

**Conservation Assessment for the  
Black Salamander (*Aneides flavipunctatus*)  
in Oregon**

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Interagency Special Status and Sensitive Species Program

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**Disclaimer**

*This Conservation Assessment was prepared to compile the published and unpublished information on the black salamander (*Aneides flavipunctatus*). 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 at <http://www.fs.fed.us/r6/sfpnw/isssp/contactus/>*

## Executive Summary

**Species:** Black salamander (*Aneides flavipunctatus*)

**Taxonomic Group:** Amphibian

**Other Management Status:** U.S.D.A. Forest Service, Region 6 - Sensitive; U.S.D.I. Bureau of Land Management, Oregon – Bureau Sensitive; Oregon State Sensitive - Peripheral; NatureServe ranks this species as Globally not rare (G4), Oregon State imperiled (S2), 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 complex occurs from southwestern Oregon to northwestern California, with several disjunct populations including one as far south as Santa Cruz, California, although a potential to describe 2-4 species across this area is currently being considered. In Oregon, the species is currently known from the Siskiyou Mountains of Josephine and Jackson counties. The Oregon range is about 187,400 ha (463,075 ac). There are 17 known sites in Oregon, with 14 on federal lands. An additional five uncertain sites occur to the west of the main portion of the range.

**Specific Habitat:** This is a terrestrial salamander that does not need standing or flowing water for any part of its life cycle, yet may be found near creeks or seeps. In Oregon, it is typically found in coniferous forest or deciduous woodland habitat, under surface cover including down wood and rocks. It can be found in talus of road cuts, or along streams at dry interior sites.

**Threats:** Little has been studied about this species, so the threats listed here are based on information known about likely habitat associations and similar terrestrial salamanders in the same general area. Land-use activities that affect surface microhabitats and microclimates may impact individuals or populations at occupied sites. Forest management effects are of concern. These salamanders are also likely adversely affected by chemicals (such as herbicides, pesticides and fertilizers), rockpit mining, stand replacement fire, roads, disease, global climate change and population fragmentation.

**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 northern distribution of the species, habitat associations, distribution of suitable habitat across the species' range, 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. 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 the black salamander, *Aneides flavipunctatus*, 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. 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, and its apparent rarity in the state of Oregon. 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](http://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 black salamander 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 is not restricted to that coming from federal sources, site data were 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 Medford BLM District and the Rogue River-Siskiyou National Forest.

## Management Status

State and federal agencies classify the black salamander as a potentially vulnerable species due to its restricted distribution and vulnerability to a variety of anthropogenic disturbances. It is listed by the: U.S.D.A. Forest Service, Region 6, as Sensitive; U.S.D.I. Bureau of Land Management, Oregon, as Bureau Sensitive; Oregon State as Sensitive-Peripheral; NatureServe as

Globally not rare (G4), Oregon State imperiled (S2) and 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, and NatureServe reports it as “apparently secure” (S4) in that State. Management of the species in Oregon follows Forest Service 2670 Manual policy and BLM 6840 Manual direction.

## II. CLASSIFICATION AND DESCRIPTION

### Systematics

The black salamander (*Aneides flavipunctatus*) is a lungless terrestrial salamander of the family Plethodontidae. Members of the genus *Aneides* are known as the climbing salamanders and occur primarily in California and Oregon, with one species in the Appalachians and another in New Mexico. The black salamander is not known to be arboreal, however. *Aneides* salamanders generally can be distinguished by their relatively low number of costal grooves and large jaw muscles, male upper front teeth which can be felt when the mouth is closed, squared toe tips and prehensile tail (Stebbins 1985). The black salamander’s closest relatives are *A. ferreus* and *A. vagrans*.

The taxonomy is under study for the *A. flavipunctatus* species group. To briefly summarize, Myers and Maslin (1948) described the Santa Cruz black salamander (*A. f. niger*) as a subspecies distinct from the speckled black salamander (*A. f. flavipunctatus*), with the northernmost population of *A. f. flavipunctatus* occurring in Oregon. Lynch (1981) considered *A. flavipunctatus* to be one polytypic species, but Highton (2000) suggested that the *A. f. niger* subspecies be recognized as a species. Rissler and Apodaca (2007) developed ecological niche models for the species, combining genetic information with ecological data, which resulted in the identification of four lineages that are geographically and/or genetically distinct (Southern Disjunct, Shasta, Northwest, and Central lineages). From their analyses, they recommended two groups be elevated to species-level status, their Southern Disjunct lineage which corresponds to *A. f. niger* (i.e., *niger* Myers and Maslin 1948) and the Shasta lineage (available name: *iëcanus* Cope 1883) which occurs in the inland zone of California near Shasta Lake. They recommended that the southern end of the Northwest lineage (name not available) be delineated (especially around Mendocino County, California) before it is recognized as a separate species from the Central lineage (name available: *flavipunctatus* Strauch 1870). Although they did not sample in Oregon, their samples included locations near the Oregon-California border that were placed into the Northwest lineage. Hence, a new species name is possible for Oregon populations, but at this writing, the work appears to be in progress; hence it is premature to recognize the northern form as distinct from the Central “*flavipunctatus*” form. Tilley et al. (2008) recommended that we follow Lynch’s (1981) treatment of a single polytypic species until conclusions are available.

### Species Description

Lynch (1981) provided detailed descriptions of black salamanders. Adult black salamanders are slate to black in color, dorsally and ventrally, with small white spots or an infusion of bronze or olive coloration. Juveniles are green-gray or brassy, and the base of the limbs may be yellow with small white or blue spots. Juvenile and adult feet may appear pink (Corkran and Thoms

2006). In the northern portion of the species' range, adults are paedomorphic, retaining the juvenile greenish-gray or brassy coloration and small white spots into adulthood (Larson 1980, Lynch 1981). Adults may reach 94 mm snout-vent length (SVL, Stebbins 1985) and 160 mm total length. They have 15-16 costal grooves, and sometimes more. Larger adults have a triangular head, due in part to large jaw musculature. These salamanders have relatively short limbs with 3-5 costal folds between adpressed limbs, and unlike its congeners, toe tips are not squared.

Eggs are laid subsurface, but only one clutch has been found. Eggs are white, ~6 mm diameter, and attached to overhanging objects by a pedicel measuring 5 mm. Ovarian eggs number 5-25, with an average of 12 eggs per female dissected.

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

#### **Life History**

The black salamander is a terrestrial salamander that does not need standing or flowing water for breeding or any other part of its life cycle, although it may be found close to creeks or seeps (Stebbins 1985, Nauman and Olson 2004a). Eggs are oviposited in clutches underground. Oviposition appears to occur in July and August. In the laboratory, females stayed with eggs until hatching (Staub and Wake 2005). There is direct development of eggs into juveniles that resemble miniature adults, except with some color variation. Females seem to mature at 54 mm SVL and males at 50 mm SVL (Blaustein et al. 1995). This animal has lived 20 years in captivity (Staub and Wake 2005).

In moist microhabitats, such as in stream riparian zones and in the southern portion of the range, animals may be active on the ground surface year-round; in drier areas and to the north-interior portion of the range (i.e., Oregon sites), black salamanders may retreat subsurface during the dry summer months (Lynch 1974, 1981), June to September (Bury 2005).

These salamanders are known to be aggressive with conspecifics and predators. Their aggressive and defensive behaviors have been documented, including a bite-hold behavior, and 35% of field-caught black salamanders were scarred, suggesting they had been in conflicts (Staub 1993).

#### **Movements**

Home ranges and dispersal patterns of the black salamander are not known. These salamanders are known as good jumpers, and use their tail in jumping and locomotion (Nussbaum et al. 1983).

#### **Breeding Biology**

While little is known about breeding, it is likely that mating occurs in the fall or spring, and eggs are deposited in the early summer. One nest of 15 eggs was found 38 mm subsurface with a female in attendance (Van Denburgh 1895). Female egg brooding possibly enhances egg survival by guarding eggs from predators or caring for them in other ways (moisture retention,

anti-microbial activities). Females may deposit eggs every other year, as in other plethodontids (Blaustein et al. 1995).

### **Range, Distribution, and Abundance**

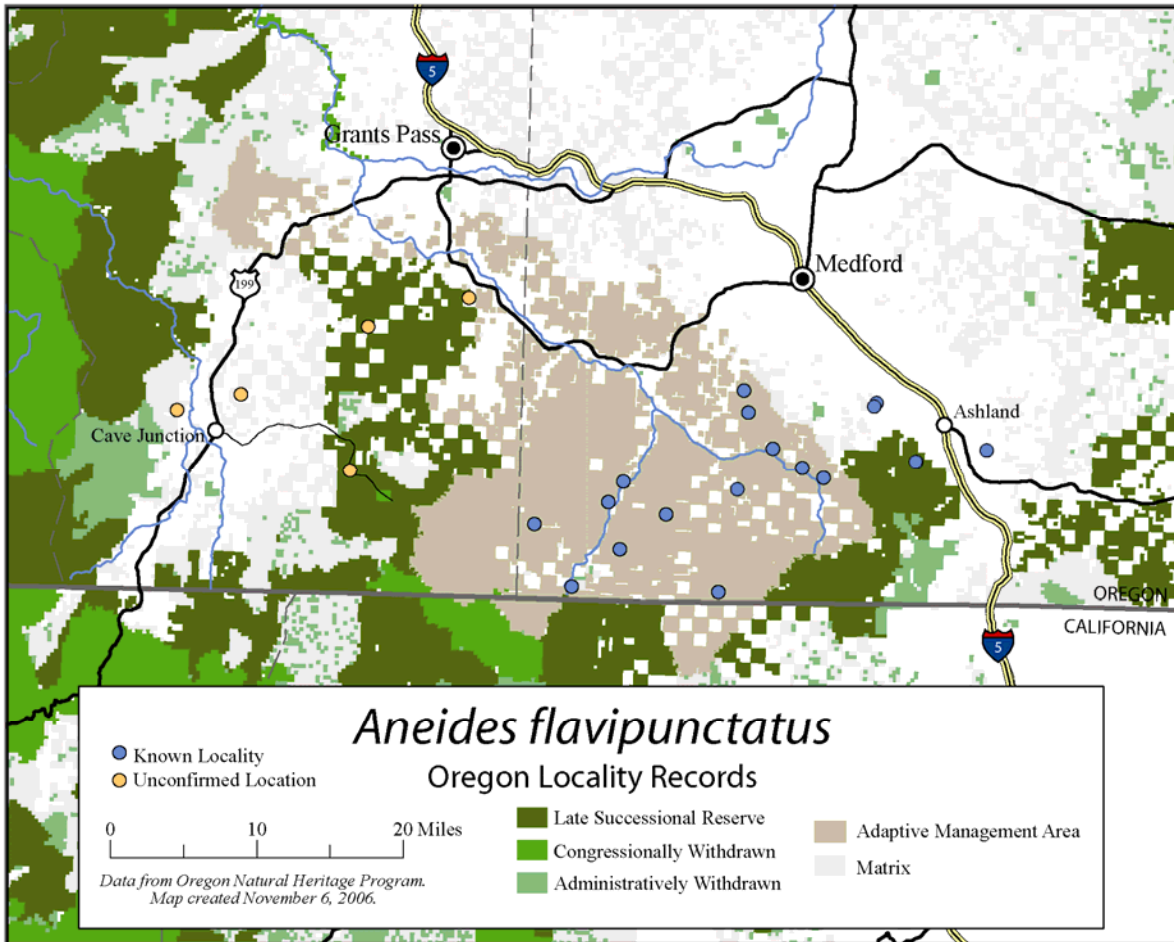
The black salamander species group ranges from southwest Oregon south along the California coastal mountains to the Russian River, Sonoma Co. There are four lineages recognized at this time (Rissler and Apodaca 2007) with the Oregon range appearing to be part of the Northwest lineage, which extends from Josephine County, Oregon, south and west into California, into the Del Norte, Siskiyou, Humboldt and Trinity Counties. A disjunct lineage, *A. flavipunctatus niger*, occurs near Santa Cruz, California, and another lineage is described from Shasta County, California. The fourth lineage occurs from southern Humboldt County to Sonoma and Napa Counties, California. Distributional gaps appear to be coincident with high elevations and xeric habitats (Larson 1980, Lynch 1974, Rissler and Apodaca 2007). Limits of the species may be related to subfreezing winter temperatures or interactions with other plethodontid salamanders (Larson 1980).

In Oregon, the current known range of the species is about 187,400 ha (463,075 acres), primarily in the Applegate watershed of Jackson County, Oregon (Figure 1). However, a portion of this range is uncertain at this time. The five site records nearest Cave Junction are uncertain (R.B. Bury, R.S. Nauman, D.R. Clayton, pers. comm.) and these localities and this portion of the potential species range warrant confirmation; black salamanders can be confused with other species, such as its congener the clouded salamander, *A. ferreus*, which is thought to occur at these locations. The Oregon range without these five western-most sites would be about half the size of the range listed above. The Medford BLM District and the Rogue River-Siskiyou National Forest are the only BLM or Forest Service lands in Oregon where this species is documented or suspected. Across its entire range, the black salamander species group occurs from sea level to about 1700 m (4,500 ft) elevation.

In Oregon, there are 17 known sites of this species (Figure 1), with 14 of the 17 occurring on federal lands, and an additional five uncertain sites to the west that warrant confirmation. The species range in Oregon is not well delineated. Gaps in both distribution and knowledge are apparent by inspecting the distribution map (Figure 1). 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. The black salamander is more common in California. Although the number of sites has not been compiled for California, Rissler and Apodaca (2007) conducted their ecological niche modeling using 502 California locations they retrieved from natural history museum specimen databases.

For this Conservation Assessment, Oregon sites were compiled from several sources, including searches of the University of California, Berkeley, Museum of Vertebrate Zoology data (however, while >400 records [i.e., specimens] were found for California, no Oregon records were found), Oregon Natural Heritage Information Center data, and data provided by D. Clayton (Rogue River-Siskiyou National Forest). Only one site in Oregon was reported from two extensive federal Survey and Manage strategic survey efforts that targeted two other terrestrial salamander species (Nauman 2001, Nauman and Olson 2004b), and no sites are known from pre-project surveys, although pre-project data records were not searched thoroughly (unpubl. data: e.g., *Plethodon stormi* electronic data available in US BLM GeoBob and US Forest Service

Fauna databases, available from K. Van Norman, federal inventory coordinator; original field forms are likely retained at the Forest Service Applegate Ranger District or BLM Medford District offices). One effort in particular involved searching for terrestrial salamanders at 52 survey points in the Applegate Watershed, Oregon, within the apparent range of the black salamander; however this study targeted habitat conditions for another species, the Siskiyou Mountains salamander, which may not match those of black salamanders and only one black salamander was reported from these surveys (J. Reilly, pers. comm.).



**Figure 1. Oregon known sites of *Aneides flavipunctatus*, the black salamander, showing distribution relative to federal land allocations of the Northwest Forest Plan.**

Patterns of abundance in Oregon are not well known. In 1994, Bury (1995, pers. comm.) found black salamanders at 3 of 49 survey sites in the BLM Medford District, Ashland Resource Area, east of Yale Creek. Eighteen black salamanders were captured of 156 salamanders total (11.5%), and 14 of 18 were at south-facing sites and 4 were at north-facing sites (however, few northward sites were searched). During aquatic surveys conducted during the same timeframe, no black salamanders were found.

In California, several studies have information on site-specific occurrence patterns. First, north of Shasta Lake (in the range of the Shasta lineage, which may be recognized as a different species soon: Rissler and Apodaca 2007), black salamanders were the amphibian with the highest capture rate in a sample of randomly selected sites surveyed for terrestrial salamanders with streamside and upslope transects (Nauman and Olson 2004a). They occurred at 30 of 40 sites sampled, and had a mean capture rate of 0.978 salamanders per person-hour of search effort. Second, Nauman and Olson (2008) sampled for terrestrial salamanders at randomly selected sites on federal lands just south of the Siskiyou Mountains crest in California (likely to be same lineage as in Oregon: Rissler and Apodaca 2007). They found only 14 black salamanders at 6 of 69 (8.7%) sites surveyed, with a maximum of 6 animals at one site, a mean of 2.3 animals per site with black salamanders, and a relative abundance of 0.004 salamanders per square meter and 1.17 salamanders per person-hour of survey effort. In contrast, both ensatina and Siskiyou Mountains salamanders were found more often in this study. Third, R.B. Bury (unpubl. data, pers. comm.) conducted time-constrained surveys (1 person-hr per site, 31 sites) west of Redding, California, in which black salamanders dominated captures (n = 66 animals, 9 sites [29%]; an additional 4 animals were caught during opportunistic searches; 59 ensatina were found at 12 sites [38.7%]). In their aquatic searches in the area, only one black salamander was detected during headwater belt surveys (1 x 5 m long along a 50-m reach; 3 ensatina found) and no black salamanders were found walking along the edges of 6 large water bodies, but no cover objects were turned. Fourth, Bury et al. (2005, pers. comm.) found black salamanders during surveys in the Whiskytown National Recreation Area; they occurred at only 2 of 50 terrestrial sites where 2 person-hr searches were conducted per site.

## **Population Trends**

Little is known about population trends in this species in Oregon. In California, vineyards have altered much of their habitat and the animal has become rarer in those locations (Staub and Wake 2005).

## **Habitat**

The black salamander occurs in coniferous forests, mixed coniferous-hardwood forests, deciduous woodlands, open hillsides, coastal grasslands, meadows, and forested riparian areas, from sea level to ~4,500 ft (1,400 m) elevation (Bury 2005). At many interior sites, dry site conditions are apparent. However, in one California study, Welsh et al. (2005) found black salamanders occurred in higher abundances in late-seral forests in comparison to mixed grasslands. Welsh and Lind (1991) found the black salamander was not associated with forest age classes (young, mature, old) but was most abundant in mature stands. It can occur along streams and near seeps, and may be restricted there at some interior sites (Nauman and Olson 2004a, Bury 2005). Welsh et al. (2005) found a significant association of black salamander abundance with intermittent stream reaches.

The multivariate bioclimatic models developed for the four black salamander lineages by Rissler and Apodaca (2007) found them to be distributed in unique “environmental space.” The climatic attributes which appeared to distinguish the occurrences of the Northwest lineage, the lineage that likely extends into Oregon, from the other three lineages included: 1) more precipitation in the warmest quarter of the year; 2) more precipitation in the driest quarter of the year; and 3)

lower mean temperature in the wettest quarter of the year. Lynch (1974) showed that this salamander group mostly occurs in areas with annual precipitation >75 cm.

Microhabitat for black salamanders includes surface cover such as down wood (in or under logs, under bark or boards) and rocks (Lynch 1981). They frequent talus slopes and have been found in the talus exposed by road cuts. At interior sites, they have been found among rocks along streams. There is uncertainty regarding the species' reliance on any one type of microhabitat attribute, and its use of microhabitat features may be dependent on overall site conditions.

### **Ecological Considerations**

Terrestrial salamanders are centrally nested in food webs. In California, the diet of black salamanders included invertebrates from at least 25 orders, with the following six orders accounting for 78% of the pooled prey volume: Diplopoda, Coleoptera, Hymanoptera, Isoptera, Diptera, and Collembola (Lynch 1985). Pseudoscorpions also have dominated gut contents in one sample (R.B. Bury, pers. comm., n ~ 16 animals). Site and seasonal prey differences were noted in Bury's study, and one animal had 500 prey items in its stomach, but most stomachs contained 5-50 prey. Larger animals take fewer, larger prey. Predators are not well documented, but include western terrestrial garter snakes (Staub and Wake 2005). To deter predators, they have a defensive posture and noxious skin secretions.

Across their range, black salamanders co-occur with several plethodontid salamanders, such as ensatina and Del Norte salamanders (R.B. Bury, pers. comm.), yet interspecific dynamics are unstudied.

## **IV. CONSERVATION**

### **Land Use Allocations**

Relationship of the species' distribution to lands managed under Land and Resource Management Plans as amended by the federal Northwest Forest Plan is a key consideration for conservation in Oregon. Of the 17 currently known sites in Oregon, 14 (82%) occur on federal lands. Of these, 1 (7% of federal sites) occurs within a Late-Successional Reserve land-use allocation and 13 (93% of federal sites) occur within the Applegate Adaptive Management Area. It is unknown how many of these sites may be within Riparian Reserves. One black salamander site occurs at a site proposed for salamander species conservation as part of the federal Siskiyou Mountains salamander Conservation Strategy, which was approved as a multi-agency Conservation Agreement in 2007 (Olson et al. 2007). Since habitat descriptions are broad, and somewhat unknown, it is difficult to discern how much habitat for this species is within protective land allocations under the federal Northwest Forest Plan.

### **Threats**

Threats to this species are not studied. Suspected threats across the species' entire range include activities that degrade likely habitat and microhabitat conditions used by this ground-dwelling species. In California, forest and oak woodland-mixed grassland conversion such as the

development of vineyards is proposed to be linked to losses of this animal in portions of its range (Staub and Wake 2005). 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. Thomas et al. (1993) indicated that this species was an old-growth associated species, and rated it to be at medium to high risk under some forest management schemes. While 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, this species occurs in a fire-disturbance ecosystem, and may be able to persist with relatively frequent low intensity ground fires. Relative to other plethodontid salamanders in the northwest, this species often occurs in drier sites, but it appears to rely on moist microhabitats (deep talus, stream courses); altered habitat conditions could particularly affect this animal if it occurs near the limits of its tolerance, but this is largely conjecture. Chemical applications, rockpit mining, roads, disease, and global climate change are potential threats. Additionally, loss of connectivity among habitat patches is a concern due to the likely limited mobility of these animals across the landscape and consequent population isolation.

### ***Timber Harvest***

Timber harvest is a primary land management practice in forested ecosystems in the geographic region of this species' range in Oregon and historic regeneration harvest practices are estimated to have had several effects on the species and its habitat. One California study (Welsh et al. 2005) found black salamanders occurred in higher abundances in late-seral forests in comparison to mixed grasslands, supporting a forest dependency. Welsh and Lind (1991) found the black salamander was not associated with forest age classes (young, mature, old) but was most abundant in mature stands. At this time, the scope of timber harvest as a threat is uncertain. Potential adverse effects on this species and its likely habitats may occur from loss of overstory if that results in altered microclimates beyond the limits of tolerance of this animal, loss of down wood upon which this animal relies, and ground compaction reducing interstitial spaces through which the animal maneuvers subsurface. For example, loss of standing green trees reduces the future potential for down wood recruitment on the forest floor. As new trees regenerate in harvested stands, their smaller sizes likely do not provide the same functions for salamanders for several decades to centuries. 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. Talus substrates may provide microhabitat refugia for this species in Oregon, such that it has a reduced reliance on down wood. These potential effects on the black salamander warrant further study.

It bears acknowledgement at this time to recognize that not all timber harvest practices are equal. Some harvest practices, including deployment of riparian reserves, may have a reduced, minor or no impact on black 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. Conceptually, the effects of timber harvest may vary with the practices

implemented as well as site condition. In particular, we do not know if aspect, and metrics such as hill-shading or heat index might interact with the disturbance of timber harvest. Again, this warrants study relative to black salamanders.

Within the Oregon range of the black salamander, forest habitat is fragmented both naturally and by past timber harvest practices, and is a patchwork of stands of different seral stages, from early seral to mature forests, and with differing timber harvest practices over time and space. Sites with salamanders are nested within this patchy forested regime. There are no estimates of how much area within the species' range has been impacted by timber harvest activities, but 16 of 17 (94%) salamander localities occur on land allocations in which timber harvest activities may occur (nonfederal lands, federal Adaptive Management Area). On federal lands alone, 13 of 14 (93%) sites are on these managed lands.

### ***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.

### ***Rockpit Mining***

Rockpit mining potentially affects this species by direct substrate disturbance. There are no data that directly address this activity relative to these salamanders, however.

### ***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. The effects of a more intense level of fire disturbance due to fire exclusion and fuel loading is of concern in that stand replacement fire represents a more catastrophic disturbance to flora and fauna. In particular, relative to black 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 reduces existing down wood. Two reports have found this animal in recently burned areas: 1) Wood (1936) reported finding black salamanders in two burnt-over areas in California, and they were not found in adjacent forest; 2) Nauman and Olson (2004a) found black salamanders in two sites that had been burned 2 years previous to the sampling effort. The intensities and scales of the fires in these instances were not reported.

### ***Roads***

Many roads have been constructed within the range of the species. While roads may compact substrates, making them unsuitable habitat, salamanders have been found in the adjacent road cuts where talus has been exposed. Road kill is not documented for this species, and it is uncertain if it is an important factor. Other aspects of roads that may have adverse effects on black salamanders include an altered chemical environment or microclimate. It is unknown if

roads act as barriers for this salamander.

### ***Disease***

Current research on global amphibian declines is focusing on the effects of disease agents. While disease has not been implicated for this salamander, the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) 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.

Disease warrants mention here to alert biologists to be aware of and report observations of ill or dead animals. Individuals or tissues collected can be analyzed at regional or national laboratories.

*Bd* may be spread from boots or nets, wildlife, translocated animals including fishes, or movement of water (e.g., during fires).

### ***Global Climate Change***

Oregon represents the northern margin of the range of the black 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. The association of this species with bioclimatic attributes was supported by Rissler and Apodaca (2007). 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 of the Siskiyou Mountains become less suitable for the species. Also, it is possible that additional “new” habitats might become available for this species in Oregon, which is at the northern extent of the species’ range. Although more extremes in conditions might forestall the ability of these animals to use habitats that on average appear suitable. Warming trends also 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***

Larson’s (1980) genetic study found isolated populations of this animal and proposed dispersal may be hindered by topography, climate, or interspecific interactions (e.g., competition or predation, however there is no further information on this aspect to support how interactions might play a role in this species’ geographic distribution). Rissler and Apodaca (2007) conducted ecological niche modeling and found geographic and climatic factors were associated with the four distinct lineages of black salamanders that they described. Additional disturbances to habitat quality, including all of the potential threat factors cited above, can increase the natural isolation of populations that Larson considered over a quarter of a century ago.

### **Conservation Status**

This species is of concern due to its extremely limited distribution and rarity in southwestern Oregon and potential vulnerability to several threats. 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 in Oregon. Optimal habitat, while not well understood, may be patchy across the landscape.

### **Known Management Approaches**

This species was determined to be a close associate of late-seral or old-growth forest conditions (Thomas et al. 1993, Welsh et al. 2005) and hence was addressed by the Northwest Forest Plan across the range of the northern spotted owl (USDA and USDI 1993, 1994). Habitat protections offered by the Northwest Forest Plan, including federal riparian reserves, reserved land allocations, and down wood provisions, likely reduced concern for the species. Specifically, the USDA and USDI (1993) reported this to be a riparian-associated species. In a panel assessment conducted by vertebrate experts, this species was estimated to fare well under the Northwest Forest Plan (USDA and USDI 1993). It was ranked in the top two categories assessing likelihood of persistence on federal lands: 1) it was considered to have a 75% chance that it would be well-distributed on federal lands; and 2) it was rated to have a 90% chance that it would be either well-distributed or locally restricted. Riparian reserves were judged to be an effective mitigation measure for the 25% of the species' range estimated to coincide with federal lands. Recently, its significant association with intermittent stream reaches (Welsh et al. 2005) suggests the riparian protection applied to the uppermost headwater reaches may be critical for this species. However, what extent of riparian protection is needed has not been examined. It should be noted that the Northwest Forest Plan assessment (USDA and USDI 1993) covered a significantly larger portion of the species' entire range than just the small section in Oregon, such that a heightened risk to a small portion of the range may have seemed inconsequential to the entire species' range. Nevertheless, as federal riparian or other reserves transect habitat for this species in Oregon, protection is likely offered. Some of the federal reserved lands within this species range are at high elevations, and it is not known if such areas provide optimal habitat for these terrestrial salamanders. However, they have been found to ~4,500 ft (1,400 m) elevation (Bury 2005). Also, the down wood provision of the Plan likely provides benefits to this species, but to what extent is unknown.

As previously mentioned, at least one black salamander site was found to be coincident with those of the Siskiyou Mountains salamander, and was identified as a "high priority" site for species persistence in the development of the conservation strategy for the latter species in Oregon. Management guidelines for the Siskiyou Mountains salamander would benefit this second species, so that piggy-backing protection is an efficient approach.

In Oregon, the US Forest Service 2670 sensitive species policy, and the BLM 6840 special 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 black 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.

### *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 the species, 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 for historically occupied watersheds are listed above, and should be considered during development of site-level and basin-level management approaches.

### *Specific Considerations*

Specific considerations for the black 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 black salamanders.

The following should be considered as habitats with black 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 or are highly suspected to occur:

- Maintain the integrity of substrates for subsurface refugia and retain cool, moist microclimates during the following activities:
  - rockpit mining
    - \* Consider disturbing only a proportion of habitats occupied by salamanders to maintain site-level persistence
  - timber harvest
    - \* 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.

- \* Implement and maintain riparian reserves (including along ephemeral and intermittent streams).
- Manage to reduce likelihood of stand replacement fires by reducing fuel loads both within the occupied area, and in the immediate surrounding landscape.
  - Within the occupied area, consider hand piling, placing piles outside of the occupied patches.
  - Consider pile burning or other management activities during drier conditions, as possible, to reduce potential for direct mortality to dispersing or mobile salamanders.
- 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.
- Restrict chemical applications.
- Disinfect field gear between sites if disease agents become known.
  - Disinfection guidelines to reduce risk of transmission of *Bd* among water bodies by field gear are under development and at this time include bleaching equipment between uses in different aquatic locations (e.g., 20% bleach solution, 30 seconds, e.g., 22 ounces of liquid Clorox per gallon water; alternatively, 7% bleach solution, 10 minutes, e.g., 9 ounces of liquid Clorox per gallon water; additional guidance available at: [http://www.fs.fed.us/r4/resources/aquatic/guidelines/aq\\_invasives\\_interim\\_fire\\_guidance08\\_final.pdf](http://www.fs.fed.us/r4/resources/aquatic/guidelines/aq_invasives_interim_fire_guidance08_final.pdf)).
- Seasonally restrict activities to summer weather 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 (cool, moist conditions) 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. Of primary importance, 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 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?

Second, we have no studies addressing the effects of land management activities on this species. What is the effect on the animal of timber harvest, with varying degrees of green tree 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 we consider, how wide should buffers be)? Do federally reserved land allocations protect this species?

Third, we have 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? How far do these animals move? 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 we have 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. A habitat map would be a great asset to federal land managers within the species' range.

In 2009, the BLM Medford District and the Rogue River-Siskiyou National Forest received ISSSSP funding to conduct known site and purposive surveys for black salamanders. The aim of the known site surveys will be to determine more accurate coordinates of historic sites for which we have only general descriptive locations. The goal of purposive surveys will be to search for additional black salamander sites, and collect information to increase our understanding of suitable habitat conditions. In particular, purposive surveys will begin to explore whether or not this species has an association with riparian areas in Oregon.

Time-constrained searches have been particularly effective for assessing the occurrence of black salamanders (e.g., Nauman and Olson 2004a, 2008; R.B. Bury, pers. comm.) and other plethodontids in the region (e.g., 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 their area, but R.B. Bury (pers. comm.) suggested the method may be ineffective for black salamanders (i.e., the genus is known as “climbing salamanders”). 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 black 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).

## **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 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 this species habitat associations and how various forest management practices may affect these salamanders. A comparison of known sites with and without timber harvest could help to provide a better understanding of timber harvest impacts. Also, movement ability is unknown, and could aid in designing protection of sites and retention of connectivity between neighboring sites to reduce potential fragmentation.

The use of the federal GeoBOB/NRIS databases could 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. Sites surveyed with no detections also should be reported in these databases; these data can better enable potential future investigations of relationships of salamander distributions with available data on vegetation types, slope, aspect, topography, elevation, riparian areas, land allocation, land ownership, historical disturbances, and current disturbances.

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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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