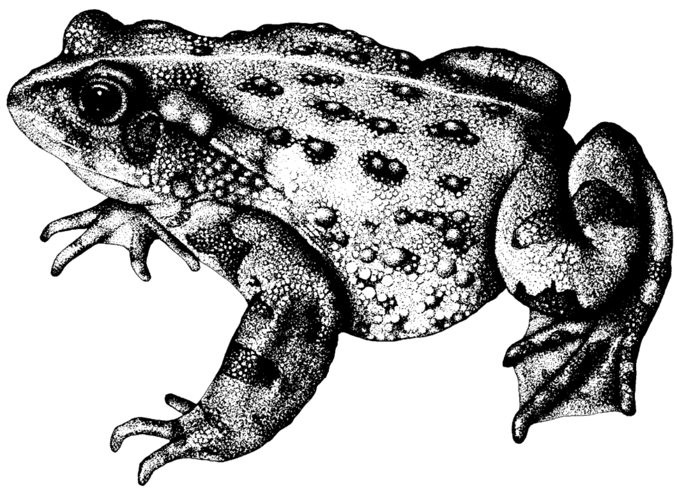
COSEWIC
Assessment and Status Report

on the

Western Toad
Bufo boreas

in Canada



SPECIAL CONCERN
2002

COSEWIC
COMMITTEE ON THE STATUS OF ENDANGERED WILDLIFE IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION DES ESPÈCES EN PÉRIL AU CANADA

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COSEWIC
Assessment Summary

Assessment Summary – November 2000

Common name
Western Toad

Scientific name
Bufo boreas

Status
Special Concern

Reason for designation
This species has suffered population declines and population extirpations, at least one of which is well documented. It is relatively intolerant of urban expansion and the conversion of habitat for agricultural use. Dependent upon oligotrophic and fishless ponds and small lakes for breeding, it is also sensitive to habitat deterioration, introduced exotic predators and competitors, and disease. This species remains widespread and locally abundant throughout most of its historic range in Canada despite its known vulnerabilities to urban expansion, conversion of habitat for agriculture, habitat deterioration, introduced exotic predators and competitors, and disease, all of which have severely reduced its abundance and range further south..

Occurrence
Yukon Territory, Northwest Territories, British Columbia, Alberta

Status history
Designated Special Concern in November 2002. Assessment based on a new status report..

COSEWIC
Executive Summary

Western Toad
Bufo boreas

The western toad (*Bufo boreas*) has an extensive range throughout western North America, including southern areas of the Yukon Territory, most of British Columbia, and western Alberta. It is one of only a few amphibians inhabiting alpine areas. Two subspecies are recognized, the most widely distributed of which occurs within Canada (*B. b. boreas*). The western toad lives nine to 11 years. It is an explosive breeder, congregating along the shallow margins of lentic breeding sites for a one- to two-week period each spring. Females lay between 5,000 to 16,500 eggs per breeding season once they reach sexual maturity at four to five years. Males mature in three years. The black tadpoles metamorphose in approximately three weeks, at which time they typically form large aggregations along the shoreline. Western toads are highly philopatric; most males return to breeding sites annually whereas females return every one to three years. Females travel farther from breeding sites, moving 400 to 600+ m upland to summer ranges. Occasional long distance excursions of up to 7.2 km have been noted for this species. Summer home ranges are distinct, and approximately three to seven hectares in size. Toads are found in a variety of habitats, including forests, wetlands, clearcuts, and grasslands, with their summer ranges usually including a combination of upland and wetland areas. Toads exploit open areas, often basking in the sun to thermoregulate. Toads hibernate for roughly four to six months each winter in animal burrows and under debris where they remain in contact with moisture.

Although *B. boreas* is listed as secure in British Columbia and Alberta, it is the only IUCN red-listed amphibian species occurring in Canada. This is due largely to its status in southern parts of its range. Many populations in the United States have declined or become extirpated. The Southern Rocky Mountain *B. b. boreas* is a candidate for endangered species listing by the U.S. Fish and Wildlife Service. Red-leg disease, fungal agents that attack toad eggs (e.g., *Saprolegnia*), and UV radiation have all been proposed as potentially contributing to the decline of toads. *Bufo boreas* is vulnerable to mass reproductive failure, especially in areas with small, isolated populations. Newly emerged toadlets are also vulnerable to mass die offs. In addition, spring storms, summer drought and early fall freezing can reduce populations to critical levels, and small populations can be significantly impacted by predators in both terrestrial and aquatic environments.

The south-coast population of *B. boreas* should be considered to be of special concern in Canada because their numbers on the Lower Mainland of B.C. and eastern

Vancouver Island (the Georgia Depression) appear to be declining. Long-term data sets are lacking, but encounter rates were low in all surveys conducted recently in these areas compared to historical records. The majority of Western toad populations in the Georgia Depression are isolated from other mainland populations due to the habitat fragmentation and alteration associated with high urban and agricultural development. Therefore, the potential for rescue through immigration is very limited. Severe and rapid toad population declines in the U.S. in recent decades demonstrate the vulnerability of this widespread and otherwise common species. With the cause of declines largely unknown, and with some of our B.C. populations exposed to similar stresses, including deformities and disease, there is an elevated concern for this species in areas where it has become less common. If trends continue, our interior and northern populations may serve as the stronghold of the species. The remainder of the western toad population is likely not at risk at this time but this should be re-examined on a regular basis.

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.

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune

Canada

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COSEWIC Status Report

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Western Toad
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in Canada

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2002

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INTRODUCTION

Species description

The Western Toad, *Bufo boreas*, can be identified by its dry, bumpy skin, conspicuous, oval-shaped parotoid glands, horizontal pupils, and cream-coloured or white dorsal stripe (Fig. 1). It varies in colour from olive-green, to reddish-brown, to almost black. The parotoid glands are large, well separated, and generally larger than the upper eyelids (Blaustein *et al*. 1995). These large glands, along with those of the dorsum and the dorsal surface of the upper legs, house a mild, white poison that is secreted when individuals are threatened by a predator (Leonard *et al*. 1993, Blaustein *et al*. 1995). The ventral surface is pale and coarsely mottled, and the hind feet are equipped with two horny tubercles, which assist it in burrowing (Leonard *et al*. 1993). These tubercles are yellow in juvenile toads. Males are 60 to 110 mm long. They possess longer arms and narrower heads than females and develop dark nuptial pads on their thumbs during the breeding season. Females are larger, attaining a total length of 125 mm. They are always silent whereas males will chirp their release call when grasped under the arms (Green and Campbell 1984).

Figure 1. Adult *Bufo boreas*. (Pamela Hengeveld and R. Chris Brodie, photos).

Western toad eggs are laid in long, loosely intertwined strings in the shallow margins of lakes and ponds. The eggs are black above and white below and contain a double jelly layer (Corkran and Thoms 1996). The tadpoles are small and black, roughly 12 to 13 mm snout-vent length (SVL), or 25 to 30 mm total length, prior to metamorphosis (Green and Campbell 1984, Blaustein *et al*. 1995). They have a square snout that juts forward from their round body outline (Corkran and Thoms 1996). Their eyes are set in from the margin of the head when viewed from above (Leonard *et al*. 1993). They have relatively narrow tail fins, with the dorsal fin about as tall as the greatest height of the tail musculature (Nussbaum *et al*. 1983). The tail fin does not extend beyond the tail as in other frog tadpoles (Corkran and Thoms 1996). Newly emerged toadlets are approximately 11 mm in snout-vent length (SVL), and possess the dry bumpy skin characteristic of adults (Corkran and Thoms 1996).

Taxonomic status

The Western Toad is also known as the northwestern or boreal toad. The species belongs to the family Bufonidae, suborder Neobatrachia (Ford and Cannatella 1993), characterized by short legs, warty skin, and large parotoid glands (Stebbins 1966).

There are two subspecies of *B. boreas: B. b. halophilus* in California, western Nevada, and Baja California, and *B. b. boreas* throughout its remaining range (Stebbins 1985). The southern Rocky Mountain *B. b. boreas* population (i.e., Colorado, southeast Wyoming, and north-central New Mexico) is geographically isolated from populations to the north and west by dry, non-forested intermountain valleys. It is genetically differentiated and probably represents an independently evolving lineage or species (Ireland 1997, Goebel 1999). Other subspecies may exist. For example, there is an isolated population near the Atlin region, in northern British Columbia, which is closely tied to tufa springs on the Meister and Coal Rivers. Unlike other northern populations, this one breeds in February when water temperatures range from roughly 23 to 26 °C. From this northern latitude site, toadlets can be seen emerging as early as the third week of March (B. Slough, pers. com.). In Alberta, where the range of *Bufo boreas* overlaps with that of the Canadian toad (*Bufo hemiophrys*), mismatched amplexed individuals have been recorded (Cook 1983, Eaton *et al*. 1999). Cook (1983) found an obvious hybrid individual of these two species, but it is not known if this hybrid was fertile.

History of Study within Canada

Only one study in Canada to date, by Davis (2000), has specifically focussed on *B. boreas*. Numerous amphibian inventories and studies investigating impacts of forest practices on amphibians include information on toads (e.g., Gyug 1996, Ward and Chapman 1995, Hengeveld 2000, Kinsey and Law 1998, Beasley *et al.* 2000, Haycock and Knopp 1998, Mennell and Slough 1998, C. Paszkowski and B. Eaton, unpublished data). Long-term data sets, extensive inventories, and intensive population studies are lacking, so the distribution and population dynamics (e.g., survivorship, annual population fluctuation, etc.) of this species within Canada remains unclear.

DISTRIBUTION

Bufo boreas occurs from the Rocky Mountains to the Pacific Coast, from sea level to 3660 m (Jones 2000). It is one of the few amphibians that occupy alpine areas. Its eastern range includes western Alberta, western Montana, Colorado, parts of Utah and most of western Nevada. West of the Rocky Mountains, the species occurs from southeast Alaska to Baja California, Mexico (Fig. 2). Within this region, It is absent only from the most arid areas, such as the Columbia Basin in Washington and the Willamette Valley in Oregon (Leonard *et al*. 1993).

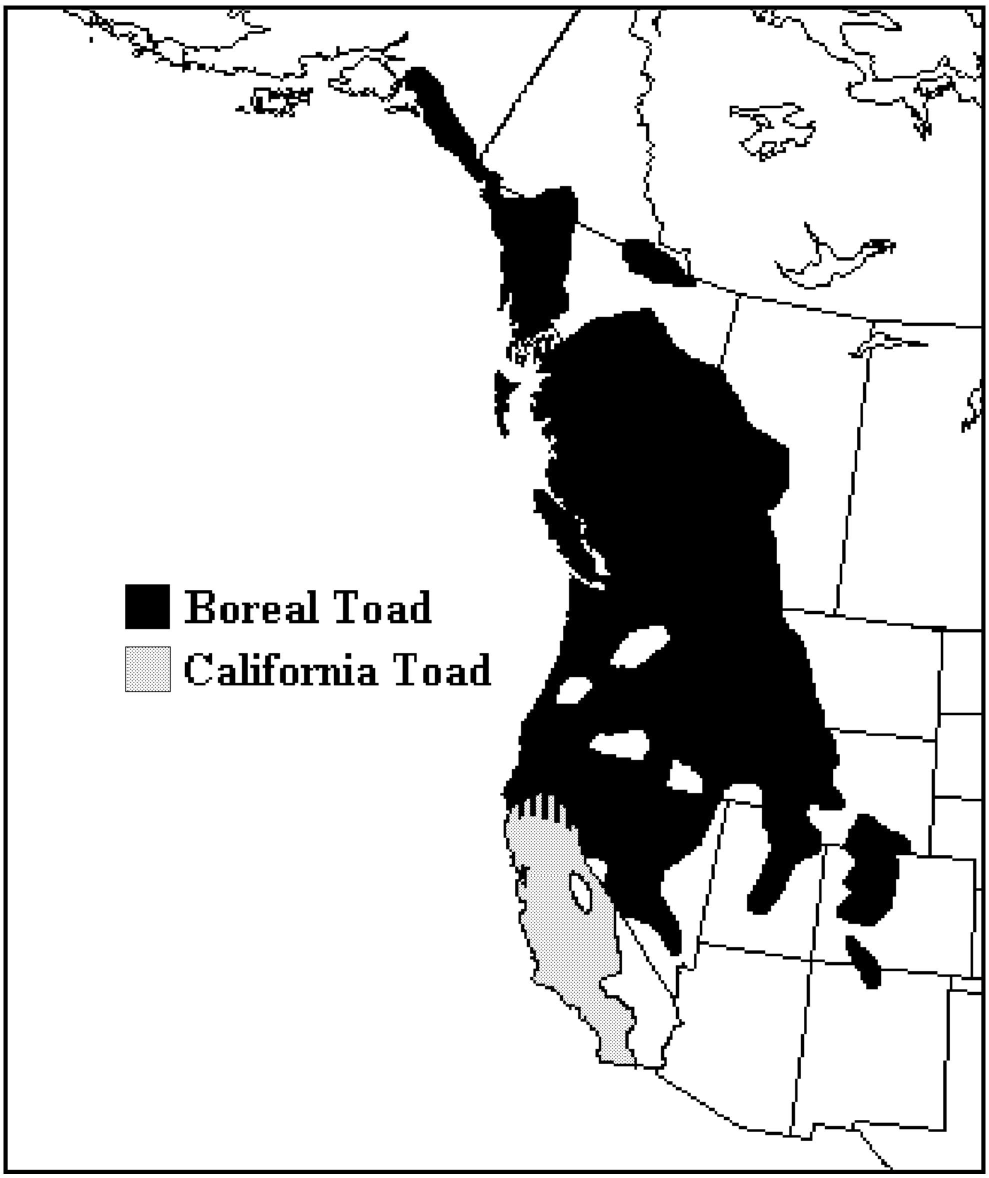

Figure 2. North American distribution of *Bufo boreas*, indicating the range of the two subspecies, the Boreal toad (*B. b. boreas*) and the California toad (*B. b. halophilus*). Reproduced with permission from the North American Center for Amphibian Malformations (original produced by Jeff Jundt and Ralph Tramontano).

Populations appear to be faring well in Canada (Fig. 3). It is found as far north as Yukon as there is a record from Lake Lindeman in the Chilkoot Trail National Historic Site (Mennell 1997) and 13 records from the Liard River Basin, including five separate populations at Meister River, Watson Lake, Toobally Lake, Coal River, and Beaver River (Slough 1999). North-coast records for British Columbia include Sloko Inlet at the south end of Atlin Lake, and Fantail River south of Tagish Lake. The majority of northern records come from valleys that receive early high accumulations of snowfall annually (Cook 1977; Mennell 1997), assuring safe winter hibernation. These permafrost-free valleys may link northern toad populations. It was previously thought that they were isolated by an over-wintering dependence on hotsprings (Cook 1977).

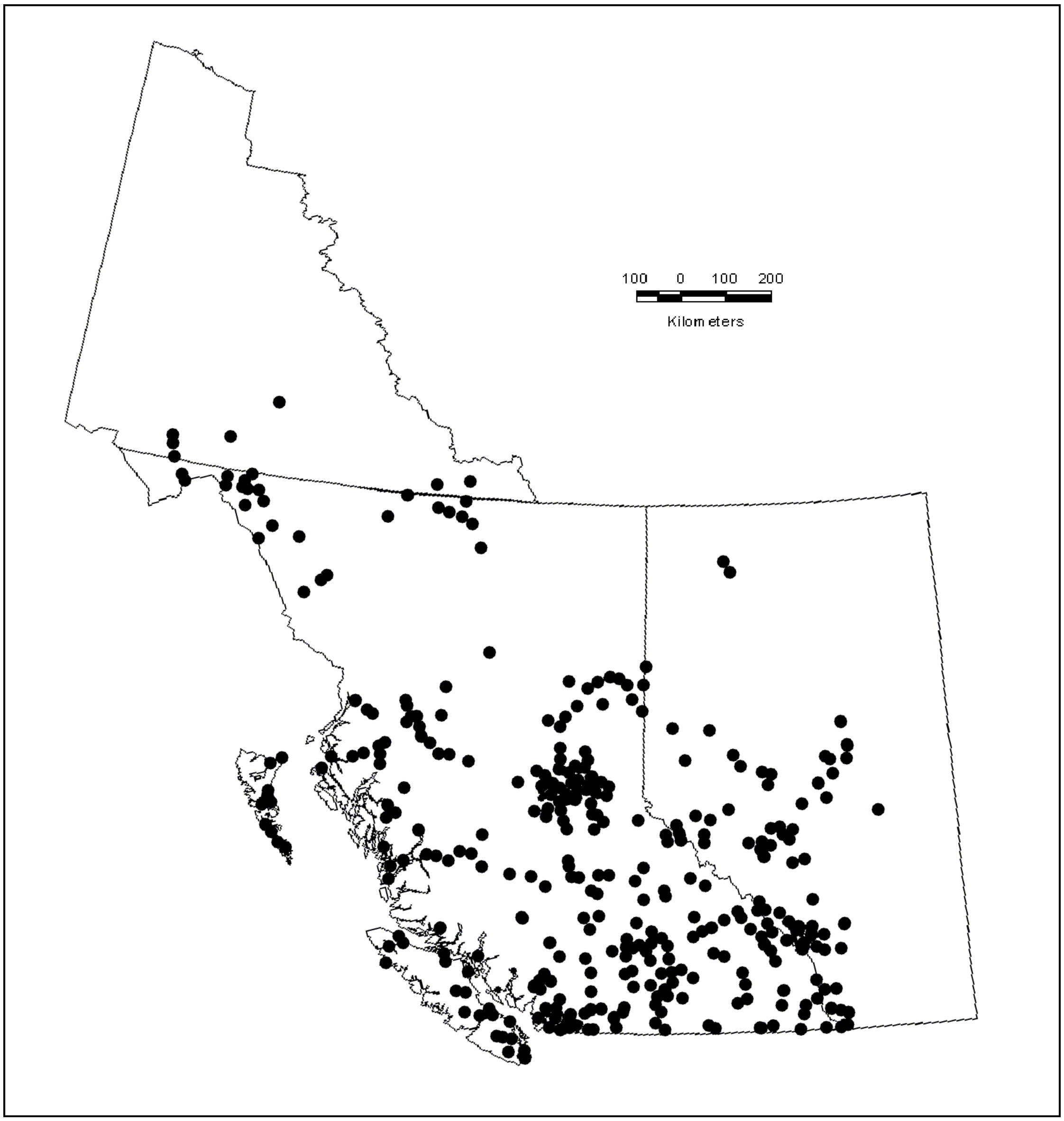

Figure 3. Distribution of *Bufo boreas* within Canada. Map plotted by Arnold Moy.

Bufo boreas is the only amphibian evidently native to the Queen Charlotte Islands of British Columbia (Green and Campbell 1984). It is absent from the northeast corner of the province, in the Taiga Plains Ecoprovince and in the north-central portion of the Northern Boreal Mountains Ecoprovince, but common historically (Hollister 1912, Williams 1933, Wade 1960, Green 1975) and currently (Poll *et al*. 1984, Kinsey and Law 1998, Hengeveld 2000) throughout the Interior. Tadpoles and metamorphosed individuals are seen frequently throughout the midcoast (P. Friele, pers. com.). Metamorphs have been relatively abundant as far south as Strathcona Park (K. Ovaska, pers. com.) on Vancouver Island, and the Elaho watershed and Garibaldi Mountains north of Squamish (Dupuis, pers. obs). The species may have declined, however, on southern and central Vancouver Island, and in the Lower Mainland of British Columbia, where recent records are scarce (e.g., Haycock and Knopp 1998, Dupuis 1998, Davis 2000, Beasley *et al*. 2000, Materi and Blood 2000). *Bufo boreas* is common in Alberta, from the Lac la Biche area in the central east (Eaton et al. 1999) to the BC border. Only two sightings of toads have been reported north of Slave Lake (Russell and Bauer 1993), which may be a reflection of the inaccessibility of northern regions rather than of toad densities.

PROTECTION

Within Canada, *B. boreas* is yellow listed within B.C. (i.e., secure) by the Ministry of Water, Land and Air Protection and green listed in Alberta (i.e., not considered at risk) by Alberta Environment. Slough (1999) recommended that *B. boreas* be listed as critically imperilled or at risk of extirpation in the Yukon, because of the limited geographic extent of its five known, isolated populations. All native amphibians of British Columbia were declared “wildlife” in 1990, entitling them to protection under the British Columbia Wildlife Act (1982). That is, amphibians can no longer legally be killed, collected or held in captivity without a permit. Protection offered by this act is minimal since it does not protect wildlife habitat from loss, alteration or fragmentation. There are a number of large parks in Canada that protect Western Toad populations, including: Banff and Jasper National Parks in Alberta; Garibaldi Provincial Park (194,000 hectares) and Manning Provincial Park (65,884 ha) in the southern portion of the toad’s coastal range; the 91,000-ha Fjord Land Recreation Area, and the 317,291-ha Kitlope Protected Area along the mid-coast of British Columbia; Goldstream and Strathcona Parks on Vancouver Island; and the Coal River Springs Territorial Park in the Yukon (Slough 1999). Smaller parks also afford some protection to toad populations. The Forest Practices Code’s Wildlife Habitat Areas for rare, threatened and vulnerable species may also protect some populations, if wide riparian buffers are maintained to protect microclimatic conditions for other species. The Riparian Management Guidelines of the Forest Practices Code only protects stream channels and classified wetlands (Ministry of Forests and B.C. Environment 1995a,b). The majority of toad wetland breeding sites within Canada are not protected due to their small size (e.g., < 0.5 ha).

In the United States, *B. boreas* as considered ‘rare, threatened or uncommon’ in Alaska, Washington, and Montana, and ‘apparently secure’ in Washington, Oregon, California, Idaho, and Nevada (Table 1). Populations in Utah are 'imperiled'. The boreal toad (*B. b. boreas*) was listed as State endangered in Colorado and New Mexico, and designated 'imperiled due to rarity or some factors making it vulnerable to extirpation or extinction' in Wyoming in the mid 1990's. Populations in New Mexico are listed as SH (possible extirpated). The U.S. Fish and Wildlife Service lists the boreal toad as 'warranted but precluded for listing by actions of higher priority' under the Federal Endangered Species Act for Southern Rocky Mountain populations found in Colorado, New Mexico, and Wyoming. A Boreal Toad Recovery Team was established in 1994 in response to significant declines in the Southern Rocky Mountain populations of the United States (Jones 1999b).

Table 1. Status of *Bufo boreas* in the United States.

State	State Natural Heritage Program[a] (Federal = G4)	State Fish and Wildlife Agency	U.S. Fish and Wildlife Service	U.S. Forest Service
AK	S3?			
WA	S3S4	Candidate	Species of Concern	
OR	S4	Sensitive/ Vulnerable		
CA	S5			
ID	S4	Special Concern	Watch/ Species of Concern	Region 1 = Sensitive
MO	S3S4	Nongame Wildlife		
UT	S2	Special Concern		
NE	Southern: S3S4 Northern: S4			
WY	Southern: S1 Northern: S2	SSC1 (ongoing loss of habitat & restricted or declining population)	Southern: Candidate; warranted but precluded for listing by actions of higher priority	Region 2 = Sensitive
CO	Southern: S1	Endangered	Southern: Candidate; warranted but precluded for listing by actions of higher priority	Sensitive
NM	Southern: SH	Endangered	Southern: Candidate; warranted but precluded for listing by actions of higher priority	Sensitive

[a]G = Global rank for species, S = State rank for species; ? = unranked, H = historical (possibly extirpated), 1 = critically imperiled, 2 = imperiled, 3 = rare, threatened or uncommon, 4 = not rare, apparently secure, 5 = widespread, abundant and secure.

Due to declines in the United States, B. boreas is the only IUCN red-listed amphibian species within Canada; it is listed as 'EN A1ce', meaning that it is considered endangered with a high risk of extinction in the wild because of population reductions of 50% in the last 10 years or three generations as a result of declines in area or occupancy (World Conservation Union 2000).

POPULATION SIZE AND TREND

Current numbers

There are no long-term data sets, or abundance estimates available for this species to provide an estimate of the current numbers of Western Toads within Canada. Based on the species' extensive range, and the frequency of occurrence reported for this species in British Columbia and Alberta, we estimate that the toad population within Canada is greater than the critical limits set by COSEWIC for listing a species as threatened or endangered, i.e., more than 10,000 individuals occupying an area > 5,000 km^2.

Western toads can appear to be very common and abundant. Female toads lay thousands of eggs each per breeding season, which results in an abundance of tadpoles at breeding sites. But young toads experience high mortality rates and populations fluctuate extensively from year to year in response to climatic factors. In montane areas of Colorado, individual breeding sites recruit in one out of three years at best (Jones 1999a). Populations can also be cyclical. For example, at a pond in the Blackwater Creek drainage in Pemberton, B.C., there appears to be a major population boom every 5 to 10 years (Dupuis, pers. obs). Without long-term monitoring it is impossible to estimate current population numbers.

Population Trends

In Alberta, the range of *B. boreas* appears to be expanding, potentially replacing the Canadian toad, *Bufo hemiophrys*, which has declined throughout its range within that province (C. Paszkowski, pers. com.).

In the interior of British Columbia, Western Toads are the most widely distributed of all amphibians in Kootenay National Park (Poll *et al.* 1984), the Prince George Forest District (Kinsey and Law 1998), and the Williston and Dinosaur Reservoir Watersheds west of Fort St. John (Hengeveld 2000), especially at high elevations. Although commonly encountered along the mid-coast of B.C., there are reports of apparent declines or extirpations of Western Toad populations in the more heavily populated south coast of the province (Dupuis *et al.* 1995, Haycock and Knopp 1998, Dupuis 1998, Beasley *et al.* 2000, Wind 2000, 2001, B. Matsuda, unpublished data, K. Ovaska, pers. com.), within the Georgia Depression Ecoprovince. Haycock and Knopp (1998) surveyed 94 ponds over an extensive area of the Fraser River Lowlands for amphibians in 1997 and noticed a marked decline in the abundance and frequency of encounter of Western Toad populations, compared to historical figures (R. Haycock, pers. com.). Western toads were once common and abundant on southern Vancouver Island (Carl 1944, Hardy 1949, Oliver 1973). Many long-term residents in the Parksville area claim that toads are less abundant now than 30 years ago (Davis 2000). Hardy (1949) described them as "…by far the commonest amphibian encountered" at Jordan Meadows (an extensive wetland area; 0.5 x 4.5 km), just north of Victoria. Western toads were abundant here during the mid to late 1970's (approximately 0.8 toads per person hour of searching) but few were encountered during the mid 1980's, and none were found during intensive searches conducted between 1997 to 1999 (Davis 2000). Records from Jordan Meadows represent the only documented local extirpation of *B. boreas* within Canada. In the Queen Charlotte Islands, some toad populations may be threatened by predators. Populations along lakeshores on Moresby Island were very abundant during the breeding season up until the early 1990's, when they were decimated by raccoon predation (Reimchen 1992). Adult treefrogs have been observed feeding heavily on Western Toad eggs (Erhardt 1996). Both raccoons and Pacific treefrogs, *Hyla regilla* have invaded Moresby Island from Graham Island where they were introduced (Reimchen 1992).

Toad populations in the United States have declined rapidly in many areas (Table 1). Corn *et al.* (1989) failed to find toads at 49 of 59 known localities within Colorado and Wyoming. The range of the toad in Wyoming may be experiencing elevational contractions (Livo and Yeakley 1997). The species is considered endangered in Colorado and New Mexico and is a federal candidate species because the population in the Southern Rocky Mountains has dropped precipitously over the last 20 years (Jones 2000). There may only be one breeding population left in New Mexico, where only one adult and tadpole were seen in 1996 (Jones 2000). In Colorado, there are four metapopulations of toads composed of two or more breeding sites, with several dozen to several hundred toads each, for a total of 37 known breeding localities (Jones 2000). Researchers are attempting to reintroduce toads to historic but currently unoccupied sites within this state (Jones 2000). There have been severe declines in some parts of Washington. Toads are uncommon in the Puget Lowland ecoregion and the mountain meadows of the North Cascades (Leonard *et al.* 1993, Hallock and Leonard 1997). The status of toad populations in Utah is unclear, largely because extensive surveys have not been conducted, especially in unpopulated areas (Ross and Esque 1995). In 1992, Drost and Fellers (1996) revisited sites surveyed for amphibians in 1915 in the Sierra Nevada's of California. Toads had been very abundant at most survey locations previously, but only small numbers of toads were found at one of the six previously occupied sites. The reason for the declines remains unclear but the authors suggested that insecticide use in agricultural valleys below the mountains, drought, and fish stocking may have been factors. In Oregon, there was a severe decline of *B. boreas* at two sites in the Cascade Range in the early 1990's, with entire cohorts of eggs and larvae lost. This prompted several studies investigating potential causes such as UV radiation, disease, drought, etc. (Olson, 2001). There has been a steady recovery of these two populations since that time and the collapse some had predicted has not taken place (Olson 2001). The recovery of these two populations appears to be related to the longevity of the species and the alternating breeding schedule of the adults (Olson 2001). Although it is the montane populations of *B. boreas* that have declined in some areas, not all high elevation populations are threatened, potentially because of the variable ecology montane populations demonstrate across their range (Olson 2001).

HABITAT

Aquatic habitat

Western toads breed in a variety of natural and artificial aquatic habitats, with or without tree or shrub canopy cover, coarse woody debris, or emergent vegetation. They breed in ponds, stream edges, or the shallow margins of lakes (Olson 1992, Reimchen 1992, Corkran and Thoms 1996), as well as in ditches and road ruts (Gyug 1996, E. Wind and L. Dupuis, pers. obs.). Recorded oviposition depths range from 5 cm to 2 m, but depths greater than one metre are rare (Corn 1998). Adult toads may oviposit in the same locations within breeding sites each year, irrespective of water depth (Olson 1992). Livo (1999) found that toad breeding sites in Colorado had significantly fewer predators such as beetles and salamanders, than sites without and that site selection was a balance between water temperature and the presence of predators. In support of this, toad larvae aggregate in the warm, shallow margins of lakes during the day to accelerate their developmental rate (Poll *et al.* 1984) and seek cover among emergent vegetation (Olson 1992. They disperse to deeper waters at night (Livo 1999).

The practice of stocking fishless lakes may be one of the biggest threats to Western Toads, where population declines can occur unnoticed in relatively pristine, uninhabited areas. Fish stocking has occurred extensively throughout North America. Although unpalatable amphibian species that contain skin toxins, like toads, may not be directly threatened by fish predation (Kats *et al.* 1988), they are threatened by diseases associated with fish, including *Aeromonas* (Carey 1993) and *Saprolegnia* (Blaustein *et al.* 1994a, Kiesecker and Blaustein 1997). Davis (2000) hypothesized that the extirpation of Western Toads at Jordan Meadows on Vancouver Island may have been due to the introduction of diseases associated with stocked fish.

The potential declines of toads in the Lower Mainland and on southern Vancouver Island are also the result of habitat degradation and loss. Approximately 75% of wetlands in the Greater Vancouver and Victoria areas have been converted to agriculture and development (Nowlan and Jeffries 1996). Assuming that the remaining 25% of wetlands are suitable for toads, populations are likely isolated and extremely vulnerable to stochastic events. Gibbs (2000) determined that increased urbanization is associated with fewer and more isolated wetlands, beyond the scale at which most amphibian dispersal operates. He calculated that wetlands at least 0.4 ha in size must be protected to maintain the metapopulation structure of most wetland organisms (Gibbs 2000). In B.C., current legislation affords no protection to wetlands less than 0.25 to 1 ha, depending on their location within the province.

Western toads are also exposed to various contaminants in both urban and rural areas. In Quebec, Ouellet (unpub. data) found higher proportions of deformed amphibians in ponds in agricultural areas contaminated by pesticides than in ponds in untreated areas. Pesticides can increase mortality rates and deformities, and reduce growth rates of larval amphibians (Bridges 2000). This is likely true for Western Toads as well. Western toads have been found in the tailings ponds of mines, attracted by the relatively warm waters (Brinkman 1998, R. Brodie, pers. com.). Larvae experience reduced growth when exposed to even low levels of cadmium (Brinkman 1998). At high elevations, decreased growth could affect recruitment and overwinter survival (Jones 2000).

The degradation of riparian habitat can also negatively impact Western Toads. Like many amphibian species, newly emerged Western Toads congregate in riparian areas before they disperse upland (Jameson 1956, Richter 1997, E. Wind, pers. obs.). The sandy shorelines of lakes are often utilized as recreation and cattle grazing areas. Cattle can have a major impact on the structural integrity of the riparian habitat and the survival of young amphibians through trampling and grazing (Friend and Cellier 1990). Davis (2000) found a greater incidence of deformities among Western Toadlets in riparian areas than upland. He concluded that predators, people, and freshwater clams might have injured toadlets, which in turn affected their dispersal abilities (Davis 2000).

Gyug (1996) surveyed amphibian larvae in wetlands of forests and clearcuts from 1993 to 1995, and found no correlation between the proportion of breeding sites used by toads, distance to the nearest forest, or time of harvest. He suggests that the major impact of forest harvesting on aquatic-breeding amphibians may be the creation of small breeding ponds of under 0.02 ha and at least 20 cm deep that potentially act as population sinks. Created as a result of industrial activity ditches and wheel ruts become more attractive to amphibians because they warm early in the spring, yet even under normal air temperature and precipitation levels, they dry up too early for successful metamorphosis. Furthermore, they usually lack thermal and predatory cover for developing larvae, in the form of downed wood or emergent vegetation. In the absence of such sites amphibians would have bred in natural areas, leading to improved reproductive success. This attraction to ponds in clearcuts may have long-term implications for population persistence (Gyug 1996, Waldick *et al.* 1999). Conversely, road ruts have been actively used as an amphibian conservation tool in some areas, such as Kentucky, and appear to be effective where their depth and surface area are suitable (Adam and Lacki 1993).

Terrestrial habitat

Outside of the breeding season, adult toads move to summer ranges that often include wetland habitats not necessarily used for egg laying (Jones 1999a). Radio-tracked toads use terrestrial habitats up to 90% of the time (Bartelt and Peterson 1994). Adults disperse into forested areas, wet shrublands, avalanche slopes, and subalpine meadows (Poll *et al.* 1984). Western toads appear to favour dense shrub cover, where they are protected from desiccation and predation (Bartelt and Peterson 1994, Davis 2000). Toads are often found in clearcuts, and may favour these habitats to closed canopy forests in coastal habitats (Raphael 1988, Dupuis 1998, Davis 2000, Matsuda, unpublished data) and interior habitats (Ward and Chapman 1995, Gyug 1996). Radio-tracked toads in Colorado utilized spring seep areas and roadside ditches in proportion to their availability, and selected for lake and rocky, grass habitats (Jones 1999a).

Toads make use of their ‘pelvic patch’, area of specialized epidermis, to take up moisture from their surroundings when in terrestrial environments (Green and Campbell 1984). They take shelter during the day by burying themselves in loose soils or hiding in animal burrows (Erhardt 1996, Davis 2000). They also occupy other microsites, including moist depressions (Green and Campbell 1984), dense ground vegetation, and tree root tangles (Davis 2000).

Western toads use a large variety of upland habitats within their home ranges. They do not appear to be dependent upon mature or old-growth forest and are frequently found within cut-over areas. It is unclear what the long-term effects of forest harvesting might be on the population dynamics of this species. Their use of dense shrubs for thermal and predatory cover may preclude them from dense young forest stands, which are typically characterized by an undeveloped understory (Franklin 1988). Populations on the south coast may in part be declining in response to a combination of urbanization and a decreased proportion of early seral stands (Davis 2000; Huggard, pers. com.).

Western toads in the southwestern B.C. are likely isolated from mainland populations due to their geographical location and urbanization. Eastern Vancouver Island and the Lower Mainland are the most heavily populated areas of B.C. Rapid housing and industrial development, as well as extensive transportation corridors, are increasingly isolating wetlands in these areas. In addition, Vancouver Island populations are physically isolated from mainland populations, and Lower Mainland populations have limited immigration potential due to the occurrence of the Fraser River that bisects the area. Fragmentation of metapopulations resulting from land development may result in a loss of genetic diversity and increase susceptibility to disease in remaining populations.

Habitat protection needs

State listing of Western Toads in Colorado, New Mexico and Wyoming provides the species itself with some level of protection, but not the species’ habitat. Western toads do not receive any specific habitat protection measures in Canada, either. Western toads require wetland and upland habitat, and movement corridors between these areas for their survival. Relatively shallow wetlands that retain water for the 3 months from early spring until mid-late summer (Stebbins 1951) are important for breeding and should be protected. Buffers around breeding sites have been suggested for amphibian management (Semlitsch 1998), but their effectiveness in maintaining Western Toad populations has not been determine. Buffers may be insufficient given that post-metamorphs need upland habitats with some measure of suitable cover to reduce exposure to climatic extremes, and that population viability requires that some individuals disperse between wetlands. Habitat corridors between wetlands would likely be beneficial but the extent of protection they would offer, and the details for optimal design unknown. Overwintering areas must also be protected, however, nothing is known of hibernacula requirements for this species in Canada. Based on montane populations in Colorado, upland areas near seeps, stream banks, and underground burrows are important areas used for hibernation (Jones and Goettl 1998).

GENERAL BIOLOGY

Reproduction, growth and survivorship

Adult Western Toads congregate at breeding sites in the spring. In south-central British Columbia they breed in May (Poll *et al.* 1984, Gyug 1996) but in southern regions, such as California, breeding may begin as early as January (Erhardt 1996). In the Okanogan Highlands, Gyug (1996) found toad breeding to coincide with the time when average daily minimum and maximum temperatures rose above freezing and 10°C respectively. Tadpoles of this species are often found at high elevation and latitude in early fall, where little time remains before the onset of winter snows (Kinsey and Law 1998, E. Wind, pers. obs.).

There is disagreement as to whether or not Western Toads produce an advertisement call. In many parts of the range, researchers have observed males actively searching for females (e.g., Black and Brunson 1971, Nussbaum *et al.* 1983, Olson *et al.* 1986). They will clasp anything that remotely resembles a female, including rocks, sticks, other frogs, and male toads. As a result, male toads utter a release call, a weak bird-like 'chirp', when grasped by other males whereas females do not. Lone males may also produce a different sound than the release call (F. Cook, pers. com., L. Dupuis, pers. com., C. Davidson, pers. com.), indicating that their vocalizations have more than one function. Male Western Toads in the interior of B.C. (Hengeveld 2000, Kinsey and Law 1998, C. Houwers, pers. com.), in Alberta (E. Wind, pers. obs, W. Roberts, pers. com., F. Cook, pers. com.), Washington (K. Richter, pers. com.), and in California (J. Crayon, pers. com., C. Davidson, pers. com., S. Morey, pers. com.) have been heard calling. Differentiation between calling and non-calling population have not been investigated.

Western toads reach sexual maturity in two to six years (Porter 1972, Green and Campbell 1984, Olson 1988, Carey 1993), with a life expectancy of nine (Campbell 1970) to 11 years (Olson 1988, Carey 1993). Toad aggregations at breeding sites tend to be male biased (Blaustein *et al.* 1995), with the number of males exceeding females by up to 20 to 1 (Leonard *et al.* 1993). Blaustein *et al.* (1995) studied Western Toad populations at sites in central Oregon for almost 20 years. They found that the minimum breeding age for males is three years, with even proportions of males in age classes four to seven years old reproducing. In contrast, females reached sexual maturity at four to five years of age, and few older females (i.e., > 4 to 5 years) were observed at the sites. Toads are 'explosive' breeders, with breeding periods lasting only one to two weeks per year (Olson *et al.* 1986). Although the majority of individuals at each breeding site mate only once per season (Olson *et al.* 1986), breeding schedules differ between the sexes. Males may mate more than once per season and in consecutive years, whereas females appear to skip 1 to 3 years between breeding sessions (Olson 1988). Only 5% of female toads were observed at breeding aggregations more than once in five years, which, when combined with their reduced longevity compared to males, suggests that few females breed more than once within their life time due to the high energy expenditure required for reproduction (Olson 1988). Males persist at the site for several weeks after breeding has been completed (Jones 1999a, Davis 2000).

Amplexus with a female is generally tenacious and prolonged. Each female produces a double-strand of black ova, which are generally intertwined amongst other eggs and submerged vegetation. In shallow pools without vegetation, the eggs lay unattached at the bottom. Females produce clutches of 5,000 to 15,000 eggs (Blaustein *et al.* 1995). The eggs are black and about 1.5 to 1.7 mm in diameter (Blaustein *et al.* 1995). Embryos develop and hatch at approximately ten mm in total length (Nussbaum *et al.* 1983) within three to twelve days, depending on water temperatures (Leonard *et al.* 1993, Hengeveld 2000). Western toad tadpoles are highly gregarious, feeding and swimming in synchronized schools. By mid-summer, transforming tadpoles and toadlets aggregate on the water's edge, potentially for thermoregulation (Black and Black 1969). Their transformation into ten to 12-mm long toadlets takes roughly six to eight weeks (Green and Campbell 1984). Metamorphosis is usually complete within 3 months of egg laying (Stebbins 1951).

Toadlets form post-metamorphic aggregations (PMAs) throughout the species' range (Livo 1998). These aggregations are hypothesized to be the result of either a deteriorating larval environment, an inability to disperse, protection from desiccation, and/or selfish herding behaviour that invokes predator saturation. In Colorado, Livo (1998) found that lack of inlet and outlet channels and associated moisture, as well as desiccating soils surrounding natal ponds appeared to limit the ability of toadlets to disperse. In July 1998, a large PMA two to three inches deep died along a section of the Stewart-Cassiar Highway in northern B.C., where the road bisects a large wetland (R. Pojar, pers. com.). The reason for the massive toadlet death remains unclear, but seems to be related to a heat wave. Also, as PMAs increase in size, and the longer they last, there is an increased potential for individuals at the bottom to become injured, and for dispersal to become ineffective, rendering PMAs lethal in some instances.

Like other aquatic-breeding amphibians, Western Toad populations fluctuate extensively from year to year. Mortality is greatest during the larval and juvenile stage, but slight thereafter (Campbell 1970). In some regions, reproductive success appears to be related to the amount of snow pack and rate of snowmelt, which determines the persistence of breeding pools (Black and Brunson 1971). The rebound of Western Toad populations at sites in Oregon provides some evidence that Western Toads can recover after years of depression (Olson 2001).

Movement and dispersal

In contrast to jumping frogs, Western Toads move overland primarily by climbing and crawling. On Vancouver Island, radio-tracked toads moved mostly at night, starting approximately four hours after dusk and peaking at midnight (Davis 2000). Although toads are most active at night at lower elevations, they can often be seen during the day at higher elevations (Carey 1978, Russell and Bauer 1993). Toads may be diurnal in mountain habitats in response to the activity patterns of their principal food sources (Carey 1978). In some cases, activity levels appear to be related to seasonal changes in temperature, where toads are nocturnal during mid summer, and diurnal in spring and fall (Sullivan 1994).

Many Bufo species have distinct home ranges that include aquatic breeding sites, summer ranges encompassing a variety of upland and riparian areas, and hibernacula. Because female Western Toads do not breed every year they tend to move farther upland than males after breeding, up to 400 to 600+ m away from breeding sites (Jones 1999a). On Vancouver Island, Davis (2000) found toads to have small, distinct home ranges of about 0.1 ha. In Colorado, toads moved an average of 11.83 m per day, within an average home range of 46,185 m^2, including the breeding site (males = 72,869 m^2; females = 34,325 m^2), and 43,558 m^2, excluding the breeding site (males = 70,296 m^2; females = 31,675 m^2; Jones and Goettl 1998). Home range size varies according to the condition of the habitat (Campbell 1970). Males may be territorial, especially where breeding sites are scarce (Campbell 1970). Toads repeatedly return to particular microsites within their home range (Carpenter 1954, Davis 2000, Jones and Goettl 1998, Bartelt and Peterson 1994). Davis (2000) observed that toads frequently returned to small moist soil patches that they had created, and moved little the majority of the time, but that occasional long-distance excursions were made. Western toads are capable of moving over 5 km between breeding sites (Corn and Muth, unpublished data in Roelle 2000). Davis (2000) commonly found adult toads one to two kilometres away from breeding sites on Vancouver Island during the spring and summer, with some toads moving as much as 7.2 km. Movements appeared to be directional but their significance was undertermined (Davis 2000).

Western toads exhibit strong annual site fidelity. During spring migration to breeding ponds, American toad individuals are capable of well-oriented movements as large as 595 m (Oldham 1965). They will return to their traditional breeding grounds even when other potential sites are available. Davis (2000) found that Western Toads were highly philopatric and homed to their original location up to one kilometre away. Tracy and Dole (1969) found Western Toads homing to breeding ponds when displaced 200 m away. Oldham (1965) determined that toads rely on topographic gradients more so than olfactory, auditory, hygrotactic or visual cues to orient themselves. Tracy and Dole (1969) found that anosmic displaced toads were more disoriented than blind toads.

Toadlets spend the first period of their terrestrial life within the riparian area, eventually dispersing upland. Little is known of the mechanisms that determine the direction and magnitude of their dispersal. Davis (2000) found toadlets at least 300 m from breeding sites on Vancouver Island. Nothing is known of the effect of habitat features on toadlet dispersal. For example, toadlets that emerge from breeding sites within clearcuts may be seriously disadvantaged by extreme climatic conditions and increased predation. Smaller toads heat up and cool down more rapidly than larger toads (Carey 1978). The ability of toadlets to disperse may also be impacted by the persistence of PMAs, especially in riparian areas which receive a lot of trampling by people and/or cattle and near roads where there is a high risk of injury or mortality.

Diet and predation

The diet of tadpoles is comprised of filamentous algae and organic detritus, but they will also scavenge carrion. Adult toads wait for their prey on the surface of the ground or in burrows. They feed on a wide variety of invertebrates, including worms, spiders, bees, beetles, ants, and arachnids (Leonard et al. 1993, Sullivan 1994). They also eat crayfish, sow bugs, grasshoppers, trichopterans, lepidopterons, and dipterans (Stebbins 1951, Verner and Boss 1980). In urban areas, adults toads feed on cuculionids (weevils and billbugs), however, analysis of fresh fecal pellets revealed that the billbugs survive through the digestive tract, so little, if any nutrition is derived from the bugs (Ehrhardt 1996). It takes an average of three to four days for toad prey to pass through the digestive tract at body temperatures fluctuating between five and 30°C (Carey 1978).

Although juvenile and adult toads secrete a mild white poison from their parotoid glands and warts to deter predators, they are preyed upon by coyotes, raccoons, skunks, foxes, corvids, and garter snakes (Olson 1989, Leonard et al. 1993, Jones et al. 1999). Olson (1988) witnessed high predation of adult toads by ravens in Oregon. D. Low (pers. com.) found decapitated Western Toads, along with spadefoot toads, Spea intermontana, in burrowing owl holes in the interior of B.C. Many species eviscerate toads to avoid their toxic skin. The highest predation pressure on adult toads comes during the breeding season when they are exposed and vulnerable in the shallow water margins of lakes and ponds.

Western toad tadpoles and metamorphs are particularly vulnerable to snakes and birds during the period of transformation and migration, when they are not adequately suited to life in either environment (Huey 1980). Gyug (1996) witnessed high predation of newly metamorphosed young by ravens at artificial ponds in clearcuts. Garter snakes, Thamnophis sirtalis, often feed to satiation on maturing tadpoles and newly emerged toadlets (Davis 2000, E. Wind, per. obs.). Devito et al. (1998) found that metamorphic toadlets emerged sooner, in higher levels of aggregation, and more synchronously in the presence of T. sirtalis, regardless of whether or not they had completed tail resorption and were thus physically suited for terrestrial life. This altered behaviour in the presence of T. sirtalis may result in smaller size at emergence, which could have long-term effects on survival (Bellis 1962, Berven 1990) especially in clearcuts where reptiles are abundant (Raphael 1991). Synchronous metamorphosis and aggregation may function as an antipredator adaptation by swamping predators during this vulnerable period.

Western toad tadpoles are eaten by ravens, crows, ducks, herons, garter snakes, backswimmers, and giant water bugs (Olson 1989, Leonard et al. 1993, Jones et al. 1999). They are unpalatable to fish and newts. In experiments, tadpoles did not demonstrate anti-predator behaviour when exposed to trout or newts but did when exposed to aquatic invertebrate and snake predators (Kiesecker et al. 1996). Livo (1999) studied the impacts of various predators on Western Toad tadpoles in Colorado. She found that predacious diving beetle larvae, genus Dytiscus, had the greatest impact on Western Toad larvae compared to adult beetles, tiger salamander larvae, Ambystoma tigrinum, or western terrestrial garter snakes, Thamnophis elegans. The life history of the beetle larvae and of Western Toad tadpoles overlaps significantly, in terms of the onset and duration of the aquatic life phase, the relative size of the predator and prey during this life phase, and daily activity patterns as both are diurnal (Livo 1999). Boreal toad tadpoles may be susceptible to predation by these larvae throughout their entire aquatic life phase. Species of Dytiscus are wide spread throughout North America (Livo 1999).

Physiology

Like all amphibians, Western Toads are ectothermic, relying on movement between habitat types to thermoregulate. Unlike other smooth-skinned amphibians, toads and newts depend largely on their lungs for thermoregulation (Noble 1954). The range of voluntary thermal minima (3.0°C) and maxima (29.5°C) of Western Toads from southern latitudes is relatively wide compared to other amphibian species (Brattstrom 1963). Davis (2000) fitted toads on Vancouver Island with data loggers and found that their temperatures fell exactly within this range, even though surface temperatures fluctuated more extensively. This tolerance partially explains why Western Toads are commonly found in clearcuts, where temperatures fluctuate extensively compared to areas with forest cover. In spring and autumn, toads were able to maintain higher temperatures in openings than under forest cover (Davis 2000). Carey (1978) calculated an energy budget for toads and found that they could sit in direct sunlight for long periods without fatally overheating, as long as they were moist. Bufonids are relatively tolerant of drying, reaching their critical activity point when dehydrated to 41% of their initial hydrated body mass (Hillman 1980). Their warty skin is moderately resistant to desiccation, and the thin skin of the lower abdomen, referred to as the ‘pelvic patch’, enables them to absorb moisture from the ground (Green and Campbell 1984). Although toads can venture relatively far from water compared to other amphibians, they must rehydrate daily in some sort of standing water (Campbell 1970). Davis (2000) occasionally found toads sitting in water, and observed that suitable moist microsites were readily available within cut-over areas on Vancouver Island. Newly metamorphosed individuals however, have a higher surface area to volume ratio, and are more vulnerable to desiccation than adults (Livo 1998).

Hibernation

Western toads hibernate from three to six months each year, depending on the location. Jones and Goettl (1998) radio tracked toads to their hibernacula in Colorado over a three-year period. Hibernation began in early October, but toads associated with the hibernacula by late August. They found that toads used a variety of sites, including the underside of a bank above a spring seep, willow clumps (sometimes in association with a seep), the base of an Engelman spruce, *Picea engelmannii*, and a burrow associated with a spring. By far the majority of toads used burrows of golden-mantled ground squirrels, *Spermophilus lateralis*, even some that were not abandoned. Burrows that were deep enough to prevent freezing and moist enough to prevent desiccation were used. Toads hibernate up to 1.3 m under ground (Mennel and Slough 1999). Campbell (1970) states that *B. b. boreas* must hibernate in contact with water all winter. Jones and Goettl (1998) found that hibernacula were reused across years, and often occupied by more than one toad. Toads maintained an average body temperature of 5 to 6°C between

November and April. Jones and Goettl (1998) noted that a group of toadlets was found under a rock after winter, meaning that they had experienced freezing, or near freezing, temperatures. The fate of toadlets that do not reach adequate hibernacula sites before the onset of freezing, because of their late emergence at high elevations and latitudes, is unknown (Jones and Goettl 1998). In northern regions, toads may be dependent upon areas of high snow accumulation, that lack permafrost, to survive through winter (Cook 1977, Slough 1999).

LIMITING FACTORS

The fact that *B. boreas* populations have declined so severely in the southern half of the range, in so short a period, and in relatively pristine areas, is cause for concern. No satisfactory hypotheses have emerged to explain the declines. Mass mortality episodes of all life stages of toads have been recorded under a variety of conditions including predation, desiccation, UV radiation, and fungal infection. Climatic conditions each year can also have a major impact on recruitment (Jones 1999a). Spring storms, summer drought and early fall freezing have lead to mass mortality of young toads, larvae and eggs. Furthermore, Western Toads tend to lay their eggs in the same location within a breeding site, temporally and spatially (Blaustein *et al.* 1995). These factors, along with the persistence of PMAs, makes them vulnerable to mass predation (Sullivan 1994).

The southern region of B.C. is the most populated portion of the Western Toad's range in Canada. High levels of agricultural and urban development have cause the species to be exposed to intense encroachment and/or its associated factors such as increased road traffic, habitat deterioration, isolation, pesticides, and disease, predation or competition with introduced exotics such as bullfrogs and stocked fish. Consequently, populations in the Georgia Depression Ecoprovince are fragmented and have likely suffered declines (e.g., Haycock and Knopp 1998; Dupuis 1998; Davis 2000). Small, isolated populations like this one are most vulnerable to extirpation from environmental stresses (Corn 1994; Blaustein *et al.* 1995).

Western toads may be particularly vulnerable to pathogens and disease. Davis (2000) suspects that the only known local extirpation of *B. boreas* within Canada may be linked to pathogens associated with fish, including the water mold, *Saprolegnia*. This same pathogen was linked to a 50 to 95% mortality rate of Western Toad eggs at three breeding sites in Oregon (Blaustein *et al.* 1994a). The authors suggest that populations stressed due to habitat degradation and/or increased UV-B may be more susceptible to infection. The communal egg laying habits of *B. boreas* increases infection rates (Kiesecker and Blaustein 1997).

A chytrid fungus has been identified from amphibians in Australia, Central America and North America, as the cause of amphibian declines of many montane amphibian species, including Western Toads (Berger *et al.* 1998, Daszak *et al.* 1999). In Colorado, *B. boreas* experienced population declines in the late 1970's and the early 1980's, and again from the late 1990's to the present (C. Carey, pers. com.). Carey (pers. com.) found that four decreasing populations of *B. boreas* in Colorado in the 1990's had chytrid infections from *Batrachochytrium dendrobatidis* at levels sufficient to kill amphibians exposed in laboratory studies. Based on similarities in the patterns of population declines and the presence of chytrids in museum specimens, Carey believes that the *B. boreas* declines witnessed in the late 1970's and early 1980's in Colorado were also due to this disease. Virtually nothing is known of how this pathogen kills its host, how it is spread among populations, or where it originated. This virulent pathogen has the ability to drive its' host population to extinction because it can survive outside of the host on keratinized material after the population has died off, and it can reproduce saprophytically (Daszak *et al.* 1999). *Batrachochytrium* develops most rapidly at low temperature (Daszak *et al.* 1999), which may explain why montane populations are susceptible. A histologically similar pathogen, *Basidiobolus ranarum*, has been described in endangered wild Wyoming toads, *Bufo baxteri* (Taylor et al. 1999) and captive dwarf African clawed frogs, *Hymenochirus curtipes* (Groff *et al.* 1991), a widely introduced species in the United States in the late 1980s in ornamental garden ponds. The introduction of this latter species may have been involved in the dissemination of *Batrachochytrium* in North America.

Worrest and Kimeldorf (1975) exposed *B. boreas* tadpoles to high levels of artificial UV-B, resulting in spinal, corneal and epidermal deformities. In Oregon, studies have demonstrated greater mortality of Western Toad larvae exposed to natural levels of UV-B radiation compared to shielded larvae, potentially due to relatively low levels of photolyase within this species (Blaustein *et al.* 1994b, Hays *et al.* 1996). However, similar studies conducted in Colorado failed to find any effect of UV radiation on toad larvae (Corn 1998). Licht and Grant (1997) suggest that current levels of UVB are not high enough to support the hypothesis of UV alone as a causative factor of amphibian declines, but acknowledge that radiation levels will likely increase in the next decade and that some species may be more vulnerable to these changes. UV in combination with some stressor(s) may encourage infection by pathogens.

Amphibian deformities have received a lot of attention in the last decade. On Vancouver Island, Davis (2000) found increased deformities of toadlets along the shoreline relative to upland, and concluded that deformities may affect dispersal abilities of toads. The North American Reporting Center for Amphibian Malformations has two reports of deformed Western Toads from within Canada; two individuals from the Alberni-Clayoquot area (July 1998), and one in the East Kootenays (Sept. 1998). Over the past five years, T. Dickinson (pers. com.) has encountered numerous deformed *Bufo boreas* toadlets in the region of Isobel Lake, B.C. (51º 23'W 50º 51'N), approximately 5 km from Kamloops. He claims that the amphibians have a "higher than average incidence of limb deformity; 50% for *Rana pretiosa* and *Hyla regilla*, and 30% for *Bufo boreas*. In all cases there is a prevalence of multiple appendages at anywhere from the pelvic girdle to the metatarsals". People have reported seeing deformed Western Toads in the Little Shuswap Lake area as well (T. Dickinson, pers. com.). The reasons for the deformities are unknown. Johnson *et al.* (1999) identified a parasite that caused high rates of deformities in *Hyla regilla* (15 to 45%) and *B. boreas* tadpoles in California. An aquatic snail (*Planorbella tenuis*) appeared to be the first host of the trematode parasite (*Ribeiroia* sp.), which infected the tissue around the pelvic girdle and hind limbs of the amphibians, resulting in abnormal or extra limbs. Under experimental conditions, even low parasite densities resulted in deformities and low survival rates of tadpoles. They suggest that the increased incidence of deformities we have been seeing in many amphibian species may be due to increased densities of one of the parasite's host species and/or changes in the environment such as accelerated eutrophication due to organic pollution that has caused the snail population to increase.

Toads are often abundant in clearcut habitats both terrestrially and at breeding sites in many areas of B.C. However, the condition of individuals inhabiting these areas has not been studied. Ward and Chapman (1995) suspect that in northern regions, direct toad mortality from timber harvesting may be reduced because harvesting occurs in winter. Increased warmth in cut-over areas may be beneficial where the growing season is limited. On the other hand, cut-over areas may harbour more snakesand other predators (Raphael 1991), which could increase the predation rate on newly metamorphosed young. Studies are needed to address whether the increased abundance of toads in cut-over areas is a true reflection of habitat suitability or whether these areas act as reproductive sinks. Because toads are attracted to open areas, they may spend a great deal of time on roads, which increases mortality. The small metamorphs are particularly vulnerable, and easily decimated. For example, Wind (unpublished data) observed large numbers of toadlets trapped in road ruts 20-30 cm deep that were heavily used by all terrain vehicles. The toads either entered the ruts when they were attempting to cross the road, using the road for basking, or they were attracted to the water trapped inside the ruts. The mass die off of toadlets in northern B.C., mentioned earlier, may have been influenced by the presence of the road. Davis (2000) found road surveys an effective way of sampling Western Toads.

The relatively high rate of development and fragmentation associated with south-coastal areas of B.C. has likely pushed Western Toad populations in that area to a stress level that has made them particularly vulnerable to all of these contributing factors.

SPECIAL SIGNIFICANCE OF THE SPECIES

Given the status of Western Toad populations in the southern half of its range, Canadian populations represent the remaining stronghold of this species. We have an opportunity to begin monitoring and protecting this species before numbers fall below critical levels.

Bufo boreas is one of the widest ranging amphibians found within B.C., and it occurs at higher elevations than other amphibian. In this way it contributes significantly to the ecological processes of high elevation and high latitude wetlands. The sheer volume of Western Toad tadpoles contributes significantly to the biomass of wetland ecosystems: the eggs and tadpoles are consumed by many aquatic invertebrates and vertebrates and the tadpoles feed on large quantities of algae. Western toads are capable of ingesting large quantities of food and thus are a significant player in terrestrial, especially riparian, food webs, effectively converting items of low food value to a biomass more readily available to reptiles, birds and mammals (Feder 1983), and possibly maintaining lowered populations of some insect pests. Thus, declines in widespread, common species such as *B. boreas* can have big repercussions on ecosystem functioning (Corn 1994).

EVALUATION

Western toad populations found within the Georgia Depression of south-coastal B.C. should be considered a special concern. All recent surveys in this area have yielded low encounter rates of Western Toads compared to historical figures. On Vancouver Island, the local extirpation of one extensive population has been confirmed. Populations in the Georgia Depression are generally isolated from one another, and from other mainland populations as a result of fragmentation and habitat loss. Without immigration of individuals, population viability is improbable. The severe and rapid Western Toad declines witnessed in the United States in recent decades demonstrates the vulnerability of this widespread and common species. The lack of information on population dynamics and the absence of long-term data sets in Canada contribute to an elevated concern for the species in this region. Base on current abundance and distribution information, *B. boreas* appears not to be at risk of extinction throughout the remainder of its range within Canada at this time. In some areas, it may be the most abundant amphibian species. This status should be re-examined regularly, however, given that declines can happen so rapidly.

TECHNICAL SUMMARY

Bufo boreas

Western Toad — Crapaud de l'Ouest

Range of Occurrence in Canada: YT NT BC AB Parks YFWMB

Extent and Area information	
• *extent of occurrence (EO)(km²)* Based on map Fig. 3 in report	Ca. 1,300,000 km²
• *specify trend (decline, stable, increasing, unknown)*	Stable
• *are there extreme fluctuations in EO?*	No
• *area of occupancy (AO) (km²)*	Ca. 130,000 Km²
• *specify trend (decline, stable, increasing, unknown)*	Decline especially on Vancouver Island and adjacent mainland
• *are there extreme fluctuations in AO ?*	No
• *number of extant locations*	A great many
• *specify trend in #*	Decline especially on Vancouver Island and adjacent mainland
• *are there extreme fluctuations in # locations?*	No
• *habitat trend:*	Declining quality & extent especially on Vancouver Island and adjacent mainland
Population information	
• *generation time*	3 – 4 yrs
• *number of mature individuals*	unknown
• *total population trend:*	Decline especially on Vancouver Island and adjacent mainland
• *% decline over the last/next 10 years or 3 generations.*	unknown
• *extreme fluctuations in number of mature individuals?*	Most probably
• *is the total population severely fragmented?*	yes
• *list populations with number of mature individuals in each*	unknown
• *specify trend in number of populations*	Decline especially on Vancouver Island and adjacent mainland
• *are there extreme fluctuations in number of populations?*	no
Threats (actual or imminent threats to populations or habitats)	
- agricultural and urban development - road traffic - habitat deterioration, including fragmentation and the creation of unsuitable but attractive breeding ponds - introduced exotic predators and competitors, especially bullfrogs and predatory fish - diseases (*Saprolegnia*, chytridiomycosis) - unknown factors implicated in US declines	
Rescue Effect (immigration from an outside source)?	**negligible**
• *does species exist elsewhere (in Canada or outside)?*	yes

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Elke Wind investigated effects of forest fragmentation on amphibians in the mixedwood boreal forest of Alberta for her Master's thesis. Upon completion, she worked with the Long Beach Model Forest designing and implementing an amphibian inventory and monitoring program in Clayoquot Sound. She returned to the Centre for Applied Conservation Biology at the University of British Columbia as a research associate for two years. Currently, she is an independent biological consultant working with the forest industry to incorporate aquatic-breeding amphibians into an adaptive management monitoring program.

Linda Dupuis did her Master's Degree on the effect of logging practices on amphibian communities on Vancouver Island. She then worked as a research associate at the University of British Columbia's Centre for Applied Conservation Biology for five years. She focused her research on the riparian management needs of amphibians in altered and undisturbed, forested watersheds. Linda is now a mother of two and an environmental consultant, although she continues to pursue her research into wildlife management needs.