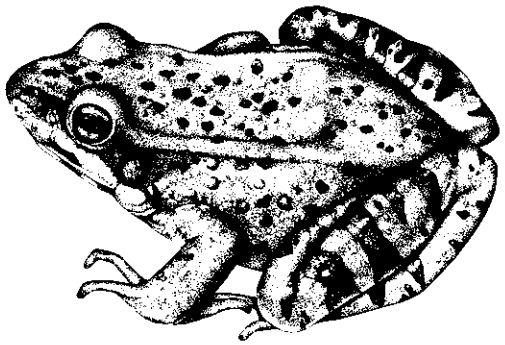
COSEWIC
Assessment and Status Report

on the

Oregon Spotted Frog
Rana pretiosa

in Canada



ENDANGERED
2000

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE IN
CANADA

COSEPAC
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COSEWIC
Assessment Summary

Assessment Summary – May 2000

Common name
Oregon spotted frog

Scientific name
Rana pretiosa

Status
Endangered

Reason for designation
This highly aquatic frog of floodplain wetlands is reduced to only three isolated sites, each containing very low numbers of individuals. It has been adversely affected by habitat loss due to urban expansion, agriculture, exotic competitors and exotic vegetation.

Occurrence
British Columbia

Status history
Designated Endangered in an emergency listing in November 1999. Status re-examined and confirmed in May 2000. May 2000 assessment based on new quantitative criteria applied to the interim status report.

COSEWIC
Executive Summary

Oregon Spotted Frog
Rana pretiosa

The Oregon spotted frog, *Rana pretiosa,* is brown to reddish brown with black halos spread over its head and back. Adults have a mottled belly and yellow to salmon colour wash. Egg masses are laid communally in tight groupings. Single egg masses or groups of two or three egg masses are uncommon. *Rana pretiosa* and the Columbia spotted frog (*Rana luteiventris*) are sibling species identifiable through protein analysis and differentiated since 1997. Previously, they were collectively known as a single species, *Rana pretiosa*.

The life cycle of *R. pretiosa* begins when males move to breeding sites in late winter and call to female frogs during day and night. Female frogs lay a single egg mass, fertilized externally by a male, in a communal cluster. Embryos develop and hatch in 2 - 3 weeks and free-swimming aquatic larvae metamorphose into froglets measuring 30 - 33 mm snout-vent length in as few as 4 months.

Rana pretiosa is a warm-water marsh specialist that prefers wetlands with emergent vegetation. Shallow ephemeral pools and small floodplain wetlands associated with permanent water bodies are important habitat features for *R. pretiosa*. Potential habitat is fragmented throughout the Fraser River Lowlands and extant populations appear to be isolated from one another.

The historic distribution of *R. pretiosa* extends from the extreme southwest corner of British Columbia to the northeast corner of California. In British Columbia, 6 populations of *R. pretiosa* have been documented: 3 extirpated historic populations and 3 populations newly discovered resulting from an ad hoc survey. During this inventory of wetland sites in the Fraser River Lowlands, *R. pretiosa* was observed at only 3% of sites. It is estimated that *R. pretiosa* has been lost from more than 90% of its historic range in North America. All three historic Oregon spotted frog populations have been lost in British Columbia compared to 91% in Washington State (10 of 11), 76% in Oregon (34 of 45), and 100% in California (3 of 3).

Rana pretiosa has been defined by the British Columbia Conservation Data Centre as critically imperilled (five or fewer occurrences) and has been "red-listed" as an endangered species of major management concern. The Washington Fish and Wildlife Commission has designated the species "endangered" and the Oregon Department of

Fish and Wildlife has designated it as "sensitive critical". The US Fish and Wildlife Service is currently assessing the status of *R. pretiosa* for listing at the federal level.

Factors limiting Oregon spotted frog populations include human-effected habitat losses, succession-related habitat losses, hydrologic alteration, exotic predators and vegetation, livestock management, and isolation.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as “Vulnerable” from 1990 to 1999, or “Rare” prior to 1990.
** Formerly described as “Not In Any Category”, or “No Designation Required.”
*** Formerly described as “Indeterminate” from 1994 to 1999 or “ISIBD” (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.

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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Oregon Spotted Frog
Rana pretiosa

in Canada

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2000

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INTRODUCTION

The spotted frog complex are a group of aquatic frogs with short legs and upturned eyes. Previously, these frogs were collectively known as a single species, the spotted frog (*Rana pretiosa* sensu lato). Green, however, suggested that eastern and western populations of the spotted frog were karyotypically and biochemically distinct (1986a, 1986b) and, later, Hayes (1994a) determined that populations of spotted frogs ranging from southwestern British Columbia to northeastern California possess a distinctive belly colouration that is absent in populations to the east. Further biochemical evaluation over a wider geographic range (Green *et al*., 1996) confirmed the distinctiveness of the eastern from western populations and recognized the spotted frog complex as comprising two distinct species: the western Oregon spotted frog, *Rana pretiosa* sensu stricto, and the northern and eastern Columbia spotted frog, *Rana luteiventris* (Green *et al*. 1997).

In extreme southwest British Columbia, *R. pretiosa* is well documented by Licht (1969a, 1969b, 1971a, 1971b, 1972, 1974, 1975, 1986a, and 1986b). In this population, female and male Oregon spotted frogs reached a maximum snout-vent length of 78 mm and 64 mm respectively (Licht 1986a). In a Washington State population, female and male frogs reached a maximum snout-vent length of 76 mm and 65 mm respectively (McAllister and Leonard, 1997).

Adult Oregon spotted frogs possess light-centered black spots, scattered on a brown or reddish brown head and back region that becomes increasingly red with age. Light brown to orange dorsolateral folds begin directly behind the eye and run over the tympanum posteriorly along the back. Beyond the middle of the back, the folds become discontinuous and disappear as they approach the lower back (Figure 1). Juvenile Oregon spotted frogs are olive green or light brown.

Figure 1. Oregon spotted frog, *Rana pretiosa*
Dempsey Creek, Washington, USA. (K. McAllister photo.)

Adult Oregon spotted frogs have a distinctive mottled belly and highly fragmented colour wash. The fragmented colour wash refers to the discontinuous orange to red-orange colour on the undersurfaces of the upper thigh and belly. Belly mottling refers to the dark spots interspersed ventrally within the fragmented colour wash (Hayes 1997). The belly mottling is prominent in adult Oregon spotted frogs and absent in most newly metamorphosed frogs (Hayes 1997).

In Licht's study population in southwest British Columbia, the red-legged frog (*Rana aurora*) was reported to occur sympatrically with *R. pretiosa*. *Rana aurora* shares gross morphological similarities with *R. pretiosa* and, since both occur syntopically in the extreme southwest corner of British Columbia, there is opportunity to incorrectly identify these species.

Geographic range alone eliminates the chance for Columbia spotted frogs to be confused with either *R. aurora* or *R. pretiosa* in British Columbia. *Rana luteiventris* occupies the majority of the province of British Columbia with the exception of the extreme southwest corner, which is occupied by *R. pretiosa* and *R. aurora*. However, for the sake of comparison, *R. luteiventris* is included in the discussion on species identification that follows.

The adult Oregon spotted frog is easily distinguished from the adult red-legged frog using a number of characteristics. The underbelly of *R. aurora* lacks the fragmented colour wash and mottling of *R. pretiosa*. Instead, the underbelly of *R. aurora* is a consistently coloured orange-red to red. Alternatively, bright colouration is completely absent and the underbelly is slate coloured. The groin region, the area where the legs fold against the body, shows faint yellow pigmentation. *Rana luteiventris* does not possess the same ventral mottling as *R. pretiosa*.

In comparison to *R. aurora*, *R. pretiosa* is more of an aquatic species and is adapted accordingly. *Rana pretiosa* and *R. luteiventris* have more extensive toe webbing than *R. aurora*. The toe webbing of the Oregon and Columbia spotted frogs extends to the tips of the digits, whereas the toe webbing of *R. aurora* never extends to the tip of the digits. The lower leg of *R. pretiosa* is usually less than half its snout-vent length, whereas that of *R. aurora* is usually more than half its snout-vent length (Hayes 1994b). The eyes of the Oregon and Columbia spotted frogs are turned upward whereas the eyes of *R. aurora* are turned outward. Secondary distinguishing characteristics may be described as behavioral or, more specifically, postural. *Rana pretiosa* sits low to the ground, keeping a low profile while "crouching". *Rana luteiventris* also exhibits this posture. Conversely, *R. aurora* sits "straight up" with its elbows extended and appears ready to move quickly in a forward direction.

Although *R. pretiosa* and *R. luteiventris* are not known to occur sympatrically, a discussion of their respective oviposition patterns is useful. Oviposition patterns of *R. pretiosa* and *R. luteiventris* are slightly different in that *R. pretiosa* masses are laid communally in a tight grouping. Columbia spotted frog egg masses are also laid in tight groupings, but interspersed over a large area. Egg masses laid by *R. pretiosa* are

typically laid on top of one another and the top portion of the grouping of egg masses is usually above the surface of the water. In smaller populations in the interior of British Columbia, egg masses of *R. luteiventris* are often laid singly. Egg masses of *R. aurora* are always laid singly on sturdy vegetation and always below the surface of the water. Occasionally, red-legged frog egg masses become detached from the vegetation onto which they were originally laid and can be found touching one another on the surface. Ovum size in Oregon spotted frogs is reported to average 2.31 mm compared to an average of 3.03 mm in red-legged frogs (Licht 1971a). Gill filaments of post-hatchling (stage 22; Gosner 1960) Oregon spotted frogs appear longer than those of *R. aurora*.

Altig (1970) reports that tail length of *R. pretiosa* tadpoles is proportionately greater than that of *R. aurora* tadpoles. Dividing the total length of an Oregon spotted frog tadpole by its body length results in a number larger than 2.6. Conversely, red-legged frog data result in a number smaller than 2.6. Colouration of the underbelly tends to be less reliable and must be used in conjunction with other reliable distinguishing characteristics. The underbelly of Oregon spotted frog tadpoles is white or slate in colour and lack flecking, whereas the underbelly of red-legged frog tadpoles is yellow or a washed-out red with many yellow, brass or gold flecks. Distinguishing juvenile Oregon spotted frogs from juvenile red-legged frogs is easier than distinguishing tadpoles of the two species. Juvenile Oregon spotted frogs are olive coloured whereas juvenile red-legged frogs are red-brown coloured.

DISTRIBUTION

Rana pretiosa is a Pacific Northwest species whose historic distribution extends from the southwest corner of British Columbia to the northeast corner of California (Figure 2). In British Columbia, *R. pretiosa* occurs in the extreme southwest corner of the province in an area generally referred to as the Fraser River Lowlands (Table 1; Fig. 3). In the United States (Table 1), *R. pretiosa* is documented in the Puget Trough and Willamette Valley in Washington State, in the central Cascade Mountains of Oregon, and into the Pitt River drainage of northeast California (Stebbins 1985). In addition, *R. pretiosa* is documented to the East in the south central Cascade Mountains of Washington, a population that is discontinuous with the Puget Trough/Willamette Valley populations.

Historic Populations

In British Columbia, there are three historic populations of *R. pretiosa*. The first is a well-documented population in the District of Langley that appears to be extirpated (Haycock, unpub. data). The second historic record, dated October 20, 1941, is from Nicomen Island in the Fraser River (Carl and Cowan 1945). The third historic record is Carl and Cowan's (1945) reference to a notation made by E.B.S. Logier who reported *R. pretiosa* within a large expanse of farmland referred to as Sumas Prairie. Details of the specific locations of these sites were not provided by Carl and Cowan. Despite the lack of locality detail provided by Carl and Cowan (1945), attempts were made to verify

the records of these two historic populations. A cursory survey of Nicomen Island by the author in the summer of 1997 did not confirm the presence of *R. pretiosa*. An anecdotal observation of *R. pretiosa* by S. Orchard (pers. comm. 1996) provided a starting point for a survey of the remnant portion of Sumas Lake and associated ditches in the summer of 1996 and the spring and summer of 1997 (Haycock 1998). This did not reveal the presence of *R. pretiosa*.

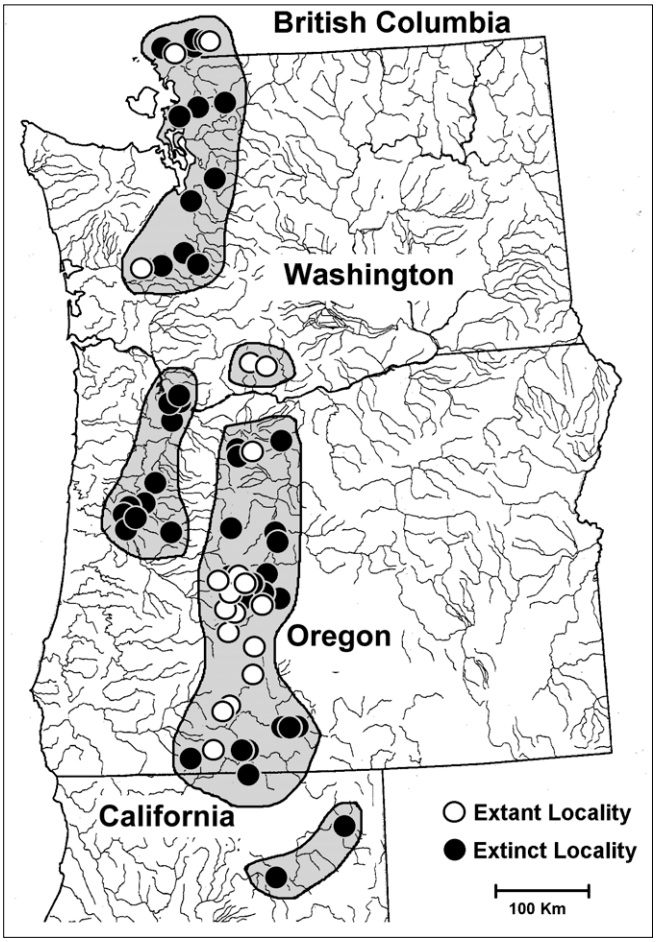

Figure 2. Historic distribution of *Rana pretiosa* (adapted from Hayes *et al*. 1997).

Elsewhere in North America, 59 historic populations of *R. pretiosa* are documented: 11 in Washington State (McAllister and Leonard 1997), 45 in Oregon, and 3 in California (Hayes 1997). One of the historic populations in Washington State is extant, 13 of the historic populations in Oregon are extant, and none of the historic populations in California are extant.

Previously Unknown Populations

Three populations of *R. pretiosa* have been recently located in British Columbia. Haycock (1998) presents an inventory of amphibian species in the Fraser River

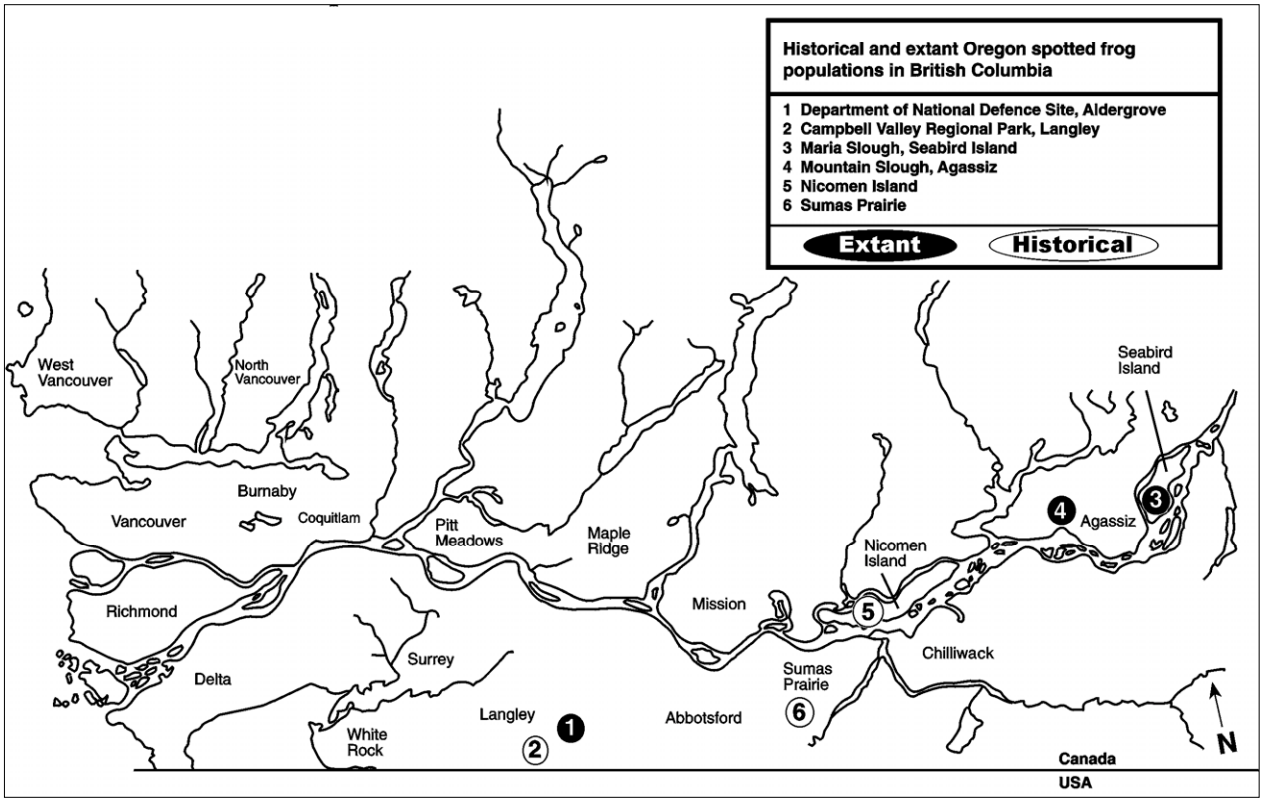

Figure 3. Distribution of *Rana pretiosa* in Canada.

Lowlands that documents 94 sites surveyed during 1996 and 1997. The survey focused on amphibian species whose life stages are associated with aquatic systems. From this inventory, three new populations of *R. pretiosa* were located at previously unknown locations. The new sites include populations at Naval Radio Station Aldergrove, Mountain Slough in Agassiz, and Maria Slough adjacent to Seabird Island.

In Washington State, McAllister and Leonard (1997) report two previously unknown populations of *R. pretiosa*, and report a recently discovered population at Beaver Creek (Thurston County; McAllister, pers. comm. 1999). In Oregon State, Hayes (1997) reports 8 previously unknown populations of *R. pretiosa*. Recently, Hayes reports 4 recently located populations. These are: Muskrat Lake, Deschutes County; Penn Lake - Cabin Meadows, Lane County; Sunriver, Deschutes Drainage; and, Wicoppee Lake, Deschutes County (Hayes, pers. comm. 1999). There are no new populations of *R. pretiosa* in California (Hayes, pers. comm.).

Across its geographic range, 80 historic and extant populations of *R. pretiosa* have been documented in total: 6 in B.C., 14 in Washington, 57 in Oregon, and 3 in California.

Table 1. Known site locations for the Oregon spotted frog, *Rana pretiosa*

Currently occupied sites are indicated "+" under "Status", locally extinct sites are indicated "-".

Site	County	Last Date Observed	Status
British Columbia			
Department of National Defense, District of Langley		March 22, 1999	+
Campbell Valley Regional Park, District of Langley		August 21, 1979	-
Maria Slough, Seabird Island		April 17, 1997	+
Mountain Slough, Agassiz		April 5, 1997	+
Nicomen Island, Chilliwack		October 20, 1941	-
Sumas Prairie, Chilliwack		-	-
Washington State (McAllister and Leonard, 1997)			
Beaver Creek	Thurston	September 16, 1998	+
Conboy National Wildlife Refuge	Klickitat	August 21, 1992	+
Concrete, 2 mi Northwest	Skagit	April 23, 1930	-
Dempsey Creek floodplain	Thurston	May 18, 1994	+
Kapowsin, 3 mi West	Pierce	August 10, 1937	-
Kent 1957	King		-
Monroe, 3 mi South	Snohomish	September 7, 1939	-
Mount Vernon, 3 mi West	Skagit	October 9, 1937	-
Pattison Lake	Thurston	-	-
Seattle	King	March 19, 1905	-
Sedro Woolley, 3 mi East	Skagit	August 23, 1930	-
Spanaway Lake pond	Pierce	February 24, 1959	-
Trout Lake	Klickitat	August 21, 1992	+
Trout Lake Creek, Guler	Klickitat	September 2, 1938	-
Trout Lake, 0.5 mi North	Klickitat	June 25, 1958	-
Trout Lake, 0.5 mi Northeast	Klickitat	June 25, 1958	-
Trout Lake, 1 mi North	Klickitat	June 25, 1958	-
Vancouver	Clark	September 30, 1909	-
Orchards	Clark	March 15, 1962	-
Oregon (Hayes, 1997a)			
Albany	Linn		-
Aumsville	Marion		-
Big Lake (N end)	Linn		-
Big Marsh	Klamath	September 5, 1994	+
Buck Lake	Klamath	August 25, 1996	+
Camas Prairie	Wasco	September 10, 1996	+
Clackamas Lake	Clackamas		-
Cline Falls State Park	Deschutes		-
Corvallis	Benton		-
Cow Camp Crossing	Deschutes		-
Crane Prairie Reservoir	Deschutes		-
Crater Meadows	Clackamas		-
Crystal Springs Lake	Multnomah		-
Cultus Creek Ford	Deschutes		-
Cultus Creek Gravel Pit Pond	Deschutes	August 22, 1995	+
Cultus Lake	Deschutes		-
Ferguson Butte (near)	Klamath		-
Fourmile Creek	Klamath	August 22, 1996	+

Table 1. (Continued)

Site	County	Last Date Observed	Status
Gold Lake Bog	Lane	September 26, 1998	+
Goose Lake	Lane		-
Hosmer Lake	Deschutes	June 26, 1996	+
Jack Creek	Klamath	August 19, 1996	+
Johnson Creek (Portland)	Multnomah		-
Junction City (SW of)	Lane		-
Klamath Falls	Klamath		-
Klamath Marsh NWR	Klamath	September 27, 1994	+
La Pine (Lower Long Prairie)	Deschutes	July 27, 1996	+
Lava Lake	Deschutes	August 4, 1995	+
Little Cultus Lake	Deschutes	August 4, 1995	+
Little Deschutes River	Deschutes		-
Little Hyatt Reservoir	Jackson		-
Little Lava Lake	Deschutes	August 2, 1995	+
Lower Bridge	Deschutes		-
McFadden Marsh	Benton		-
Muskrat Lake	Deschutes		+
N Fork Sprague River	Klamath		-
Odell Creek at Davis Lake	Klamath	August 12, 1994	+
Odell Creek at NFD 4660	Klamath	August 25, 1994	+
Oregon Electric Railroad	Linn		-
Paulina Prairie (Creek)	Deschutes		-
Penn Lake	Lane		+
Portland	Multnomah		-
Quinn River Campground	Deschutes	July 29, 1996	+
Ranger Creek (Davis Lake)	Klamath	August 25, 1994	+
Ryan Ranch	Deschutes		-
South Twin Lake	Deschutes		-
Spring Creek	Klamath		-
Sunriver	Deschutes		+
Sweet Home	Linn		-
Tangent (11 km E Corvallis)	Linn		-
Tygh Valley (0.8 km S of)	Wasco		-
Upper Klamath Lake	Klamath		-
Wickiup Dam (base)	Deschutes	July 27, 1996	+
Wickiup Reservoir (NW)	Deschutes		-
Wicopee	Deschutes		+
Wood River (Ft Klamath)	Klamath	August 24, 1994	+
California (Hayes, 1997a)			
Alturas	Modoc		-
Fall River Mills (near)	Shasta		-
Lower Klamath Lake	Siskiyou		-

PROTECTION

The British Columbia Conservation Data Centre (BCCDC), which maintains records pertaining to the status of rare, threatened, sensitive and vulnerable floral and faunal species in British Columbia, has assigned the Oregon spotted frog (*Rana pretiosa*) a global rank of "G2/G3" and subnational rank of "S1". The BCCDC has further assigned *R. pretiosa* as a "Red-Listed" species that can be defined as an endangered or threatened species of major management concern. The British Columbia Wildlife Act and its associated regulations designate native members of the Family Ranidae as wildlife. A permit is required from the Wildlife Branch of the Provincial Ministry of Environment, Lands and Parks in order to collect, keep in captivity, or manipulate *R. pretiosa* in any manner. There are no provisions in the *Act* for the protection of *R. pretiosa*'s habitat. Protection afforded *R. pretiosa* through the Wildlife Act is minimal at best.

The US Fish and Wildlife Service is currently reviewing the status of *R. pretiosa* for possible listing at the federal level. The Washington Department of Fish and Wildlife maintains a list of endangered, threatened, and sensitive species (Washington Administrative Codes 232-12-014 and 232-12-011, Appendix). In August 1997, a Final Status Report and Listing Recommendation for *R. pretiosa* was presented to the Washington Fish and Wildlife Commission and the species was designated as, "Endangered" (McAllister and Leonard, 1997). The Oregon Department of Fish and Wildlife also maintains a list of endangered, threatened, and sensitive species. Currently, *R. pretiosa*'s status in Oregon is "sensitive critical" (M. Hayes, pers. comm. 1999).

POPULATION SIZE AND TREND

Size of Extant Populations

The number of egg masses counted at *R. pretiosa* breeding sites is data suitable for estimating the sizes of *R. pretiosa* populations in Canada, assuming that female frogs lay a single, annual clutch of eggs. Olson and Leonard (1997) reported that this assumption holds true in Washington State. At the Naval Radio Station in Aldergrove, up to 7 communal breeding sites contained 48 egg masses in 1997 and 29 in 2000 (Haycock 1998 and unpublished). Two communal breeding sites at the Mountain Slough site contained 16 egg masses in 1997 and 45 in 2000 whereas at Maria Slough there were 38 egg masses in 1997 and 75 in 2000. Assuming a 1:1 sex ratio among adults, the population sizes in 1997 can be estimated to have been 96 for the Naval Radio Station, 32 for Mountain Slough, and 76 for the Maria Slough and therefore, the total number of documented breeding *R. pretiosa* in Canada in 1997 was an estimated 204 adults. For these same sites, the populations in 2000 were estimated as 54, 90, and 150, respectively, totaling 294 adults (unpublished data). Licht (1969a) counted 30 egg masses in 1968 and 54 egg masses in 1969 at his site in Langley. The number of egg masses at Langley in 1968 appears consistent with the numbers found at all extant sites in British Columbia. The Langley site is now extirpated.

In Washington State, McAllister and Leonard (1997) reported a population size of 242 adults at Dempsey Creek, 1,144 adults at Trout Lake, and 1,328 adults at Conboy Lake.

Population Trends

Of the 62 historic Oregon spotted frog populations in North America, only 13 are extant; 1 in Washington and 12 in Oregon. Thus, across its geographic range, 79% of historic Oregon spotted frog populations have been lost. In British Columbia, 100% of historic *R. pretiosa* populations have been lost (3 of 3), 91% have been lost in Washington State (10 of 11), 76% in Oregon (34 of 45), and 100% in California (3 of 3). If a much broader range suggested by the historic data is considered, Hayes (1997) estimated that *R. pretiosa* has been lost from more than 90% of its historic range. A current calculation may be slightly higher than 90%, since Hayes (1997) did not include the two historic populations in B.C. reported by Carl and Cowan (1945).

An inventory of 94 wetland sites in the Fraser River Lowlands (Haycock 1998) located three new populations of *R. pretiosa*, only 3% of all sites surveyed in the Fraser River Lowlands.

HABITAT

Typical and Essential Habitat

In British Columbia, Licht (1969b) clearly illustrated that shallow, ephemeral pools and small floodplain wetlands associated with permanent water bodies are important habitat features for *R. pretiosa*. McAllister and Leonard (1997) described typical Oregon spotted frog habitat as wetland with emergent vegetation within forested landscapes. Hayes (1994a, 1994b) further described *R. pretiosa* in Oregon as a warm-water marsh specialist that occupies wetland areas greater than 4 hectares.

The three extant populations of *R. pretiosa* in British Columbia occupy wetland habitats consistent with the descriptions provided by McAllister and Leonard (1997) and Hayes (1994a, 1994b). A portion of the Naval Radio Station Aldergrove property occupied by *R. pretiosa* is characterized as wetland with emergent vegetation within a forested landscape. Maria Slough and Mountain Slough are characterized as floodplain wetlands surrounded by deciduous and coniferous forest.

Although an assessment of the amount of habitat suitable for breeding at the three extant sites has not been carried out, Ward (1989) provided gross area assessments for each as follows: Naval Radio Station Aldergrove - 2.6 hectares of shallow basin marsh and 4 hectares of shallow basin water; Maria Slough - 9.2 hectares of floodplain marsh and 17.1 hectares of stream water; and, Mountain Slough - 12.3 hectares of floodplain marsh and 37 hectares of stream water. *Rana pretiosa* has been located in the shallow basin marsh and floodplain marsh of each site, which generally coincides with the habitat descriptions by McAllister and Leonard (1997) and Hayes (1994a, 1994b).

Habitats selected by *R. pretiosa* are described as early seral habitats, or habitats where the rate of succession is reduced or eliminated through various mechanisms. At the Licht site, grazing cattle reduced the rate of succession and helped maintain an open habitat structure. At Naval Radio Station Aldergrove, succession is eliminated by maintenance of the area immediately surrounding the radio towers. At other locations at Naval Radio Station Aldergrove where the vegetation is not routinely maintained, beaver (*Castor canadensis*) thin the canopy and create open areas where breeding occurs and juvenile Oregon spotted frogs are found (pers. obs.).

Breeding habitat appears to be the most critical habitat to *R. pretiosa* in British Columbia, since the amount available is limited. In 1997, two main communal breeding sites were located at Naval Radio Station Aldergrove. Further, egg laying at both breeding sites was initiated 3 - 5 weeks apart. Eggs were deposited at the first breeding site in late February and early March in extremely shallow water (5 - 8 cm) with a silty bottom substrate and a sparse amount of vegetation. When *R. pretiosa* begins to lay eggs at the second site, embyros at the first site have hatched and the water has receded, leaving the first site dry. At the second breeding site, the water is deeper (15 - 30 cm) and there is considerably more vegetation (e.g., reed canarygrass, *Phalaris arundinacea*) in the area.

Hayes (1994a, 1994b) postulated that four hectares may represent the minimum size that would enable a water body to achieve the warm temperatures that are preferred by *R. pretiosa*. Hayes further reported that Oregon spotted frog populations inhabiting high elevation lakes and marshes in the Oregon Cascades probably retreat to springs where they find highly oxygenated, ice-free water. Therefore, springs may be a habitat requirement for high elevation Oregon spotted frog populations.

Historic Habitat and Trends

Photographs from Licht (1971b, 1974) indicate that his study pond was located within a wet meadow. Licht (1971a, 1971b) described the Langley site as a wet, flat, lowland, covered predominately by bulrushes (*Juncus effusus*), sedges (*Carex sp.*), and buttercup (*Ranunculus spp.*). *Ranunculus* formed almost a complete carpet throughout the field. The other two plant types were abundant but scattered throughout the whole area. The eastern and western borders of the field were alder, birch, and coniferous woods, the southern border was more lowland marsh, and the northern side was interrupted by an asphalt road, across which was more lowland. A permanent, slow moving stream flowed through the centre of the field. During the completion of a biophysical description of Campbell Valley Regional Park, Haycock and Mort (1988) designated vegetation associations bordering Licht's site as, “Douglas Fir - False Lily of the Valley” and “Red Alder: Riparian Seral”.

The Douglas fir association bordering Licht's site is a typical Coastal Douglas fir biogeoclimatic zone bordering a Coastal Western Hemlock biogeoclimatic zone. Although the Douglas fir association does not border any other reach of the Little Campbell River within the park, its occurrence adjacent to Licht's site is not thought to

be significant. The association is relatively small, and does not contain pockets of shallow, ephemeral warm water that may be important to juvenile life stages. Characteristic species within this association can be described as Douglas fir *(Pseudostuga menziesii*), vine maple (*Acer circinatum*), false lily of the valley (*Maianthemum dilatatum*), and star-flowered Solomon's seal (*Smilacina stellata*). The red alder stand is typical of a seral association bordering a field, wet meadow, or wetland. The floral communities comprising this association are swiftly growing species that contribute to rapid succession and include red alder (*Alnus rubra*), Pacific ninebark (*Physocarpus capitatus*), red osier dogwood (*Cornus stolonifera*), oceanspray (*Holodiscus discolor*), black twinberry (*Lonicera involucrata*), and hardhack (*Spiraea douglasii*).

None of the floral species reported are known to be particularly important to *R. pretiosa*. Aquatic vegetation such as (*Potamogeton spp.*) was reported by Licht (1971a,b) and remains at the site today. Emergent macrophytes such as *Carex rostrata* and *Juncus effusus* also remain at the site. However, small-flowered bulrush (*Scirpus microcarpus*) is abundant at the site and was probably not detected or recognized during Licht's work. It is unlikely that the presence or absence of small-flowered bulrush affected the historic population of *R. pretiosa* at this site. I extensively surveyed what is now referred to as Licht's pond and did not observe *R. pretiosa*. Also, I did not observe *R. pretiosa* after survey of MacLean Pond, an extensive wetland to the north. Amphibians present at the site include *Ambystoma gracile, Ambystoma macrodactylum, Bufo boreas, Hyla regilla, Taricha granulosa, Rana aurora, Rana catesbeiana,* and *Rana clamitans*.

Habitat of the historic sites at Sumas Prairie and Nicomen Island was not documented by Carl and Cowan (1945), although both sites bear some resemblence to observations made by Slipp (1940) who observed *R. pretiosa* in association with lakes in a prairie landscape. Most of what is now referred to as Sumas Prairie was once Sumas Lake that spanned the Fraser River Lowlands from Vedder Mountain to Sumas Mountain. Sumas Lake was drained in the early 20th century; and therefore, Carl and Cowan's (1945) record appears to indicate that *R. pretiosa* persisted in the area for at least 45 to 50 years. There are no credible records of *R. pretiosa* in this region since Carl and Cowan's record. Nicomen Island lies within the Fraser River and is comprised of agricultural land with floodplain on its perimeter.

With the exception of changes by resident beaver (*Castor canadensis*), habitat at Naval Radio Station Aldergrove remains static. The rate of succession at the Maria Slough and Mountain Slough site has not been assessed, but it appears to be slow. With their connection to the Fraser River, water levels at Maria and Mountain Slough are dynamic and are subjected to rapid fluctuations, which does not allow plant species that contribute to rapid succession to propagate.

The six documented populations of *R. pretiosa* in British Columbia are spread approximately 70 km apart. These populations are fragmented and coincide with patches of habitat that have been spared from development. Thirty-two years after the

start of Licht's research in 1967, Licht's site has changed significantly. Licht's pond is no longer a shallow ephemeral marsh bordered by wet *Ranunculus* meadow. Nor does it include a well-established connection to the Little Campbell River. Presently, the vegetation associations adjacent to Licht's site described by Haycock and Mort (1988) are still intact, although the riparian seral association has spread well into Licht's site. Other pioneering floral species such as willow (*Salix spp.*) and hardhack (*Spiraea douglasii*) are well established on the fringe of the Douglas fir association and contribute to a dense shrub layer occupying the shallow fringe of the wetland. It is possible that sunlight cannot penetrate through these shrubs to warm the waters beneath to temperatures preferred by *R. pretiosa*.

Licht (1971a, 1971b) reported the presence of cattle periodically grazing the pastures adjacent to his 2.8 hectare study area. Further, he reported that the site was closed to the public and had a minimal amount of human disturbance. During Licht's research, his study area was privately owned and cattle were allowed to graze the pastures adjacent to *R. pretiosa* breeding areas. After the privately owned land was transferred to the Greater Vancouver Regional District (GVRD), which included Licht's site, cattle were removed from the area. In the absence of cattle and their grazing and trampling of the land, succession was no longer impeded and began to proceed at a natural rate. Also, since the land was transferred to the GVRD for use as a park, the GVRD developed the area in the immediate vicinity of Licht's pond with a horse trail and a walking trail approximately 300 feet apart. The boardwalks accompanying both trails dissect Licht's site. Further, a municipal road, approximately 300 feet West of Licht's site, was reconstructed in the 1980's and may have altered the hydrology of the area.

Habitat Protection

The Department of National Defence site in Aldergrove is owned by the Federal Department of National Defence and *R. pretiosa* is afforded protection by exclusion of civilians from the area. The lands are managed by the Canadian Forest Service of the Federal Department of Natural Resources. This site is routinely cleared of shrubby vegetation to maintain the integrity of the radio towers. Succession is not allowed to proceed at the two locations where breeding has been observed. Development plans for this site, if any, are unknown. Presently, the level of protection afforded the population of Oregon spotted frog appears to be adequate. Any potential sale of this land for development would pose a serious threat to the existing Oregon spotted frog population.

Maria Slough is owned by the Seabird Indian Band. The development potential of this area appears to be limited since Oregon spotted frog habitat is confined to the flood basin. Mountain Slough is privately owned, but like Maria Slough, it appears that the development potential is limited due to site-specific geography and hydrology of the site.

Campbell Valley Regional Park is owned by the Greater Vancouver Regional District and is protected as parkland. Although loss of Licht's population of Oregon spotted frogs at Campbell Valley Regional Park is thought to be a local extirpation, there

appears to be suitable habitat in the near vicinity of the historic location that may afford an opportunity to reintroduce *R. pretiosa*.

GENERAL BIOLOGY

Reproduction

The life cycle of *R. pretiosa* is closely associated with water and begins when frogs move to shallow-water breeding sites in late winter. Frogs become active in late winter-early spring and may commence at temperatures as low as -0.5º C; the lowest temperature at which active Oregon spotted frogs have been observed (McAllister and Leonard 1997). The location of hibernation sites is unknown. Male Oregon spotted frogs arrive at traditional breeding pools in late winter (Licht 1969a, McAllister and Leonard 1997) and congregate very close to one another. Calling occurs during day and night (McAllister and Leonard 1997) and is reported to be intense on sunny afternoons (Licht 1971). Males emit a series of 6 to 9 low clucks. The male's mating call can be heard 18 m to 30 m away and is often obscured by other wildlife vocalizing in the same vicinity (Licht 1969b). Another description of *R. pretiosa*'s mating call was provided by Davidson (1995) as, "A rapid series of 5 to 50 faint, low-pitched, hollow notes. Can be imitated by knocking on wood with a fist or clicking the tongue on the roof of the mouth." While breeding, male Oregon spotted frogs call in very close proximity to one another, and do not exhibit agonistic behaviour toward other males. Solitary males have been observed calling during mid-day in early autumn (Hayes *et al*. 1997).

When ready to lay their eggs, gravid females move towards calling males. As an adult male frog encounters a gravid female, the male grasps the female behind the front limbs and the pair enter amplexus. Male and female frogs in amplexus have been encountered more than 20 m away from traditional breeding sites, apparently making their way towards the site (McAllister and Leonard 1997). Males fertilize eggs while the female is laying the egg mass, often laying it on top of masses laid by other females (Licht 1969b, pers. obs.). Adult females lay a single egg mass per year (Licht 1974, Olson and Leonard 1997). Licht (1974) reported an average of 643 eggs per mass in British Columbia, while McAllister and Leonard (1997) reported an average of 598 eggs per mass in Washington State. From a small sample of egg masses laid at the Naval Radio Station site in Aldergrove (n=14), the author reports an average of 670 eggs per mass.

Eggs are laid communally during mid-afternoon (Licht 1971) and at night (McAllister and Leonard 1997). Breeding sites are typically the highly exposed, shallow fringe of marshes (Hayes 1997). Once pairs separate, females presumably lead a solitary life, while males may remain at the breeding site for 2 to 3 weeks seeking additional mates.

Embryos of Oregon spotted frogs average 2.31 mm in diameter (Licht 1971). Embryonic development is temperature dependent and can occur in less than 10 days

(Hayes 1997). Licht (1971) measured daytime water temperature surrounding egg masses and reported an average of 20ºC. Using staging tables developed by Pollister and Moore (1937), Licht (1971) determined that Oregon spotted frog embryos hatch at stage 21.

Larvae metamorphose in less than 4 months, slightly faster than typical Anurans (Duellman and Trueb 1986). Licht (1973) postulated that the shorter larval developmental period of *R. pretiosa* in comparison to syntopic populations of *R. aurora*, may be responsible for a higher survivorship of juvenile Oregon spotted frogs. Size at metamorphosis is 30 mm to 33 mm snout-vent length (Licht 1986a) and froglets in British Columbia become sexually mature and begin to breed in their third year (Licht 1986). In Washington State, McAllister reports that females are sexually mature at age three, although males are sexually mature at age two (pers. comm. 1997). Based on growth data from three different populations in Oregon, Hayes (pers. comm. 1997) reports that both male and female Oregon spotted frogs in the Klamath Basin reach adult size in two years.

Physiology

Licht (1971) reported adult females begin to lay eggs when temperatures reach 6ºC. Licht (1971) also reported an upper temperature limit of 28ºC for Oregon spotted frog embryos and that young embryos can withstand temperatures as low as 1ºC for up to 8 hours. To thermoregulate, juvenile Oregon spotted frogs may gain body heat by inhabiting very shallow, warm-water marshes (pers. obs.). Adult male Oregon spotted frogs have been observed calling during sunlit periods of late afternoon, and may benefit from direct exposure to the sun. Females are active during daylight hours and have been observed laying eggs during sunlit periods (Licht 1971).

Food Habits

Food habits of *R. pretiosa* do not appear specialized and do not appear to limit their abundance. Licht (1986a) reported post-metamorphic Oregon spotted frogs fed on leaf beetles (Chrysomelidae), ground beetles (Carabidae), spiders (Arachnidae), rove beetles (Staphylinidae), syrphid flies (Syrphidae), long-legged flies (Dolichopodidae), ants (Formicidae), and water striders (Gerridae). Oregon spotted frog tadpoles feed on algae, decaying vegetation and detritus (Licht 1974).

Growth and Survivorship

Licht (1974) reported hatching success rates of 68% at oviposition sites near the edge of the pond and 74% at river margins. During prolonged dry periods or extreme cold, eggs are especially vulnerable to freezing and desiccation, a major disadvantage of communal breeding sites at the shallow fringe of the wetland. In Licht's second year of study, all embryos would have desiccated had Licht not relocated the egg masses to water. Similar occurrences have been observed at Naval Radio Station Aldergrove in 1997 (pers. obs.), at Dempsey Creek during 1995, and at Trout Lake during 1997

(McAllister and Leonard 1997). In the summer in which the research pond dried up, Licht (1974) estimated that less than 1% of hatched tadpoles survived to metamorphosis. Although the river did not dry up in this same summer, Licht reported only 7.3% of tadpoles surviving to metamorphosis.

Licht (1974) reported 67% of metamorphosed frogs surviving their first year and 64% of adults surviving between years. Sex-specific mortality rates were significantly different with 45% of male frogs surviving in comparison to 67% of female frogs surviving. The life span of *R. pretiosa* is unknown.

Behaviour

Little is known of the behaviour of *R. pretiosa* outside of the breeding season. When disturbed while *R. pretiosa* is in the water, Licht (1986b) reported Oregon spotted frogs slowly sinking or diving to the bottom to seek refuge in bottom substrate. When on land, frogs move towards the water, dive to the bottom, and seek refuge in dense vegetation or bottom substrate.

LIMITING FACTORS

Population numbers for Oregon spotted frogs in British Columbia are extremely low in comparison to numbers documented in Washington State and Oregon. Hayes *et al.* (1997) discussed a number of limiting factors that can potentially contribute to low population numbers. These are summarized as follows: human-effected habitat losses; succession-related habitat losses; hydrologic alteration; exotic predators and vegetation; livestock management; and, isolation.

Habitat Losses

The minimum amount of habitat thought to be required to maintain an Oregon spotted frog population is 4 hectares (Hayes 1994b). Hayes *et al.* (1997) reported that 14 of 24 (58%) extant Oregon spotted frog sites are made up of a relatively small area of suitable habitat (<25 hectares). Hayes *et al.* (1997) postulated that these sites are at risk simply because little suitable habitat is available.

The largest documented population of Oregon spotted frogs in British Columbia is found at Naval Radio Station Aldergrove, which includes approximately 2.6 hectares of shallow basin marsh (Ward 1989). Ward (1989) also provides area assessments for Maria Slough and Mountain Slough of 9.2 hectares and 12.3 hectares of floodplain marsh respectively. If Hayes' (1997) evaluation of risks associated with Oregon spotted frog habitats in Oregon are similar to risks to Oregon spotted frog populations in British Columbia, the three extant populations in British Columbia are similarly at risk due to the small size of the habitats.

The natural advancement of early seral stages appears to impact breeding habitat of *R. pretiosa*. The shallow floodplain marsh that is essential to *R. pretiosa* is reduced or altered to a state that is no longer suitable for breeding Oregon spotted frogs. Conversely, succession has the potential to eliminate suitable breeding habitat.

Hydrologic Alteration

Historical breeding sites where eggs are laid communally are susceptible to losses due to hydrological alteration resulting in water no longer being present at the site, or the area becoming inundated with too much water. The later scenario was caused by the actions of beaver (*Castor canadensis*) at Naval Radio Station Aldergrove in 1999 (pers. obs.). Although beaver (*Castor canadensis*) are beneficial to *R. pretiosa* by creating an open habitat structure in the forested wetland of the site, they have created a shallow rim around the fringe of the main breeding area where Oregon spotted frog eggs were located in 1997. The rim has effectively eliminated the shallow floodplain marsh along approximately 300 metres of shallow marsh edge where *R. pretiosa* laid its eggs in 1997. In 1999, two communal breeding sites were located at the site at either end of the pool created by the beavers. It can be assumed that the pool created by the beaver is too deep for breeding Oregon spotted frogs and may further reinforce that *R. pretiosa* requires extremely shallow floodplain marsh in which to breed.

Exotic Predators and Vegetation

Historically, there have been a number of gravel mining operations in South Langley and South Surrey. Once gravel mining operations ceased, the mines were allowed to fill with water and become small lakes. These small lakes are excellent habitat for the bullfrog, *Rana catesbeiana*. The bullfrog is a well-known predator of amphibians species (Duellman and Trueb 1986) and may prey on both larval and adult Oregon spotted frogs.

Reed canarygrass (*Phalaris arundinacea*) is present at all extant Oregon spotted frog sites in British Columbia. Although its impact on *R. pretiosa* is not fully understood, it appears that once it invades a shallow floodplain marsh, it reduces or eliminates the amount of open breeding habitat available to *R. pretiosa* by creating dense mats of decaying vegetation. In the absence of reed canarygrass, these areas would otherwise be available to *R. pretiosa* as communal breeding sites.

Livestock Management

Domestic cattle grazing and trampling the ground adjacent to Licht's site may have been slowing the rate of natural succession. The actions of the cattle may have sustained the *R. pretiosa* population by preserving suitable breeding habitat. When the area became a public park, the cattle were removed and succession began to occur at a natural rate. The change of the use of the land and the removal of the cattle probably contributed to the demise of *R. pretiosa* at Licht's site.

Population and Habitat Isolation

The *R. pretiosa* population at Naval Radio Station Aldergrove is completely isolated from the other two extant Oregon spotted frog populations in British Columbia. Further, the habitat is isolated from any adjacent, suitably-sized habitats. Although egg masses have been found in one location approximately 1 km from the main breeding habitat at Naval Radio Station Aldergrove, the amount of suitable habitat at this location is less than 0.5 hectares. The Maria and Mountain Slough habitats are isolated from one another. Suitable habitats between the two sites are highly fragmented and movement between populations is unlikely.

Climate Change

Climate change issues cannot be overlooked as potentially having a severe impact on all, or part of *R. pretiosa*'s current year reproductive output. The communal oviposition pattern of *R. pretiosa* makes its embryos especially susceptible to desiccation if water levels fluctuate rapidly.

SPECIAL SIGNIFICANCE OF THE SPECIES

Rana pretiosa is not known from other canadian provinces. It is at its northern range limit in British Columbia and its range is not continuous into Washington State and Oregon as it has become fragmented through population losses. *Rana pretiosa* is considered an endangered species in Washington and Oregon. There has been little public interest in *R. pretiosa* in British Columbia, likely because it is a little known species that was only recently recognized as distinct from the Columbia spotted frog, *Rana luteiventris* (Green et al. 1997). *Rana pretiosa* is not economically important, hunted, captive bred, or commercially exploited and there is no adverse public opinion or prejudice against the species.

There is opportunity for *R. pretiosa* to be confused with *R. aurora* and to a lesser extent, *R. luteiventris*. Although none of these species is purposely exploited or willfully destroyed by humans, knowledge of existing populations is largely incomplete and a lack of recognition of Oregon spotted frog populations and habitats would lessen efforts to effectively manage this species in British Columbia.

EVALUATION AND PROPOSED STATUS

The decline of *R. pretiosa* populations in British Columbia is probably due to range-wide habitat losses throughout its historic range in the Fraser River Lowlands. The first record of *R. pretiosa* in British Columbia appeared in the literature in 1945, at least 45 years after one of the most extensive wetlands in the Fraser Valley, Sumas Lake, was drained for agricultural use. *Rana pretiosa* is critically imperiled because only 3 sites are now known. The small population sizes at these sites, small habitat areas

that do not meet minimum size requirements, and *R. pretiosa*'s communal breeding pattern make it especially vulnerable to extirpation or extinction. The British Columbia Conservation Data Centre has "Red-Listed" *R. pretiosa* considering it to be an endangered or threatened species of major management concern. The Washington Department of Fish and Wildlife has designated *R. pretiosa* "endangered" (McAllister and Leonard, 1997) and the Oregon Department of Fish and Wildlife currently lists *R. pretiosa* in Oregon as "sensitive critical" (M. Hayes, pers. comm.). The US Fish and Wildlife Service is currently reviewing the status of *R. pretiosa* for possible listing at the federal level.

Rana pretiosa should be considered **Endangered** in Canada.

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