Discovery and Status of Oregon Spotted Frog (*Rana pretiosa*) Population at the Parsnip Lakes, Cascade-Siskiyou National Monument

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Introduction

The Oregon spotted frog (*Rana pretiosa*) is one of the most imperiled amphibian species in the Pacific Northwest, with fewer than 40 known extant populations (Cushman and Pearl 2007). Among the 4 species in the family Ranidae native to western Oregon, *R. pretiosa* is the most aquatic, and requires relatively large, seasonally warm wetland complexes to persist (Pearl and Hayes 2004). Extensive alteration and loss of wetland habitat and widespread distribution of non-native species have reduced *R. pretiosa* distribution by more than 70% throughout its historic range, which extends from SW British Columbia to NE California (Pearl and Hayes 2004), and by more than 90% in western Oregon (Hayes 1994). Most extant populations are very small, widely dispersed and locally isolated which increases their probability of extinction due to stochastic events, decreased genetic diversity, and potential inbreeding depression (e.g., Funk et al. 2008). Currently, the Oregon spotted frog is a Candidate for protection under the federal Endangered Species Act, and is ranked as Sensitive-Critical by the Oregon Department of Fish and Wildlife, a Special Status Species by the Bureau of Land Management, and as Sensitive by the U.S. Forest Service.

In April 2003 a population of *R. pretiosa* was discovered at the Parsnip Lakes, Jackson County, Oregon by the Herpetology class from Southern Oregon University who, under my supervision, were conducting the first extensive survey of breeding amphibians at this site. Spotted frogs were known to have inhabited a large wetland meadow at the head of Little Hyatt Reservoir, a small impoundment of Keene Creek located approximately 20 km upstream from the Parsnip Lakes. The last recorded observation of spotted frogs at this location was 10 May 1971 (Museum Specimens 823 and 824; Southern Oregon University Museum of Vertebrate Natural History). Numerous surveys after 1971 found no evidence of spotted frogs at this site, and the species was presumed to have been extirpated from this portion of its range (Hayes 1994). Historically, extensive emergent wetland habitat existed throughout high elevation plateaus that are now beneath Howard Prairie and Hyatt reservoirs, impoundments built in the 1950s to export water from the Klamath watershed to irrigate crops in the Rogue Valley (Johnson et al. 1985). These wetlands were within the upper reaches of Keene and Jenny creeks and probably supported a large population of *R. pretiosa* that was widely distributed throughout this portion of the Klamath watershed. Conversion of this wetland complex into large open water reservoirs, introductions of non-native fishes (both trout and warmwater species) and
bullfrogs, expanded residential and recreational development, and high densities of domestic livestock virtually eliminated *R. pretiosa* from the region. The Parsnip Lakes population is a remnant of this once extensive population, and is the westernmost extant population of *R. pretiosa* in Oregon.

Since its discovery in 2003, I have conducted annual surveys of the *R. pretiosa* population at the Parsnip Lakes. In this report, I (1) present a summary of annual egg mass counts and distribution of oviposition sites from 2003-2008, and (2) discuss habitat conditions, threats, and management priorities to assist in conserving this population.

*Parsnip Lakes*

The Parsnip Lakes are a group of emergent wetlands and wetland ponds located within the boundaries of the Cascade-Siskiyou National Monument (T40S, R3E, Sect. 10), southwestern Oregon. The water bodies making up the Parsnip Lakes range in elevation from 1,232 to 1,340 m and are separated into two clusters (Fig. 1) by a NW to SE trending ridge created by a series of rotated landslide blocks. The SW cluster (1315-1340 m elev.) is located within a long, relatively narrow basin on the back side of a large back-rotated landslide block and includes the largest water bodies in the system. The NE cluster (1232-1266 m elev.) includes smaller, shallower cattail marshes and ponds located on a series of gently sloping benches. These marshes and ponds are fed by numerous springs arising from the face of the landslide block and are highly interconnected by perennial springbrooks and stream channels. These streams coalesce to form a tributary of Keene Creek. Historically, beavers created and maintained the larger ponds within this cluster, which include the most important *R. pretiosa* breeding sites. In contrast ponds and marshes on the SW side of the ridge are much less interconnected, particularly during the summer when stream channels are largely intermittent.

Currently, none of the water bodies comprising the Parsnip Lakes are inhabited by fish or non-native bullfrogs (*Lithobates catesbeianus*). Breeding populations of native amphibians, in addition to *R. pretiosa*, include Pacific chorus frog (*Pseudacris regilla*), western toad (*Anaxyrus boreas*), long-toed salamander (*Ambystoma macrodactylum*), and rough-skinned newt (*Taricha granulosa*). Larvae of the coastal giant salamander (*Dicamptodon tenebrosus*) are common in most perennial streams, and western pond turtles have been observed near the largest ponds in
the SW cluster (Frank Lang, personal communication). The most common vertebrate predator within the system is the common garter snake (*Thamnophis sirtalis fitchii*). In addition, diverse assemblages of large invertebrate predators, including numerous Hemiptera (Notonectidae, Belastomatidae, Nepidae), Coleoptera (Dytiscidae), and Odonata (Aeshnidae, Libellulidae, Corduliidae) and leeches (Annelida: Hirudinida) occur throughout the Parsnip Lakes (Parker 2002).

Most of the forested uplands surrounding the Parsnip Lakes were heavily logged in the past and there are a number of active and abandoned roads passing through the area. Some pass very close to many of the larger water bodies and provide easy access to recreational users of the area. Abandoned roads are frequently used by off-highway vehicles, mountain bikers, and hikers. Livestock grazing has been common in and around the Parsnip Lakes with obvious, persistent impacts to shoreline areas and springs. In addition, there is evidence that the outflows of some of the ponds, particularly in the NE cluster, have been altered to increase water storage for livestock. For example, as recently as spring 2008, someone installed flashboards in the outflow of the furthest downstream pond to manipulate its discharge, potentially altering flow through the entire system. Trapping and hunting may also have negative impacts on *R. pretiosa* habitat. By removing beavers and muskrats, beaver dams that historically maintained areas of open water are rapidly deteriorating and phreatophytic vegetation is beginning to encroach on and reduce the extent of this important habitat. In addition, livestock frequently walk across the top of the large beaver dam that maintains the most important *R. pretiosa* breeding site within the Parsnip Lakes, and have caused the dam to fail in a number of places. This has increased outflow from the pond and caused water levels to drop rapidly, stranding *R. pretiosa* egg masses in shallow marginal areas of the pond, particularly in years with below average precipitation and reduced snow pack.

**Egg Mass and Visual Encounter Surveys**

Beginning in 2003, I have conducted annual egg mass counts at the Parsnip Lakes, usually with the assistance of students in herpetology and aquatic ecology classes from Southern Oregon University. These surveys typically begin in mid-March during spring thaw, and continue through late April when eggs have hatched and tadpoles have dispersed. I attempt to conduct the first survey of the season several days before the onset of breeding and oviposition
and once or twice weekly thereafter until no new egg masses are observed. This allows me to estimate, relatively accurately, the date of initial oviposition and duration of the breeding season. Because male frogs aggregate at breeding sites from a few to several days before females, observing adult frogs at or near known oviposition sites signals the onset of the breeding season (e.g., Licht 1969). In addition to egg mass counts I have conducted periodic visual encounter surveys at many of the ponds during summer and fall to determine the distribution of metamorphs, juveniles, and adult frogs among the different habitats and to determine which water bodies retain surface water throughout the year.

Egg mass counts are made by slowing walking the entire perimeter of each water body searching all potential shallow water habitat. In marshes with extensive shallow water habitat throughout, I attempt to search the entire area by walking back-and-forth in a zigzag pattern to cover as much of the potential habitat as possible (e.g., Thoms et al. 1997). On each date, I record numbers and specific locations of all egg masses observed. Visual encounter surveys for juvenile and adult frogs follow the same basic procedure, but include frequent stops of up to several minutes while the immediate area is searched for frogs floating at or near the water surface.

Oregon spotted frogs have a protracted breeding season at the Parsnip Lakes, beginning in late March to mid-April (Table 1) depending on weather, and lasting less than 2 weeks. Oviposition begins as soon as there is sufficient open water along the W-SW margins of larger water bodies. At this time, there is typically a large amount of snow remaining throughout the area and ponds often retain patches of surface ice, particularly in shaded areas. I have recorded water temperatures as low as 5-6 °C at the initiation of oviposition. However, water surface temperature fluctuates widely throughout the day and can increase rapidly at shallow, sunlit sites. Egg masses in shallow margin habitats are typically several degrees warmer than the surrounding water from mid-morning through early evening. For example, between 1000-1300 hr on 17 April 2008 I recorded egg mass temperatures between 17 - 20 °C while surrounding water temperatures were 7-9°C.

The number of egg masses observed has fluctuated among years, but has been consistently 20 or fewer (Table 1). The 11 masses observed in 2003 may be an underestimate, though, because our initial survey did not include all possible sites. After 2003, surveys included all ponds and emergent wetlands with standing water within the NE cluster. Thorough surveys
of water bodies in the SW cluster were conducted in 2005, 2006 and 2007, but no egg masses were observed in any of them. Nor have I observed tadpoles, metamorphs, or juvenile or adult frogs within these sites. Thus, it appears that *R. pretiosa* reproduction is currently restricted to the NE cluster of wetland ponds (Fig. 1) and within this cluster a single pond appears to be the primary breeding site, with 75-100% of egg masses observed in any given year occurring at this site. Moreover, a single oviposition site within this pond (42°06’24. 20”N, 122°27’01. 25”W) has consistently had a greater number of egg masses (N=7-12) than any other site (N=1-4 among 6 oviposition sites and 4 ponds). These observations reveal the importance of this pond as the primary breeding site and show that connections via stream channels allow for dispersal from this pond into other wetland habitats within the system. This is also an indication of just how precarious the persistence of this population may be. Loss of habitat within this single pond would likely cause a dramatic decline in an already small population.

The SW cluster of lakes and ponds is largely isolated from the rest of the system and lacks an extensive network of springs and streams like those that flow throughout and interconnect ponds and wetlands within the NE cluster. Flowing water that remains ice-free provides important over-wintering habitat for *R. pretiosa* (e.g., Pearl and Hayes 2004). So although most water bodies within the SW cluster appear to provide abundant breeding, tadpole rearing and summer habitat, the lack of suitable over-wintering habitat may prevent long-term population persistence within them. In addition, because adult spotted frogs do not venture far from water (Watson et al. 2003, Pearl et al. 2005), it is unlikely that overland dispersal could link populations across the divide separating these two clusters of wetland ponds.

Although I have not conducted extensive surveys of springs and streams connecting the different water bodies within the Parsnip Lakes, I have on a number of occasions observed juvenile or adult frogs within these habitats. One observation is of particular note because it was relatively far from any known breeding sites and suggests that frogs may be able to disperse great distances along Keene Creek, the largest stream draining this portion of the Monument. On 07 April 2005 I captured a sub-adult *R. pretiosa* (39 mm SVL) in a flooded meadow adjacent to Keene Creek > 1 km upstream from the Parsnip Lakes (Fig. 1). This meadow complex, referred to as Mayfield Garden, is seasonally flooded but dries completely by mid-summer. There is clear evidence of past beaver activity in this area and it is likely that the meadow was formed, in part, by beavers damming sections of the Keene Creek creating ponds that would have persisted
throughout the year. For several decades, however, this meadow complex has been used extensively for livestock grazing and the resulting stream channel down cutting and beaver removal has effectively eliminated all permanent standing water habitat. Limiting access to livestock and allowing beavers to recolonize this area would likely restore substantial habitat available to the spotted frog population. All other observations of juvenile and adult frogs within stream habitats have been within the main spring channel feeding the uppermost, and largest breeding pond and in streams connecting lower cattail marshes in the NE cluster (Fig. 1). Gaining a more thorough understanding of seasonal movements among ponds, and use of springs and stream habitats will be important in defining habitats critical for long-term conservation of this population and to identify potential sites for restoration.

Habitat Conditions, Threats, and Management Recommendations

With the transfer of former timberlands to the Bureau of Land Management, via the Pacific Forest Trust, the Parsnip Lakes and their watershed are entirely within the boundaries of the Cascade-Siskiyou National Monument. The diverse aquatic and riparian communities within this portion of the monument clearly represent “objects of historical or scientific interest” as presented in the Presidential Proclamation (June 9, 2000) and should, therefore, be managed to conserve their ecological integrity. Maintaining habitats that support a viable \textit{R. pretiosa} population will not only conserve this rare species, but will contribute to sustaining overall biological diversity within the Monument.

Potential threats to the continued existence of \textit{R. pretiosa} within the Parsnip Lakes include (1) small population size, isolation, and risk from stochastic events, (2) habitat loss due to succession of marsh vegetation within primary breeding sites (Fig. 3), (3) continued impacts of livestock grazing within breeding and over-wintering habitats, (4) colonization or introduction of non-native species, particularly bullfrogs, (5) proliferation of pathogens such as the chytrid \textit{Batrachochytrium dendrobatidis} (Bd) (Pearl et al. 2007) and oomycete fungi (Oomycota: Saprolegniaceae) (Petrisko et al. 2008), and (6) largely unknown impacts of climate change, particularly as they affect precipitation timing, wetland persistence, and shifts in breeding phenology. Regardless of actions taken to minimize these threats, long-term population monitoring will be an essential component of any management plan for this site.
**Isolation and small population size** – Because there are no other spotted frog populations near the Parsnip Lakes, maintaining existing habitat and connectivity among sites within this restricted area will be crucial for sustaining the population long term. Restoring habitats within areas likely inhabited by spotted frogs in the past (such as the Mayfield Garden meadow complex described above) could greatly increase population size and spatial distribution. In addition, it may be possible to introduce frogs into the larger ponds within the SW cluster to increase the number of subpopulations, though connection with other subpopulations would be limited and lack of over-wintering habitat may limit the success of such translocations. Thorough habitat surveys of these ponds, with particular focus on the locations and extent of potential over-wintering habitats, should be a priority.

**Marsh succession and loss of habitat** – This is perhaps the most immediate concern because it involves what is currently the most important breeding site within the Parsnip Lakes. Because this site was created and historically maintained by beaver, their absence in recent years has resulted in deterioration of the dam and lowering of the water level within the pond. In April 2005, I observed a single beaver at this site, but none before or since. I also frequently observed muskrats at this site between 2002 and 2004, but they appear to have been extirpated by spring 2005. Muskrats feed extensively on cattails and other aquatic vegetation and can maintain patches of open water habitat, increase habitat complexity, and slow the encroachment of marsh vegetation, roles they played historically within this site. Lowering of the water level and large-scale encroachment by cattails (*Typha latifolia*) have dramatically reduced available open water habitat (Fig. 3). In addition, during 2004 and 2007, years with below average precipitation and reduced snow pack, water level in the pond dropped rapidly during the breeding season, stranding egg masses at both main oviposition sites within the pond.

It is likely that ongoing fur trapping and illegal hunting, facilitated by relatively easy road access, is responsible for the absence of beavers and muskrats. Attempts should be made to reduce the impacts of these activities and allow beavers and muskrats to recolonize and play a role in maintaining spotted frog habitats throughout the watershed. It may be necessary and desirable to relocate beavers to this area if recolonization does not occur naturally. In the interim, it may be necessary to shore-up the existing beaver dam to slow pond draining during
the breeding season when egg masses are most vulnerable to stranding. Also in the short term it may be necessary to move stranded egg masses. For example, on 13 April 2007, 8 of 12 egg masses had become stranded at the main breeding pond and I moved them approximately 10-12 m and placed them back into areas with water depth of 8-10 cm. Although there was high embryo mortality within these egg masses, many survived to hatch and disperse.

**Impacts of livestock grazing** – Although livestock density in and around the Parsnip Lakes appears to have declined since around 2005, they continue to have an impact on the area, particularly near springs and along stream channels. Undercut banks, accumulations of large woody debris and crevices in and around stream channels may provide important over-wintering habitat for spotted frogs. Where cattle congregate they tend to break down channel banks, cause channel down cutting, or create low-lying, muddy basins, all of which result in habitat loss. Reducing livestock access to sensitive springs and streams would minimize habitat loss, and maintain connectivity among ponds and between ponds and ice-free flowing water habitats during winter.

As described above, cattle have accelerated the deterioration of the large beaver dam maintaining the most important breeding pond, reducing pond surface area and depth. Without beavers to actively maintain this and other dams, much of the open water pond habitat is rapidly decreasing as shallow water, phreatophytic vegetation proliferates.

**Non-native species** – Currently, there are no non-native fish or amphibians within the Parsnip Lakes. The absence of invasive, non-native species is an attribute of this wetland complex worth maintaining. Most of the water bodies may be too shallow and experience extensive freezing during most winters, which has likely prevented successful colonization or introduction of fish and bullfrogs. During warmer than average winters, however, it might be possible for bullfrogs to gain a foothold if they are able to over-winter in any of the larger, deeper ponds. This may become increasingly likely with climatic warming because bullfrogs already inhabit water bodies in close proximity to the Parsnip Lakes, including larger reservoirs in the Keene Creek watershed and Jenny Creek into which Keene Creek flows.

A number of non-native aquatic plant species have become naturalized in streams and reservoirs throughout the region (e.g., *Myriophyllum spicatum, Potamogeton crispus*). Although
it is unlikely that most of these plants pose an immediate threat to the Parsnip Lakes, plant fragments, seeds, and other aquatic organisms can be easily transported among sites. Care should be taken to prevent unintended introductions of aquatic organisms by thoroughly cleaning sampling equipment and footwear prior to using them in within the Parsnip Lakes.

Pathogens – Preliminary samples of juvenile and adult frogs (September 2006) revealed the presence of Bd within the Parsnip Lakes population (C. A. Pearl, USGS, personal communication). In addition, oomycete infections are common, and in 2008 resulted in 10% to nearly 70% embryo mortality among individual egg masses. Consequences of these pathogens, at the population level, are unknown for this location and long term monitoring will be necessary to detect changes in pathogenicity of existing organisms or introductions of additional strains. It has been shown that a large number of Saprolegniaceae species infect amphibian eggs throughout the Pacific Northwest (Petrisko et al., 2008), with some being responsible for very high mortality rates and large population declines (e.g., Blaustein et al. 1994). Because these organisms are effective “hitchhikers” and are easily transported among locations, it is critical that anyone conducting research or surveys within the Parsnip Lakes thoroughly cleans and disinfects all sampling equipment (e.g., Thoms et al. 1997), particularly boots and waders that have been used in other water bodies.

Climate Change – Specific effects of ongoing and future climate change are difficult to predict with certainty. Consensus among general circulation models, however, suggests that this region will likely experience 0.5-1.6 °C increases in average annual temperature by 2040, 2.2-4.4 °C increases by 2080, and large scale shifts in the timing and form of precipitation (Doppelt et al. 2008, Lawler et al. 2008). Although average annual precipitation may remain roughly similar to historic levels, it will likely be more concentrated during mid-winter months and fall predominantly as rain. Snowpack is predicted to decline 25-75% by 2040 and by as much as 94% by 2080.

Such climatic shifts will likely have dramatic effects on mid to high-elevation wetland habitats throughout the region. Many ponds that are permanent year round will become dry in summer, and succession of marsh vegetation will likely be accelerated. In addition, spring and stream flows may increase during winter rain events, but will rapidly diminish during spring and
summer due to reduced snow pack. Variation in the timing of pond filling, and pond level fluctuations will likely increase in response to the shift in precipitation from predominantly snow to rain. Emergence from winter torpor and initiation of the breeding season will also shift to being earlier, which may put egg masses in jeopardy of being alternately stranded or flooded with increased pond level fluctuations. Frogs over-wintering in springs and streams will likely experience greater discharge fluctuations that may render many current over-wintering sites unsuitable in the future. In addition, many of these habitats may remain dry during late fall when frogs would typically migrate to over-wintering sites.

In addition to direct effects of climate change on habitat conditions, warmer temperatures and less frequent winter freezing among ponds may allow colonization of high elevation sites by bullfrogs and non-native plant species. Warmer temperatures may also increase physiological stress and increase the distribution and virulence of pathogenic organisms.

In order that environmental and population monitoring not simply document habitat loss and species declines, it will be important to identify shifts in habitat availability and manage the landscape to allow population distributions to shift in response. Maintaining connectivity among wetlands will be essential in allowing the population to respond to environmental change, and habitats that are currently not inhabited by frogs, may provide refuge in the future through restoration or reintroductions.

**Monitoring and Research**

Monitoring and research activities should be coordinated with the Interagency Special Status/Sensitive Species Program (ISSSSP) spotted frog working group to insure information obtained for this population contributes to conservation of the species range wide. Below are suggestions for population and habitat monitoring and research projects that could be provide data relevant to conservation efforts.

1. Continue to conduct annual egg mass counts at all potential breeding sites. These counts will allow trends in population size to be tracked in response to changes in management practices, habitat restoration, and translocations. In addition to numbers and locations of egg masses, the proportion of non-viable embryos and those infected with oomycete fungi should be
estimated. Oviposition sites should be located using GPS and habitat characteristics at each site (water depth, vegetation, temperature, etc.) should be recorded.

2. Establish photopoints at each breeding site to document variation in water level and changes in vegetation composition over time.

3. Survey potential, but currently unoccupied habitats (i.e., SW cluster of ponds, Mayfield Garden meadows) to identify sites where habitat could be restored and frogs reintroduced. These surveys may also locate additional occupied sites, sites that may be colonized, or that are used irregularly depending on variation in precipitation and duration of standing water.

4. Track seasonal movements of adult and juvenile frogs, identify over-wintering sites, and determine the extent of connectivity among sites. This may require trapping and marking individual frogs using pit tags and tracking movements using radio-telemetry.

5. Collaborate with other spotted frog researchers to obtain tissue samples for DNA analyses to contribute to the larger effort of describing phylogeographic patterns and extinction risk of small, isolated populations.
Figure 1. Map of Parsnip Lakes showing approximate locations of oviposition sites among ponds (•) and sites where adult or juvenile frogs have been observed (★)

Table 1. Summary of egg mass survey results, 2003-2008.

<table>
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<th>Year</th>
<th>Beginning oviposition date</th>
<th>No. of egg masses observed</th>
<th>No. of oviposition sites</th>
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Figure 2. Typical cluster of egg masses (N=11) deposited in shallow, near shore habitat at the main breeding pond within the Parsnip Lakes (17 April 2008). Note the white, fuzzy appearance of egg masses near the top of the cluster indicating infection by pathogenic water mold (Saprolegniaceae).

Figure 3. Primary breeding site, 11 September 2008, illustrating large scale encroachment of cattails and reduction of open water habitat (compare with photo on report cover).
References Cited


