined effects of canopy removal and the low abundance of woody debris. Because large woody debris such as used by the salamander for nesting is rare in many recent clearcuts and plantations, Vesely et al. (1999) believed that forests intensively managed on short harvest rotations were likely population "sinks" in which mortality exceeds reproduction.

Older clearcuts on the Cascades Resource Area (prior to ~1960) with higher down wood volumes may have contributed to the persistence of this species at harvested sites. For example, many recent surveys of stands ages 40-70 yrs, that were previously clearcut or burned, and some also subsequently thinned, have detected this species (S. Dowlan, pers. commun.). Legacy large, decayed down wood volumes are relatively high in some of these stands (Olson et al. 2006). Two case studies have looked at the effect of thinning these old clearcuts on salamander abundances. Both found no difference in Oregon slender salamander abundance between the thinned and unthinned treatments (one site: Rundio and Olson 2007; two sites: Wessell et al. 2007). Again, the legacy down wood component may ameliorate the disturbance effects on the species. In contrast, more recent (i.e., 1960 to 1990) clearcut practices that retained little down wood may be associated with reduced occupancy and abundances of these salamanders, and is perhaps captured by some of the studies cited above. There has been no study of the effects to or

the short or long term persistence of this species from Northwest Forest Plan regeneration harvest practices, including green tree and down wood retention and reserve land use allocations (e.g., riparian reserves). Relative to previous clearcut conditions on federal lands, 1960-1990, it is expected that the increased shading and down wood cover of Northwest Forest Plan procedures would have some benefit for the species.

Recent observations of this salamander east of the Cascade Range crest suggest habitat may differ geographically (R. Thurman, pers. commun.). Most observations to the east were in the dry grand fir zone, however some individuals have been found in pine/oak and the wet grand fir zone. Stand characteristics of these eastern sites include tree diameters ranging from 25-50 cm dbh (10-20 in), down wood diameters of 10-50 cm (4-20 in), with decay classes including class 1 and 2 logs (i.e., logs used by salamanders), and canopy closures ranging 40-80%. These stands have been thinned or underburned. Available down wood may be in earlier decay classes, compared to west-side forests, although this has not been well quantified.

### **Ecological Considerations**

Plethodontid salamanders are thought to have important roles in forest ecosystems, including being a significant trophic link between small ground-dwelling invertebrates and larger vertebrate predators. The diet of Oregon slender salamanders consists of a variety of invertebrates, such as springtails, mites, flies, spiders, snails, beetles, centipedes and earthworms (Storm 2005), but their predators are not well-known. Plethodontid salamanders also comprise a considerable portion of the forest vertebrate biomass in some areas (e.g., Burton and Likens 1975a, 1975b), but the specific role of Oregon slender salamanders in local communities or ecosystem processes has not been addressed. Their general ecology and life history traits suggest they are ideal indicators of forest ecosystem integrity (Welsh and Droege 2001).

## **IV. CONSERVATION**

### **Threats**

Habitat loss and degradation are the primary potential threats to the persistence of Oregon slender salamander populations. Activities that may pose threats are those that disturb the surface microhabitats and microclimate conditions, compact soil, and include clearcut timber harvest and habitat loss from development such as urbanization or large recreation sites. Disturbance of surface microhabitats is of primary concern because alteration of the microhabitat can negatively impact these salamanders. Additionally, loss of connectivity among habitat patches is a concern due to the likely limited mobility of these animals and consequent population isolation.

### ***Timber Harvest***

Timber harvest is a primary land management practice in forested ecosystems in this geographic region and is estimated to have had the most impact on the species and its habitat. Numerous retrospective studies with this salamander support the negative effects of timber harvest activities on salamander abundances (see habitat above). Several disturbances can result from timber harvest practices. Removal of overstory changes the local microclimatic regime and may cause

desiccation of substrates and ground cover. Tree-felling and ground-based logging systems mechanically disturb the substrate and ground cover which can result in both substrate compaction and loss of the integrity of existing down wood. These actions can result in loss of interstices used by salamanders as refuges and for their movements, and a drying out of the ground surface if cover is lost. Loss of standing green trees reduces the future potential for down wood recruitment, and as new trees regenerate in harvested stands, their smaller sizes likely do not provide the same functions for salamanders for several decades to centuries.

In addition to the retrospective studies of timber harvest effects reported above (habitat section), many other studies have reported effects to plethodontid salamanders from timber harvest, in particular regeneration harvest practices (Ash 1997, Dupuis et al. 1995, deMaynadier and Hunter 1995, Herbeck and Larsen 1999, Grialou et al. 2000). DeMaynadier and Hunter (1995) reviewed 18 studies of salamander abundance after timber harvest and found median abundance of amphibians was 3.5 times greater on controls over clearcuts. Petranka et al. (1993) found that *Plethodon* abundance and richness in mature forest were five times higher than those in recent clear cuts and they estimated that it would take as much as 50-70 years for clearcut populations to return to pre-clearcut levels. A comparison of recent (<5 years) clearcuts and mature (120 years) forests also suggested salamanders are eliminated or reduced to very low numbers when mature forests are clearcut (Petranka et al. 1993). In a paired plot study, H.H. Welsh, Jr. and others (unpubl. data) found that *P. elongatus* salamanders were greatly reduced for as long as twelve years after clear cutting when compared with an adjacent control plot. The proportion of juveniles/subadults was dissimilar between the two plots ( $t = 2.49$ ,  $p = 0.0282$ ,  $df = 12$ ,  $power = 0.6255$ ;). Juveniles and subadults comprised a significantly larger proportion of captures in the clear-cut compared to the late-seral stand. These data are best explained by a “source-sink” model (Pulliam 1988) wherein the clear-cut is the “sink” and the surrounding late-seral forest is the “source” of the juveniles and subadults found in the clear-cut. These two early life stages appear to be the “dispersers” (see Marsh et al. 2004). Adult territoriality likely results in the movement of subadults and juveniles out of currently occupied habitat into edges (Ovaska and Gregory 1989; Fraser 1976a, Fraser 1976b). In contrast, Messere and Ducey (1998) found no significant differences in abundance of red-backed salamanders in forest canopy gaps in stands that had been selectively logged, indicating that limited logging may have little effect on that species.

Studies in the Pacific Northwest documented greater salamander abundance in old-growth compared to clearcuts or early seral forest (e.g., Bury and Corn 1988, Raphael 1988, Welsh and Lind 1988 and 1991, Welsh 1990, Corn and Bury 1991, Dupuis et al. 1995). Alternatively, Diller and Wallace (1994) found *P. elongatus* in managed young stands in northwestern California and found no relationship of salamander presence to forest age. However, they sampled stands that were from zero to 90 years old. The areas surveyed were also in the coastal redwoods that have a milder, wetter climate than interior sites sampled by others (Welsh and Lind 1991).

The Bureau of Land Management (BLM) conducted searches for Oregon slender salamanders at paired sites: mature forest stands paired with adjacent clearcuts (Larson and England 1994). No *B. wrighti* were found in older clearcuts, even when 20 to 30 years old with Douglas-fir regeneration, but *B. wrighti* was present in 1 to 2 year old cuts where logs apparently were still wet enough for the species to be present. It is possible that *B. wrighti* might persist 3 to 5 years after regeneration harvest, a time span that may match the lifespan of *B. wrighti*. The lack of

persistence in old clearcuts parallels data from the Vesely et al. (1999) study and poses questions regarding this species ability to persist on a landscape scale in light of current and proposed timber harvest within the range of the species.

While it warrants further study, it bears acknowledgement at this time to recognize that not all timber harvest practices are equal. Some harvest practices may have a reduced impact on Oregon slender salamanders. Salamanders may persist at sites, or recolonization may be accelerated, with retention of down wood and retention of standing trees that reduces ground disturbance, ameliorates microclimate alteration, and offers recruitment of future down wood. 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 contrast, private industrial timberlands within the species range may pose a greater risk to these animals. Current clearcut rotations on some industrial lands are short, about 40 yrs, and likely do not leave sufficient down wood or standing trees to provide habitat for this species and may pose a significant barrier to recolonization of nearby federal lands in large parts of the species range (e.g., Eugene and Salem BLM lands).

Within the range of the Oregon slender salamander, the landscape is fragmented by past timber harvest practices, and is a patchwork of stands of different seral stages, from early seral to mature forests, with differing timber harvest practices. Sites with Oregon slender salamanders are nested within this patchy forested regime. There are no real estimates of how much potential suitable habitat has been impacted by timber harvest activities, but 595 of 740 (80%) salamander localities occur on land allocations in which timber harvest activities may occur (nonfederal lands, federal Matrix and Adaptive Management Area; Table 1). Looking at federal lands only, 542 of 687 sites (79 percent) occur on land with programmed timber harvest (Table 1a). However, these numbers likely reflect a bias in where survey efforts have occurred for this species because surveys have most often been associated with federal timber sale planning, resulting in fewer locations on nonfederal lands and in federal reserved lands. Inspection of land use allocations within the species’ known range (minimum convex polygon of known sites, partitioned by three areas as in Figure 1) may give a better estimate of potential occurrence across the landscape: 67.5% of the species range occurs in land allocations with timber harvest activities (38% of the range on nonfederal lands, 24.5% on federal Matrix, 5% on federal AMA). Conversely, 31% of the range is in federal reserves, not including Riparian Reserves (In assessing just the range on federal lands, about 49% of federal lands are in reserves allocations, not including Riparian Reserves). The value of Riparian Reserves or owl set-asides for this species’ persistence is not known, however trans-riparian transect surveys conducted by Rundio and Olson (2007) at one case study site generally resulted in more Oregon slender salamander captures > 100 m from headwater streams, suggesting narrower riparian buffers may have limited conservation value.

Thus, while historic timber harvest activities such as clearcut regeneration harvest were likely detrimental to Oregon slender salamander persistence, it is not clear if alternative silviculture practices would have the same effects. If down wood microhabitats and forest microclimates are retained with selective harvest activities, salamanders may persist or recolonize the site.

## *Fire*

The effects of fire on Oregon slender salamanders are poorly understood. Prescribed fire for fuels reduction treatments may have different effects than natural fire that can differ significantly in intensity. Low intensity fires that retain large down wood and occur during the seasons when these salamanders are not surface active may not have adverse effects. One recent study surveyed for this species following a midsummer fire (Clark Fire, July 2003), and numerous detections were reported. However, it is unknown how detections were distributed relative to fire severity or how the fire will affect long term persistence of the population in the area. Also, this species is now known east of the Cascade Range in an area susceptible to more frequent natural fire events. The historical fire regime in the area was likely one of high frequency and low intensity fire, which consisted of very frequent underburning of the forest in the summer and fall and few stand replacement events. The effects of a more intense level of fire disturbance due to fire suppression and fuel loading is of 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 and low moisture) and can reduce decayed down wood.

## *Chemical Applications*

Chemicals such as herbicides, pesticides, fungicides, fertilizers and fire retardants may have a direct impact on all woodland salamanders. These animals breathe through their skin, which must be moist and permeable for gas exchange. However, it is not known to what extent these substances affect Oregon slender salamanders. However, due to the scale of this action across the range of this species, this action is not considered to be a primary threat.

## *Global Climate Change*

The range of the Oregon slender salamander includes habitats that are particularly vulnerable to predicted patterns of global climate change. In particular, a change in storm patterns that alters the snow cover, either annual accumulation or seasonal pattern, would affect this species. West of the Cascade crest, warming trends could increase the elevational extent of the species range and increase occupancy of north-facing slopes, and also restrict its distribution at lower elevations or south-southwest aspects. A smaller band of habitat might result if the current foothills become less suitable for the species. East of the crest, 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.

## *Disease*

Current research on global amphibian declines is focusing on the effects of disease agents. While disease has not been implicated for this salamander, chytrid fungus has recently been detected in a plethodontid salamander (Cummer et al. 2005). This disease is thought to be the cause of local extirpations of montane frogs in the Washington Cascade Range and the California Sierra

Nevada Range.

### ***Roads***

Many roads have been constructed for various reasons within the range of the slender salamander. Road construction in suitable habitat directly removes overstory, affects down woody material, and compacts the substrate. The intensity of impacts is more intense and longer lasting than timber harvest. Road construction likely causes direct mortality to individuals and some amount of habitat loss; however due to the scale of impact and the linear nature of the action, the impacts to the species may be significantly less than timber harvest or stand replacement fire. Roads are not generally known to be barriers to plethodontid salamanders. Road kill is not well-documented for this species.

### ***Developed Recreation/Dispersed Camping***

Construction of camping areas, access roads, boat ramps, and other developed recreation sites have likely impacted Oregon slender salamanders by the direct alteration of substrate as well as canopy loss due to overstory vegetation removal. Dispersed campsites also may have had an impact from soil compaction and vegetation alteration, although it is expected to be somewhat limited.

### **Conservation Status**

This species is of concern due to its limited distribution to the northern Oregon Cascade Range and its associations with older forest habitat conditions, the extent of which have been dwindling over the last several decades. Given the hundreds of sites that are now compiled, and with our knowledge of its range being extended east of the Cascade crest, this species no longer appears to be extremely rare; it is not on the brink of extinction. However, when the animal is found, numerous individuals are rarely seen; there are often single to a few animals found with considerable survey effort. While its cryptic nature and use of subsurface habitats likely reduce its detectability and cloud our understanding of abundance patterns, this animal does not seem to occur in high numbers within suitable habitat and optimal habitat may be patchy across the landscape.

Currently, this species is considered a sensitive species by both Region 6 Forest Service and Oregon BLM, as well as the state of Oregon. The Oregon Natural Heritage Information Center ranks this species as Globally imperiled (G2G3), Oregon State imperiled (S2S3) and it is List 1 (threatened with extinction or presumed to be extinct throughout their entire range). Given that this species has low reproductive rate, vagility, and genetic diversity, and is a habitat specialist, there are concerns as to the potential effects on populations from anthropogenic events.

### **Known Management Approaches**

The federal Northwest Forest Plan is the only management plan that has specifically addressed this species. This species was assessed on federal lands by an expert panel during development of the Northwest Forest Plan (USDA and USDI 1993, 1994) and down wood mitigations in addition to other Plan provisions such as land use allocations resulted in its rating of having no

risk of extirpation. The panel determined that implementing the Northwest Forest Plan would result in a 70% likelihood that the species would persist in a well-distributed manner, a 24% chance it would persist with some gaps, and a 6% likelihood it would persist solely in reserves.

Thirty-one percent of the range is within reserve lands (late-successional reserves, administratively withdrawn areas and congressional reserves) in Region 6 and OR BLM, some of which are at higher elevations and likely function as potentially marginal or suboptimal habitat for the species. The species potential range as we currently understand it includes about 400,000 ha (~980,000 ac) of federal reserved lands. The areas of reserved lands within the ranges of the three areas delineated in Figure 1 are: northern population, ~105,000 ha (40% of the total area of this population, 31 of 199 sites); intermediate zone, ~82,000 ha (26%, 20 of 152 sites); southern population, ~208,000 ha (29%, 90 of 389 sites).

In addition to these federally reserved land use allocations, retention of spotted owl cores or riparian reserves in matrix may add a significant amount of protected land within the range of the species. However, the roles of owl cores, riparian reserves or other reserved land use allocations are unstudied relative to this species. Whether smaller patches such as owl cores or linear areas such as riparian reserves can contribute significantly to the retention of subpopulations in a managed landscape is a critical issue; there is concern that such fragmented areas may not serve the long term conservation goal of this relatively non-vagile organism. Forest habitat fragmentation is more pronounced in the foothills and lower elevation Cascade Range within this species range, where federal lands are interspersed with private industrial forestlands, which may coincide with the species' optimal habitat.

Quality, quantity, and longevity of down wood at managed sites are key issues for this species. Research supports use of decayed large logs by this salamander (> 50 cm [20 in]). The quality of habitat provided by a log in a clearcut may be reduced in comparison to a log in an intact stand (i.e., altered interior log microclimate, M. Kluber and D. Olson, unpublished data). While the Northwest Forest Plan provides minimum guidelines that recommend retention of large (20 in. diameter) down woody debris on federal lands, it is unclear if these guidelines are sufficient in quantity and quality for this species. In particular, this species does not appear to be able to use large down wood until it is in advanced state of decay. The NWFP S&Gs promote retention of this older decay class, and Standards and Guidelines in place to limit soil and ground disturbance during harvest operations also provide for retention of this resource. In addition, where there is dramatic reduction of canopy closure such as occurs with regeneration harvest, it is uncertain that the recruitment of large wood would be sufficient to provide suitable microhabitat conditions for the species at these sites over the long term, although the NWFP S&Gs promote the need for long term down wood recruitment in the stand. There are observations of this species on the Salem BLM District, Cascades Resource Area occurring in stands clearcut >30-40 years ago when downed woody material was retained (S. Dowlan, unpublished data), suggesting that these past practices retain habitat for this species. Also, the species has persisted at two case study sites where forest thinning ( thinned from approximately 200 to 80 trees per acre) has been conducted, suggesting that alternative silvicultural practices to clearcutting may not negatively impact the animal (D Olson pers. obs.). Regeneration harvest is only one harvest method used on federal lands; timber harvest on many of the federal lands managed for timber production within the range of this species may be through thinnings and small group selections. How this mosaic of federal forestry practices coupled with reserve lands impact the persistence of Oregon

slender salamanders is uncertain at this time. However, given that a considerable portion (38%) of its known range lies within private land, it is highly likely that further direct habitat loss and fragmentation will continue to occur over the short term at least.

## **Management Considerations**

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

Although considerations 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 warrants consideration of each site with regard to the extent of both habitat protection and possible restoration measures. Methods to identify occupied sites to manage 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 considerations*

To maintain an occupied site, an understanding of the site-extent and habitat quality is needed. Occupied habitats range from small patches to entire hillsides. For large sites, species management may vary across the site such that areas of conservative protection are identified, as well as areas for restoration or for management activities that have a higher risk to salamanders or their habitat integrity. To assess site extent, surveys may be conducted or the site extent can be visually estimated. For an estimate, once the presence of Oregon slender salamander has been determined at a site, all similar habitat contiguous with the site may be included as part of the site; occupancy may be assumed for contiguous similar habitat unless information demonstrates otherwise.. Spatial heterogeneity in vegetation, microclimate, and illumination (as determined by aspect and topography) may also be used to qualitatively assess habitat suitability for these ground-dwelling salamanders.

Retention and both short-term and long-term recruitment of large down wood should be considered when managing sites of Oregon slender salamanders. At this time, there are no known minimum guidelines but studies suggest sizes and decay classes preferred by the species (Vesely et al. 1999). Vesely et al. (1999) found that the Oregon slender salamander was positively associated with large (51-70 cm) logs in decay classes of 4 and 5. Restoration of young managed stands might include thinning, and to promote tree growth for future large down wood recruitment. A short-term risk in altered microclimate conditions from reduced canopies might be weighed with a longer term benefit of growing larger trees.

Management activities in areas adjacent to known sites may be evaluated with regard to their affect on habitats and populations of salamanders. Exactly how edge effects may interact to affect suitable microclimate conditions for salamanders is unknown. Also unknown are the variances that may occur with different sorts of forest edge conditions (i.e., not all edges are clearcuts). Occupied sites that abut Federal reserve land allocations (e.g., botanical reserves, owl cores, riparian reserves) with similar suitable habitat conditions for salamanders may provide larger areas for subpopulations, habitat connectivity to other sites, and reduce fragmentation of

the animal subpopulations across the landscape. In contrast, the habitat value for Oregon slender salamanders of private or industrial timber lands adjacent to federal sites may be limited. Managing sites for the maintenance of well-distributed populations may require this expanded look of the position of sites and habitats across land allocation and ownership boundaries. Also, an understanding of the variety of land management activities predicted to occur at each site relative to their impacts on salamanders and their habitat needs is important.

Also, landscape design needs consideration. Based on land allocations, some portions of watersheds may promote conditions for salamander persistence, with activities having higher risk to salamanders occurring in other portions. Effects to landscape habitat conditions might be considered relative to the quality, amount, and orientation of current and future habitat for the species, while acknowledging that many stands in a landscape may not currently be occupied by the species, the species may have a limited ability to disperse, and there are likely effects due to short or long term habitat barriers, particularly within checkerboard federal and private ownerships.

### *Specific Considerations*

The following Considerations are actions or mitigations that a deciding official can consider as a means of providing for the continued persistence of the species' site. These considerations are not required and are intended as general information that field level personnel can choose to use and apply to site-specific situations.

- Maintain the integrity of substrates (avoid soil compaction) for subsurface refugia.
- Reduce, where possible, the area traversed by large machinery or over which logs are dragged.
- Maintain and manage for current and future large down wood (51+ cm or 20 inches plus) of various decay classes, especially 4 and 5, for current cover, and decay classes 1-3 for future cover. Grow large trees (51+ cm or 20 inches plus), and if current or future decayed down wood levels are or will be sparse, fell large trees.
- Maintain or restore canopy closure to retain cool, moist microclimate conditions. In old growth stands canopy closure was a median of 93 percent, with a range of 24 percent; in second growth stands, canopy closure was a median of 92 percent, with a range of 34 percent.
- Consider the benefits of partial harvest approaches. Thinning or aggregated green tree retention areas can reduce ground disturbance, retain canopy closure, ameliorate microclimate shifts, and provide standing trees to provide future down wood.
- Manage to reduce likelihood of stand replacement fires.
- Avoid chemical applications.
- Assess the proposed activity to identify the potential hazards specific to the site. The hazards and exposure to salamanders of some activities relative to ground 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.

- Seasonally restrict activities to dry summer or fall conditions. For land-use practices proposed for areas within Oregon slender salamander sites (e.g., thinning, prescribed fire), take the seasonal activity patterns of this species into consideration. Disturbance of animals and their habitats during wet periods (fall/spring), when animals have increased surface activities could result in direct mortality of individuals. A seasonal restriction for any ground disturbing activity may be implemented during wet spring, fall, or winter conditions to reduce direct mortality of animals. Exact dates of a seasonal restriction can vary, based on local conditions.
- Consider the context of the site with regards to the larger scale. Assess the amount and condition of adjacent reserve lands to determine if site management is needed, and whether a more protective or less protective approach is warranted.
  - Consider benefits of riparian reserves and upslope set-asides (e.g., leave islands, owl cores).
  - Consider proximity to large reserve blocks, maintain connectivity to such areas.
  - Consider proximity to lands unlikely to serve as suitable habitat and their possible edge effects.
- Consider monitoring the effects of land management on this species.
- Consider delineating the spatial extent of the area occupied by this species.
- Report observations of ill or dead animals. Individuals or tissues collected can be analyzed at regional or national laboratories.
- To avoid the spread of disease, disinfection protocols for field personnel and field gear are under development for aquatic habitats, and include soaking boots and field gear such as nets in bleach solutions between their use in different water bodies. Use of disposable gloves when handling diseased animals has been suggested. Similar disinfection of field gear used in terrestrial habitats could be applied.

## **V. INVENTORY, MONITORING, AND RESEARCH OPPORTUNITIES**

### **Data and Information Gaps**

Additional data are needed to refine distribution and management effects on this species. Both monitoring and research studies may contribute to knowledge gaps. Appendix 1 lists all information gaps determined by an interagency work group assessing this species. The work group determined that in particular, information is lacking in these priority areas:

- The distribution of the species: 1) to the south, west of the crest; 2) to the south, east of the crest; 3) to the west and northwest, west of the crest; 4) on federal reserve land allocations; 5) at higher elevations, east and west of the crest; and 6) relative to the two discrete genetic populations.
- The distribution of optimal habitat across the species' range relative to federal land allocation.
- Assessment of threats relative to geographic distribution.
- The response of the species to alternative silviculture activities such as differing

intensities of density management, regeneration harvest, prescribed fire, and with differing levels of down wood retention and recruitment.

- The role of riparian reserves and other set-asides for population persistence at stand-to-watershed spatial scales.

Work is currently underway to address some of these information gaps, and the progress to date is shared below:

- *The distribution of optimal habitat across the species' range relative to federal land allocation.* Using existing site data, a habitat suitability model is being developed using habitat parameters that are available spatially, in Geographic Information System (GIS) coverages. Attributes assessed for the model include climate data, forest composition, and topographic attributes such as elevation and aspect. A draft of the model is expected to be completed by the end of FY07.
- *Assessment of threats relative to geographic distribution.* Relative to species locations and suitable habitat, as modeled for (1) above, the spatial distribution of key threats is being investigated, as threat data are available in GIS coverages. For example, since this species is associated with down wood and older forest conditions, an assessment can be made of the species habitat and range relative to likely forest harvest intensities. This can be estimated by using the habitat model developed in (1) above, the distribution of forest lands by ownership, and the land use allocation. A draft of this model is expected by the end of 2007.

## **Inventory**

Survey approaches may vary with objective and available resources. Several protocols can be considered for the Oregon slender salamander to detect presence and estimate relative abundance.

First, terrestrial mollusk surveys have routinely detected this species. An advantage of this approach is the multi-taxa sampling that can be conducted, and the streamlined approach used. However, it is uncertain if the microclimate conditions used for mollusks and the relatively small sampling area per plot may result in some false negatives for salamanders. The Survey and Manage terrestrial mollusk survey protocol is available at: <http://www.blm.gov/or/plans/surveyandmanage/SP/Mollusks/terrestrial/IM-OR2003-mollusks-final-v3.htm>

Second, standardized survey protocols were developed for the federal Survey and Manage program to help assess terrestrial salamander presence prior to habitat disturbing activities associated with land management and these may be applicable to the Special Status Species program. The survey protocol for the Larch Mountain salamander (*P. larselli*) also is suited for this species, due to its use of extensive transect surveys across suitable habitat patches. The Larch Mountain salamander similarly occurs in the Cascade Range, and may be detected in association with down wood. This protocol outlines

survey procedures and environmental conditions that optimize detection probabilities. Surveys using this protocol may assist biologists with some of the information gaps such as, microhabitat conditions required by the species as well basic answers to the potential effects of various land management activities on the species. This survey procedure requires more effort than the terrestrial mollusk protocol. It is available online at: <http://www.blm.gov/or/plans/surveyandmanage/SP/Amphibians99/protoch.pdf>, Other protocols that may be appropriate for this species includes survey protocols for both the Siskiyou Mountains and the Del Norte salamanders, these are also available at the website shown above.

Third, surveys designed with a random site selection can provide inference to the larger landscape in which the surveys are conducted. This approach is useful for understanding the estimated occupancy patterns on different lands, such as federal reserves vs. matrix, or older vs. younger forest stands.

Other types of inventory or research methods may be needed for studies that address such questions as species-habitat associations, long-term effects of timber harvest, and other activities, movement or occupancy patterns. This type of work will have additional inference to the sampled population if random site selection is used. Nonrandom site selection results in case studies with implications only to the sampled sites; biased samples and results may occur. Pitfall trapping and mark-recapture methods may be effective approaches for long-term site or population studies (Heyer et al.1994). The success of artificial cover boards to survey for terrestrial salamanders has been limited in xeric forest habitats of southern Oregon (K. McDade, unpublished data), but may be effective within the range of this more northerly species. Nocturnal surveys may be effective, but may be hazardous to surveyors in remote areas.

## **Monitoring**

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 persistence assessments.

In particular, monitoring is needed to better understand the species' response to:

- Prescribed fire, especially for areas east of the Cascade Range
- Large-scale or high intensity fire
- Thinning
- Regeneration harvest with Northwest Forest Plan guidelines
- Alternative levels of down wood, with various overstory treatments
- Heterogeneous stands with riparian reserves, patch reserves, thinned areas, clearcut areas.

Resurveys of historic populations are needed, in addition to both implementation and effectiveness monitoring of past management actions. Have populations changed in the last few decades? How has land-use changed in the area over the last twenty years? What population-specific threats were present in the 1970's, and how have they changed today? Do current timber practices continue to impact this species at the same level as previously perceived? What protective measures have been implemented, and what were the results of this management?

Ongoing monitoring of current-populations and the implementation and effectiveness monitoring of currently-imposed protective measures also 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 management practices may affect microhabitats or populations of these salamanders. It is also of particular interest to investigate gene flow capability among discrete lineages, and to determine lineage boundaries.

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. If sites surveyed with no detections were also reported 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. A risk assessment is currently being developed between these factors and the long-term persistence of populations to assist in answering such questions as: are there populations or areas where stronger or relaxed protective measures may be warranted, or where adaptive management might be attempted? Development of strategies to address these questions of conservation biology is a critical research need.

## **VI. ACKNOWLEDGMENTS**

We thank Mike Blow, Steve Dowlan, Rich Thurman, Fred Wahl, Kelli Van Norman, Rob Huff, Carol Hughes and David Larson for expert opinion and comments on an earlier draft. Nobuya Suzuki compiled and mapped site records and analyzed species distribution patterns. Lynne Larson edited an earlier draft. We thank the former Survey and Manage Amphibian Taxa team for their efforts to compile some information included here, which also was used in the 2002 Step 2 panel for the Survey and Manage annual species review.

## **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**

**G2** – Imperiled because of rarity or because other factors demonstrably make it very vulnerable to extinction, typically with 6-20 occurrences.

**G3** – Rare, uncommon, or threatened but not immediately imperiled, typically with 21-100 occurrences.

**State Imperiled**

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

**S3** – Either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors.

**List 1** -contains taxa that are threatened with extinction or presumed to be extinct throughout their entire range

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## **APPENDIX**

### **Information and Conservation gaps identified by an interagency workgroup for the Oregon slender salamander.**

During the spring and summer of 2006, a group of Forest Service and BLM biologists met on 5 occasions regarding the Oregon slender salamander. The goal of the group was to identify the information and conservation gaps regarding the species, and develop a strategy to address these gaps including tasks, personnel, costs, and timelines. The following displays the results of brainstorming the team did to identify the gaps in information and conservation for this species, as it relates to management under the agencies Special Status and Sensitive Species policies.

Team personnel consisted of:

Mike Blow, Eugene District BLM

Dave Clayton, Rogue River/Siskiyou National Forest

Steve Dowlan, Salem District BLM

Rob Huff, Region 6 Regional Office, Forest Service and Oregon State Office, BLM

Dede Olson, Pacific Northwest Research Station, Corvallis

Rich Thurman, Mt. Hood National Forest

Kelli Van Norman, Region 6 Regional Office, Forest Service and Oregon State Office, BLM

Fred Wahl, Willamette National Forest

## **Information and Conservation Gaps**

### ***Life History***

- Movements (dispersal, home range distances)
- How far down in the substrate do they go in dry season, and in low canopy closure stands?

### ***Habitat***

- How to measure habitat attributes at stand level (goal is to assess and manage stands)?
- Define microsite requirements
  - Amount, size, and decay classes of downed wood
  - Canopy closure
  - Climate
- What is the role of riparian reserves in helping provide for the persistence of the species?
- What level of landscape connectivity is needed for species persistence?
- What is the distribution of habitat across the landscape, given land management allocations/ownership, elevation, climate (coarse filter)?
  - What is the potential for young stands to provide habitat?
  - Can we look at down wood recruitment potential? Where? When?

### ***Survey/Survey efforts***

- Determine the range of the species
  - refine southern range (and potentially habitat) both on westside (Eugene BLM) and eastside (Warm Springs, Deschutes National Forest)
  - distribution gap on westside Mt. Hood and Willamette National Forests (including the western edge; what is the western edge of the range)
  - Range gap - are there sites between eastside Mount Hood and Westside Columbia River Gorge?

- Compile site and survey data; we don't have it all in one spot (FS and BLM work)
  - Mining other data efforts: Warm Springs, Deschutes National Forest, "CVS" plot work, H.J. Andrews, USGS, etc.
- Need for a consistent survey protocol, data and habitat forms
  - What is the most efficient and cost effective detection technique?
  - How many site visits do we need for presence/lack of detection?
- Delineate the genetic sub-populations to answer questions about managing and conserving sub-pops.
  - Why do we have eastside Mount Hood populations? What sort of genetic link might there be between this population and westside sites?

### ***Site Issues/Threats***

- Need to be able to assess risk of a potential project upon this species, since we may not be able to survey for it all the time (or we may survey and find it...and do the project). Could develop a "risk assessment" model, Bayesian Belief model, habitat model map.
- What is a site? How to delineate a site.
- Are we recruiting adequate coarse woody debris?
- Is the species persisting at historically logged sites (1960s) and/or was it recolonization? Differences due to amounts of coarse woody debris left behind?
  - Are there juveniles? Measure reproductive capability? Sink/source?
- Need for development of a Conservation Strategy
  - Define management objectives for the species

### ***Population monitoring/trends***

- Post treatment surveys of treated sites (fire, thins, regen) looking at the effects/effectiveness of the treatment prescription.
  - What are the responses to alternative types of harvest and fuel treatments?
  - Is catastrophic fire a threat to sites and to species persistence?

The team then determined which gaps were the most relevant to address in order to help BLM and FS management of the species. Those medium and high priority information and conservation gaps are presented in the text of the document.