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Effects of Disturbance on Amphibians of Conservation Concern in Eastern Oregon and Washington

Abstract

The effects on amphibians of forest insects, tree diseases, wildfire, and management strategies designed to improve forest health (e.g., thinning, prescribed burns, road removal, and spraying with pesticides or biological microbial agents) are discussed. Those species that occur in forested habitats in eastern Oregon and Washington that are considered of concern include the Oregon spotted frog (*Rana pretiosa*), Columbia spotted frog (*R. luteiventris*), northern leopard frog (*R. pipiens*), Cascades frog (*R. cascadae*), tailed frog (*Ascaphus truei*), Larch Mountain salamander (*Plethodon larselli*), and Cope's giant salamander (*Dicamptodon copei*). Little is known regarding the effects of forest health on amphibians, although tree mortality resulting from insects and disease is unlikely to dramatically affect these species, except for the tailed frog and larch mountain salamander. Both these species depend on overstory canopy to maintain temperature and moisture conditions; timber harvest in their habitats has rendered them unsuitable. Wildfire and prescribed burning to a lesser extent, may alter the abundance of prey, coarse woody debris, and vegetation, which could influence movements and survival of dispersing amphibians. Spraying with pesticides could negatively affect these species if the abundance of their prey is decreased. Spraying with biological microbial agents is unlikely to affect prey abundance. Additional research is needed to determine if these disturbance agents are contributing to the decline of many of these amphibians.

Introduction

This account includes information on amphibians that occur in forested habitats, have distributions in eastern Oregon and Washington, and are classified by the Natural Heritage Program with state ranks S1 to S3 or having Federal status of threatened, endangered, or candidate species. The Oregon spotted frog (*Rana pretiosa*) is listed as a candidate species. The Columbia spotted frog (*R. luteiventris*), northern leopard frog (*Rana pipiens*), cascades frog (*Rana cascadae*), tailed frog (*Ascaphus truei*), Larch Mountain salamander (*Plethodon larselli*), and Cope's giant salamander (*Dicamptodon copei*) are State Ranked as S1-S3.

This account is not intended as an exhaustive literature review; rather it is intended to provide readers with an introduction to potential effects of disturbance and forest management and some of the primary sources of information for each species. The management strategies being considered here include thinning, prescribed burns, road removal, and spraying with pesticides and biological microbial agents, although there may be other treatments that apply. Additional information and references on life history and distribution can be found in the following sources: Amphibians and Reptiles of the Pacific Northwest (Nussbaum et al. 1983), Atlas of Oregon Wildlife (Csuti et al. 1997), Amphibians and Reptiles of Washington State: Location Data and Predicted Distributions (Dvornich et al. 1997), and Management Recommendations for Washington's Priority Species: Amphibians and Reptiles (Larson 1997).

Oregon Spotted Frog and Columbia Spotted Frog

The Oregon spotted frog is endemic to the Pacific Northwest and was recently differentiated from the Columbia spotted frog. Historically, the Oregon spotted frog was found from southwestern British Columbia to the northeastern corner of California. It has disappeared from 79% of its historical range and is currently known to occur at only 24 sites across its geographic range (Hayes 1997). In eastern Oregon, Oregon spotted frogs occur at nine sites in the Deschutes Basin and two sites in the Klamath Basin (Hayes 1997). This significant reduction in range and abundance was the justification for the candidate status of this species. This species is highly aquatic and is closely associated with ponds, marshes, and slow-flowing streams throughout the year. However, these aquatic sites must contain a shallow emergent wetland component for this species to occupy it. Breeding occurs in early spring at communal oviposition sites (Hayes 1994, 1997). Adults feed on insects (ants, beetles, mosquito larvae,

grasshoppers), spiders, mollusks, tadpoles, crayfish, and slugs (Csuti et al. 1997).

In contrast to the Oregon spotted frog, the Columbia spotted frog is found throughout much of eastern Oregon and Washington (Leonard et al. 1993, Dvornich et al. 1997). It is thought that preemptive measures are needed to preserve its distribution, even though the Columbia spotted frog still occurs throughout its range (Larson 1997). The Columbia spotted frog is closely associated with ponds, marshes, streams, and rivers throughout the year and occurs at elevations up to 2200 m in Oregon. Breeding occurs in early spring shortly after the water is free of ice and takes place in warm, shallow margins of ponds or streams. Breeding habitat has been described by Turner (1960), Morris and Tanner (1969), Hovingh (1993). Adults are opportunistic feeders and forage primarily on invertebrates (Turner 1959). A limited amount of information is available on their movements and habitat use during the summer (Bull and Hayes 2001, Pilliod et al. 1994).

Potential Effects of Insects, Disease, Fire, and Management Strategies

Neither species of spotted frog is likely to be affected by forest insects or tree disease due to the close association of these frogs with permanent water and especially their need for warm water for oviposition. Consequently, the loss of trees due to insects or fire may be beneficial at breeding sites in reducing the canopy cover and increasing solar radiation. Death of trees adjacent to permanent bodies of water will eventually result in an influx of coarse woody debris, which would enhance the habitat by providing additional refugia for these frogs; coarse woody debris in water is readily used by Columbia spotted frogs as escape cover from predators (Bull, unpublished data). Fire could have short-term negative effects if ground cover adjacent to permanent water sources were removed or if the availability of invertebrate prey decreased as a result of fire.

Forest health and protection treatment strategies that include harvest activities are unlikely to negatively affect these species. However, road building, which is often associated with harvesting, has eliminated breeding sites in the past (Bull, unpublished data). Mortality of green frogs (*R. clamitans*) has been reported from traffic on roads (Lamoureux and Madison 1999). Any spraying with pesticides that alter the abundance of invertebrates that these species depend on could also be detrimental. However, spraying with biological microbial agents, like *Bacillus thuringiensis* var. *kurstaki*, is unlikely to be detrimental because those agents do not affect most aquatic insects (USDA Forest Service 2000).

Although most treatment strategies would have either little effect or a positive one on spotted frogs, there are disturbance agents that could significantly affect these species. High- and low-water events, ice events, beaver (*Castor canadensis*) activity, livestock grazing, and the introduction of exotic predators could influence populations of spotted frogs. Frogs overwintering in rivers can be swept downstream during high water or injured during ice movements (Bull, unpublished data). Considerable mortality of embryos occurs when water levels drop in some breeding sites of the Columbia spotted frogs. Beaver activity is primarily beneficial in creating ponds or pools that can be used for breeding along streams and rivers.

There is considerable debate regarding the influence of livestock grazing on frogs. Bull and Hayes (2000) found that livestock grazing did not negatively affect reproduction in the Columbia spotted frog in northeastern Oregon and may have a beneficial effect by increasing nutrient availability. However, the intensity and timing of grazing are important considerations in determining the impact on amphibians. For example, if grazing occurs during oviposition, the potential exists for egg mortality from trampling. Trampling of banks along rivers and ponds could eliminate overwintering sites in undercut banks. In contrast, trampling and removal of vegetation in shallow water can be beneficial at breeding sites because of the increase in solar radiation and shallow water.

The introduction of exotic predators, such as brook trout (*Salvelinus fontinalis*) and bullfrogs (*Rana catesbeiana*), has the potential to negatively affect Oregon spotted frogs, as well as other amphibians (Hayes and Jennings 1986, Bradford 1991).

Northern Leopard Frog

Historically, the northern leopard frog was found east of the Cascade Mountains and was thought to have entered the Northwest in areas adjacent to the Columbia and Snake Rivers in Oregon and

Washington. This species is of concern (S1 Washington, S2 Oregon) because it has declined precipitously in numbers across North America in the last 20 years and is absent from up to 90% of its historical range in Washington (Larson 1997). Recent surveys in Oregon have failed to find it in the state, although older records verify its presence in the past (Csuti et al. 1997). The northern leopard frog is a highly aquatic species living in marshes, wet meadows, ponds, and reservoirs. A high degree of vegetative cover for concealment is required. Breeding occurs in the spring shortly after ice and snow have disappeared, with frogs moving to breeding sites from overwintering habitat. Adult frogs feed primarily on invertebrates, although worms, snails, and other small frogs are also taken.

Potential Effects of Insects, Disease, Fire, and Management Strategies

Forest insects, tree disease, and fire are unlikely to influence populations of the northern leopard frog, primarily because their distribution is so limited. In addition, their historical range includes an increasing amount of agricultural, residential, and urban lands (Larson 1997). The cause of their decline is unknown, although habitat loss, water contaminants, disease promoted by environmental stress, and introduced predators are thought to have contributed (Larson 1997). Leonard et al. (1993) list predation by bullfrogs as the primary reason for the disappearance of northern leopard frogs from Washington's Columbia National Wildlife Refuge.

There should be no effects from management strategies associated with forest health unless spraying with pesticides decreases the abundance of their potential prey or unless there is road building associated with thinning. Agricultural chemicals have been implicated in decline of this species in other areas. Vehicles on roads have been a significant source of mortality in some areas because leopard frogs move from breeding to summering to overwintering habitats through the course of the year. Any disturbance (e.g., land conversion, climate, livestock grazing) that affects the water level or water quality during the frogs' embryonic and larval periods may negatively affect their populations (Leonard and McAllister 1996).

Cascades Frog

The Cascades frog is primarily a west-side species occurring in the Olympic Mountains of Washington with the range extending on the west and east sides of the Cascade Mountains in Oregon and Washington. Its vulnerable status in Oregon (S3) has resulted from its discontinuous distribution, and the disappearance of this species from 80% of 30 previously confirmed locations since the 1970s (Csuti et al. 1997). This species is closely associated with water and is most common in small pools adjacent to streams flowing through subalpine meadows (Leonard et al. 1993). It is rarely found below 780 m in elevation (Csuti et al. 1997). Breeding occurs in early spring as soon as water is free of ice and snow. Adults feed primarily on invertebrates.

Potential Effects of Insects, Disease, Fire, and Management Strategies

Forest insects and tree disease are unlikely to be detrimental to Cascades frogs. Higher elevation sites may be prone to stand-replacement fires, which may negatively affect this species if the abundance of its potential prey or if water quality during embryonic or larval stages are altered.

Spraying with pesticides could negatively affect the Cascades frog if the availability of its prey is altered. Comments made earlier regarding the effects of livestock grazing, beaver activity, changing water levels, and the introduction of exotic predators on spotted frogs, apply to this species as well.

Tailed Frog

The tailed frog is found in forested coastal and interior mountains of the Northwest. Although this species has a rather broad geographic range, it appears to be distributed in small, but locally abundant populations that are disjunct from one another. This species is restricted to cold, fast-moving permanent streams and is commonly found within old-growth forests (Blaustein et al. 1995). Fertilization is internal as an adaptation to life in fast-moving water. The biology of the tailed frog has been described in detail by Metter (1964), Daugherty and Sheldon (1982), Brown (1990), and Munger et al. 1996. The tailed frog may be considered an obligate inhabitant of mesic forest stands (Sayler and Martin 1996). Adults are

insectivorous, foraging at night along the stream or in the moist forest nearby (Leonard et al. 1993). Larvae attach themselves to smooth rock surfaces and feed on diatoms and algae.

Potential Effects of Insects, Disease, Fire, and Management Strategies

In eastern Oregon and Washington, the tailed frog has the greatest potential for being influenced by disturbance agents because of its close association with cold, rocky, fast-moving streams in the headwaters of portions of the Cascade Range and Wallowa and Blue Mountains. A loss of canopy cover from forest insects, tree disease, or fire would likely have a detrimental effect on tailed frogs because of the increase in stream temperatures and in the case of fire, because of an increase in sedimentation.

There is evidence that tailed frogs disappear from streams within logged areas in western Oregon and Washington, possibly because of increased stream temperatures and sedimentation (Sayler and Martin 1996). Bull and Carter (1996) found no significant differences in the number of larvae or adults in streams with a low, moderate, or heavy amount of timber harvest in the landscape within the watershed surrounding the stream in northeastern Oregon. They suggested that stream characteristics and adjacent forest buffers exerted a stronger influence on tailed frog abundance than the surrounding landscape characteristics.

Any management strategy that increased stream temperatures or sediment in the streams would be detrimental to this species. If spraying with pesticides decreased the abundance or distribution of those insects eaten by adults, it could be detrimental. Protecting headwater streams from harvesting, prescribed fire, and road building would help retain the integrity of these systems.

Larch Mountain Salamander

The Larch Mountain salamander was once thought to be restricted to sites in the Columbia River Gorge, (Kirk 1983, Nussbaum et al. 1983) until recently, when at least six populations were discovered north of the gorge near Mt. St. Helens and just south of Mt. Rainier (Dvornich et al. 1997). This species is listed as imperiled (S2) because populations are small, isolated, and occur in a limited area; and their habitats are naturally discontinuous and vulnerable to human activities (Larson 1997). Larch Mountain salamanders inhabit moist, shady talus with cool temperatures and high humidity, although they have also been found under woody debris on steep, forested slopes (Larson 1997).

Potential Effects of Insects, Disease, Fire, and Management Strategies

Insects, disease, fire, and forest health and protection treatment strategies (e.g., thinning, prescribed fire, spraying with pesticides and biological insecticides, road removal) could affect this species if the overstory providing shade for the talus at occupied sites is killed or removed (Washington Department of Wildlife 1993). Herrington and Larsen (1985) found Larch Mountain salamanders at a tree-covered talus field but absent from an adjacent talus field that had been clearcut. Although most of its habitat is protected within the Columbia River National Scenic Area, some habitat has been lost due to road-building activities that use the talus (Leonard et al. 1993, Washington Department of Wildlife 1993). Bury et al. (1980) and Larson (1997) recommended that logging and road building be avoided on slopes occupied by Larch Mountain salamanders.

Cope's Giant Salamander

The Cope's giant salamander occurs primarily in the Coastal mountains and the west slope of the Cascade Range in Washington, but has been recorded at a few east-side localities in Oregon and Washington. Conservation concern (S2 Oregon, S3 Washington) has resulted primarily from its limited distribution and scarcity. This species is most commonly found as larvae or neotenes, which inhabit small, cold, rocky streams and seeps (Leonard et al. 1993). Terrestrial adults are extremely rare, but have been found beneath surface debris on the margins of water. Prey items include insects, fish, and eggs and larvae of their own as well as those of tailed frogs (Leonard et al. 1993).

Potential Effects of Insects, Disease, Fire, and Management Strategies

The effects of insects, disease, fire and management strategies on the Cope's giant salamander would be similar to those described for the tailed frog because of their use of similar habitat.

Summary

Few studies have been conducted investigating the effects of forest insects, tree disease, or wildfire on amphibians in the Pacific Northwest. The loss of tree canopy would have minimal effects on the Oregon and Columbia spotted frogs, northern leopard frog, and Cascades frog, but more significant effects for the tailed frog, Larch Mountain salamander, and Cope's giant salamander, which depend on shade to maintain temperature and moisture conditions.

The majority of studies looking at management practices have focused on timber harvest and road building, both of which can be detrimental to the tailed frog and Larch Mountain salamander. More subtle activities such as thinning to reduce fuels and the risk of wildfire, have not been considered. Russell et al. (1999) concluded that prescribed fire has little direct effect on most amphibians. Indirect effects through a modification of habitat could alter food resources, change water quality and quantity, and reduce vegetative cover. The moist, permeable skin of amphibians increases their vulnerability to microhabitat drying (Stebbins and Cohen 1995), so these indirect effects could influence survival of dispersing amphibians. The immediate consequences of road removal because of the increase in sedimentation may be as detrimental as road construction depending on the methods employed. The long-term benefits of a decrease in sedimentation and decrease in direct mortality from humans need to be considered. Treatments for insect outbreaks that involve the use of spraying with biological microbial agents or conventional pesticides may or may not affect the abundance of amphibian prey.

At present, there are no existing decision-support tools to aid the management of these amphibian species of conservation concern. Currently, management of these species has been treated on a case by case basis, although the current policies that relate to the protection of riparian areas have protected habitat for some of these amphibians as well. Additional research is warranted to consider the effects of forest health issues as well as other disturbance events on amphibian populations.

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Note

This special issue of *Northwest Science* is a set of papers reviewing the state of knowledge about disturbance processes in eastern Oregon and Washington, related management practices, and effects on key management issues.