Conservation Assessment for the

Rocky Mountain Tailed Frog in Oregon and Washington

(*Ascaphus montanus*)

Version 1.0

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Deanna H. Olson

Tadpole photographed by Brome McCreary

U.S.D.A. Forest Service Region 6 and U.S.D.I. Bureau of Land Management
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This Conservation Assessment was prepared to compile the published and unpublished information on the Rocky Mountain tailed frog (Ascaphus montanus). 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/issssp/contactus/

Executive Summary

Species: Rocky Mountain Tailed Frog (*Ascaphus montanus*)

Taxonomic Group: Amphibian

Other Management Status: U.S.D.A. Forest Service, Region 6, Oregon - Sensitive; U.S.D.I. Bureau of Land Management, Oregon – Sensitive; Washington State, Species of Concern – State Candidate; Oregon State, Sensitive – Vulnerable; NatureServe, Globally not rare and apparently secure (G4), Oregon State imperiled (S2), Washington State imperiled (S2?); Oregon Biodiversity Information Center - List 1 – taxa that are threatened with extinction; and US Endangered Species Act – Species of Concern. Management of the species follows Forest Service 2670 Manual policy and BLM 6840 Manual direction.

Range: The species ranges from the southeastern corner of Washington and northeastern corner of Oregon through central Idaho and the panhandle of Idaho into northwestern Montana and the southeastern corner of British Columbia. In Oregon and Washington, it is known from the Blue Mountain ecoregion, from the Wallowa Mountains in Oregon and the Blue Mountains in Washington, in four Oregon counties (Baker, Umatilla, Union, Wallowa) and three Washington counties (Asotin, Columbia, Garfield). The Oregon and Washington combined range is about 37,820 ha (~934,600 ac). There are 276 site records total in Oregon and Washington, and as sites of individual frogs are condensed to reflect distinct stream reaches, this number reduces to 51 condensed sites.

Specific Habitat: This is a stream-breeding frog reliant on cool, perennial streams with coarse substrates, often small streams with high gradients, within forested uplands. Although juveniles and adults are not restricted to streams and may disperse into upland forests, this species appears more stream-oriented than the coastal tailed frog (*A. truei*) due the drier upland landscape within its range.

Threats: Land-use activities that alter stream temperatures, substrates, and peak stream flows may affect tailed frogs at occupied sites. Forest management and road construction/maintenance effects are the greatest concern due to increases in stream temperature or peak flows from canopy removal, and increases in stream siltation from erosion. These frogs are also likely adversely affected by chemicals, such as herbicides, pesticides, fertilizers, and possibly fire retardants. Stand replacement fire, grazing, floods, disease, global climate change, introduced species, and population fragmentation are also concerns.

Management Considerations: Considerations for maintaining local populations include maintaining the integrity of stream substrates and microclimates at occupied sites. Reducing the impact of forest management and road work are key considerations. Riparian buffers, upland canopy retention, and reduced stream substrate disturbance would benefit this species.

Inventory, Monitoring, and Research Opportunities: Information gaps include the distribution of the species, reliance on upland habitats, life history, habitat associations, and threats to the species.

TABLE OF CONTENTS

I. INTRODUCTION

Goal

The primary goal of this conservation assessment is to provide the most up-to-date information known about the Rocky Mountain tailed frog (*Ascaphus montanus*) 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 a vertebrate endemic to Oregon, Washington, Idaho, Montana, and British Columbia, Canada; its known range in Oregon is restricted to the northeast portion of the state, and its range in Washington is in the extreme southeast corner. In Oregon and Washington, it is recognized as a potentially vulnerable species by various federal agencies and by the states of Oregon and Washington because of its restricted range and its potential susceptibility to land management activities that occur within this portion of its range. The goals and management considerations of this assessment are specific to BLM and Forest Service lands in Oregon and Washington. 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/Washington BLM SSS is available on the Interagency Special Status Species website (www.fs.fed.us/r6/sfspnw/ISSSSP).

For lands administered by the Oregon/Washington Bureau of Land Management (OR/WA BLM), SSS policy (6840 manual and IM OR-2009-039) details the need to manage for species conservation. BLM shall further the conservation of SSS and shall not contribute to the need to list any SSS under provisions of the ESA.

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

Scope

While the synthesis of biological and ecological information for the species focuses on information from eastern Oregon and Washington, range-wide references also are highly relevant and are included, and general information on the genus *Ascaphus* is included to describe general "tailed frog" characteristics. This Conservation Assessment relies on published accounts, reports, locality data from individuals and databases, and expert opinion, each noted as appropriate. Although information compiled here is not restricted to that coming from federal sources, the scope of the management considerations of this assessment are specific to BLM and Forest Service lands in Oregon and Washington. The known range of the Rocky Mountain tailed frog on federal lands in Oregon and Washington includes the Umatilla National Forest and Wallowa-Whitman National Forest. The species may occur on BLM's Vale District.

Management Status

The Rocky Mountain tailed frog is listed by the: U.S.D.A. Forest Service, Region 6, Oregon - Sensitive; U.S.D.I. Bureau of Land Management, Oregon – Sensitive; Washington State, Species of Concern – State Candidate; Oregon State, Sensitive – Vulnerable; NatureServe, Globally not rare and apparently secure (G4), Oregon State, imperiled (S2), Washington State, imperiled (S2?); Oregon Biodiversity Information Center - List 1 – taxa that are threatened with extinction; and US Endangered Species Act – Species of Concern.

II. CLASSIFICATION AND DESCRIPTION

Systematics

The two Pacific Northwest frog species of the genus *Ascaphus* (tailed frogs) are currently placed in the family Leiopelmatidae (Frost 2010). This family also includes the bell toads, genus *Leiopelma*, of New Zealand. Extinct frog fossils linking the extant *Ascaphus* and *Leiopelma* have been found in Argentina. Leiopelmatids have a suite of primitive characteristics, such as tail wagging muscles (Green and Cannatella 1993), and are considered the most ancient frogs in the world; this family is phylogenetically a sister taxon and a basal lineage to all other frogs (Cannatella and Hillis 1993, Ford and Cannatella 1993, Ritland et al. 2000, Frost et al. 2006, Roelants et al. 2007). However, based on their time of divergence by the Jurassic (> 200 million years ago; Savage 1960, 1973), separation of *Ascaphus* frogs into the family Ascaphidae was suggested (Bossuyt and Roelants 2009).

Until recently, only one tailed frog species was known in the Pacific Northwest: *Ascaphus truei* Stejneger, 1899. Originally found west of the Cascade Range crest in Washington and Oregon and in north-coastal California, tailed frogs were reported in western Montana in 1932 (Smith 1932), and two years later they were reported to occur west of the Continental Divide near Glacier National Park (Donaldson 1934). The coastal-inland disjunct distribution of tailed frogs has remained a geographic pattern through the present, with a broad gap in distribution east of the Cascade Range. These species' occurrences in mesic forests west of the Cascade Range and in the Rocky Mountains suggested phylogenetic divergence, similar to at least 156 other mesic forest taxa with this geographic pattern (Nielson et al. 2001; these species include two other cold stream-associated amphibians, *Dicamptodon tenebrosus/aterrimus* and *Plethodon vandykei/idahoensis*). This divergence has been associated with the building of the Cascade Range during the Miocene and Pliocene (28-10 million years ago), and subsequent climate change events that occurred in the region (Savage 1960, 1973; Nielson et al. 2001).

In 1979, a study of tailed frog allozymes using electrophoresis supported genetic distinction of the Rocky Mountain form (Daugherty 1979). In 2001, the Rocky Mountain tailed frog, *Ascaphus montanus* Mittleman and Myers, 1949*,* was formally described using the more powerful mitochondrial DNA analyses (Nielson et al. 2001). This division was later supported by additional analyses (Nielson et al. 2006). Morphological differences were found by Mittleman and Myers (1949), Metter and Pauken (1969) and Pauken and Metter (1971), but morphological differences between the two tailed frog forms were not detected in one analysis (Metter 1967). Crother (2008) and the Center for North American Herpetology (http://www.cnah.org/) identify the species as "Rocky Mountain tailed frog" and that common name is used here, although the name "inland tailed frog" is sometimes used. Similarly, the coastal tailed frog is sometimes referred to as the Pacific tailed frog (http://www.cnah.org/). Ecological differences between coastal and Rocky Mountain tailed frogs have been reported subsequently (Karraker et al. 2006), and biochemical differences of skin secretions between the two tailed frogs similarly support separate species status (Conlon et al. 2007).

Furthermore, two Evolutionary Significant Units (ESUs) of *Ascaphus montanus* have been recognized (Nielson et al. 2006). These distinct groups are separated by the Salmon River into populations occurring: 1) south of the South Fork of the Salmon River, Idaho; and 2) north and west of the Salmon River, including animals in the Blue, Wallowa, and Seven Devils Mountains (Nielson et al. 2006). Rocky Mountain tailed frogs in Oregon and Washington belong to this second ESU.

Species Description

Adult tailed frogs can be distinguished from other frogs using a suite of traits: 1) the eye has a vertical pupil; 2) there is no distinguishable "ear" (tympanum); 3) the outermost hind toes are broad and flat; and 4) males have a "tail", which is an extended cloaca that is used as a copulatory organ for internal fertilization during mating. Dorsal coloration can vary from tan, brown, reddish brown, green, or gray, to mottled gray with yellow. Ventral coloration is light, pink, tan, or gray. The skin texture is rough, grainy, or bumpy with small tubercles, and an eye stripe extends from snout to forelimb. There is extensive hind-toe webbing. This is a relatively small frog, with the total length of adults reaching 45 mm for males (without tail) and to 51 mm for females. During the breeding season in late summer and fall, males develop secondary sexual characteristics: black nuptial pads on their hands and forelimbs; tubercles on their sides; chin and pectoral area; and cloacal spines (Metter 1963, 1964a, b). Presumably these male features aid in the clasping of females and improve mating success.

Larval tailed frogs are the life history form most commonly encountered in streams. Larvae are easily distinguished by their round suction cup mouth morphology. Larvae can attach to rocks in fast-flowing streams using this sucker-like mouth. Larval coloration varies from cream (small/young individuals), to tan, brown, dark gray, or black. The tail tip may have a white spot. Rocky Mountain tailed frogs have a 3-year larval period, and 3 age classes may be distinguished by total length and emergence of limbs. Larval lengths can be variable among years or sites, likely due to site conditions such as water temperature. Mean total lengths of larvae in July from 6 Idaho sites from 1997 to 2010 ranged: 23.6 – 34.8 mm for 1-year olds; 35.1-51 mm for 2-year olds; 44.7 – 57.2 mm for 3-year olds (maximum size of a 3-year old was ~60 mm); and 3-year olds shrink when they transform (K. Lohman, USGS, pers. commun.). Metter (1964a) reported that hatchlings were 10-15 mm long, yolk sacs were absorbed by 20-21 mm, 1-year-olds were ~32 mm, 2-year-olds were ~45 mm with emerging hind legs, 3-year larvae may reach 75 mm with emergent fore and hind legs, and transformation may take 60 days in the animal's third year.

Several adult and larval characteristics differed between populations in the Blue Mountains, Washington, and Palouse River, Idaho (Metter 1963). Washington adults had fewer skin tubercles, more extensive hind foot webbing, more uniform color, and larger internasal distances, with female internasal distances being greater than male distances. Washington larvae had narrower oral discs and longer tails, and were solid black on the dorsal and lateral surfaces.

Tailed frog eggs are found in clutches of 45 to 70 eggs (Brown 1989; K. Lohman, USGS, pers. commun.; mean of 88 Rocky Mountain tailed frog clutches was 66.6 eggs, Karraker et al. 2006), although Metter (1964a) reported female Rocky Mountain tailed frogs with up to 85 developing embryos in dissected specimens. Eggs are attached to each other in a single a gelatinous string. The clutch may be found on the underside of stream rocks, often in a cluster. Communal nests of Rocky Mountain tailed frogs were found 41% of the time (Karraker et al. 2006). Since Karraker et al. (2006) was published, additional double clutches have been seen in the Palouse River, Idaho (K. Lohman, USGS, pers. commun.). Eggs are white with a diameter of 4-5 mm, which are the largest eggs for North American frogs (Brown 1975, 1989).

Figure 1. Rocky Mountain tailed frog larva, *Ascaphus montanus* (photograph by Jason Jones).

Figure 2. Tailed frog larva showing sucker-like mouth (*Ascaphus truei* shown, photograph by Brome McCreary).

III. BIOLOGY AND ECOLOGY

Life History

This is a stream-breeding frog that may venture into riparian zones and uplands after metamorphosis and when not breeding. It appears to be nocturnal, emerging from streams at dusk (Metter 1963). The breeding season is thought to occur in the late summer to fall, when males fertilize females. This fall breeding season is supported by the development of male secondary sexual characteristics in July to October, with the maximum size of nuptial pads, tubercles and cloacal spines in September and October (Metter 1964a). In northeastern Oregon, Bull and Carter (1996b) found 6 pairs of frogs in amplexus, 4 pairs in August (one of these was a male-male pair), one pair in September, and one pair in October. Three pairs were floating upside down in stream pools.

Females retain sperm until the following spring or early summer after stream flows subside, when they oviposit (Metter 1964b). Eggs are attached to stream rocks, and hatch after about 6 weeks. Karraker et al. (2006) reported hatching to occur 17 July to 14 August, after a ~30 day oviposition period, a period that was considerably shorter than that of coastal tailed frogs (81 days). They reported 25% of the variation in oviposition period was explained by water temperature for the Rocky Mountain tailed frog. Nests with recently hatched larvae were found in August and September in southeastern Washington and Idaho (Metter 1964a).

Hatchlings feed off their yolk sac initially, and stay near oviposition sites over the first winter. Larval sucker-like mouthparts are developed by the following spring, allowing them to withstand stream current. This pattern was supported by a study in Idaho, 1997-2009, where oviposition occurred in July, hatchlings were present in September, and emergence of the new larval cohort into the stream reach occurred the following spring (K. Lohman, USGS, pers. commun.).

Tailed frog larvae can live several years within streams (Brown 1990). Metamorphosis of Rocky Mountain tailed frogs occurs in the late summer to fall of the larvae's third year: July-August in Idaho (K. Lohman, USGS, pers. commun.); July –September in Oregon (Bull and Carter 1996b). It may take up to 8 years for a tailed frog to reach sexual maturity (Daugherty and Sheldon 1982). This is a relatively long-lived frog, reaching 15 to 20 years.

Movements

Rocky Mountain tailed frog movements are poorly understood, especially juvenile movement patterns. This frog is thought to have limited overland dispersal (Daugherty 1979). In the Blue Mountains of Washington, Metter (1963, 1964a) speculated that the open and dry ridges between stream drainages were "strong barriers to dispersal" of Rocky Mountain tailed frogs. This conjecture was supported during his surveys of the area by the distribution of tailed frogs in disjunct pockets, where only short sections of each stream within a drainage were inhabited. In Idaho, he found creeks inhabited by larvae along 500- to 600-yard reaches (457-549 m), and no adults were observed more than 150 yards (137 m) from creeks. In the spring, adults were found up to 40 ft (12 m) from streams after snow melt. In the summer, animals were only found along creeks. Metter (1964a) stated that Rocky Mountain tailed frogs were much more restricted to streams than coastal tailed frogs, which may have resulted in the relatively higher densities of adults found along inland streams.

Metter (1963) thought that the Washington animals he studied moved from the larger stream into tributaries in the summer. He attributed this movement pattern to the "intense sunshine and low relative humidities" along the larger stream. Adams and Frissell (2001) found tailed frogs in a Montana creek moved downstream in October.

When disturbed in the stream, they folded their limbs against their body and allowed the water current to carry them (Metter 1963). This suggests that downstream movements may occur via this passive drifting or 'rafting' behavior. Other anurans raft downstream like this, including western toads (*Anaxyrus boreas*, Adams et al. 2005).

Metter (1963, 1964a) described Rocky Mountain tailed frogs as nocturnal, emerging from stream habitats at dusk. He also noted they were agile, able to "surmount large logs and even climb streamside vegetation".

Genetic analyses indicated an exchange rate of 10 migrants per year between the northern and southern populations of this frog, supporting limited dispersal at larger spatial scales (Nielson et al. 2006).

Breeding Biology

Most reports of tailed frog breeding discuss fall mating and spring oviposition. Metter (1963, 1964a) reported early fall mating and June to August oviposition for Rocky Mountain tailed frogs in Idaho and southeastern Washington. Karraker et al. (2006) found oviposition ranged from 24 June to 20 July. However, some spring mating has been observed in Idaho (K. Lohman, USGS, pers. commun.). The following scenario suggests that spring mating can occur in coastal tailed frog as well; the quote is included here to describe the mechanics of breeding in this group which is an anomaly among frogs. Mating of coastal tailed frogs in Mount Rainier National Park, Washington, on May 17, 1930 was described by Slater (1931):

> "When the male and female met, the male crawled on the female's back and clasped here around her body opposite the sacrum, not posterior to her fore limbs as most other Anura do. Whereupon the female straightened her hind limbs so that they extended posteriorly in the same general line of the body and held them so that they formed a narrow V. The male flexed his sacroiliac joint so that his pelvis made nearly a right angle with his vertebral column. Then by muscular manipulation bent his so-called "tail" vertically so that it made nearly a right angle to his pelvic girdle and brought it into position to transfer sperm to the female. This "tail", when the male is in a natural position, points posteriorly, but with the two flexes mentioned above it comes to point anteriorly."

Metter (1964b) documented mating in September and October 1964. Males clasped any adult frog, male or female. Females appeared to resist clasping by striking the V position described by Slater (1931), quoted above. Matings lasted to 48 hours, during with the male's fingers were interlocked, and his intromittent organ was purple, indicating it was engorged with blood. Successful mating occurred when the female's legs were drawn up into a more natural resting position. Adult male clasping pads and tubercles appeared from September to November (Metter 1964a, b). November dissection of females revealed sperm storage, and developing eggs that were 0.8 to 3.3 mm in diameter; it was estimated that these eggs would have been oviposited the following July, in 1965. Metter (1964a) suggested that sperm may be retained for 2 years.

Oviposition sites have been found under large rocks within streams (Metter 1963). Karraker et al. (2006) reported on tailed frog oviposition, comparing coastal and Rocky Mountain tailed frogs. They reported that all clutches were attached beneath rocky substrates, likely protecting them from stream flows. They found that Rocky Mountain tailed frogs oviposited more frequently on boulders (57% of clutches; vs. cobble or gravel), in stream riffles (vs. cascades or pools) with cold water (~11°C). Communal oviposition occurred in 7 of 17 (41%) sites.

There is no mating call, and mates may find each other by visual or chemical cues. Females may breed every other year (Metter 1964a) to every 3 years (Daugherty 1979).

Range, Distribution, and Abundance

The Rocky Mountain tailed frog occurs in the extreme southeast corner of British Columbia, Canada, western Montana, north and central Idaho, southeast Washington, and northeastern Oregon (Figure 3). In Oregon and Washington, knowledge of the species' distribution comes from historic records and from a variety of studies and observations spanning the last several decades, 1950s to 2000s.

Herein, a compilation of historic records is reported. Data were compiled from the Washington State Department of Fish & Wildlife, Wildlife Survey and Data Management Database (L. Salzer, pers. commun.; dates of surveys ranged from 1958 [4 records] to 2006 [1 record], with one record in 1961, 3 records in the late 1990s, and 22 total records from the 2000s; dates for all records were not included in the data received), Oregon Natural Heritage Program (OHNP, 50 records), Dr. Evelyn Bull (US Forest Service, La Grande, OR; 41 records on paper maps, however, only 10 were not represented by ONHP data; surveys from 1992 and 1999), and Dr. Mike Adams (US Geological Survey, Corvallis, OR; one site in Oregon, one site in Washington, both from 1991). No museum records were found (Museum of Vertebrate Zoology and California Academy of Science, Berkeley, CA, search conducted 21 July 2006), although the Washington state data cited the National Museum in Washington, D.C. (data from D. Metter), the Slater Museum at the University of Puget Sound, Washington, and Western Washington University.

It should be noted that the range documented here may not be current. There has been no systematic sampling of this species across its Oregon and Washington range, and hence the known distribution is biased by an accumulation of opportunistic sampling events. Such sampling may underestimate a species distribution. However, in 2010, Kirk Lohman (USGS, Wisconsin) revisited Dean Metter's study sites in Washington, and he expressed concern that he did not find Rocky Mountain tailed frogs at many of the historic known sites he visited (pers. commun.).

Figure 3. Range of the Rocky Mountain tailed frog, *Ascaphus montanus*, in northwestern North America.

In Washington, this frog occurs in three counties (Columbia, Garfield, Asotin) and in Oregon, it occurs in four counties (Wallowa, Union, Umatilla, Baker) (Figure 4). In the Oregon and Washington portion of its range, a conservative estimate of the area of the range was determined by calculating the area of the minimum convex polygon for the two main clusters of sites, north and south, eliminating the one outlier to the north-east in Oregon (Figure 5). The southern cluster occurred over 211,500 ha and the northern cluster occurred over 166,700 ha, summing to 378,200 ha (934,600 ac).

Known sites occur either on private lands (30 site records) or on US Forest Service lands: Umatilla National Forest (208 site records in Washington, 9 sites in Oregon); Wallowa- Whitman National Forest (29 sites). Hence on federal lands, there are 38 site records in Oregon and 208 in Washington (246 total site records). Sites in Washington are clearly clustered along discrete stream reaches (Figure 6), and likely represent individuals or habitat units with animals that were sampled as a stream reach was surveyed. Metter (1963) described this species in the Blue Mountains of Washington as occurring in "disjunct pockets". This pattern is observable in Figure 6, and may represent sampling bias from only a subset of areas being surveyed for these animals. In contrast, Oregon sites are much more dispersed across a broader landscape, and likely primarily represent reaches or drainages with tailed frog occupancy. The 208 Washington sites can be condensed to 49 occurrences on different stream reaches, which may be a more biologically relevant number to consider because they likely represent interacting individuals in a subpopulation. Animals in adjacent stream reaches within close proximity may also belong to the same population, but the geographic boundaries that would separate tailed frogs into different populations are not known. Nevertheless, about 17 different ~2^{nd}-3^{rd}-order stream drainages are represented by the 49 clusters in Figure 6. Upon close inspection of Figure 4, two Oregon sites in the Umatilla National Forest are very close together, and appear to occur on the same reach. Similarly, there are two clusters on the Wallowa-Whitman National Forest, a cluster of 3 and a cluster of 2 sites. Condensing these sites, as done for Washington, there would be a total of 34 Oregon sites (8 sites on Umatilla National Forest; 26 on the Wallowa-Whitman National Forest). Using these condensed numbers that likely resemble occupied stream reaches, the total number of Rocky Mountain tailed frog 'condensed sites' on federal lands in Oregon and Washington is 51 (17 + 34).

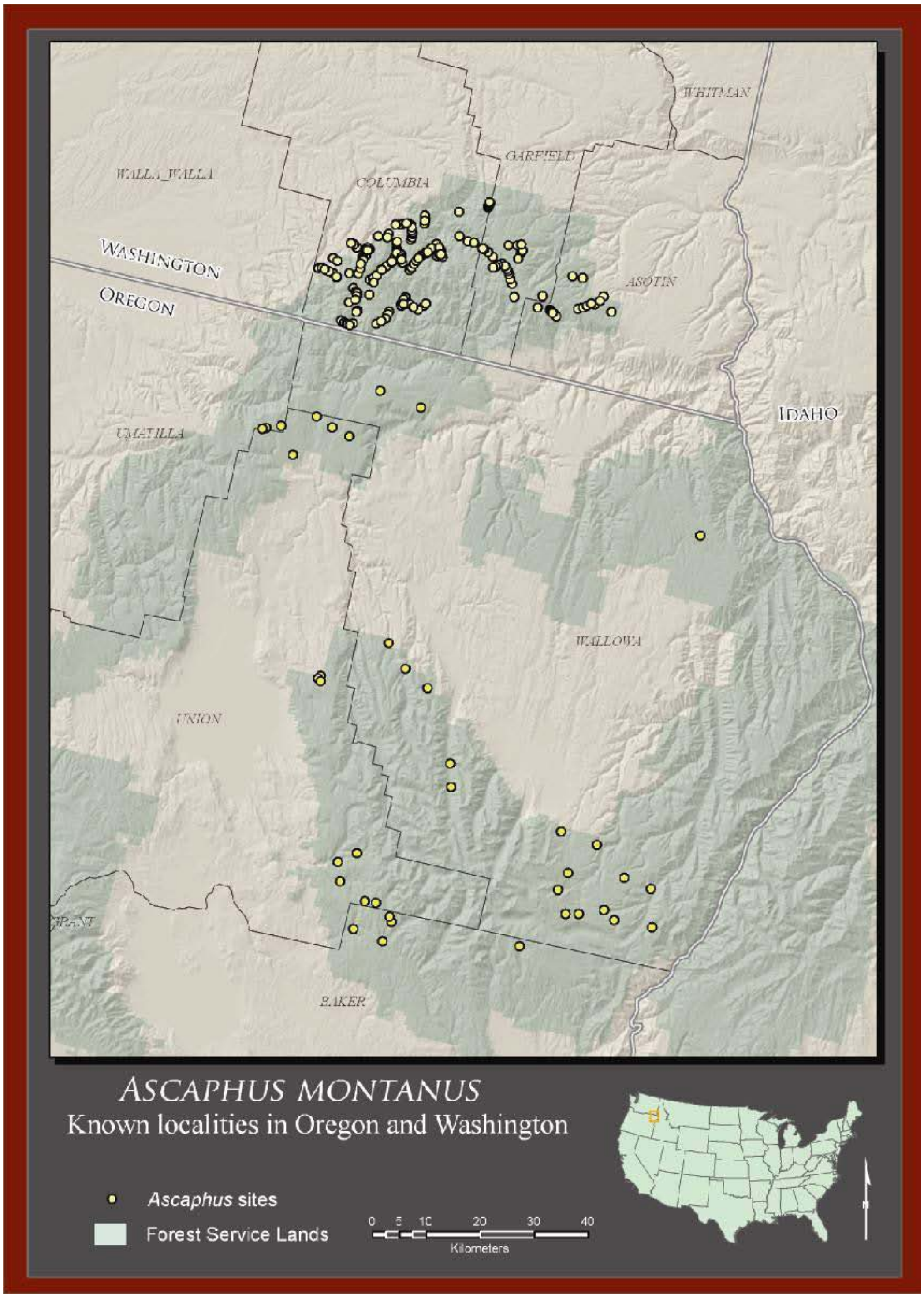

Figure 4. Oregon and Washington known sites of the Rocky Mountain tailed frog, *Ascaphus montanus*, showing distribution relative to federal lands.

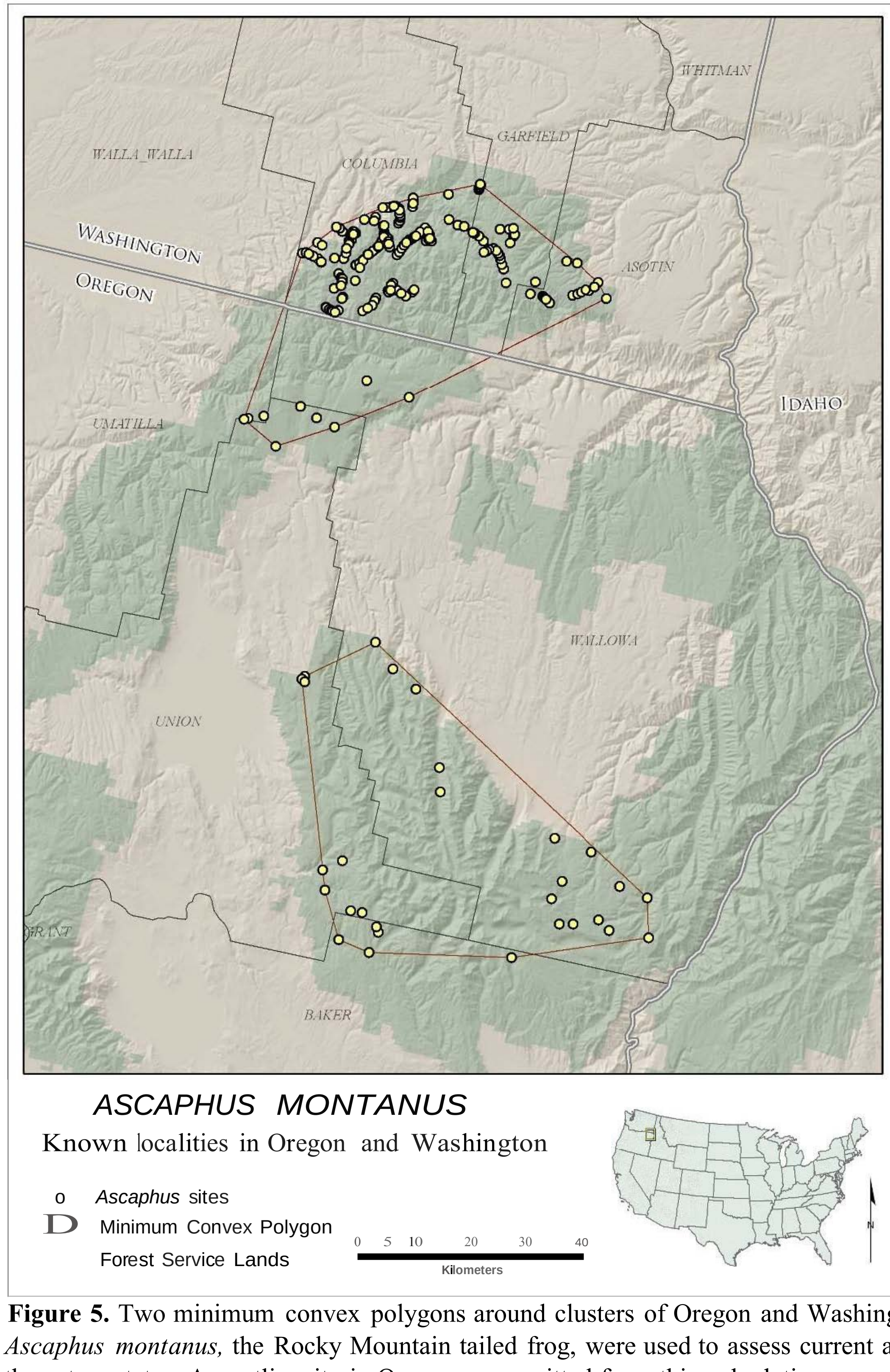

Figure 5. Two minimum convex polygons around clusters of Oregon and Washington known sites of *Ascaphus montanus,* the Rocky Mountain tailed frog, were used to assess current area of known range in these two states. An outlier site in Oregon was omitted from this calculation.

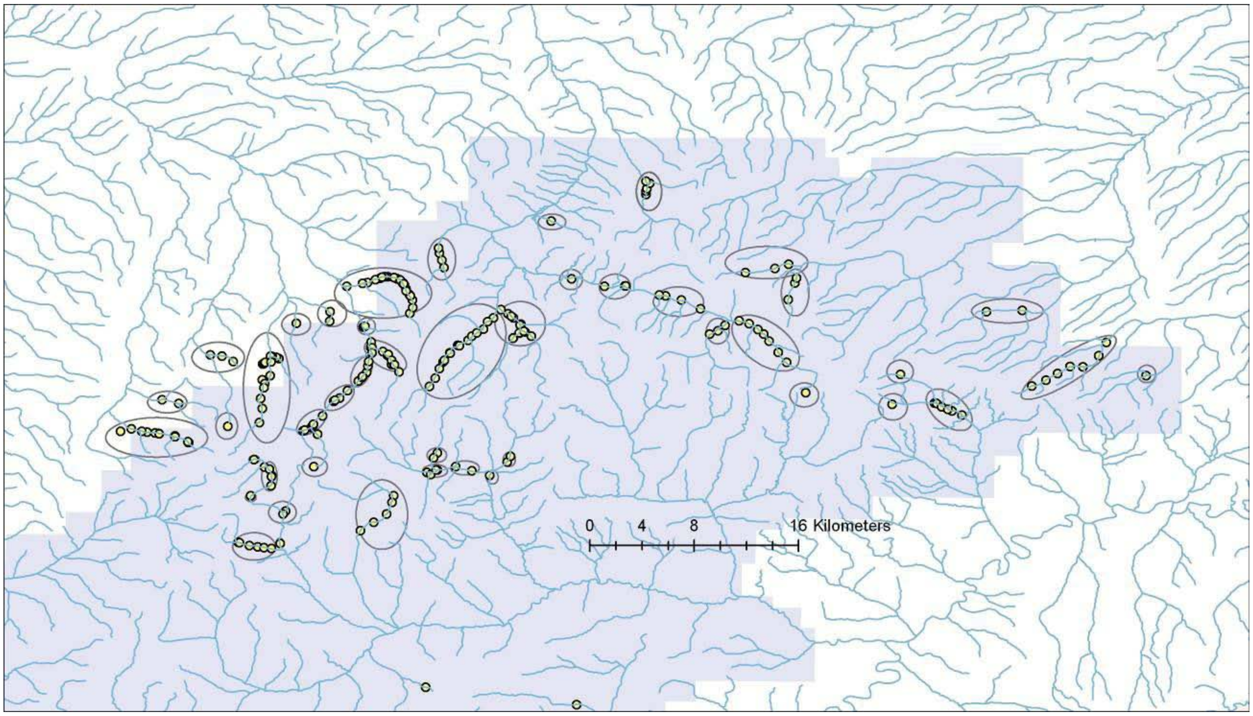

Figure 6. Washington site records for the Rocky Mountain tailed frog, *Ascaphus montanus*, were clustered along contiguous stream reaches.

Population Trends

Rocky Mountain tailed frog population trends have not been formally studied. However, several case studies have examined Rocky Mountain tailed frog populations, from the 1960s to the present. Most studies reported occurrences and abundances within stream reaches examined, and some reported frog abundances within study reaches among years. No study to date has estimated population sizes. Nevertheless, this work could provide a baseline for future monitoring of reach-scale distribution patterns.

High densities have been reported: 1) >70 adults in a 60-yard (55-m) reach of a stream tributary in the Touchet River, Washington (Metter 1963, 1964a); 2) >100 adults in a 60-yard (55-m) stream reach (Metter 1964a); 3) 121 adults in 2 hours of surveys in a 250-yard (229-m) creek with rocky rapids in tributaries of the Palouse River, Idaho (Metter 1963, 1964a); 4) 0.4-1.1 individuals/m length of stream in the Touchet River, Washington and Palouse River, Idaho (Metter 1964a); 5) 543 animals were marked in 80 m of a Montana stream (Daugherty and Sheldon 1982).

In Oregon, Bull and Carter (1996b) found tailed frogs in 42 of 80 streams surveyed: 26 of 37 (70%) streams in Wallowa County; 10 of 19 (53%) streams in Union County; 5 of 10 (50%) streams in Baker County; 1 of 6 (17%) streams in Umatilla County, and no streams in Grant County. In 1992, they found 292 frogs, total, of which 60% were adults, 27% metamorphs, and 13% juveniles.

Lohman (2002) found larval densities ranging from 1.96 larvae/m^2 to 10.99/m^2 for the Mica Creek, Idaho, drainage as a whole, across 4 years, 1997-2000. Site variation within and among years was also evident, ranging from a low of 0.36 to a high of 24.09 larvae/m^2. First-year tadpoles (young of the previous fall) were most abundant in 3 of 4 years, comprising 58-64% of the tadpole population. In those 3 years, second-year tadpoles were 24-27% of the total and third-year tadpoles were 8-15% of the total. This Mica Creek, Idaho population continues to be monitored, 2002 to 2010 (K. Lohman, USGS, pers. commun.). Average larval captures at 6 sites in this drainage were approximately: 2 larvae/m^2 in1997-1998; 10/m^2 in 1999-2000, 2/m^2 in 2002-2003; 10/m^2 in 2004-2009. At an individual site, abundance was as high as 40 larvae/m^2. The larval population was composed of ~60% 1st-year larvae, 30% 2nd-year larvae, and 10% 3rd-year larvae. Lohman observed that high spring runoff was associated with low abundances. Metter (1968) also suggested that the stream flow regime was a dominant factor affecting tadpole numbers. High flows were not present during Lohman's 1997-2000 study at Mica Creek, which may account for the high densities reported (Lohman 2002).

Habitat

Rocky Mountain tailed frogs are found primarily in mountain streams in forested landscapes. Stream characteristics important for these frogs include permanent flow, mid-elevation locations, cool water temperatures, rocky substrates, and clear, unsilted water. Often they are found in high-gradient reaches of small streams. They appear to be much more restricted to streams than the coastal tailed frog (Metter 1963); the coastal form can be found frequently along stream banks and sometimes in uplands. Metter (1964a) found Rocky Mountain tailed frogs up to 40 ft (12 m) from streams following snow melt, but they were usually found within the stream prism. In Idaho, he found these frogs up to 150 yards (137 m) from streams. Upland habitat requirements are not known, and may not be relevant if animals do not use uplands. However, if animals disperse overland, they may use ground cover as microhabitat refugia, such as rocky substrates, down wood, and leaf litter.

Several studies document occurrences in stream reaches with cool temperatures. Ferguson (1952) found tailed frogs in Wallowa Mountains streams that were 9-11°C. Karraker et al. (2006) reported ~11°C water temperatures during oviposition. A 12°C optimum for development (Wernz and Storm 1969) and an 18.5°C upper limit for embryos (Brown 1975) were reported. Lohman (pers. commun.) found July stream temperatures at his Mica Creek, Idaho study sites to range from 6.5 to 13°C, and from 9 to 14°C in the Palouse River tributaries that he has studied. However, Lohman (pers. commun.) found *Ascaphus* in water temperatures to 20°C, and Adams and Frissell (2001) reported larvae and frogs in water temperatures up to 21°C in Moore Creek, Montana, although frogs were aggregated at a cool seep within the reach and there were cooler stream temperatures in occupied reaches downstream. Metter (1963) documented survival of larvae and adults in laboratory experiments with short-term exposure to 22°C.

Metter (1963) studied the Rocky Mountain tailed frog in the North Fork of the Touchet River, Washington (elevation 3,800 ft [1,158 m]). Water temperatures ranged 0-4°C in the winter, and ~5-13°C in the summer, in 1961 and 1962. The occupied stream was 12 ft wide (3.6 m), and two occupied headwater tributaries in the study were about 3 ft (~1 m) wide. The tributaries had perennial flow but had spatially intermittent surface flow due to infilling behind down wood in the stream channel. Pool habitats had silt and debris.

Winter habitat use by Rocky Mountain tailed frogs in northeastern Oregon was described by Bull and Carter (1996a). Ten perennial 1st- and 2nd-order streams (0.5- to 2-m wide) occupied by frogs in the summer retained flowing water under 1-2 m snow in November to February, and water temperatures ranged from -1 to 2°C. They searched four of these streams for frogs, using a 10-min timed search per stream, and found adults and larvae under rocks in riffles in all four streams; the animals were not burrowed into substrates.

Bull and Carter (1996b) found larval abundance was associated with cobble and fine substrates. Adults were positively associated with the percent of a reach with a timber harvest buffer, percent boulder and cobble substrates, and stream gradient. They suggested stream characteristics are more important to frogs than landscape characteristics such as forest stand age.

Spear and Storfer (2010) examined Rocky Mountain tailed frog population genetics in Idaho in order to understand gene flow patterns in relation to landscape habitat attributes and disturbances including fire and timber harvest. They found: 1) greater overland connectivity across their roadless landscape that had been subjected to fires, in comparison to their harvested area, with movements inversely associated with solar radiation (i.e., movements in shaded zones); 2) frogs moved along riparian corridors in the harvested landscape, with this pattern occurring primarily in privately owned timberlands managed for timber production in comparison to public lands that were managed for multiple uses; 3) in the harvested area, the spatial distribution of genetic variation was associated with precipitation, suggesting that these frogs' dispersal is highly sensitive to small changes in moisture availability. Furthermore, their data suggest that Rocky Mountain tailed frogs likely use down wood in uplands as refugia during overland dispersal, because such legacies from historical canopy crown fires were evident in the unharvested landscape.

Ecological Considerations

Trophic relations of Rocky Mountain tailed frogs were documented by Metter (1963, 1964a) in Washington and Idaho, with no differences reported between the sites. Hatchling larvae at nests contained yolk in their stomachs, 1st-3rd-year larvae stomach contents were primarily diatoms, and transforming larval stomachs were empty. However, during June, large amounts of pollen were found in larval stomachs. About 30-40% of larval stomach contents were fine grains of sand, and some strands of filamentous algae, desmids, and tiny insect larvae were noted. Adults appear to feed opportunistically, primarily along stream banks. They appear to be ineffective at feeding underwater (Metter 1963). Adult stomach contents in May-October including over 20 invertebrate types, primarily spiders, Diptera larvae, Coleopteran adults and larvae, Trichoptera adults, Hymenoptera, and Lepidoptera larvae. Prey size reached a maximum of 30-mm length (caterpillars).

Predators of Rocky Mountain tailed frogs include the gartersnake *Thamnophis elegans* and trout (Metter 1964a; E. Bull, Lick Creek, Wallowa County, pers. commun.). In Idaho, the Idaho giant salamander (*Dicamptodon aterrimus*; this species does not occur in Oregon and Washington) and sculpins prey on tailed frog larvae, with giant salamanders being their most significant predator (K. Lohman, USGS, pers. commun.). Metter (1960) found reduced numbers of frogs in the presence of giant salamanders, and suggested a predator-prey interaction accounted for this pattern. Parasites include the gut ciliate *Protoopalina*, which occurs in small larvae (Metcalf 1928). Also, Rocky Mountain tailed frogs are the intermediate host for a fluke because metacercarieae were found encysted in larval and adult skin (Metter 1964a).

Several amphibian species co-occur with Rocky Mountain tailed frog, but whether they interact is not established. Metter (1963) found *Ambystoma macrodactylum, Pseudacris regilla* (or possibly *P. sierra*, a newly described species; Olson 2009), and *Anaxyrus* [*Bufo*] *boreas* along the mainstem of the North Fork of the Touchet River, Washington.

Biological Considerations

The Rocky Mountain tailed frog has small lungs, and relies upon its skin for much of its respiration. Cool, well-oxygenated water in streams likely aids respiration.

IV. CONSERVATION

Land Use Allocations

Relationship of the species' distribution to lands administered by the US Forest Service is a key consideration for conservation in Oregon and Washington. The majority of the species range in Washington and Oregon lies within the Umatilla National Forest and Wallowa-Whitman National Forest.

Habitat for the Rocky Mountain tailed frog is largely in-stream and within near-stream riparian zones. The Forest Plan goal for riparian areas of Class I, II and II streams, including floodplains and wetlands, states "maintain or enhance water quality, and produce a high level of potential habitat capability for all species of fish and wildlife within the designated riparian habitat areas while providing for a high level of habitat effectiveness for big game." Desired future conditions include a near-natural setting adjacent to the stream, continuous high tree canopy layer with crown closure of 70% or more for stream shading (mean stream shading of 80% where natural conditions permit) and streambank stability, minimal impact on riparian vegetation of uneven-aged timber harvest (largely single tree or small group selection practices), provision of a long-term supply of large woody material for streams from a streamside zone extending at least one tree height from streams, less common streambank trampling from livestock, and dispersed recreation. For more information, see the 1990 Umatila Forest Land and Resource Management Plan, section C5 – Riparian (Fish and Wildlife) (available at: http://www.fs.usda.gov/wps/portal/fsinternet/!ut/p/c4/04_SB8K8xLLM9MSSzPy8xBz9CP0os3gjAwhwtDDw9_AI8zPwhQoY6BdkOyoCAPkATlA!/?ss=110614&navtype=BROWSEBYSUBJECT&cid=FSE_003756&navid=130100000000000&pnavid=130000000000000&position=BROWSEBYSUBJECT&ttype=main&pname=Umatilla%20National%20Forest-%20Planning#forest%20plan; accessed 11 August 2011)

Threats

Although threats to this species are not well studied, suspected threats across the species' entire range include activities that may change habitat, microhabitat, and microclimate conditions. Anthropogenic activities that may alter frog habitat conditions include timber harvest, road construction, grazing, chemical applications, and introduced species. Disease, climate change, fire and flood events also can adversely affect these frogs. In particular, factors that affect stream flow, sedimentation, and water temperature are of primary concern relative to the Rocky Mountain tailed frog.

High Stream Flows.—Both Metter (1968) and Lohman (2002) supported associations of reduced instream frog abundances following high stream flow events. High flow may occur as a result of a single storm event with high precipitation, as a result of rain-on-snow, or due to timber harvest, grazing, or fire altering stream hydrology at a site. For example, stream flow can be altered due to greater surface runoff following timber harvest activities, including increased peak flow events in small streams (e.g., Harr et al. 1975). The effects of a high flow event could result in mass mortality to multiple year classes of this frog. This frog is relatively long-lived, potentially living >10 years as adults, having a 3-year larval period, and possibly having several juvenile year classes. A high flow event could potentially sluice a stream channel and its larval residents, causing mass mortality to at least 3 year classes dependent upon instream refugia. Instream juvenile and adult frogs might also be affected by this disturbance. A subset of juvenile and adult frogs could occur upland of the stream prism, or may be lodged within substrates, and hence be protected from high flow events. However, high flows in consecutive years might affect some of these survivors. Nevertheless, the complex life history of this frog may confer population resilience to occasional high flow events. Repeatedly occurring high flow events are likely a great threat.

Sedimentation and Water Temperature.—Increased sedimentation and increased water temperature have been cited as causes of concern for both Rocky Mountain and coastal tailed frog species (Bury 1983, Bury and Corn 1988, Corn and Bury 1989, Dupuis and Steventon 1999, Welsh 1990, Karraker et al. 2006), and may be the key concerns for Rocky Mountain tailed frogs (K. Lohman, USGS, pers. commun.). Sedimentation may fill interstitial spaces in stream substrates, burying cobbles and boulders, and eliminating frog refugia and larval foraging habitat. Such infilling could expose larvae to predators. Increased water temperatures may reach thermal maxima for the species. Sedimentation and increased water temperatures may result from anthropogenic activities including some timber harvest and road construction/maintenance practices (e.g., Beschta 1978, Beschta et al. 1987, Moore et al. 2005). Bull and Carter (1996a) expressed concern for these frogs as a result of management activities that could increase the occurrence of icing conditions, and anchor ice that may be produced when streams freeze solid in the winter. Loss of forest canopy and increased exposure to wind may reduce insulation of streams during the winter and increase the chance of icing conditions.

Although an integrated study of the relationships between Rocky Mountain tailed frogs and timber harvest, road construction, sedimentation, and water temperature has not been completed, sedimentation and water temperatures were studied relative to logging and road construction in a stream inhabited by tailed frogs in Mica Creek, Idaho; these frog populations were studied earlier by Lohman (2002). Karwan et al. (2007) reported an association between increased stream sediment loads and clearcut timber harvest for one year following harvest for streams with a minimum of a 9 m (30 ft) no-entry zone along fishless streams, and a 15 m (50 ft) no-entry zone for fish-bearing stream reaches. They did not find an association between partial harvest or road construction activities and instream sediment loads. Gravelle and Link (2007) found water temperature increased up to 3.6°C in an upstream non-fish-bearing reach directly affected by the clearcut harvest treatment upland of the buffer, and no significant increase in water temperature maxima in downstream fish-bearing reaches that may have been indirectly affected by the treatment. This study did not address road construction, however.

Forest Plans in within the species range in Oregon and Washington include measures to retain bank stability and cool stream temperatures, hence these threats to habitat conditions may be largely addressed in this area. However, monitoring may be warranted to ensure tailed frog habitats are sustained.

Timber Harvest

In addition to the information provided above relative to stream flow, sedimentation, and stream temperatures, which may have links to timber harvest activities, the following reports address the effects of timber harvest on Rocky Mountain tailed frogs.

1) In eastern Oregon, Bull and Carter (1996b) reported no statistically significant differences in numbers of Rocky Mountain tailed frog larvae with increasing timber harvest (30 streams analyzed, 10 streams in each of 3 harvest categories). Although this result supports no statistically significant effect of timber harvest on these frogs, they did find a decreasing *trend* in number of larvae and adults in streams with increasing amounts of timber harvest. High variation in larval numbers among streams may have accounted for the lack of an overall finding of a statistically significant effect. Furthermore, no frogs were found in 3 of the 10 streams with heavy timber harvest, in contrast to their occurrence in all streams in drainages with low or moderate timber harvest. This is reflective of a potentially important adverse effect of timber harvest at some stream reaches. An interaction of harvest effects with site-specific conditions may explain this type of result. They suggested that retention of a no-cut buffer and maintenance of stream integrity would reduce potential effects of harvest on these frogs. This suggestion is supported by the strong stream affinity of these animals, relative to the coastal tailed frog which appears to venture into upland environments more often.
2) Metter (1964a) reported that a creek in Washington was populated with *Ascaphus* until the area was logged in 1960, after which the animals disappeared.
3) Spear and Storfer (2010) examined gene flow in relation to landscapes subject to timber harvest and fires. In the roadless area subject to fire, they found greater terrestrial connectivity. Conversely, in the timber harvest landscape, and in particular the area with privately owned lands with a greater emphasis on timber production, they found gene flow occurred via riparian pathways. Their data suggests that populations are structured in different ways relative to the landscape disturbance regime, and it supports the utility of riparian reserves for protecting these animals in a timber harvest landscape.

All timber harvest and road construction activities are not equal relative to effects on frog habitats or frogs. Historical clearcutting practices without stream buffers may have led to sedimentation, spikes in summer water temperatures, and high flow events. Current practices on federal lands of retaining stream buffers and trends toward upland green tree retention likely reduce these effects, and warrant study relative to tailed frog populations. Occurrence of tailed frogs in drainages with second-growth forest suggests they have some long-term resilience at a population level to timber harvest. Hossack et al. (2006) and Crisafulli et al. (2005; *A. truei* study) also suggest that patches of retained forest protect individuals at a landscape scale, allowing recolonization of streams after a disturbance, although their perspectives came from fire- and volcano-disturbed areas, respectively. Nevertheless, the patchiness of Rocky Mountain tailed frog occurrences across landscapes also suggests that there may be long-term effects of local extirpation.

Livestock Grazing

Although effects of grazing have not been well studied for this species, livestock grazing is a concern due to several possible effects (E. Bull, US Forest Service, pers. commun.). It may alter streamside vegetation that is used as refugia by frogs, potentially exposing them to predators or unsuitable microclimate conditions. Reduced streamside vegetation may increase stream sedimentation, infilling stream substrates and reducing instream refugia. Grazers can potentially trample tailed frogs, especially larvae in streams, causing direct mortality. The scope of this potential threat on federal lands within the range of the Rocky Mountain tailed frog in Oregon and Washington is not well understood, and may be a secondary concern relative to other factors.

Roads

Soil erosion from roads can be a source of instream sedimentation. In particular, erosion may result from road construction and maintenance. Fine substrates from erosion can infill stream substrates, eliminating frog microhabitats.

The scope of road issues within the range of the Rocky Mountain tailed frog in Oregon and Washington is unknown at present. However, there is a correspondence between the current known distribution of Rocky Mountain tailed frogs and roads in Washington and Oregon (Figure 7), suggesting that the distribution reflects a bias in surveys along roads, as well as the potential for road issues to affect these frogs.

Additionally, perched stream-crossing culverts can fragment the stream, and restrict instream movements of frogs, especially larvae, between segments. This warrants further investigation relative to tailed frogs. Although these frogs metamorphose into a form with terrestrial movement capability, restricted movements of one life stage (larvae) but not another (adults) can affect population demography, and it is possible that culverts may limit movements of adults as well, given that this species appears to be extremely stream-associated, migrating up and down streams.

There is no information about roadkill for Rocky Mountain tailed frogs. Remote roads with little traffic likely do not pose an issue in this regard. Their nocturnal movements may reduce the likelihood of roadkill on National Forest System roads. It is also likely that tailed frog movements are not hindered by the road prism.

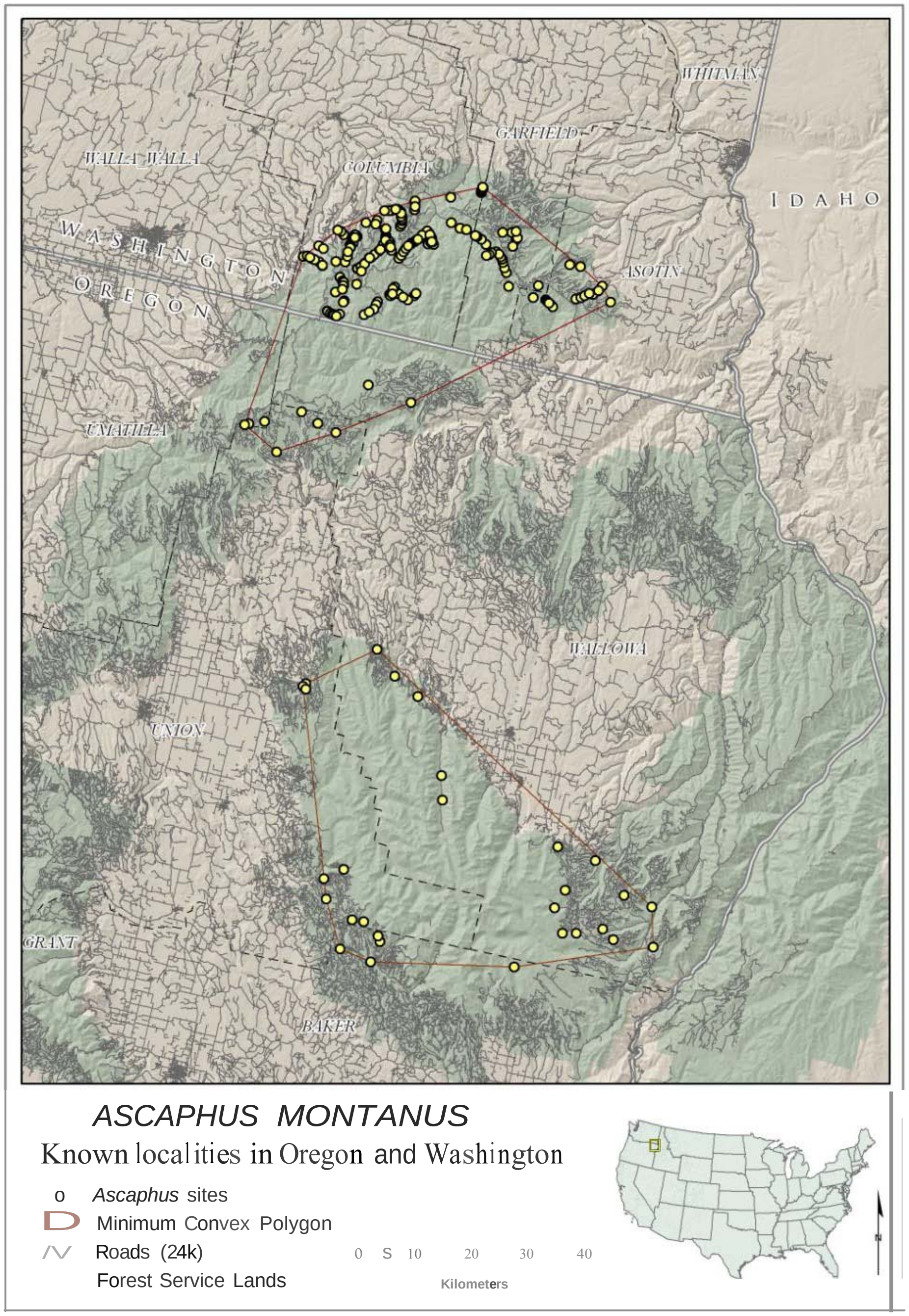

Figure 7. Roads within the range of the Rocky Mountain tailed frog *(Ascaphus montanus)* in Oregon and Washington (road GIS coverage: http://www.blm.gov/or/gis/data-details.php?data=ds000042).

Fire and Flood

Two studies have examined the effects of fire on these frogs. First, Hossack et al. (2006) examined the numbers of Rocky Mountain tailed frog larvae in 8 streams before a wildfire affected the area; after the fire, 4 streams were within the burned area and 4 were unburned. They found larvae were about twice as abundant in the unburned streams in the first 2 years following the fire, with first-year larvae having the greatest negative effect. Causes of the different abundances could be related to conditions during the fire such as high temperature, increased water ammonia concentration, and direct or indirect effects of fire retardant chemicals. Hossack et al. did not expect the fire to result in extirpation of tailed frogs from these streams, but suggested monitoring to examine long-term effects of the disturbance. Second, Spear and Storfer (2010) examined gene flow relative to roadless areas in Idaho with historical fires. They found that Rocky Mountain tailed frogs retained overland connectivity in these areas. They suggested that down wood in areas subject to past canopy fire likely provides surface refugia during terrestrial movements.

Low-intensity fires including prescribed fire for fuels reduction treatments in forested uplands likely have no adverse effect on this species, especially if those treatments occur when the animals are not surface active (summer dry seasons) and large down wood is retained. However, fires in cool, moist times of surface activity, such as in spring or fall when prescribed fire actions normally occur, might affect these frogs if they are more surface-active. The effects of a more intense level of fire disturbance due to fire exclusion and fuel loading may be a concern, because stand replacement fire represents a more catastrophic disturbance to flora and fauna. In particular, relative to potential frog habitat in uplands or in riparian zones, 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 refugia, and consumes current down woody material within which frogs may occur.

Effects of high stream flows have been cited as a threat to Rocky Mountain tailed frogs. Presumably high flows sluice streams, and result in mass mortality events of instream residents. Increased peak flows may result from loss of overstory canopy in the upland forest surrounding streams. This could occur via timber harvest or stand replacement fire. Landslides and debris flow events similarly could sluice streams, killing frogs within the stream prism, and may occur after stand-replacing fires or some timber management activities on unstable slopes.

Habitat Fragmentation

The patchy distribution of Rocky Mountain tailed frogs in Oregon and Washington suggests that either their habitat is naturally fragmented or that there are long-term signatures of past disturbances on their occurrences. Both scenarios are likely. Their dispersal capability also plays a part in the degree to which adjacent sites may be connected. Long-term isolation of small populations may result in losses due to stochastic variation in population demography (i.e., random fluctuations in animal numbers that may result in extinction of small populations). Loss of current connectivity among habitat patches would be a concern due to consequent population isolation. Spear and Storfer's (2010) study suggests that overland dispersal of this frog is affected by timber harvest activities, hence retention of overland dispersal corridors is a consideration in timber harvest landscapes.

C*hemical Applications*

Chemicals such as herbicides, pesticides, fungicides, fertilizers, and fire retardants may have a direct affect on these frogs. These animals' skin is moist and permeable for gas exchange, and can readily take up lethal chemical doses. Rocky Mountain tailed frogs have reduced lungs and may rely on cutaneous gas exchange to a greater degree than conspecific frogs. No data exists, however, specific to chemical effects on this species to understand the scope of this potential threat. However, given the location of federal lands within this species' range in Oregon, the threat of direct chemical applications to this frog's habitat is likely low. However, the threat of fire retardants and scope of their use on lands within the species range in Oregon and Washington is uncertain, and warrants examination. Also, aerial drift of agricultural chemicals has not been investigated, and may be a particular concern within the species range in Oregon and Washington.

Disease

The amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) has recently been detected in Oregon and Washington (www.spatialepidemiology.net/Bd-maps). This disease is particularly notable relative to Rocky Mountain tailed frogs because of their predominantly aquatic life history; *Bd* is an aquatic fungus and primarily has been found in aquatic amphibians. *Bd* is thought to be the cause of local extirpations of montane frogs in the Washington Cascade Range and the California Sierra Nevada. However, some amphibian species are thought to be carriers of *Bd*, and do not show symptoms of the disease. They may be resistant to the disease, or the *Bd* intensity of infection or strain virulence may be low. *Bd* in Rocky Mountain tailed frogs has not yet been detected: Hossack et al. (2010) found no *Bd* on 198 larvae and 28 metamorphosed frogs in Idaho and Montana. Furthermore, they reported no *Bd* on 60 *A. truei larvae* and 60 *Dicamptodon tenebrosus* larvae from California, 128 *A. truei* larvae from Oregon, and 3 metamorphosed *Dicamptodon aterrimus* from Idaho and Montana, and they found *Bd* on only 1 of 57 *D. aterrimus* larvae in Idaho and Montana (infected animal was in Montana) and 3 of 38 metamorphosed *A. truei* in Oregon. *Bd* prevalence appears to be low on northwestern amphibians associated with small streams, although this warrants further study, especially relative to metamorphosed individuals because few have been sampled for *Bd*. Nevertheless, relative to the Rocky Mountain tailed frog in Oregon, *Bd* has been detected in northeastern Oregon, including the following sites as of this writing: McKay Reservoir, Eden Bench, Little Summit Lake, and the Wallowa River (http://www.bd-maps.net/maps/; accessed 9 July 2011). The *Bd*-maps.net website at the previous link is updated regularly as new results emerge. More information about *Bd* occurrences can be obtained from the global *Bd* mapping project: Dede Olson, US Forest Service (dedeolson@fs.fed.us).

Disease warrants mention here also to alert biologists to be aware of and report observations of ill or dead animals. *Bd* is a skin disease. Skin has vital functions in amphibians, including important roles with oxygen, water and electrolyte exchange with the environment. Symptoms of chytridiomycosis, the disease associated with *Bd* infection, include excessive sloughing of the skin, lethargy, unresponsive animals including loss of their "righting reflex" (they do not right themselves if turned upside down), and anorexia. Also, *Bd* may be spread from field gear such as boots or nets, wildlife, translocated animals, or movement of water (e.g., during fire management or water diversions). Disease disinfection protocols for gear and water are available (http://www.fs.fed.us/r4/resources/aquatic/guidelines/aq_invasives_interim_fire_guidance08_final.pdf).

Climate Change

This species is highly attuned to the microclimate conditions of its habitat. It is a stream frog reliant on streams with cool temperatures; it may have both warm and cold water temperature limitations that define its range boundaries in montane forest landscapes. Cold-water limitations may restrict its distribution at high elevations and latitudes, for example. Icing conditions may result in overwinter mortality of instream larvae and frogs (Bull and Carter 1996a). Climate factors may also contribute to its current patchy distribution, although this is speculation. Past climate change and consequent habitat fragmentation is cited as the origin of Rocky Mountain tailed frog species divergence from coastal tailed frogs (Nielson et al. 2006). Given its current distribution, contemporary climate change at smaller spatial scales may similarly influence habitat suitability for this species. Although climate envelope modeling is needed to more accurately predict the response of this species to modeled climate trajectories, it is likely that range retraction could occur along its southern boundary, on south-facing slopes, and in low elevation areas. Conversely, range expansion could occur along the northern range boundary, on north-facing slopes, and higher elevation areas. Variable precipitation events that may accompany climate change projections for the region may result in high-flow events that could adversely affect frogs. Adaptation management considerations for this frog in the face of climate change include retention and restoration of both upland and aquatic habitat connectivity, to enable the frog to disperse to adjacent habitats. Given the species' small range in Oregon and Washington, reduction of other threats and species-habitat connectivity management may enable this species to persist on federal lands.

Introduced Species

Rocky Mountain tailed frog larvae are likely prey for introduced Eastern Brook Trout (*Salvelinus fontinalis*). This species was first stocked in the early 1900's and they are widely distributed in many high mountain lakes and headwater streams. The magnitude of this potential threat to Rocky Mountain tailed frogs in Oregon and Washington is not well known. The amphibian chytrid fungus is also considered an introduced species, as well as an emerging infectious disease.

Conservation Status

The Rocky Mountain tailed frog is of concern in Oregon and Washington due to its extremely limited distribution and potential vulnerability to several threats.

Known Management Approaches

There are no known management approaches that have been evaluated specifically relative to their effectiveness to address the Rocky Mountain tailed frogs or their habitat in Oregon and Washington.

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

Management Considerations

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

Specific Objectives

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

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

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

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

Specific Considerations

At locations where frogs have been found:

- Maintain the integrity of stream habitats including cool, moist microclimates during timber harvest activities by considering:
  - ➢ Retention of streamside riparian buffer zones to: reduce streambank erosion and sedimentation; retain stream shading to reduce alteration of stream temperatures; reduce increased peak flows from runoff; and retain terrestrial habitats for adults and juveniles. Site conditions (aspect, hill- shading, vegetation condition, watershed condition, cumulative effects) warrant consideration when buffer widths are considered and whether managed buffers or no-entry buffers are needed. No studies address the efficacy of various buffer widths in this geographic area, hence support for a specific buffer size is lacking at this time.
  - ➢ Thinning (instead of regeneration harvest) or aggregated green tree retention to retain canopy closure and ameliorate microclimate shifts in riparian zones and in upland forests. These activities will also reduce ground disturbance in riparian areas and uplands (retaining microhabitat refugia for frogs in uplands), and provide standing trees to provide future down wood (potential refugia for frogs in uplands).
  - ➢ Manage road construction or maintenance to reduce erosion and likelihood of stream

sedimentation.

- ➢ Manage forest stands to reduce likelihood of stand replacement fires, including thinning of young, dense stands.
- ➢ Consider hillshading and aspect in management of source habitats; for example, such that naturally exposed areas prone to higher temperatures have vegetative buffering (canopy retention).

- Restrict chemical applications.
- Manage to reduce likelihood of non-native predators in streams.
- Manage to reduce the effects of livestock grazing along riparian areas of stream reaches occupied by Rocky Mountain tailed frogs.
- 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 frog.
    - ➢ The hazards and exposure to frogs of some activities relative to substrate disturbance, microclimate shifts, and incidental mortality may be minimal. A minimal or short-term risk may be inappropriate at a small, isolated population, whereas it may be possible in part of a large occupied habitat. Restoration activities can be assessed, in addition to other disturbances. Thus, both current and predicted future conditions of the site and its habitat can be considered during risk assessment procedures. If the risk, hazards, or exposure to actions are unknown or cannot be assessed, conservative measures are recommended.
- Disinfect field gear between sites. Disinfection guidelines to reduce risk of transmission of *Bd* by field gear are available at: http://www.fs.fed.us/r4/resources/aquatic/guidelines/aq_invasives_interim_fire_guidance08_final.pdf.
- Disinfect water that is transported away from occupied stream reaches, or brought in from elsewhere (e.g., for fire management; see previous web link).
- Consider delineating the spatial extent of the area occupied by this species, for future monitoring.

Although we do not know whether this animal disperses overland, or the extent to which it may disperse across ridgelines, genetic analyses have suggested that overland movements occur in some parts of the Rocky Mountain tailed frog range. Hence, it is prudent to consider management activities to promote connectivity among stream habitats.

- ➢ Manage areas extending from occupied stream reaches into uplands and over ridgelines to promote refugia retention for frog dispersal habitat. Upland habitat structures that may benefit these ground-dwelling animals would likely be those that retain cool, moist microhabitats including down wood and vegetation cover by either aggregated or dispersed green tree retention. These habitats could be considered for retention in linear arrays extending from streams into uplands and over ridgelines to adjacent riparian zones of neighboring drainages during timber harvest and fire management projects.
- ➢ Consider proximity of sites to reserve areas, and maintain habitat connectivity to such areas.
- ➢ Consider hillshading and aspect in management of connectivity habitats; for example, such that naturally exposed areas prone to higher temperatures have vegetative buffering (canopy retention). Such considerations are especially important relative to potential future effects of climate variation.

V. INVENTORY, MONITORING, AND RESEARCH OPPORTUNITIES

Data and Information Gaps

A priority need is to understand the current distribution of this species in Oregon and Washington. Other information gaps include many aspects of the basic life history of the species, habitat associations, and effects of various disturbances on the species, including disease and climate change. With additional habitat knowledge, a goal would be to create a map of optimal habitat for this species. Climate envelope modeling is also a priority for this species. More information is needed on the prevalence and consequence of the amphibian chytrid fungus, *Bd*, on Rocky Mountain tailed frogs.

In particular, how well do riparian buffers protect this species (what riparian management options should be considered, how wide should buffers be)? Do we need to consider upland management activities to address overland dispersal and population connectivity? What are the movement patterns of these frogs?

There is little understanding of population ecology. What is the spatial extent of a stable population, or rather the range of areas for population persistence? At what abundances are these animals found in Oregon and Washington? Would disjunct habitats of about >500 m functionally segregate populations? Lastly, the ecological role of this species within the larger ecosystem is poorly understood. Are these frogs a critical cog in the trophic structure of the ecosystem? Are they key prey in trophic cascades? Are food webs altered by forest management practices?

Inventory

Inventories could help delineate this species' current range, especially in Oregon and Washington. While a full geographic inventory is of prime importance, if these surveys were designed carefully, then associations with habitat conditions and land management practices could also be addressed, and *Bd* occurrence could be censused. A habitat map would be a useful asset to federal land managers within the species' range.

Several stream survey approaches effectively detect larvae of this species, including stream dipnet searches, block or seine-netting, and electrofishing. Place a dipnet (e.g., a D-frame net) flush with the stream bottom and overturn, remove or kick substrate upstream of the net to dislodge larvae. Similarly, electrofishing will dislodge upstream larvae which will float into a downstream net. Placing a seine or block net across the stream and picking up, overturning, or kicking upstream substrate will cause larvae to be dislodged, swept downstream by the current, and get caught in the seine. These methods may also be used to detect juveniles or adults, which may also be observed by more careful inspection of the habitat during movement of individual rocks.

For inventory objectives, several subsamples per stream reach may be needed for detection of larvae which may be clustered in space. At the stream drainage scale, several stream reaches or segments may need to be sampled to determine occupancy in an area; tailed frogs may not occupy all tributaries of a stream drainage. In addition to simple detection of animals, the area or time of each stream unit that is searched could be standardized as well as the number of subsamples collected per stream reach of any given length. For example: 1) Lohman (2002) sampled a minimum of either 10 m stream length or a total area of at least 10 m^2; 2) Bull and Carter (1996b) searched each stream for 8 person-hours; and 3) Olson and Weaver (2007) conducted headwater stream surveys for tailed frogs and other amphibians using a modified fish survey method where 10 2-m long stream units were sampled per reach.

An emerging topic in the literature is that detectability of amphibians 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

It appears that little to no monitoring of specific sites has occurred for this species in Oregon or Washington. In Idaho, K. Lohman (pers. commun.) is continuing monitoring of animals at his long-term study site at Mica Creek. Knowledge of land management activities at sensitive species' sites might be considered a prompt to consider monitoring of this species. If monitoring were initiated, standardized methods could enable future comparisons among sites. Electronic data entry in GeoBOB/NRIS can provide a standard format for documentation.

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

Research

The data gaps discussed above each relate to needed research on this animal. In particular, there is little information on how various contemporary forest management practices such as riparian buffers may affect microhabitats or populations of these frogs. Stream-crossing culverts have not been studied relative to this species. Also, the effects of climate change and *Bd* on this species are poorly known. Climate envelope modeling would allow projections of effects within Oregon and Washington, and may prioritize habitats for management.

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

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VII. DEFINITIONS

Persistence

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

Site (Occupied)

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

Oregon and Washington 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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