SPECIES STATUS REPORT

Western Toad

(Anaxyrus boreas)

in the Northwest Territories

NORTHWEST TERRITORIES SPECIES AT RISK COMMITTEE

THREATENED

December 2014

Species at Risk Committee status reports are working documents used in assigning the status of species suspected of being at risk in the Northwest Territories (NWT).

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ABOUT THE SPECIES AT RISK COMMITTEE
The Species at Risk Committee was established under the *Species at Risk (NWT) Act*. It is an independent committee of experts responsible for assessing the biological status of species at risk in the NWT. The Committee uses the assessments to make recommendations on the listing of species at risk. The Committee uses objective biological criteria in its assessments and does not consider socio-economic factors. Assessments are based on species status reports that include the best available Aboriginal traditional knowledge, community knowledge and scientific knowledge of the species. The status report is approved by the Committee before a species is assessed.

ABOUT THIS REPORT
This species status report is a comprehensive report that compiles and analyzes the best available information on the biological status of Western Toad in the NWT, as well as existing and potential threats and positive influences. Full guidelines for the preparation of species status reports, including a description of the review process, may be found at www.nwtspeciesatrisk.ca.

Northwest Territories Environment and Natural Resources

Environment and Natural Resources, Government of the Northwest Territories, provides full administrative and financial support to the Species at Risk Committee.

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NORTHWEST TERRITORIES SPECIES AT RISK COMMITTEE

Assessment of Western Toad

The Northwest Territories Species at Risk Committee met in Fort Simpson, Northwest Territories on December 10, 2014 and assessed the biological status of western toad in the Northwest Territories. The assessment was based on this approved status report. The assessment process and objective biological criteria used by the Species at Risk Committee are available at www.nwtspeciesatrisk.ca.

Status: Threatened in the Northwest Territories

Likely to become endangered in the Northwest Territories if nothing is done to reverse the factors leading to its extirpation or extinction.

Reasons for the assessment: Western toad fits criterion (d) for Threatened.

(d) – There is evidence that the range is limited and there are threats that could cause it to disappear from the Northwest Territories in our children's lifetime.

Main Factors:

- The population of western toads in the Northwest Territories is small and its range is limited making it vulnerable to threats.
- There is evidence that chytrid fungus and ranavirus are already present in the Northwest Territories. This could be detrimental to the western toad population, particularly if coupled with additional stressors or threats that reduce immunity to diseases.
- Disease transmission can be facilitated by humans collecting and releasing toads or tadpoles between water bodies.
- Additional threats include habitat degradation, wildfires, resource exploration and development, and increased UV-B radiation. All of these threats can have complex interactions with each other and be challenging to manage.
- Life-history characteristics (e.g., long lifespan, delayed maturity of females, and females breeding only once a lifetime) make populations especially vulnerable to threats and declines.

Additional Factors:

- Currently, there are no data to determine if there is a population decline of western toads in the Northwest Territories.

- Since threats to western toads in British Columbia and Yukon Territory are similar to those present in the Northwest Territories, future rescue effect for the Northwest Territories population may be unlikely.

Positive influences to western toad and its habitat:

- Western toad range in the Northwest Territories could potentially receive some protection through zoning and under a regional land use plan currently under development.
- Climate change could have either adverse or positive impacts.

Recommendations:

- Conduct breeding site surveys and protect known breeding sites through legislation or another effective mechanism.
- Maintain and develop further studies on western toad biology, range, habitat and threats in the Northwest Territories, including collaborative initiatives with adjacent jurisdictions.
- Develop guidelines and best practices for studying amphibians to avoid disease transmission.
- Ensure climate monitoring in the range of the western toad.
- Educate residents, visitors and schools about western toad and the threats they face.
- Encourage people to report sightings of western toads.

Executive Summary

Description

The western toad is a large toad with small round or oval "warts" on the back, sides and upper portions of the limbs. Large oblong parotoid glands are situated behind the eyes. Colour is typically brown or green but varies from olive green to almost reddish-brown or black; a creamy or white vertebral stripe often extends from snout to vent. The "warts" and parotoid glands are often reddish-brown. There is a grey pelvic patch in the groin area that is used to absorb moisture from the environment. Tadpoles are jet-black or charcoal in colour.

Distribution

The western toad ranges from northern California, Nevada, Utah, Colorado and New Mexico north through Canada and Alaska. The western toad's known range in the Northwest Territories (NWT) is limited to the Liard River basin south of Nahanni Butte, in the Dehcho Region. This population is likely connected to upstream populations in the Yukon and British Columbia (BC). The species has been confirmed from at least six sites in the NWT along the Liard Highway and Liard River up to 80 kilometres (km) from the BC border. No natural breeding sites are known in the NWT; breeding has been observed in ponds in a gravel pit. There are unconfirmed reports of western toads from Nahanni Butte, Nahanni National Park Reserve (Yohin Lake) and Fort Simpson.

Biology and behaviour

The toads breed in a wide variety of wetlands. Following breeding, adults may remain to forage in the marshy or riparian edges of breeding sites, or they may disperse several kilometres to forage in other wetlands, riparian areas along streams, or upland sites. Western toads hibernate underground, below the frost line, near water, often using small mammal burrows, beaver dams or natural tunnels.

Home ranges during summer foraging are usually less than 1 km² for males and 2.5 km² for females. Seasonal movements between breeding sites and summer home ranges are usually less than 1 km for males and 2.5 km for females. Streams are often used as movement corridors. Dispersal distances of up to 13 km in less than six weeks have been documented, but longer movements are suspected.

Western toads breed communally in spring, shortly after ice breakup between late-April and late-May, during a brief one or two week period. Eggs are laid in long, intertwined strings in the shallow margins of lakes and ponds. Tadpoles form large aggregations. Metamorphosis is usually complete by July or August. Newly emerged metamorphs also form large aggregations.

Western toads reach sexual maturity at three to four years for males and four to six years for females. Males may mate more than once per season, and in consecutive years, but females rarely do so and may mate only once in their lifetimes. Males may live to 11 years of age, and females to nine years of age.

The western toad maintains an optimal temperature by moving among habitats or micro-sites, basking and evaporative cooling. It is moderately resistant to desiccation and is often found far from standing water in relatively dry habitats, but moist micro-sites are required for rehydration.

Western toad tadpoles feed on algae, organic detritus and carrion. Adult toads are ambush predators and feed on a wide variety of insects and other invertebrates. All life stages of the western toad, from eggs to adults, possess bufotoxins, which makes them unpalatable to most predators. Invertebrate predators consume tadpoles. Tadpoles and terrestrial toads are eaten by birds, including the common raven, spotted sandpipers, and mallards, and terrestrial toads are eaten by mammals such as red fox and coyotes. These predators often eviscerate toads to avoid the toxic skin.

Population

Western toad breeding has not been described in the NWT, but breeding takes place in late May in northern BC. Females are known to lay 1,200 to 20,000 eggs in southern areas; however, observations in the north suggest that smaller clutches of less than 3,000 eggs are laid. Tadpole aggregations in breeding sites in the north are typically in the 200 to 5,000 range, as compared to the hundreds of thousands or millions reported elsewhere. Small tadpole aggregations are indicative of small breeding populations.

Northern western toad populations are generally small compared to southern counterparts. Nonetheless, evidence in northern BC and Yukon points to a widespread distribution of persistent and relatively stable populations. Few adults and only one man-made breeding site, consisting of three ponds in close proximity, have been found in the NWT, but limited search effort and inherent difficulties in locating western toads make observations uncommon. It is highly likely that many more adults and undiscovered breeding sites occur in the area. The only known breeding site, three ponds at the Muskeg River gravel pit may actually represent population sinks and have a negative effect on the population. The ponds are near roads, which pose a threat of mass mortality to aggregations of breeding adults, tadpoles or dispersing metamorphs from road kill and off-road all terrain-vehicle (ATV) use.

Habitat

The western toad has three primary habitat requirements: aquatic habitat, for breeding, egg laying and tadpole development; foraging habitat; and hibernating habitat. Hibernating and breeding habitats are often in close proximity. Western toads show strong fidelity to breeding sites, summer foraging areas and hibernating sites, which may be a limited resource.

The availability of suitable habitats is largely unknown in the NWT, but widely dispersed observations of western toad adults indicate that breeding and foraging habitats, including man-made habitats, are likely present across the landscape in the Dehcho region. The availability of frost-free hibernating sites may impose the northern limit on western toad distribution in the NWT.

Roads, seismic lines and other linear developments fragment and degrade western toad habitats and may represent barriers to dispersal and migration. However, western toads have a wide thermal tolerance and resistance to desiccation, so they are able to forage in and cross open areas. The density of linear features and seismic lines is relatively high in the western toad's range compared to the rest of the NWT, and there is oil and gas, coal and mineral exploration and development taking place within the NWT range.

There is no evidence that western toad habitat has been lost in the NWT but our ability to detect impacts is low. Cumulative impacts from multiple threats such as forestry, roads, seismic lines and other linear features, and active resource exploration may be fragmenting and degrading western toad habitats in the NWT.

Threats and limiting factors

Amphibians face many threats globally and are declining more rapidly than either birds or mammals. Their reliance on aquatic and terrestrial environments and their permeable skin and exposed eggs contribute to their vulnerability. In the NWT, emerging diseases, habitat changes and vehicle collisions likely pose the greatest threats to the western toad.

Diseases that have contributed to amphibian declines elsewhere are present and pose an immediate threat. The threat is unknown but likely small at this time. The main diseases of concern are chytridiomycosis, caused by the amphibian chytrid fungus (*Batrachochytrium dendrobatidis* (Bd)), and ranavirus. Co-stressors such as habitat degradation, climate change, and increased ultraviolet radiation may act together to reduce immunity to disease.

Roads may represent barriers to dispersal and migration, and result in road kill. Adults and metamorphs are especially vulnerable to mortality near breeding sites, where there are mass movement events.

The potential effects of climate change on western toads are unknown or ambiguous at best. Western toads are adaptable to a wide range of habitats and temperature/moisture conditions; therefore, climate change may not be a serious threat to this species over the next three generations (21 years). However, extreme climatic events brought on by climate change may be linked to increased UV-B exposure caused by drought and to the outbreak of pathogens.

The long time to maturity for females, and the fact that most may breed only once in their lifetime, limits the western toads' ability to recover from population declines.

Positive Influences

Global climate change may permit earlier breeding due to earlier snow and ice melt, and subsequent range expansion by western toads. Increased snow depth may permit northern range expansion as well by increasing the number of frost-free hibernation sites. A warmer climate with increased atmospheric moisture could benefit toads by making more landscapes suitable for dispersal.

It is possible that some protection of the western toad habitat, an ecological value, could be provided for through zoning and under a regional land use plan currently under development in the Liard valley. A land use plan will describe what types of activities should occur, generally where they should take place, and terms and conditions necessary to guide land use proposals and development projects over time.

Technical Summary

Question	
Population trends	
Generation time (average age of parents in the population) (indicate years, months, days, etc.).	ca. 7 yrs
Number of mature individuals in the NWT (or give a range of estimates).	Unknown; expert opinion-based estimate less than 10,000; conceivably less than 2,500.
Percent change in total number of mature individuals over the last 10 years or 3 generations, whichever is longer.	Unknown
Percent change in total number of mature individuals over the next 10 years or 3 generations, whichever is longer.	Unknown
Percent change in total number of mature individuals over any 10 year or 3 generation period which includes both the past and the future.	Unknown
If there is a decline in the number of mature individuals, is the decline likely to continue if nothing is done?	Unknown
If there is a decline, are the causes of the decline reversible?	Unknown
If there is a decline, are the causes of the decline clearly understood?	Unknown

Question	
If there is a decline, have the causes of the decline been removed?	Unknown
Are there extreme changes in the number of mature individuals?	Unknown
Distribution Trends	
Estimated extent of occurrence in the NWT (in km²).	11,655 km²
Index of area of occupancy (IAO) in the NWT (in km²; based on 2 × 2 grid).	32 km²
Number of extant locations in the NWT.	1 location (disease is the major threat).
Is there a continuing decline in area, extent and/or quality of habitat?	Unknown
Is there a continuing decline in number of locations, number of populations, extent of occupancy and/or IAO?	Unknown
Are there extreme fluctuations (>1 order of magnitude) in number of locations, extent of occupancy and/or IAO?	Unknown
Is the total population severely fragmented (most individuals found within small and isolated populations)?	Unknown, natural breeding sites are unknown.
Immigration from populations elsewhere	
Does the species exist elsewhere?	Yes

Question	
Status of the outside population(s)	*Special Concern* in Canada (COSEWIC 2012), general status *Sensitive* in Canada, Alberta, BC and Yukon.
Is immigration known or possible?	Yes, immigration from upstream sources in northern BC and Yukon, along Liard River corridor is possible.
Would immigrants be adapted to survive and reproduce in the NWT?	Yes
Is there enough good habitat for immigrants in the NWT?	Yes
Is the NWT population self-sustaining or does it depend on immigration for long-term survival?	Unknown
Threats and limiting factors	
Briefly summarize negative influences and indicate the magnitude and imminence for each.	Diseases caused by chytrid fungus and ranavirus are an immediate threat: magnitude of the impact likely small at this time. Co-stressors may act together to reduce immunity to disease. Mass mortality events on roads are an immediate threat; magnitude is unknown at this time. Habitat loss and fragmentation also represent a potential threat of unknown magnitude. Other threats currently ranked low in magnitude and imminence include climate change; chemical contamination; UV-B radiation; invasive species; and collection. Climate change-associated extreme climatic events may be linked to increased UV-B exposure due to drought, and to the outbreak of pathogens.

Question	
Positive influences	
Briefly summarize positive influences and indicate the magnitude and imminence for each.	Climate change may promote earlier breeding, range expansion, hibernation, and dispersal. Land use planning may help conserve habitats.

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Preamble

In the preparation of this report, an effort was made to find sources of Aboriginal traditional knowledge, community knowledge and scientific knowledge. It became apparent that little documented traditional or community knowledge is available for western toad. Therefore, this report is based almost exclusively on scientific knowledge.

Names and classification

Scientific Name:	*Anaxyrus boreas* Baird and Girard, 1852
Common name used in this report:	Western toad
Other names:	ts'ahle or ts'ahli for frog, and ts'ahle cho or ts'ahli cho for big frog (South Slavey) (South Slave Divisional Education Council 2009); northwestern toad; boreal toad; crapaud de l'ouest (French)
Population	Non-calling population (COSEWIC 2012)
Synonym:	*Bufo boreas* Baird and Girard, 1852
Class:	Amphibia
Order:	Anura (frogs and toads)
Family:	Bufonidae (true toads)
Life Form:	Vertebrate, amphibian, toad

Systematic/Taxonomic Clarifications

Frost *et al*. (2006) proposed that North American toads of the genus *Bufo* be placed in a separate genus, *Anaxyrus* (see also Frost *et al*. 2008). This proposal was challenged by Pauly *et al*. (2009), who suggested that the change is unnecessary as no new clades were described (a clade refers to species derived from a common ancestor). Pauly *et al*. (2009) recommended that the previous scientific names of the New World clade of true toads be restored. The *Anaxyrus* nomenclature has been accepted though by Crother (2012).

The western toad has two recognized subspecies. *Anaxyrus boreas boreas*, the boreal, northwestern or western toad, is found from northern California, Nevada, Utah, Colorado and

New Mexico north through Canada and Alaska. This is the subspecies found in the NWT. *A. boreas halophilus*, the southern California toad, ranges from California to Baja California (Mexico) and western Nevada. It appears that rapid colonization of the Canadian range of the western toad, combined with a high capacity to disperse, has resulted in limited genetic structuring in Canadian populations (Goebel *et al*. 2009). Goebel *et al*. (2009) recommended a taxonomic revision of the *Anaxyrus boreas* species group using nuclear DNA and morphological characteristics. A rearrangement of the taxonomy would not affect the subspecies found in Canada.

Pauly (2008) described behavioural and morphological uniqueness of western toads in Alberta, where males possess a vocal sac and give loud advertisement calls. A zone of overlap between males with and without vocal sacs occurs in western and northwestern Alberta (Pauly 2008). COSEWIC (2012) recognizes two discrete and evolutionarily significant units (Designatable Units) based on Pauly's (2008) findings: a "Calling Population" in much of Alberta, entering BC in the Rocky Mountains, and a "Non-Calling Population" in northern Alberta, BC, the Yukon and NWT. Recent research suggests that the "Calling Population" of Alberta continues to expand, as western toads are now being discovered in the northeastern part of the province (Paszkowski pers. comm. 2014). Phylogenetic analyses of a multilocus nuclear sequence dataset may show further variation between Alberta populations and other populations of western toads to perhaps the species level (Pauly pers. comm. 2011).

Amplexus (a mating embrace) has been observed between mismatched pairs of the western toad and Canadian toad (*Anaxyrus hemiophrys*) in west-central Alberta (Cook 1983; Eaton *et al*. 1999). One hybrid was identified by Cook (1983) based on morphology. The viability and fertility of hybrids are unknown, but these factors presumably contribute to reproductive isolation of the two species along with the low abundance of one of the two species in the zone of overlap (Eaton *et al*. 1999). Pauly (2008) found no evidence of gene flow between the two species in Alberta. The known ranges of the western toad and Canadian toad do not overlap in the NWT.

Description

Throughout this document the term "metamorph" refers to a small toad, or toadlet, that has recently developed from a tadpole. A "juvenile" toad has lived through at least one winter, but is not yet a mature adult.

The western toad is a large toad with small round or oval glandular protuberances or "warts" on the back, sides and upper portions of the limbs (Figure 1, p.5; Russell and Bauer 2000; Matsuda *et al*. 2006). Large oblong parotoid (skin) glands are situated behind the eyes. Colour is typically brown or green but varies from olive green to almost reddish-brown or black. There is a creamy or white vertebral stripe running from snout to vent, which is sometimes broken or nearly absent. The warts and parotoid glands are often reddish-brown and may be encircled by a ring of dark pigment. These structures are poison glands that excrete a noxious white liquid to deter predators. The throat and belly are pale with dark mottling. There is a grey pelvic patch in the groin area that is used to absorb moisture from the ground. The pupil is horizontal and cranial crests are weakly developed. The limbs are relatively short and the hind toes are partially webbed. Toads move on land by walking and hopping. Horny tubercles on the hind feet are used for digging backwards into the ground.

Figure 1. Western toad adult 20 km southwest of Fort Liard, near the Liard River, NWT (photo courtesy of Floyd Bertrand) (September 24, 2009).

Adult males outside the NWT are 60 to 110 millimetres (mm) in snout-vent length and weigh up to 80 grams (g). Females are larger, reaching 75 to 125 mm in length and weighing up to 115 g. Adult western toads in the north tend to be smaller, with males reaching about 65 to 92 mm and weights up to 71 g and females reaching 82 mm and 55 g (Slough 2004; Slough unpubl. data 2004, 2007, 2010; Schock 2009).

Male western toads are distinguished from females by the presence of nuptial pads on their thumbs and first two toes of the forefeet during the breeding season (usually in late May – early June), longer forelimbs, narrower heads, and less prominent or discontinuous mid-dorsal stripes (Carstensen *et al*. 2003; Matsuda *et al*. 2006). Males give release calls or advertisement calls as described below.

Western toad eggs are black and are laid in long, intertwined paired strings in shallow margins of lakes and ponds. Tadpoles are jet-black or charcoal in colour and range from nine to 42 mm total length. Recent metamorphs are about 12 to 22 mm snout-vent length and weigh up to 0.5 g (Slough unpubl. data 2012).

In the Non-calling Population found in the NWT, the release call of the male, a quiet series of chirps like the peeping of a chick (Russell and Bauer 2000), can be elicited by gently grasping the thoracic region behind the forelimbs. The release call prevents prolonged amplexus with other males, but it may also be emitted without tactile stimulation. It is not known whether the latter call is a signal to other males or if it has some other purpose such as advertisement to females. True advertisement calls consist of relatively long and high-amplitude pulsed trills and have been documented throughout much of Alberta in the Calling Population (Pauly 2008, Long 2010).

Distribution

Global distribution

The western toad ranges from coastal Alaska and northwestern Canada in the north to Baja California, Mexico in the southwest and northern New Mexico, Colorado, and Wyoming in the east. This range includes most of BC to the Yukon border (Matsuda *et al*. 2006; Friis and Leaver unpubl. data 2007), southeast Yukon (Slough and Mennell 2006), southwest NWT in the Liard River basin (Environment and Natural Resources (ENR) 2006; Schock *et al*. 2009; Wilson and Haas 2012), and Alberta (Russell and Bauer 2000) (Figure 2, p.7). Apparent gaps in distribution occur in northeast BC (Matsuda *et al*. 2006) and much of northern Alberta (Russell and Bauer 2000).

In Alberta, the western toad ranges from the forested regions of the southwest to the central and northern parts of the province. Based on widely separated occurrence records (Figure 2, p.7), the distribution in northern Alberta may be more extensive than currently documented, but lack of access has hindered survey efforts (Russell and Bauer 2000; Paszkowski pers. comm. 2012). The range of the western toad overlaps that of the Canadian toad in east-central Alberta. The western toad appears to be expanding its range eastward in northern Alberta to areas where the Canadian toad has declined (Browne *et al*. 2003).

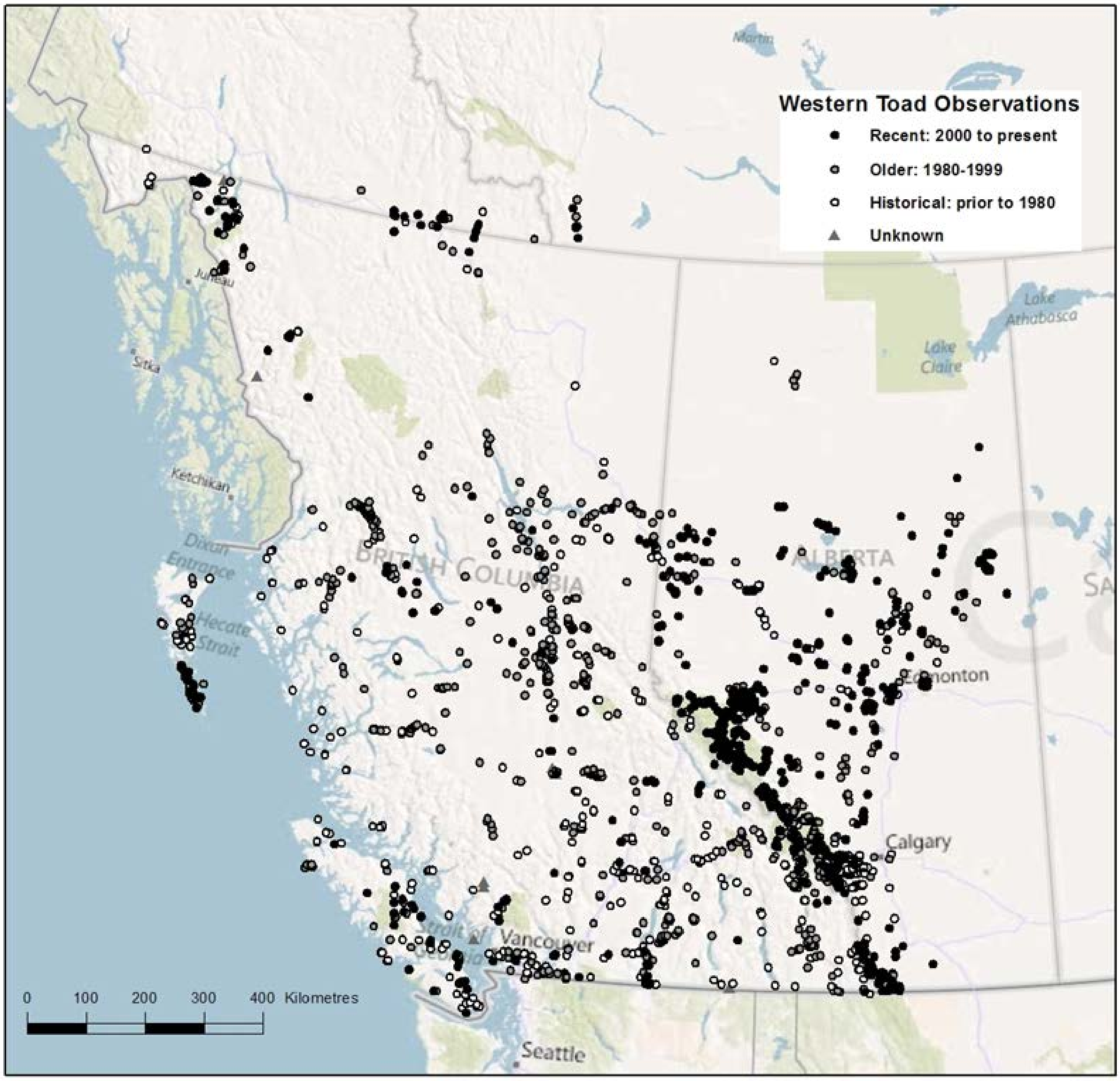

Figure 2. Approximate distribution of the western toad in Canada. Reproduced with permission from COSEWIC (2012).

NWT distribution

The western toad's known range in the NWT is limited to the Liard River basin south of Nahanni Butte, in the Dehcho Region (Figure 3, p.9). This population is likely continuous with upstream populations in the Yukon and BC. The northernmost confirmed occurrences in the NWT are about 80 km north of the BC border. Occurrence records are summarized in Appendix A, p.50.

Western toads in the NWT are known to occur in the Taiga Plains ecozone (Level II ecoregion) in the Taiga Plains Mid-Boreal ecoregion (Level III) (Ecosystem Classification Group 2007 (rev. 2009)). The confirmed observations (records or observations with documentation or other evidence that provide a reasonable degree of confidence in the accuracy of the record) occured in the Liard Upland Mid-Boreal and Liard Plain Mid-Boreal ecoregions (Level IV) (Figure 3, p.9). These are the warmest ecoregions in the NWT and are biologically very productive. Further north, the western toad may occur in the South Mackenzie Plain Level IV Mid-Boreal ecoregion, and possibly the Nahanni-Tetcela Valley High Boreal Ecoregion (in the Boreal Cordillera Mid-Boreal Level III ecoregion); however, there are no confirmed observations in these areas.

There are 15 confirmed observations of western toads from six localities in the NWT (Appendix A). The localities are all near the Liard Highway and Liard River, between 12 and 80 km from the BC border. The observations are relatively evenly spaced between 14 and 29 km of their nearest neighbours. There are eight observations within 850 m of each other at one locality near the Muskeg River.

There are unconfirmed reports of western toads at Yohin Lake in the southeast corner of the Nahanni National Park Reserve and at Nahanni Butte (Parks Canada 1984; Tate pers. comm. 2012). These are 57 and 37 km, respectively, from the nearest confirmed toad observation, just east of the Flett rapids. A specimen was also apparently collected by Preble in 1897 at Fort Simpson; however, for the various reasons given by Fournier (1997) the location is suspect. Fort Simpson is 164 km downstream from the nearest confirmed toad observation.

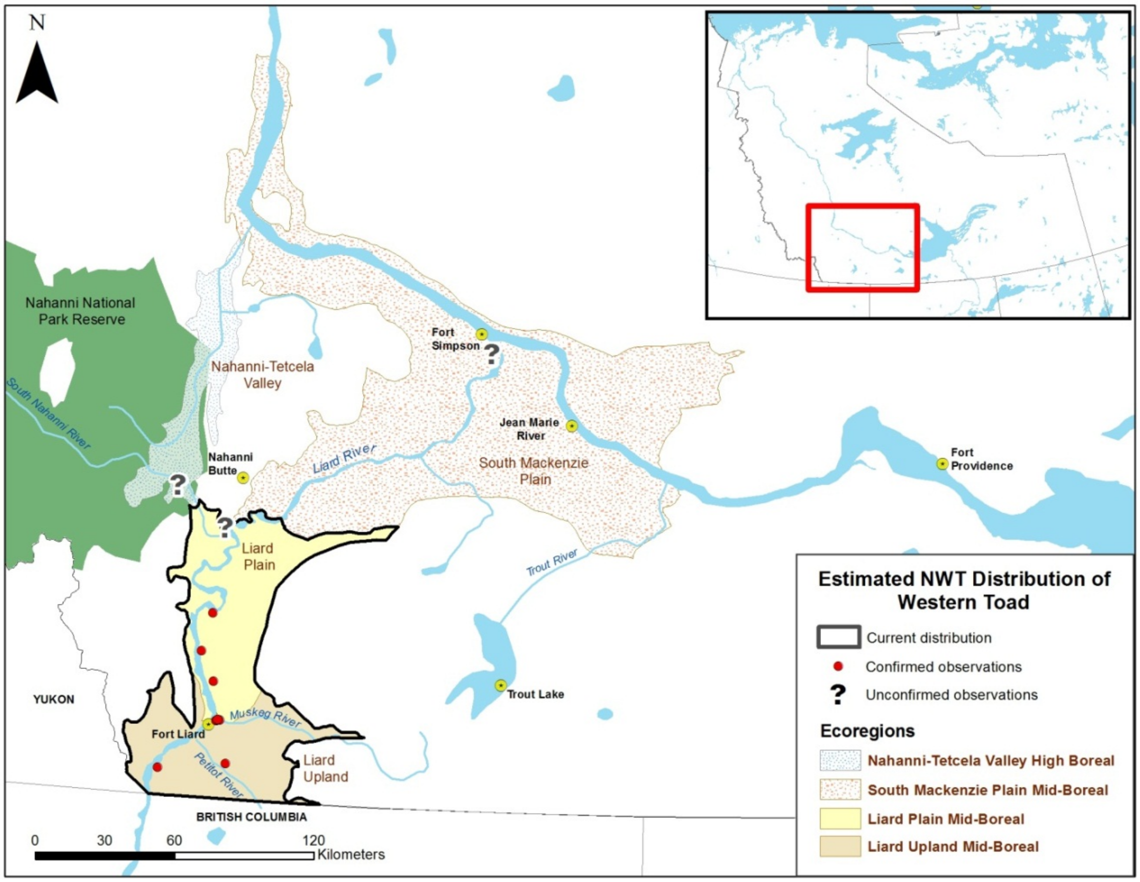

Figure 3. Distribution of the western toad in the Northwest Territories. Map prepared by Michelle Henderson & Bonnie Fournier, Northwest Territories Department of Environment and Natural Resources. Data provided by Department of Environment and Natural Resources (unpubl. data 2014).

Although there are only six known localities, given the lack of search effort and the western toad's capacity to undertake movements of at least up to 15 km, especially along water courses, it is assumed that western toads could likely occur across much of the Liard Plain and Liard Upland Mid-Boreal ecoregions (encompassing 6,297 km^2). As such, Extent of Occurrence (EO) was calculated by connecting the outer edges of the Liard Plain and Liard Upland Mid-Boreal ecoregions as a minimum convex polygon. The EO calculated this way is 11,655 km^2. EO is defined by SARC (SARC 2013) as the area included in a polygon without concave angles that encompasses the geographic distribution of all known populations of a species in the NWT.

'Area of occupancy' (AO) as defined by SARC is the area within the extent of occurrence that is occupied by a species, excluding cases of vagrancy. This measure reflects the fact that the extent of occurrence may contain some unsuitable or unoccupied habitats. The AO is measured both as an estimate of the actual area occupied ("biological occupancy") and as an index of area of occupancy (IAO), which uses a scale-correction factor to standardize this estimate across different spatial scales (SARC 2013). As suitable habitat for western toad is considered to encompass both the Liard Plain and Liard Upland Mid-Boreal ecoregions, the AO can be considered to be 6,297 km^2 (the area of the two ecoregions). The IAO is measured as the surface area of 2 x 2 km grid cells that intersect the known occurrences, and is 32 km^2.

Locations

'Location' is defined by the Species at Risk Committee (SARC) (2013) as a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the species present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a species is affected by more than one threatening event, location should be defined by considering the most serious plausible threat (SARC 2013). There is one western toad 'location' in the NWT, based on the limited distribution and the most probable threat - disease - which is global in nature and may spread rapidly across all sub-population in the NWT (see *Threats and Limiting Factors*, p.21).

Search effort

The range of the western toad in the NWT is poorly understood, since this region has received little survey effort. All confirmed observations are along the Liard Highway and Liard River, which are arbitrary transects through potentially suitable western toad habitat. There is little doubt that the species has a more extensive distribution in the NWT than is shown in Figures 2 and 3 (p.7 and p.9) (Russell and Bauer 2000; COSEWIC 2012).

Dedicated amphibian population and pathogen surveys in the Dehcho (28 sites surveyed in 2007; 40 sites surveyed in 2008) and Sahtu (19 sites surveyed in 2007) regions in 2007 and 2008 detected western toad presence at two sites in the Dehcho, including one pond where tadpoles were found both years (Schock 2009). The Dehcho sites visited in 2007 ranged from Fort Liard to Fort Simpson, and west to Nahanni Butte and the Nahanni National Park Reserve in the Yohin Lake area. The 2008 Dehcho surveys were in the areas of Fort Liard, Fort Simpson, Jean Marie River and Wrigley, and the South Nahanni River from Kraus Hot Springs to the park boundary. In the Sahtu region, surveyed sites were all in the Norman Wells area.

Sites were accessed primarily by road. Boats and helicopters were also used. The surveys used a typical visual encounter survey technique for the various life stages, which involves searching terrestrial habitats, and searching and dip-netting of wetlands and other suitable habitats (Thoms *et al*. 1997). An attempt was made to quantify abundance in terms of numbers of individuals encountered per unit of search time, but there were insufficient data to apply this technique to western toads (Schock 2009).

There have been no other dedicated amphibian surveys in or near the known range of the western toad in the NWT. Parks Canada monitors a research node of the Terrestrial Wetland Global Change Research Network in Nahanni National Park Reserve (Tate pers. comm. 2012). The research includes automated remote sound recordings at amphibian breeding habitats to document species present and to assess the size of the breeding population. These recordings have not been analyzed (Sadinski pers. comm. 2012). Amphibian surveys in the La Biche River valley in BC and Yukon, immediately west of the NWT border, did not result in western toad observations (Slough unpubl. data 1999, 2004). Western toads were found on the Beaver River and on more westerly Liard River tributaries in BC and Yukon (Slough 2005; Slough and Mennell 2006). Four observations recorded between 1994 and 2009 were collected opportunistically from Fort Liard.

Biology and behaviour

Habitat requirements

The western toad has three primary habitat requirements: aquatic habitat, for breeding, egg laying and tadpole development; foraging habitat; and hibernating habitat. These habitats, often in close proximity, must be connected by suitable corridors. Western toads show strong site fidelity (up to 90%) to sites used seasonally and/or annually for breeding, summer foraging and hibernation (Browne and Paszkowski 2010a; Palmeri-Miles 2012).

Micro-sites providing thermal or protective cover and moist soil patches are repeatedly used (Carpenter 1954; Jones and Goettl 1998; Davis 2000; Bartelt *et al*. 2004; Long and Prepas 2012). These micro-sites (refugia) likely represent habitat critical to the western toad (Long and Prepas 2012).

Typical breeding sites include shallow, sandy or silty margins of lakes, ponds, streams, rivers, stream deltas, river backwaters, floodplain marshes and geothermal springs. Human-made habitats such as ditches, road ruts, tailings ponds, and borrow pits are also commonly used (Jones *et al*. 2005; COSEWIC 2012). The only three known breeding sites in the NWT were in a gravel pit, all in close proximity (Schock 2009). Beaver (*Castor canadensis*) ponds are used extensively for breeding in the northern part of the western toad's range in BC, Yukon and Alberta (Slough and Mennell 2006; Stevens *et al*. 2007). Water depths up to two metres may be used for oviposition (laying eggs) (Olsen 1989), but shallow water (10 cm – one metre) is preferred (Corn 1998). Browne *et al*. (2009) found a positive correlation between western toad abundance and locally higher water temperatures (r = 0.299), as well as a very weak correlation between western toad abundance and local sites with higher dissolved oxygen (r = 0.067). Although Browne *et al.* (2009) don't include specific temperatures for reference, their finding is consistent with Holland (2002), who noted a difference in local mean water temperature between breeding and non-breeding sites of 13.4ºC (CI = 11.6, 15.1) and 11.0ºC (CI = 8.5, 13.5), respectively. Given that egg and larval development are dependent upon water temperature (Herreid and Kinney 1967 *in* Holland 2002), this is to be expected. Low numbers of bird and mammalian predators may also be a key feature of breeding sites (Ultsch *et al*. 1999). Permanent water bodies are usually preferred over ephemeral ponds, which may dry up in times of drought before metamorphosis. Breeding sites must also be near suitable hibernation and foraging sites. Man-made ponds may be used but since they are typically near roads can result in the road kill of large numbers of breeding adults or dispersing metamorphs. Some human-made habitats may attract breeding individuals but can result in wasted reproductive effort and a negative effect on population persistence (Stevens and Paszkowski 2006). Water may be clear or silty (Storer 1925; Slough and Mennell 2006). Breeding sites are sometimes extremely open and unprotected by vegetation, woody debris, rocks or undercut banks (Stevens and Paszkowski 2006). In Montana, western toads preferred recent burns where they increased their breeding activity (Guscio *et al*. 2008), providing further evidence of use of open terrestrial habitats. Hossack and Corn (2007) found that western toads were resistant to wildfire and benefited over the short-term by colonizing wetlands after burns.

Western toads exhibit breeding site fidelity, returning to the same wetlands in successive years (Bull and Carey 2008). Western toads show explosive breeding (breeding in large temporary groups) at communal breeding sites, where adults aggregate over a one to two week period, to ensure reproductive success. Aggregate breeding reduces energy costs associated with pair-bonding. It also takes advantage of a brief summer and temporary breeding ponds for metamorphosis, and ensures genetic mixing (Myers and Zamudio 2004). Site fidelity and communal breeding may result in the selection of only one or a few of many potential breeding sites in a given area (e.g., Slough 2004). However, ponds not used for breeding may be used for summer foraging.

Western toad tadpoles aggregate in warm shallow margins of waterbodies during the day, a behaviour that accelerates their rate of development and provides cover from predators in shoreline vegetation (Browne *et al*. 2009). They may disperse to deeper waters at night (Livo 1998).

Following breeding, adults may remain to forage in the marshy or riparian edges of breeding sites, or they may disperse up to several kilometres to other wetlands, riparian areas along streams, or upland sites such as forests, meadows, shrub lands, or subalpine or alpine meadows. Females tend to travel further to reach foraging grounds (Muths 2003; Bartelt *et al*. 2004; Bull 2006; Browne 2010). Males are more closely associated with water and move shorter distances (Bull 2006). In the boreal mixed wood forest of Alberta, Macdonald *et al*. (2006) found that western toads were more abundant in forests less than 100 metres (m) from lakes than they were 400-1,200 m away. Open, warm areas with abundant prey were selected in Alberta during the pre-hibernation season in boreal forest and aspen parkland sites (Browne 2010). Closed deciduous forest cover was preferred in the boreal region. Low shrub cover was avoided during the foraging season (Browne *et al*. 2009). Clearcuts and edges of clearcuts are used by western toads depending on the seasonal risk of desiccation (Ward and Chapman 1995; Gyug 1996; Davis 2000; Deguise and Richardson 2009a).

At a smaller scale, western toads seek overhead cover, such as shrubs, dense herb layers, coarse woody debris, boulders or mammal burrows for protection from desiccation and predation (Davis 2000; Bartelt *et al*. 2004). They may also dig shallow scrapes or their own burrows in loose soils such as sand (Bull 2006).

The western toad is not freeze-tolerant (Browne and Paszkowski 2010a). Western toads hibernate underground, below the frost line to prevent freezing, and near water to prevent desiccation. Temperature in hibernacula in Washington remained above freezing despite air temperatures of -21°C (Palmeri-Miles 2012). In Alberta, western toads used cavities in peat hummocks, red squirrel (*Tamiasciurus hudsonicus*) middens, natural crevices, decayed root channels, cavities under spruce trees, abandoned beaver lodges, and muskrat (*Ondatra zibethicus*) tunnels for hibernation (Browne and Paszkowski 2010a). These sites were in a wide variety of forested and unforested (shrub land, marsh and meadow) habitats, but there was strong selection for spruce forests. Most (68%) hibernacula were communal and could be up to 2 km from breeding sites. Larger toads arrived at hibernation sites later and along straighter routes than smaller toads, suggesting that they had superior navigation skills or sufficient energy or water reserves to accomplish rapid and longer movements (Browne and Paszkowski 2010b). In Oregon, hibernation sites were up to 6.2 km from breeding sites and were in rodent burrows, under large rocks, logs or root wads, or under stream or lake shore banks (Bull 2006). Montane populations in Colorado used upland areas near seeps, stream banks, and mammal burrows (Jones *et al*. 1998).

It has been suggested that early deep snow accumulation, providing insulation for hibernating sites, is a requirement for survival of western toads in northern BC (Cook 1977). The northern limit of the species in BC and the Yukon corresponds with deep snow regions of the coast and Rocky Mountains and the presence of geothermal springs (Slough and Mennell 2006). There is little information on range limiting factors in the NWT.

Movements

Summer home ranges were 0.01 km^2 or smaller on Vancouver Island (Davis 2000) and up to 0.43 km^2 in Washington (Palmeri-Miles 2012). Muths (2003) found that mean home ranges of males in Colorado were 0.58 km^2 (maximum 2.64 km^2), while those of females were 2.46 km^2 (maximum 7.02 km^2). Long and Prepas (2012) calculated total 'activity centre' areas (the habitat most frequently used by the species). They found that these areas were 0.57 ± 0.06 hectares for males and 0.55 ± 0.07 hectares for females observed in the Boreal Plains ecozone of Canada. The greatest seasonal movement between a breeding site and summer home range was 0.97 km by a male and 2.3 km by a female (similar to 0.94 and 2.44 km, respectively, found by Bartelt *et al*. (2004) in Idaho). Adams *et al*. (2005b) reported that western toads used streams to move within home ranges in Montana. The largest in-stream movement was 1.5 km in six days and maximum movement rates were over 500 m/day. In Alberta, western toads moved overland at rates of over 782 m in two days (Browne *et al*. 2004). Palmeri-Miles (2012) documented movement between seasonal ranges of up to 3.1 km in Washington. Maximum movement rates were 1.4 km in a week and 2.0 km in a month.

Western toads are capable of directional long-distance dispersal movements (up to 7.2 km in 24 hours along watercourses in spring on Vancouver Island (Davis pers. comm. 2004)). Schmetterling and Young (2008) documented movements of up to 13 km in less than six weeks. Adult western toads are frequently found across the landscape, often far from known breeding sites. In studies in northwestern BC (Mennell and Slough 1998; Slough 2004, 2005), adult toads were found along lake and stream corridors and in upland sites throughout the region up to 30 km from known breeding sites. Western toads have been found in dry uplands and high alpine passes in northern BC (Cannings pers. comm. 2010; Barichello pers. comm. 2010). Recent clearcuts under 0.05 km^2 in size were not impediments to movements by western toads in spring (Deguise and Richardson 2009a). However, larger clearcuts, and smaller clearcuts later in summer when temperatures are relatively high, may be inhospitable to western toads (Deguise and Richardson 2009a).

Movements and habitat use by juvenile western toads remain a large gap in knowledge. Bull (2009) studied dispersal by metamorphs and juvenile western toads in Oregon and found that metamorphs travelled up to 2.7 km from breeding sites within eight weeks of metamorphosis at an average rate of 84 m/day. Drainages were used as dispersal corridors. Juveniles were found 1.1-2.7 km from breeding sites. Dispersal distances were limited by the availability of moist habitats and by time between metamorphosis and hibernation. Davis (2000) found metamorphs within 300 m of breeding sites on Vancouver Island. Western toads in Alberta have been observed using grass/dirt roads and seismic lines, which facilitate movements (Long pers. comm. 2012).

In the southern part of their range in Canada, western toads are nocturnal (Davis 2000). At higher elevations (montane elevations between 3,000-3,355 m) and higher latitudes (Colorado versus California; where nights are cooler in summer), they are diurnal (Carey 1978; Russell and Bauer 2000). Activity patterns are likely behavioural adaptations to ambient temperatures since some toads switch from diurnal activity in spring, to nocturnal activity in summer, and back to diurnal activity in fall (Sullivan 1994). Carey (1978) notes that montane western toads likely engage in diurnal activity for a number of reasons, including the attainment of higher daytime body temperatures and improved access to prey species that are primarily diurnal. In contrast, Long and Prepas (2012), who studied western toads in the Boreal Plains ecozone of Canada, assumed nocturnal behaviour, based on the results of Forester *et al*. (2006) (study based on American Toads (*Bufo americanus*) in Maryland, U.S.). It is unknown whether western toads in the NWT are diurnal or nocturnal.

Life cycle and reproduction

Western toads congregate to breed in the spring, when minimum and maximum temperatures rise above 0°C and 10°C, respectively (Okanagan Highlands; Gyug 1996) or shortly after ice breakup (late April to late May in northwestern BC; Slough and Mennell 2006). Toads in central Alberta began calling on a hot, windless day in mid-May (Long pers. comm. 2012). At Elk Island National Park, they began calling in mid- to late May and extended into June (Browne pers. comm. 2012). Western toad calling was observed April 19-May 14 in Jasper National Park (Shepherd and Hughson 2012). Toads at the Atlin Warm Springs of northwestern BC breed in late-February – early March (Slough and Mennell 2006). Thompson (2004) also reported early breeding at warm springs in Utah, where one of the populations did not hibernate.

There are no data on breeding dates for the western toad in the NWT, but based on the relatively advanced stage of tadpole development observed June 25-26, 2007 and June 18-19, 2008 in ponds in the Muskeg River gravel pit (Schock 2009), breeding must have occurred in late May or earlier.

Eggs are laid communally in long, intertwined paired strings on vegetation or branches, or at the bottom of the shallow margins of lakes and ponds. Tadpoles hatch in 3-12 days, depending on water temperature (Hengeveld 2000; Jones *et al*. 2005). Western toad tadpoles are gregarious, taking advantage of the dilution effect on predation, where it is less likely that any given individual in an aggregation will be preyed upon (Dehn 1990). The period from egg to metamorphosis takes 4-12 weeks, depending on water temperature. Metamorphosis is usually complete by late July or early August. Metamorphosis was near completion in June 2007 in the NWT (Schock 2009), so an early July metamorphosis date can be extrapolated. Tadpoles have been observed into the late summer and fall at some northern sites, but their survival is doubtful (Slough pers. comm. 2012). There are no reports of overwintering of tadpoles.

Metamorphs form aggregations following metamorphosis, possibly to reduce predation, prevent desiccation (especially when they are unable to disperse due to dry habitat conditions (Livo 1998)), and raise body temperatures (Black and Black 1969). Western toad aggregations at any life stage are vulnerable to predation or other agents of mass mortality such as disease, desiccation, trampling, or collisions with vehicles (Bartelt 1998).

Physiology and adaptability

Western toads are ectotherms, exchanging heat with their surroundings rather than producing body heat internally. Western toads thermoregulate behaviourally, by moving among habitats or micro-sites with suitable ambient temperatures, by basking, and by evaporative cooling from the skin and lungs (Stebbins and Cohen 1995). Western toads are not normally active if their body temperatures are below 3.0°C or above 29.5°C (Brattstrom 1963; Davis 2000). This wide thermal tolerance allows western toads to exploit a wide range of habitats.

Western toads are moderately resistant to desiccation with relatively dry, thick, warty skin on their backs (Stebbins and Cohen 1995). Western toads reached a critical activity point, losing the ability to right themselves, when dehydrated to 41.4% of their initial hydrated body mass (Hillman 1980). Western toads are frequently found far from standing water in relatively dry habitats, but moist micro-sites are required for rehydration. Metamorphs and smaller juveniles have a higher surface area to volume ratio than adults, making them more vulnerable to desiccation (Livo 1998).

Interactions

Interspecific Interactions

Western toad tadpoles eat filamentous algae (pond scum) and organic detritus (decomposing animal waste and the bodies of insects and other small organisms) and opportunistically scavenge carrion. Adult western toads are primarily ambush predators and feed on a wide variety of invertebrates including worms (Clitellata), slugs (Gastropoda), spiders (Arachnida), bees and ants (Hymenoptera), beetles (Coleoptera), grasshoppers (Orthoptera), caddisflies (Trichoptera), moths and butterflies (Lepidoptera), flies (Diptera), and true bugs (Hemiptera) (Sullivan 1994; Jones *et al*. 2005; Bull 2006; Bull and Hayes 2009).

Predators of western toad eggs are largely unknown. In the true toad family (Bufonidae), antipredator bufotoxin is deposited in the eggs before it develops in the embryos and tadpoles, although the concentration diminishes over time (Brodie *et al*. 1978). Western toad tadpoles have been known to prey on other frog tadpoles, including their own species, during times of high tadpole densities and scarce food resources associated with low water levels (Jordon *et al*. 2004).

Western toad tadpoles recognize predators primarily through chemical cues given off by the predators (Kiesecker *et al*. 1996). Anti-predator behaviours include foraging in aggregations (Brodie and Formanowicz 1987), decreased movements and the use of shelter (Kiesecker *et al*. 1996). Western toad tadpoles possess bufotoxins and are unpalatable to fish (Formanowicz and Brodie 1982, Kats *et al*. 1988). However, they are consumed by birds, including common ravens (*Corvus corax*), spotted sandpipers (*Actitis macularius*), mallards (*Anas platyrhynchos*) and likely other species of waterfowl, and invertebrates (backswimmers, *Notonecta* spp. and giant waterbugs, *Lethocerus americanus*) (Olson 1989; Jones *et al*. 2005). In Colorado, predaceous diving beetle larvae (*Dytiscus* spp.) had a greater impact on western toad tadpoles than did adult beetles and other predators. Predaceous diving beetles occur throughout the range of the western toad (Livo 1998).

Western toad abundance was not affected by the presence of native or non-native fish in lakes in the foothills of Alberta (Schank 2008); however, McGarvie Hirner and Cox (2007) found higher western toad abundance in lakes with rainbow trout (*Oncorhynchus mykiss*) than in lakes without trout in the southern interior of BC. The presence of fish may help to depress the abundance of invertebrate tadpole predators (Eaton *et al*. 2005; McGarvie Hirner and Cox 2007).

Western toads are particularly vulnerable to predation by birds when they are transforming or newly metamorphosed (Gyug 1996). Synchronous metamorphosis and aggregation may be anti-predator adaptations that tend to satiate predators during this vulnerable period. Devito *et al*. (1998) found that metamorphosis occurred earlier (at a smaller size) when tadpole density was higher, and more synchronously in the presence of a predator. Emergence at a smaller size may compromise long-term survival (Berven 1990).

Adult and juvenile western toads excrete bufotoxin, among other amines and alkaloids, from their parotoid glands (warts) to deter predators. However, many species of birds, mammals, and amphibians; including ravens, coyotes (*Canis latrans*), and red foxes (*Vulpes vulpes*), prey on them (Olson 1989; Jones *et al*. 2005). Other predators in the NWT, such as mink (*Mustela vison*) and river otter (*Lontra canadensis*) likely prey on western toads as well. Many predators eviscerate toads to avoid their toxic skin. The highest predation pressure on adult toads occurs at breeding aggregations when they are exposed in shallow water (Olson 1988).

Diseases, parasites and invasive species are discussed under *Threats and Limiting Factors*, p.21+.

Population

Abundance

The western toad is apparently widespread, abundant and persistent across most of its Canadian range (COSEWIC 2012), but little information exists on population sizes or densities, and few populations have been systematically monitored. Large breeding populations, tadpole aggregations, and post-metamorphic aggregations are frequently reported. Aggregations of metamorphs are often reported in the tens to hundreds of thousands (e.g., Hawkes and Tuttle 2010; Hawkes *et al*. 2011). Large aggregations have been observed near Telegraph Creek, BC (57°55'N). The western toad is not as abundant north of 58°N where aggregations of tadpoles and metamorphs are typically in the 500 to 5,000 range (Slough 2004, 2005, 2009). Tadpole aggregations of 200 to 500 have been reported in the NWT. Aggregations of metamorphs or breeding adults have not been reported in the NWT. The small tadpole aggregations in the NWT are likely evidence of small breeding populations.

The abundance of western toads in the NWT is unknown and can only be crudely estimated. The number of site occurrences (n=6) can be used to estimate minimum breeding populations. Given the limited search effort, and inherent difficulties in surveying a low density and cryptic species, there are likely many undiscovered breeding populations.

The adult western toad population in the NWT is unknown. Based on expert opinion (Carrière pers. comm. 2014) and biological information in this report, a population estimate for the number of mature individuals in the NWT is between 200-8,000 if females have small to average clutches, egg survival is poor to average, and there are 50-100 sites . The population of the western toad in Canada was not estimated by COSEWIC (2012), but it is believed to be well above the IUCN threshold of 10,000.

Trends and fluctuations

Detecting trends in amphibian numbers requires long-term data, because amphibian populations are characterized by inherent fluctuations and are vulnerable to random events (Marsh and Trenham 2001). Western toads are vulnerable to events occurring at sites where individuals are concentrated, such as breeding sites (adults, eggs, tadpoles and metamorphs) and terrestrial migration routes to and from breeding sites. Random events such as freezing temperatures or drought can have major impacts on cohorts or even an entire population, resulting in local extirpation. Mass mortality of adults and metamorphs migrating to and from breeding sites is relatively common near transportation corridors, including roads and trails (COSEWIC 2012).

Single surveys can greatly bias apparent trends (Skelly *et al*. 2003), and restricting surveys to historic breeding sites does not distinguish between population losses and site-switching (Petranka *et al*. 2004, Pearl *et al*. 2009b) or the occupation of new habitats (Wente *et al*. 2005). However, site-switching may not occur often with western toads, which exhibit high breeding site fidelity (see the section on *Habitat requirements*, p.11).

Western Toat populations in Canada are believed to be stable or increasing, although some apparent declines or fluctuations have been observed (COSEWIC 2012). Much of the data from the Canadian range of the western toad, including the NWT, are short-term and insufficient to detect population trends. The only repeated survey of breeding sites in the NWT occurred in man-made habitats over two consecutive years (Schock 2009). No traditional or community knowledge on population trends was available for this report.

Population dynamics

Pond breeding amphibians such as the western toad are assumed to have strong breeding site fidelity, high vagility (ability to move) within home ranges, limited dispersal abilities, and spatially disjunct breeding sites (Smith and Green 2005). The dispersal ability of western toads, however, appears to be relatively high among amphibian species (see the section on *Movements*, p.13). Natural breeding sites are not known in the NWT but are likely widely separated, based on the wide separation of adult toad observations. Known breeding sites were separated by distances of up to 30 km in northern BC (Slough 2004). As a result, the breeding populations exchange migrants, may be subject to local extinction and recolonization, and may form metapopulations (Marsh and Trenham 2001; Smith and Green 2005). Local and regional population persistence depends on breeding site distribution and connectivity, which are currently unknown in the NWT.

Key life history parameters are not known for northern western toad populations. Body size appears to be smaller in northern BC, Yukon and NWT (Slough 2004, unpubl. data; Schock 2009) (up to 85 mm), compared to southern BC and the U.S. (up to 110 mm for males and 125 mm for females (Black 1970; Matsuda *et al*. 2006)).

Male western toads reach sexual maturity at three-four years of age and live up to 11 years (Olson 1988; Carey 1993; Blaustein *et al*. 1995; Matsuda *et al*. 2006). Male toads from pasture and forest populations in Alberta reached six years of age (Paszkowski pers. comm. 2012). Males may mate more than once per season. Five to 35% of males bred in consecutive years, resulting in a male-biased sex ratio at breeding sites that ranges from 1.5:1 (Olson *et al*. 1986) to 20:1 (Muths and Nanjappa 2005).

Females reach sexual maturity at four-six years of age and live up to nine years (Olson 1988; Carey 1993; Blaustein *et al*. 1995; Matsuda *et al*. 2006). Female toads in Alberta reached eight years of age (Paszkowski pers. comm. 2012). Only about five percent of females mate a second time in their lives, approximately two-four years after their first mating (Campbell 1970; Carey 1993; Olson 1988; Blaustein *et al*. 1995). Bull and Carey (2008) found that 8.5% of 844 females returned to a breeding site within five years, and 2.5% bred in two-three consecutive years in Oregon. There were no cases of consecutive-year breeding by females at high elevation sites in Oregon or Colorado (Carey *et al*. 2005; Bull and Carey 2008). In southern populations, female western toads produce clutches containing 1,200 to 20,000 eggs (Maxell *et al*. 2002); however, observations in the north suggest that smaller clutches of less than 3,000 eggs are laid (Slough 2004, 2005). Clutch size is believed to be correlated with female body size, which is related to age. The high energy costs of reproduction appear to limit most females to breed once in their lifetimes (Olson 1988). Data on breeding patterns of female toads is lacking for northern populations; nonetheless, the long time to maturity for females, and the fact that most females breed only once in their lifetime, makes northern populations especially vulnerable to threats and declines.

Western toads have their lowest survival rates during the egg, tadpole and metamorph life stages. Nussbaum *et al*. (1983) estimated that mortality rates between egg deposition and the adult life stage were 99%. Predation is the primary mortality factor. Adult mortality rates are believed to be low.

'Generation time' is defined as the average age of parents of a cohort (SARC 2013). It is greater than the age at first breeding and less than the age of the oldest breeding individuals, except in populations that only breed once. Generation time for western toads was estimated using IUCN guidelines as age of first reproduction + z* length of the reproductive period (IUCN Standards and Petitions Subcommittee 2011). Age of first reproduction was estimated as average age at maturity (3.5 years for males; five years for females), length of the reproductive period was estimated as the difference between maximum age and average age at maturity (11-3.5 = 7.5 years for males; 9-5 = 4 years for females), and z was estimated as 0.5. Using this formula, estimated generation time is 7.25 years for males and seven years for females. This has been rounded off to seven years in the *Technical Summary*, p.ix.

Possibility of rescue

The possibility of rescue of western toads in the NWT from populations upstream in BC and the Yukon is high, considering the healthy populations there, the similar habitats, the relatively high dispersal ability of the species (see *Movements*, p.13), and the ability of the toad to tolerate a relatively wide range of habitat conditions (see *Habitat requirements*, p.11). However, threats to the western toad populations in the BC and Yukon are similar to those present in the NWT.

Habitat

Habitat availability

The availability of suitable habitat for the western toad in the NWT has not been quantified. Presumably most of the reported adult toad occurrences were at summer foraging sites. The availability of summer habitats is likely not limiting western toads in this highly productive region.

Natural breeding sites are essential habitat components that are expected to be common in the Liard valley, although none have been found to date. Breeding sites may be separated by large distances, with some apparently suitable sites used for foraging but not breeding. Typical breeding sites (described in *Habitat requirements*, p.11) are no doubt available in the area.

Frost-free hibernation sites with adequate early snow cover may be a limiting factor for western toads at the northern edge of their range. The northern extent of their range in BC and the Yukon corresponds with early deep snow accumulation, and with geothermal springs (Slough and Mennell 2006).

Habitat fragmentation

Terrestrial and aquatic habitats of pond-breeding amphibians in general, including those of western toads, tend to be naturally patchy and fragmented (Marsh and Trenham 2001). Suitable habitats are often isolated from one another. The western toad is at the northern edge of its range in the NWT, where separation of breeding, hibernation and foraging sites might limit population stability and the northern extent of the range.

In addition to this natural fragmentation, the Taiga Plains ecozone has the highest density of roads in the NWT, at 0.49 km of road per 100 km² (Government of the Northwest Territories [GNWT] 2011). The main road running along the Liard River is the Liard Highway. In contrast, the road density in parts of BC where impacts on western toads (from habitat fragmentation and road kill) are cumulative to other human-related impacts (such as pollution, introduced diseases and competitors) is greater than 100 km/100 km² (COSEWIC 2012). The density of all semi-permanent linear features (including secondary roads, transmission lines and pipelines but excluding seismic lines) in the Taiga Plains ecozone is 0.75 km/100 km².

Seismic line density is 0.51 to 1.50 km/km² in the western toad's range in the Liard Valley, which is high compared to most of the NWT; this is a minimum estimate and includes coal seismic data only to 2005 (GNWTs 2011). There has been a considerable amount of oil and gas exploration and development, as well as some coal exploration activity, in the portion of the western toad's range around Fort Liard (Figure 4). Further north around Fort Simpson there are active mineral claims and prospecting permits.

Roads, trails and seismic lines alter toad habitats and represent obstacles to dispersal and migration (Fahrig *et al*. 1995; Eigenbrod *et al*. 2008). However, western toads are able to forage in and cross open areas (Long and Prepas 2012), so western toad habitat fragmentation is not believed to be a major issue. Mass mortality from road kill is by far a more serious threat caused by roads, trails and seismic lines and will be discussed under *Threats and Limiting Factors*, p.21.

Habitat trends

There is no evidence that important western toad habitat has been lost in the NWT. Landscape changes are occurring; however, the lack of information on the spatial distribution of western toad habitat in the NWT limits our ability to detect impacts. Cumulative impacts from multiple threats such as forestry, roads, seismic lines and other linear features, and active oil and gas and coal development (Figure 4, p.21) may be degrading and fragmenting western toad habitats in the NWT. The toads' ability to resist desiccation and adapt to thermal extremes mitigates some of the potential negative impacts of linear features and deforested lands.

Global climate change may have both negative and positive impacts on western toad habitats as discussed in *Threats and Limiting Factors: Climate Change*, p.26. Introduced plant species such as white and yellow sweetclover (*Melilotus alba* and *M. officinalis*), are invading western toad shoreline habitat (see *Threats and Limiting Factors: Other Threats*, p.27).

Distribution trends

There is insufficient data to determine a trend in distribution of the western toad in the NWT. The predominance of recent occurrence reports reflects the enhanced search effort.

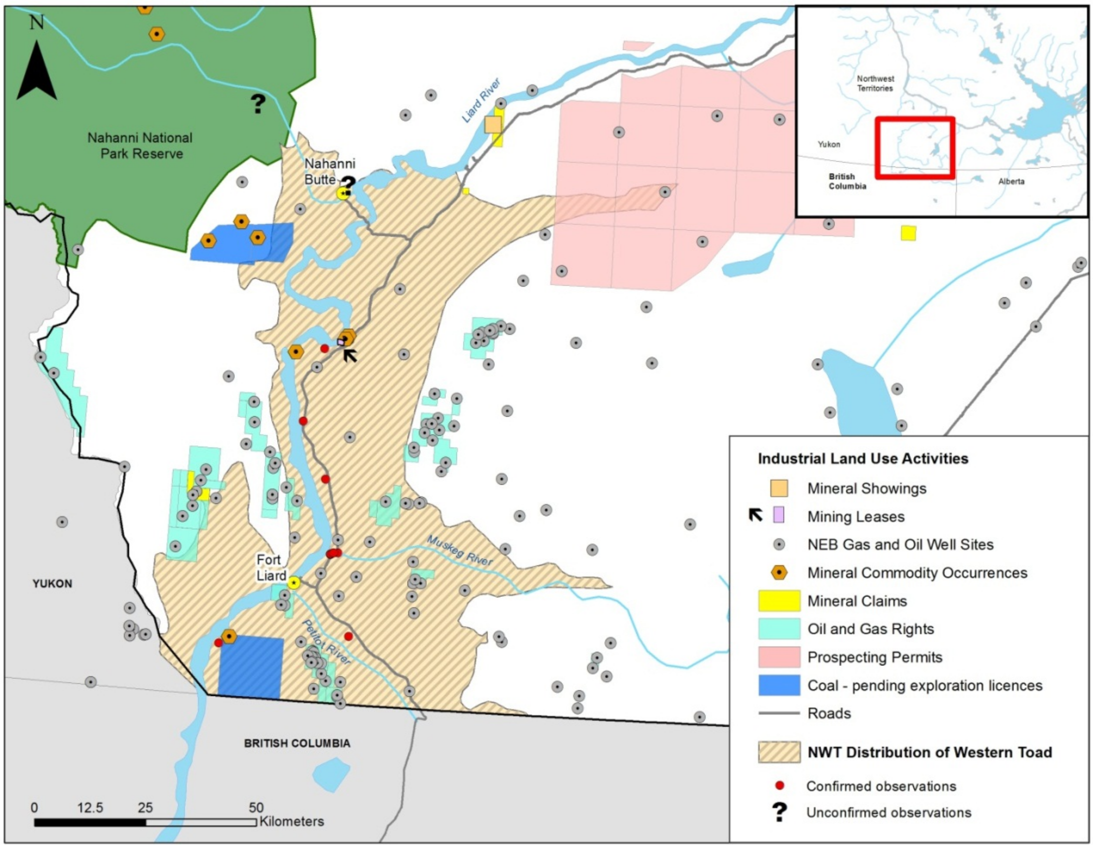

Figure 4. Industrial land use activities in the NWT range of western toad. Map created by Bonnie Fournier, Environment and Natural Resources, Government of the Northwest Territories. Data provided by Aboriginal Affairs and Northern Development Canada (2014).

Threats and Limiting Factors

Amphibians face many threats globally and are declining more rapidly than either birds or mammals (Stuart *et al*. 2004). Their reliance on aquatic and terrestrial environments and their permeable skin and exposed eggs contribute to their vulnerability. Major global threats include habitat loss, habitat fragmentation, traffic mortality, collection for food, bait, medicine and education, acid rain, chemical contaminants and pesticides, introduction of exotic species of competitors and predators, diseases transferred from non-native fish, emerging diseases, ultraviolet radiation (UV-B) (which may reduce hatching success), global climate change (which affects water levels and temperature and results in extreme weather events), or combinations of these (Daszak *et al*. 1999). The main threats to the western toad in Canada are the emerging infectious disease chytridiomycosis, habitat fragmentation and mortality associated with roads, and habitat loss due to logging, agriculture, and the oil and gas industry (COSEWIC 2012). It's important to note that the western toad's range in the NWT is at the northern-most limit of its range in the world. Even minor changes in its habitat could therefore adversely affect the species in the NWT. Threats in the NWT are discussed below.

Emerging diseases such as amphibian chytrid fungus and ranaviruses likely pose the greatest threats to the western toad in the NWT. These diseases are already present (Schock 2009; Schock *et al*. 2009). Habitat loss, degradation and fragmentation are imminent threats to western toads in the NWT but the level of impact is unknown. Our lack of knowledge of toad habitats and population trends prevents an assessment of the magnitude of this threat. The greatest threats to habitats in other parts of the western toads' range in southern Canada are localized to human population centres, agricultural areas and areas of intense development (COSEWIC 2012), none of which are present in the NWT range of the species with the exception of the small communities of Fort Liard and Nahanni Butte.

Mass mortality by vehicle collisions, a consequence of fragmentation by roads, is a threat of unknown magnitude. Climate change has potential positive and negative effects, which will increase over the coming decades. UV-B radiation is a threat of low magnitude, but it may be higher in combination with other stressors such as extreme climatic events (e.g., drought). Non-native species of plants pose very little threat at the present time. Environmental contamination and collection and harvest have not been identified as current threats.

The western toad's ability to recover from population declines may be limited because of biological factors, including the long time to maturity for females and the fact that many females may breed only once in their lifetime. Their ability to recover from declines would be further limited by naturally small and isolated populations, as are suspected in the NWT.

Emerging Diseases

Emerging diseases are current threats to western toads in the NWT. The magnitude of the impact is unknown but believed to be minor at this time. Regardless, western toads are susceptible to diseases like chytridiomycosis and ranaviral disease, which have resulted in high mortality rates and population declines elsewhere (Daszak *et al*. 1999).

A global threat to the western toad in Canada is the emerging infectious disease chytridiomycosis, caused by the fungus *Batrachochytrium dedrobatidis* (Bd). First described in the late 1990s (Berger *et al*. 1998; Longcore *et al*. 1999), the pathogen has been found in western toads as well as other amphibians across the Canadian range of the toad, including the NWT (Raverty and Reynolds 2001, Adams *et al*. 2007, Deguise and Richardson 2009b; Schock *et al*. 2009; Slough 2009; Govindarajulu unpubl. data 2011; Stevens *et al*. 2012). Slough (2009) reported Bd positive samples of western toads from five of nine sites in northwestern BC and one southeast Yukon site (Coal River, a Liard River tributary). In the NWT, chytrid fungus was found in only one toad (four toads and 95 tadpoles were screened) in the Muskeg River gravel pits near Fort Liard (Schock 2009, Schock *et al*. 2009). Infected wood frogs and boreal chorus frogs were found at the same site. The occurrence of Bd is widespread but patchy in BC (Govindarajulu unpubl. data 2011).Western toads tested positive for Bd at eight of 16 sites in Alberta (Stevens *et al*. 2012); however, other species tested positive at most of the negative sites, suggesting that western toads are widely exposed to Bd. There is concern that humans may be agents of Bd transmission between wetland sites on recreational gear such as waders and research equipment (BC Ministry of Environment 2008; Mendez *et al*. 2008; Vredenburg *et al*. 2010).

The Bd population in some North American amphibians (including western toads from Colorado) has been found to be a highly infectious lineage that resulted from the anthropogenic mixing of two other lineages and subsequent anthropogenic spread (Farrer *et al*. 2011). Other co-stressors such as habitat degradation, climate change, water mold (*Saprolegnia*), and increased UV-B radiation may act synergistically to cause immunosuppression and vulnerability to Bd (Carey 1993; Kiesecker and Blaustein 1995; Kiesecker *et al*. 2001).

Bd may require other co-stressors such as increased UV-B radiation for the disease to become pathogenic. Diseased toads are rarely reported; however, rapid mortality may quickly remove them from populations. The disease has been linked to western toad population declines in the U.S. (Kiesecker and Blaustein 1995; Daszak *et al*. 1999; Kiesecker *et al*. 2001; Muths *et al*. 2003). Western toad population declines have been noted at the Atlin Warm Springs in northern BC where Bd was isolated from nearby populations (Slough 2009). However, population monitoring and Bd testing have rarely, if at all, been conducted concurrently, and in fact each has received little effort.

There is some evidence that some amphibian species are able to survive Bd epidemics (Briggs *et al*. 2010; Woodhams *et al*. 2010). While there is evidence that Bd is a spreading pathogen that can have negative consequences for amphibian populations (Skerratt *et al*. 2007), there is also evidence that Bd is widespread in areas where there is little evidence of harm (Longcore *et al*. 2007; Pearl *et al*. 2007) or where Bd has become endemic in apparently stabilized populations (Ouellet *et al*. 2005; Pearl *et al*. 2009a; Pearl *et al*. 2009b; Pilliod *et al*. 2010). Past and future declines of western toads due to Bd cannot be ruled out.

Ranavirus (Family: Iridoviridae) is widespread in the Dehcho and Sahtu regions of the NWT; it was detected in wood frogs but not in western toads or boreal chorus frogs (Schock 2009;

Schock *et al*. 2009). Amphibian die-offs have been attributed to this disease (summarized in Schock *et al*. 2009). Infections and mortalities due to ranavirus have been reported for western toads in captive and wild populations (Miller *et al*. 2011). Co-stressors may have an effect on ranavirus dynamics (Gray *et al*. 2009).

Amphibian deformities have received considerable attention over the past 20 years (Ouellet 2000; Ballengée and Sessions 2009). Missing limbs and other limb deformities are frequently the result of physical trauma such as failed predation attempts of tadpoles by invertebrates such as dragonfly larvae (Eaton *et al*. 2004; Ballengée and Sessions 2009). Chemical contamination of amphibian habitats and UV-B radiation may also cause deformities (Taylor *et al*. 2005; Ballengée and Sessions 2009). Of four western toads screened in the Fort Liard area in 2007 and 2008, none had physical abnormalities (Schock 2009).

Transportation corridors

Roads and other transportation corridors, including trails, are a threat to western toads where they result in road kill mortality (Fahrig *et al*. 1995; Eigenbrod *et al*. 2008). Adults and metamorphs are vulnerable near breeding, foraging and hibernation sites, especially during mass movement events (Carr and Fahrig 2001). Schock (2009) reported ATV use in and around toad breeding ponds at the Muskeg River gravel pit, near Fort Liard. Mortality of toads at this site was not observed but can be inferred. Recent mass mortality events have been reported for metamorphs and adults at several sites in BC (COSEWIC 2012). Under-road amphibian passages have been installed to alleviate amphibian mortality and are used by western toads at sites in Alberta and BC (Fitzgibbon 2001, Pagnucco *et al*. 2011). Roads such as the Liard Highway are a prominent feature in the western toad's range in the NWT; however, lack of information on toad breeding sites, seasonal toad movements and dispersal in the area precludes an assessment of the risk that the roads pose. It is the juxtaposition of roads and breeding sites, and the volume and seasonal timing of traffic that determines the level of threat, not road density itself.

Habitat loss and degradation

Habitat loss, degradation and fragmentation are occurring in the western toad's range in the NWT (Figure 4, p.21; see *Habitat Trends*, p.20) but the level of impact remains unknown. Our lack of knowledge of toad habitats and population trends prevents an assessment of the current scope, severity and magnitude of this threat.

Roads and other transportation corridors are a threat to western toads. Roads remove woodland habitat and fragment habitats. Developments in the Liard Valley, and their effects on the western toad were discussed earlier in *Habitat Trends*, p.20.

Cumulative impacts are thought to be relatively low at present in the western toad's range in the NWT, compared to other jurisdictions. One of the few documented western toad population declines in Canada has occurred on eastern Vancouver Island and the Lower Mainland (COSEWIC 2012). The decline and extirpation at one site were attributed to cumulative impacts of multiple threats including habitat fragmentation and loss from housing, industrial developments and transportation corridors (Davis and Gregory 2003). Road mortality, pollution, and the introduction of water mold (*Saprolegnia*) were additional contributing factors in the population declines.

Pollution

Pollution has not been identified as a current threat to western toads in the NWT. While amphibians are known to be sensitive to chemical contaminants from industrial wastes, agricultural effluents and other sources that are transported by water and air, very little research has been undertaken on the effects of specific contaminants on the western toad. The effects of contaminants on amphibians in general are reviewed by Bishop (1992) and Biolinx Environmental Research Ltd. and E. Wind Consulting (2004).

Spills of fuel oil, various chemicals such as antifreeze and glycol-based products for vehicles, lube oil and other hydrocarbons have increased in recent years (GNWT 2011), but impacts of these chemicals on western toads is unknown.

The acidification of wetlands from airborne sources may be a source of developmental abnormalities and increased mortality of embryos and tadpoles (Vertucci and Corn 1996). Acidification from airborne sulphur is associated with oil and gas extraction in northeast BC and Alberta (Austin *et al*. 2008). Heavy metals are also transported by air. UV-B radiation may not be a serious threat to western toads, but heavy metals and UV-B radiation may act synergistically with other environmental stressors and suppress the immune system of western toads, making them vulnerable to pathogens (Carey 1993). Heavy metals including zinc, cadmium and copper can have negative effects on amphibian growth, development and survival (Glooschenko *et al*. 1992; Brinkman 1998).

Bishop (1992) reported that amphibians are vulnerable to environmental contaminants including pesticides, herbicides and fertilizers. The pesticide malathion kills the plankton that tadpoles feed on (Relyea and Diecks 2008). Many compounds such as atrazine (herbicide), DDT, dieldrin, and acids cause immunosuppression in amphibians in low concentrations. Atrazine can disrupt sexual development (Hayes 2004). In the NWT, permits are required for non-domestic pesticide or herbicide use. There are no current pesticide or herbicide permits in the known range of western toads; the closest are in Fort Simpson. Pesticides are generally only used in buildings. Herbicides are occasionally used; for example, along railway corridors and at certain locations along the Enbridge pipeline (Martin pers. comm. 2013). There is no agriculture in the NWT range of the western toad and agricultural development in the NWT is unlikely in the future. Airborne environmental contaminants have been found in wildlife in the Dehcho including very low levels of DDT and Chlordane, perfluorinated and brominated compounds as well as radionuclides from the Fukushima accident (Larter pers. comm. 2012).

Road salts used in BC produced lethal or sublethal effects on amphibians (Harfenist et al. 1989). Sublethal effects of road salts on wood frogs included reduced tadpole activity and weight, and physical abnormalities (Sanzo and Hecnar 2005). Karraker and Ruthig (2009) found no synergistic effects of road deicing salt and water molds, two known sources of mortality for amphibian embryos, on three species of amphibians. Road salt (sodium chloride, NaCl) use is planned and monitored in the NWT (Department of Transportation [DOT] 2011). It is used to increase traction on paved roads. However, the roads of the Liard valley are primarily gravel and therefore do not typically require the application of sodium chloride (DOT 2005, Suwala pers. comm. 2013). A very low level of calcium chloride (CaCl) is used for dust control on selected roads in the territory to create a thin and dust-free crust on the highway surface (Suwala pers. comm. 2013).

The prevalence of environmental contaminants in the water and sediments in the range of the western toad in the NWT are unknown.

Climate change

Environmental changes due to global climate change may be a future threat to western toads in the NWT; however, potential impacts are unknown or ambiguous at best (Ovaska 1997). The magnitude of the impact is believed to be minor in both negative and positive aspects at this time but observed effects are expected to increase in the coming decades (see also *Positive Influences*, p.28).

Climate models predict increases in temperature and precipitation in Canada (IPCC 2007), with the largest warming projected for northern Canada. Precipitation is likely to increase in winter and spring, but decrease in summer. Snow season length is predicted to decrease, but increased snowfall will more than make up for the shorter snow season, resulting in increased snow accumulation. Warm winter or spring days may entice western toads to emerge early, making them vulnerable to freezing temperatures. Adult mortality of winter breeding toads has been observed at the Atlin Warm Springs in northern BC, but the proximate cause of mortality (such as freezing or Bd) was not known (Slough unpubl. data 2005).

A decrease in summer precipitation might increase the frequency and duration of droughts, affecting the persistence of smaller wetlands used for breeding, decreasing connectivity across the landscape, and decreasing the availability of moist micro-sites used for rehydration (Provincial Western Toad Working Group 2011). An increase in wildfires could result in a loss of forest habitat, though open areas preferred by western toads are created by wildfire (Guscio *et al*. 2008).

Extreme climatic events associated with climate change may be linked to increased UV-B exposure due to drought and to the outbreak of pathogens (Pounds 2001). Increased maximum temperatures may decrease environmental constraints on Bd and permit it to expand into higher elevations (Muths *et al*. 2008).

Ultraviolet radiation

UV-B radiation is a current threat to western toads in the NWT. A thinner stratospheric ozone layer is allowing more biologically damaging ultraviolet radiation (UV-B) to reach the Earth's surface. The magnitude of the impact is believed to be low, but may be higher in combination with other environmental stressors. Adams *et al*. (2005a) found no effect of UV-B radiation on western toad distribution in western North America.

UV-B radiation has been shown to reduce the survival of western toad embryos and tadpoles in Oregon (Blaustein *et al*. 1994; Hays *et al*. 1996; Blaustein *et al*. 2005), whereas studies in Colorado did not detect a UV-B effect (Corn 1998; Hossack *et al*. 2006). Western toad juveniles also experience elevated mortality when exposed to ambient levels of UV-B radiation (Blaustein *et al*. 2005; Garcia *et al*. 2006). The western toad may be vulnerable to UV-B radiation because it lays eggs in open shallow water subjected to solar radiation and has a poor ability to repair UV-induced DNA damage (Blaustein *et al*. 1998). Other stressors may act in combination with UV-B to encourage infection by pathogens or to induce lethal and sublethal effects such as reduced anti-predator behaviour (Kiesecker and Blaustein 1995; Kats *et al*. 2000; Blaustein *et al*. 2003; Bancroft *et al*. 2008). For example, western toad embryos and larvae were susceptible to a complex interaction between UV-B radiation, water mold (*Saprolegnia* spp.), and low water levels caused by lower precipitation (Kiesecker *et al*. 2001).

Other threats

Non-native species pose very little threat to western toads in the NWT at the present time. There are no introduced predators, competitors or diseases associated with fish stocking as there are elsewhere in the species' range in Canada (COSEWIC 2012). The invasive plant species white and yellow sweetclover (*Melilotus alba* and *M. officinalis*) have invaded the NWT in the western toad range (Carrière pers. comm. 2012; Larter pers. comm. 2012), but are not expected to impact western toad habitat or impede the toads' behaviour.

Juvenile and adult western toads are preyed upon by a number of birds, mammals and amphibians. Forester *et al*. (2006) notes a 62.5% loss of adult female American toads to predation, consistent with mortality rates for Manitoba toads (Kelleher and Tester 1969 *in* Forester *et al*. 2006) and common toads (Schmidt and Adholdt 1999 *in* Forester *et al*. 2006).

In the NWT, a Wildlife Research Permit is required for the study of western toads, but they can be harvested without a permit. Western toads are not typically used for bait or food. There was one recorded incidence of people collecting tadpoles at the Muskeg River gravel pit in 2008:

> *"While the author was taking tadpole measurements at the site, a young couple and a small child drove up on an ATV. They drove through the breeding pond, stopped on a muddy area and produced a small plastic container they had brought with them. During casual conversation with the group, they indicated to the author that they had come to collect some more tadpoles as the ones they had collected earlier had died. During casual conversation, the author suggested that rearing tadpoles is actually a lot of work and it would be best if they brought the tadpoles back to the pond at the end of the afternoon so they wouldn't have to care for them. They ultimately left with a couple of wood frog tadpoles, identified for them by the author. The fate of the collected tadpoles is unknown" (Schock 2009: 24-25).*

This suggests that collection does occur in the NWT, but likely at a low level. These 'pets' may or may not be released back to the wild, and if they are it may be in unsuitable habitat. This activity has the potential to impact local populations. The loss of tadpoles at a low level would have much less of an impact on a population than the removal of breeding adults. Releasing individuals at novel ponds could result in the spread of pathogens.

Positive Influences

The NWT range of the western toad includes areas currently under negotiation in lands, resources and governance processes for the Dehcho First Nations and the Acho Dene Koe First Nations. It is possible that some protection of the western toad habitat, an ecological value, could be provided for through zoning and under a regional land use plan currently under development. A land use plan will describe what types of activities should occur, generally where they should take place, and terms and conditions necessary to guide land use proposals and development projects over time (Cumming pers. comm. 2013, McMullen pers. comm. 2013).

Global climate change may permit earlier breeding due to earlier snow and ice melt, and subsequent range expansion by amphibians, which are presently excluded from habitats beyond their northern limit by the brief ice-free period (Corn 2003). Western toad hibernation may be limited by snow depth in the north (snow depth has a positive influence on western toad hibernation); therefore increased snow depths as predicted by the Intergovernmental Panel on Climate Change (IPCC) (2007) may permit range expansion (Alaska Department of Fish and Game 2006). A warmer climate with greater amounts of atmospheric moisture would benefit toads by reducing physiological costs of crossing landscapes (Bartelt *et al*. 2010) and possibly reduce the incidence of Bd, which can be cleared from infected individuals at elevated body temperatures (Woodhams *et al*. 2003). Climate change models are discussed in *Threats and Limiting Factors – Climate Change*, p.26.

The NWT Protected Areas Strategy has identified amphibians and reptiles (including western toad) as special features and makes this information available for use in protected areas planning and other land stewardship processes (www.nwtpas.ca)

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Biography of Preparer

Brian G. Slough obtained a M.Sc. in Biological Sciences from Simon Fraser University in 1976. His thesis on Beaver (*Castor canadensis*) ecology led him to a 15-year career as furbearer management biologist with the Yukon Fish and Wildlife Branch. He has published work on several furbearer species including beaver, arctic fox (*Alopex lagopus*), American marten (*Martes americana*), and Canada lynx (*Lynx canadensis*), and has also written about trapline and furbearer management in northern and western Canada. He prepared COSEWIC status reports on wolverine (*Gulo gulo*) (2003), American marten, Newfoundland population (*M. americana atrata*) (2007) and western toad (*Anaxyrus boreas*) (2012). In 2012 he prepared an NWT SARC status report on the northern leopard frog (*Lithobates pipiens*).

Since leaving the Yukon Government in 1996, Mr. Slough has conducted environmental assessments, protected areas research, and research on rare amphibians and mammals, including rodents, shrews and bats. He has conducted extensive amphibian surveys in the Yukon and northern British Columbia and has sampled the region for amphibian chytrid fungus. He is currently preparing an update report on the status of the wolverine in Canada for a COSEWIC reassessment in 2014. He is serving in his second term as a member of the Terrestrial Mammals Specialist Subcommittee of COSEWIC.

Status and ranks

Region	Coarse filter (Ranks) To prioritize	Fine filter (Status) To provide advice	Legal listings (Status) To protect under species at risk legislation
Global	G4TNR – Apparently Secure (NatureServe Canada 2014)	NT – Near Threatened [IUCN-2004] (Hilton-Taylor et al. 2004)	
Canada	NNR – Unranked (NatureServe Canada 2014) Sensitive (Canadian Endangered Species Conservation Council (CESCC) 2011)	Special Concern (COSEWIC 2012)	Special Concern (Schedule 1, 2005)
Northwest Territories	SNR –Unranked (NatureServe Canada 2014) May Be At Risk (Working Group on General Status of NWT Species 2011)	Threatened (SARC 2014)	**To be determined**
Adjacent jurisdictions			
Alberta	SNR – Unranked (NatureServe Canada 2014) Sensitive (Government of Alberta 2011)		
British Columbia	SNR – Unranked (NatureServe Canada 2014) S3S4 Vulnerable, Apparently Secure (BC Conservation Data Centre 2014)		
Yukon Territory	SNR –Unranked (NatureServe Canada 2014) Special Concern (Government of Yukon 2013)		

Appendix A – Additional Details: Distribution

Location	Confirmation Status	Date	Coordinates		Number of Individuals		Observer	Reference	Notes
			Latitude	Longitude	Adults	Juveniles/ Tadpoles/ Eggs			
Fort Simpson	Unconfirmed – specimen collected but location suspect	13-Aug-1897	61.77407	-121.29393	1		National Museum of Natural History	Fournier 1997	Specimen housed at the National Museum of Natural History. Not confirmed to be from this location (see Fournier 1997). Collected. ENR Amphibian Database record no. 2.
Flett Cutblocks	Confirmed	1-Jul-1994	60.71667	-123.41667	1		Bob Decker		Infobase ref H174. Observed. ENR Amphibian Database record no. 3.
Liard area	Confirmed	27-Jun-1999	60.50316	-123.44356	1		Craig Machtans		Craig Machtans, 1999; seen in same area in repeated years, infobase ref H161. Observed. ENR Amphibian Database record no. 4.
Liard area	Confirmed	5-Jun-1999	60.45299	-123.37333		100s	Craig Machtans		Craig Machtans, 1999; seen in same area in repeated years, infobase ref H161. Observed. ENR Amphibian Database record no. 5
Liard area	Confirmed	13-Jul-1999	60.55742	-123.48493	1		Craig Machtans		Craigh Machtans 1999; seen in same area in repeated years, infobase ref H161. Observed. ENR Amphibian Database record no. 6

Location	Confirmation Status	Date	Coordinates		Number of Individuals		Observer	Reference	Notes
Muskeg River	Confirmed	1-Jul-2000	60.30505	-123.30495	many		local knowledge		H161, Observed at Muskeg River, just N of Fort Liard. ENR Amphibian Database record no. 7.
Muskeg River Gravel Pit, N pond	Confirmed	25-Jun-2007	60.30108	-123.33432		200 - 300 tadpoles	Danna Schock & ENR field staff	Schock 2009; Schock *et al*. 2009	2 tail-clip samples collected. ENR Amphibian Database record no. 8.
Muskeg River Gravel Pit, N pond	Confirmed	26-Jun-2007	60.30481	-123.32283		200 - 300 tadpoles	Danna Schock & ENR field staff	Schock 2009; Schock *et al*. 2009	60 tail-clip samples collected. ENR Amphibian Database record no. 9.
Muskeg River Gravel Pit, S of the S pond	Confirmed	27-Jun-2007	60.30181	-123.33497	1		Danna Schock & ENR field staff	Schock 2009; Schock *et al*. 2009	1 toe-tip sample collected. ENR Amphibian Database record no. 10.
Roadside Pond 3	Confirmed	28-Jun-2007	60.13800	-123.23848	1		Danna Schock & ENR field staff	Schock 2009; Schock *et al*. 2009	Observed. ENR Amphibian Database record no. 11.
Off Liard Hwy, by 50 km road sign	Confirmed	1-Jul-2007	60.56667	-123.48333	1		Reported to D. Tate, Parks Warden		Observation reported to D. Tate, Parks Warden, record of email on file from Jan 28, 2008. ENR Amphibian Database record no. 12.

Location	Confirmation Status	Date	Coordinates		Number of Individuals		Observer	Reference	Notes
Muskeg River Gravel Pit, pond 1	Confirmed	19-Jun-2008	60.30478	-123.32286		300 - 500 tadpoles	Danna Schock & ENR field staff	Schock 2009; Schock *et al*. 2009	Observed at same pond where 100's of *A. boreas* tadpoles found in 2007. Elevation 198 m. ENR Amphibian Database record no. 13.
Muskeg River Gravel Pit, pond 3	Confirmed	19-Jun-2008	60.30214	-123.33392	1		Danna Schock & ENR field staff	Schock 2009; Schock *et al*. 2009	1 toe-tip sample collected. Elevation 210 m. ENR Amphibian Database record no. 14.
Muskeg River Gravel Pit, pond 4	Confirmed	19-Jun-2008	60.30358	-123.32756	2	3	Danna Schock & ENR field staff	Schock 2009; Schock *et al*. 2009	2 toe-tips and 3 tail-clips collected. This pond not surveyed in 2007. Elevation 206 m. ENR Amphibian Database record no. 15.
Muskeg River Gravel Pit, pond 1	Confirmed	21-Jun-2008	60.30478	-123.32286		31	Danna Schock & ENR field staff	Schock 2009; Schock *et al*. 2009	31 tail-tips collected. Tadpoles in distinct clumps in the shallowest, clearest part of the pond. ENR Amphibian Database record no. 15.
Liard River	Confirmed	24-Sep-2009	60.10572	-123.76188	1		Floyd Bertrand, RR Officer, Fort Liard	4 Photos	Encountered while hunting. Habitat appears to be mature riparian forest. Photos identified by B. Slough. ENR Amphibian Database record no. 17.
Yohin Lake	Unconfirmed	Pre-1984	61.2023	-123.7669			Unknown	Parks Canada 1984	Report of toads, with no documentation or evidence.

Location	Confirmation Status	Date	Coordinates		Number of Individuals		Observer	Reference	Notes
Nahanni Butte	Unconfirmed	Pre-1984	61.04930	-123.36490			Unknown	Parks Canada 1984	Report of toads, with no documentation or evidence.