Management Plan for Amphibians in the Northwest Territories

Draft for Public Review






July 6, 2016

This draft management plan was prepared and provided to the amphibian management agencies for the NWT, including the Government of the Northwest Territories, Tłı̨chǫ Government, Wek’èezhìı Renewable Resources Board, Sahtú Renewable Resources Board, Gwich’in Renewable Resources Board, Wildlife Management Advisory Council (NWT), and Government of Canada.

Input is being sought on this draft. It will be used to make revisions and prepare the final version of the management plan.

For copies of the management plan or for additional information on NWT species, please visit the Department of Environment and Natural Resources' website (www.enr.gov.nt.ca).

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ISBN to come

Cover photos (left to right):
Wood frog, credit: Danna Schock, 2009
Northern leopard frog, credit: Kris Kendell, 2014.
Boreal Chorus Frog: Danna Schock, 2009.
Western Toad, Floyd Bertrand, 2009.
Canadian Toad, Danna Schock, 2010.
Long-toed salamander, Mark Thompson, 2006.

EXECUTIVE SUMMARY

Amphibians are an important part of our ecosystem. They consume many insects and are prey for other species. Amphibians are sensitive to changes in their environment and can act as indicators of ecosystem health. Globally, many amphibian species are in decline.

There are five amphibian species in the Northwest Territories (NWT): northern leopard frog (*Lithobates pipiens*), boreal chorus frog (*Pseudacris maculata*), wood frog (*Lithobates sylvaticus*), western toad (*Anaxyrus boreas*), and Canadian toad (*Anaxyrus hemiophrys*). The long-toed salamander (*Ambystoma macrodactylum*) is suspected to occur in the NWT but there are no confirmed records of this species yet.

Northern leopard frog and western toad are threatened species in the NWT. Many people in the NWT are interested in frogs, toads and salamanders, and sometimes voice concerns about them. This multi-species *Management Plan for Amphibians in the Northwest Territories* was developed to address the needs of all amphibians in the NWT. It is intended to provide guidance and direction to co-management partners to help them with their decision-making for amphibian management. Ongoing communications, cooperation and public participation will be fundamental to the plan's success.

Species information

NWT amphibians spend part of their life in water and part on land. They require aquatic habitat for breeding, egg laying and tadpole development. They also need habitat on land for foraging and overwintering. These habitats must be connected by travel corridors for migration and dispersal. Amphibians often return to use the same breeding or overwintering sites year after year.

Overwintering habitat is an important limiting factor for NWT amphibians. Other limiting factors include predation and breeding failure due to unpredictable environmental factors. Amphibians are vulnerable to events occurring where many individuals are found together, such as breeding sites, overwintering sites, and during mass movement events.

Threats and positive influences

Amphibians within the NWT are facing threats. Amphibians with naturally small and/or isolated populations, including northern leopard frog, western toad and Canadian toad, are particularly vulnerable to threats and declines.

The main threats facing amphibians in the NWT are diseases, in particular chytrid fungus and ranavirus, which have been known to cause amphibian declines elsewhere. Both these diseases have been found in the NWT. Human activities that alter habitat or prevent movements, such as land clearing, wetland modification or hydroelectric development, can have negative impacts on amphibians. Accidental human-caused mortality presents a threat to amphibians, particularly where vehicle traffic or other human activities overlap with areas where amphibians are concentrated (eg, breeding ponds). Increasing ultraviolet (UV-B) radiation is a threat to amphibians because it can impact hatching success and may interact with other threats. Amphibians are sensitive to chemical contaminants but the extent of this threat in the NWT is not well known.

The potential effects of climate change on amphibians in the NWT could be negative or positive. Negative impacts could include changes to the food supply, reduced availability and connectivity of suitable habitats, and disease expansion. Positive impacts could include a longer breeding season and possible range expansion.

Research and increased awareness in recent years has added to our knowledge of amphibians in NWT and the challenges they face. Land conservation initiatives have the potential to have a positive effect on amphibians in the NWT. For threatened amphibian species, recovery efforts and increased scrutiny of development activities through the regulatory process could have a positive influence.

Management Goal and Objectives

The management goal is to maintain a healthy and viable population for each amphibian species across its NWT range. In order to attain this goal, five objectives were set (in no particular order), combined with recommended approaches to achieve these objectives. Progress towards achieving these objectives will be evaluated every 5 years. The five objectives are:

1. Improve knowledge about NWT amphibians, including traditional, community and scientific knowledge, to inform sound management decisions.
2. Identify and maintain key amphibian habitats.
3. Mitigate, monitor and manage the effects of disease and other important threats to amphibians.
4. Increase public awareness and stewardship of amphibians and their habitats.
5. Manage amphibians using an adaptive and collaborative approach, and the best available information.

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ACCEPTANCE STATEMENT

[Insert appropriate Ministerial text to accept this management plan. List the participating wildlife management authorities who helped develop the management plan. This can include text from the Conference of Management Authorities consensus agreement to adopt the plan for northern leopard frog and western toad.]

To be completed as a final step once the management plan is finalized.

WHY DEVELOP A MANAGEMENT PLAN FOR AMPHIBIANS?

Amphibians play a significant role in our ecosystems. As predators they consume large quantities of insects and other invertebrates every summer; as prey they provide food to other species. Because of their sensitivity to changing environmental conditions, amphibians are indicators of environmental change and ecosystem health.

The global status of amphibian species is changing rapidly, with substantial population declines being observed in many regions (Alford and Richards 1999). Nearly one-third of the world's amphibian species are known to be threatened or extinct, and at least 42% of all amphibian species are experiencing population decline (IUCN 2011). This makes amphibians the most threatened and rapidly declining vertebrate group in the world (Bruhl *et al.* 2011). There are many factors contributing to their global decline, with habitat destruction, predation, contamination, harvest, disease, ultraviolet (UV) radiation, and climate change being major stressors (Alford 2010).

Five amphibian species are known to occur in the Northwest Territories (NWT): northern leopard frog (*Lithobates pipiens*), boreal chorus frog (*Pseudacris maculata*), wood frog (*Lithobates sylvaticus*), western toad (*Anaxyrus boreas*), and Canadian toad (*Anaxyrus hemiophrys*). The long-toed salamander (*Ambystoma macrodactylum*) is suspected to occur in the NWT based on anecdotal observations, but as of 2015 there are no confirmed records of this species yet.

The northern leopard frog and the western toad are currently listed as Threatened species on the NWT List of Species at Risk under the *Species at Risk (NWT) Act*. Both are also listed as species of Special Concern on Schedule 1 of the federal *Species at Risk Act*. Due to their species at risk status, there are national management plans for these two species and there is a legal requirement to complete NWT recovery strategies for them. The remaining NWT amphibians do not have this requirement, however the species share several threats in common and there is considerable overlap in their management needs. Therefore, this NWT-wide multi-species management plan was developed to address the needs of all NWT amphibians.

HOW DO WE KNOW ABOUT AMPHIBIANS?

Amphibians in the NWT have been little studied and there are many knowledge gaps with respect to their population, distribution, biology and threats. Many amphibian records are collected opportunistically and the ability to distinguish between species is often limited by the experience of the observer. Additional challenges include limited access, a small human population, and the difficulties of surveying uncommon species with widely dispersed breeding sites (Schock 2009; Lesbarrères et al. 2014). Much of what is known about NWT amphibians comes from research conducted elsewhere.

According to one Dehcho Dene, Dene people called the full moon in spring the *Frog Moon* because it is when the frogs come out of the ground and are heard singing in ponds (D.Allaire, ENR. pers. comm.). Many people in the NWT are interested in frogs, toads and salamanders, and sometimes voice concerns about them. For example, participants at a community workshop reported an observed decline in frog populations in the Slave River and Delta ecosystem (Dagg 2012). Some Aboriginal traditional knowledge holders have noticed declines in frogs (e.g. Salt River First Nation elders, according to Fraser pers. comm. 2011 as cited in SARC 2013; M. Clark and P. Campbell, as cited in GSCI 2016) or in amphibian populations in general (e.g. Beaulieu pers. comm. 2011 as cited in SARC 2013). Others report that there may be new frogs, or the frog population may be increasing (A.M. MacLeod and W. Tyrrel, as cited in GSCI 2016).

People in the NWT may hold a great deal of traditional and community knowledge about amphibians although relatively little of it has been collected and documented. A search of the Gwich'in Social and Cultural Institute's digital archives (GSCI 2016) revealed that many Gwich'in people have seen frogs around their camps and there are seven Gwich'in traditional place names which refer to frogs. A frog also plays a role in the Gwich'in legend *Katchukye – The Man Who Paddled Down the Wrong River or The Saga of Two Brothers*. Elsewhere in the NWT, knowledge about amphibians has not yet been systematically compiled but surely exists. For example, there is a 'Frog Pond' in Fort Smith (Fraser pers. comm. 2011 as cited in SARC 2013) and a 'Toad River' near Fort Liard, and elders in Fort Liard have spoken about salamanders (D.Allaire, ENR. pers. comm.).

Collection and harvest of amphibians may occur in the NWT at a low level, but amphibians are not generally considered important as food for humans. Frogs have reportedly been used as bait by fishing guides in the NWT (Côté pers. comm., cited in Rescan 2008) and there is at least one reported incidence of people collecting toad tadpoles, presumably as 'pets' (Schock 2009).

From a scientific perspective, amphibian research and monitoring in the NWT is typically short-term and relatively few sites have been revisited to determine population persistence or trends. Historical information on NWT amphibians was summarized by Fournier (1997). A pamphlet on *Amphibians and Reptiles in the Northwest Territories* was produced and was last updated in 2006 (Ecology North et al. 1998; ENR 2006). Further baseline information was gathered by Schock, who carried out dedicated population surveys for amphibians and tested for diseases (chytrid fungus and ranavirus) between 2007 and 2010 at 16 sites in the South Slave region, 67 sites in the Dehcho region, and 20 sites in the Sahtu region (Schock 2009; 2010; Schock et al. 2009). New research in the South Slave region will add to this knowledge base (e.g. Bienentreu 2015).

Occasionally, an amphibian survey is completed by industry as part of a development project (e.g. Rescan 2008) or amphibians are documented during field work conducted for another purpose (e.g. EBA Engineering Consultants Ltd. and Canadian Wildlife Service 2006). Environment and Natural Resources maintains a database of amphibian occurrences in the Wildlife Management Information System (WMIS) and encourages reporting of amphibian observations to WILDLIFEOBS@gov.nt.ca.

As part of the species at risk process, detailed species reports and status assessments were recently completed for the northern leopard frog and western toad in the NWT (Species at Risk Committee 2013, 2014). These reports were used extensively in writing this management plan.

1. SPECIES INFORMATION

1.1 All Amphibians

The name *amphibian* comes from a Greek word meaning to live a double life. This is fitting because amphibians spend part of their lives in the water and part on land. They breed and lay their eggs in the water. The larvae (tadpoles) are aquatic; they move with fins and breathe with gills. They grow and transform into juveniles and then adults through a process called metamorphosis. Adults are typically terrestrial; they move with legs and breathe with primitive lungs.

In addition to their gills (tadpoles) or lungs (adults), amphibians also respire (breathe) through their thin, permeable skin. They exchange gases with the air or water through the skin, which allows adult amphibians to stay underwater for long periods of time and to overwinter at the bottom of ponds. Amphibians are vulnerable to drying out and they have mucous glands to keep their skin damp. They can absorb moisture from dew or damp soil and often use moist habitat sites.

Amphibians are cold-blooded, meaning they do not generate their own body heat and rely on the temperature of their environment. They obtain heat from their surroundings and maintain a fairly stable body temperature by moving between warmer and cooler areas.

Amphibians in the NWT share three primary habitat requirements: aquatic habitat for breeding, egg laying and tadpole development; foraging habitat; and overwintering habitat. These habitats, often in close proximity, must be connected by travel corridors that are suitable for migration and dispersal (Baldwin et al. 2006). Local and regional population persistence depends on breeding site distribution and connectivity.

All NWT amphibians depend on fresh water for egg-laying and tadpole development. Breeding takes place in a wide variety of permanent and semi-permanent water bodies, with specific selection preference varying among species. NWT amphibians typically show strong fidelity to breeding sites, returning to the same sites year after year (Sinsch 1990; Blaustein et al. 1994). Egg and larval development are dependent upon water temperatures, so a positive correlation between locally higher water temperatures and amphibian abundance is to be expected.

When amphibians are found on land outside the breeding season, sites with moderate temperatures, damp conditions and abundant prey are probably important (Seebacher and Alford 2002; Rittenhouse and Semlitsch 2007).

Overwintering habitat is one of the most important factors that limit amphibian distribution in the NWT. Northern leopard frogs, western toads and Canadian toads are not freeze-tolerant and must overwinter below the frost zone. This is probably one reason for their restricted distribution in the NWT. Boreal chorus frogs and wood frogs can tolerate some freezing at slightly sub-zero temperatures. This allows them to overwinter within the frost zone, although they still need adequate insulation from snow cover. These species are more abundant and widespread in the NWT.

The tadpoles of frogs and toads eat foods such as algae, aquatic vegetation and plankton, and also scavenge on dead plants and animal carcasses. Salamander hatchlings and larvae are predatory and eat zooplankton and aquatic invertebrates. The adults and juveniles of frogs and toads are predators that eat ground-dwelling invertebrates such as insects, spiders, worms, millipedes and snails. Adult salamanders may eat tadpoles and small fish in addition to invertebrates (COSEWIC 2003, 2006; SARC 2013, 2014).

Appendix 1 summarizes the current status of NWT amphibian species at global, national and territorial scales.

1.2 Frogs

1.2.1 Northern Leopard Frog (*Lithobates pipiens*)

Figure 1. Northern Leopard Frog (Photo courtesy of L. Bol, 2008).

Figure 2. Distribution of northern leopard Frog in North America. Map prepared by Bonnie Fournier, Northwest Territories Department of Environment and Natural Resources. Data provided by Department of Environment and Natural Resources (unpubl. data 2016).

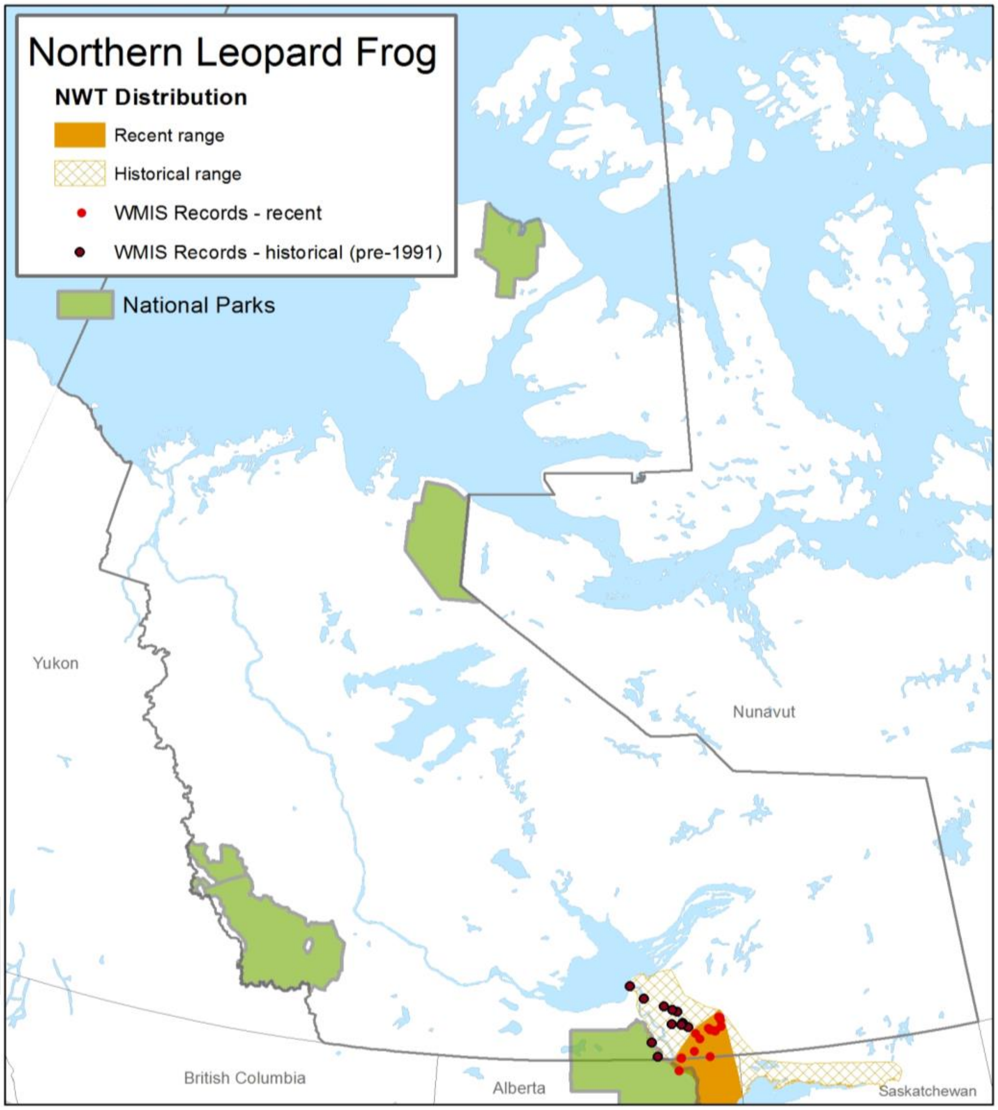

Figure 3. Distribution of northern leopard frog in Northwest Territories. Map prepared by Bonnie Fournier, Northwest Territories Department of Environment and Natural Resources. Data provided by Department of Environment and Natural Resources (unpubl. data 2016).

The northern leopard frog is usually green, or sometimes brownish, with an unmarked, milky-white underside. It has dark spots with distinct light borders (Figure 1). It grows to a maximum length of approximately 11 cm. Newly hatched tadpoles are slender and black. The northern leopard frog's call is a long, drawn-out rattling snore, usually ending with several rapid short grunts.

The northern leopard frog is found throughout most of central and northeastern North America from Labrador, James Bay and the NWT in the north, south to Virginia, Nebraska, and Arizona (Figure 2). Northern leopard frogs in the NWT are known to occur in the South Slave region, mostly east of the Slave River, near the Slave, Taltson and Tethul rivers (Figure 3). Connectivity between the NWT population and populations in southern Canada is uncertain (SARC 2013).

Northern leopard frogs breed in a wide variety of wetlands sites that have a combination of open water and emergent vegetation and are usually shallow, pH neutral, and without fish (Wershler 1992; Wagner 1997). Northern leopard frogs breed early in the spring when some ice may still be on the wetlands (Werschler 1992). Breeding depends on weather and water temperature, and likely occurs in the NWT from mid to late May (based on information from the Yukon; Slough and Mennell 2006). Many northern leopard frogs gather to breed and lay eggs in the same place and at the same time, usually over a short period of just a few days (Alberta Northern Leopard Frog Recovery Team 2010). Female northern leopard frogs produce one clutch of eggs per year containing 600-7,000 eggs. Clutch size is correlated to female body size, which is related to age. Hatching success is highly variable (Corn and Livo 1989; Gilbert *et al.* 1994).

Metamorphosis (transformation from tadpoles to adults) takes 2-3 months; the timing depends on temperature and possibly on the density of the population (Wershler 1991; Seburn 1993). Early drying of sites leads to increased tadpole density, accelerated development, and metamorphosis at a reduced size (Merrell 1977). Sexual maturity is dependent on size more than age, with females reaching maturity at 55-60 mm (Hine et al. 1981; Merrell 1977; Gilbert et al. 1994). This probably takes at least 2 years in the NWT (Merrell 1977; Prescott pers. comm. 2012 as cited in SARC 2013; SARC 2013). Northern leopard frogs rarely live longer than 4-5 years in the wild (Eddy 1976).

In the summer northern leopard frogs are often found along the margins of water bodies, preferring open and semi-open areas with short vegetation (Merrell 1977; Wershler 1992; Wagner 1997). Movement and dispersal probably takes place along moist habitats like streams and wetlands (Seburn et al. 1997).

Northern leopard frogs are not freeze tolerant; they become inactive underwater during winter (Churchill and Storey 1995; Waye and Cooper 2001). Northern leopard frogs usually overwinter in the sand or mud bottoms of water bodies that are well-oxygenated and do not freeze to the bottom (Hine et al. 1981; Russell and Bauer 2000; Alberta Northern Leopard Frog Recovery Team 2010). They often overwinter in groups and may return to the same overwintering sites year after year (ENR unpubl. data 2011; Waye and Cooper 1999).

Globally, the northern leopard frog has a wide distribution and presumed large population (Appendix A; Hammerson et al. 2004). Northern leopard frog is a species of special concern in Canada because of past range contraction and loss of populations (particularly in the west), increased isolation of the remaining populations, and vulnerability to threats (Appendix A; COSEWIC 2009; SARC 2013). Northern leopard frog abundance in the NWT is unknown but their range is very small. Their population size is probably less than 10,000 and possibly even less than 2,500 mature adults (SARC 2013).Traditional and community knowledge sources indicate that northern leopard frog numbers declined on the Taltson River between the 1950s and 1980s (Beaulieu pers. comm. 2011 and Beck pers. comm. 2011, as cited in SARC 2013). There is some evidence from recent amphibian searches that northern leopard frogs may now be absent from the Slave River (SARC 2013). However, many sites in the ‘historic range’ (Figure 3) have not been searched since before 1995 so there is uncertainty about how the range of northern leopard frogs in NWT may have changed. Northern leopard frogs are threatened in the NWT because of their small range, shrinking range and declining population.

1.2.2 Boreal Chorus Frog (*Pseudacris maculata*)

Figure 4. Boreal Chorus Frog (Photo courtesy of D. Schock 2010).

Figure 5. Distribution of boreal chorus frog in North America. Data from IUCN et al. (2008c).

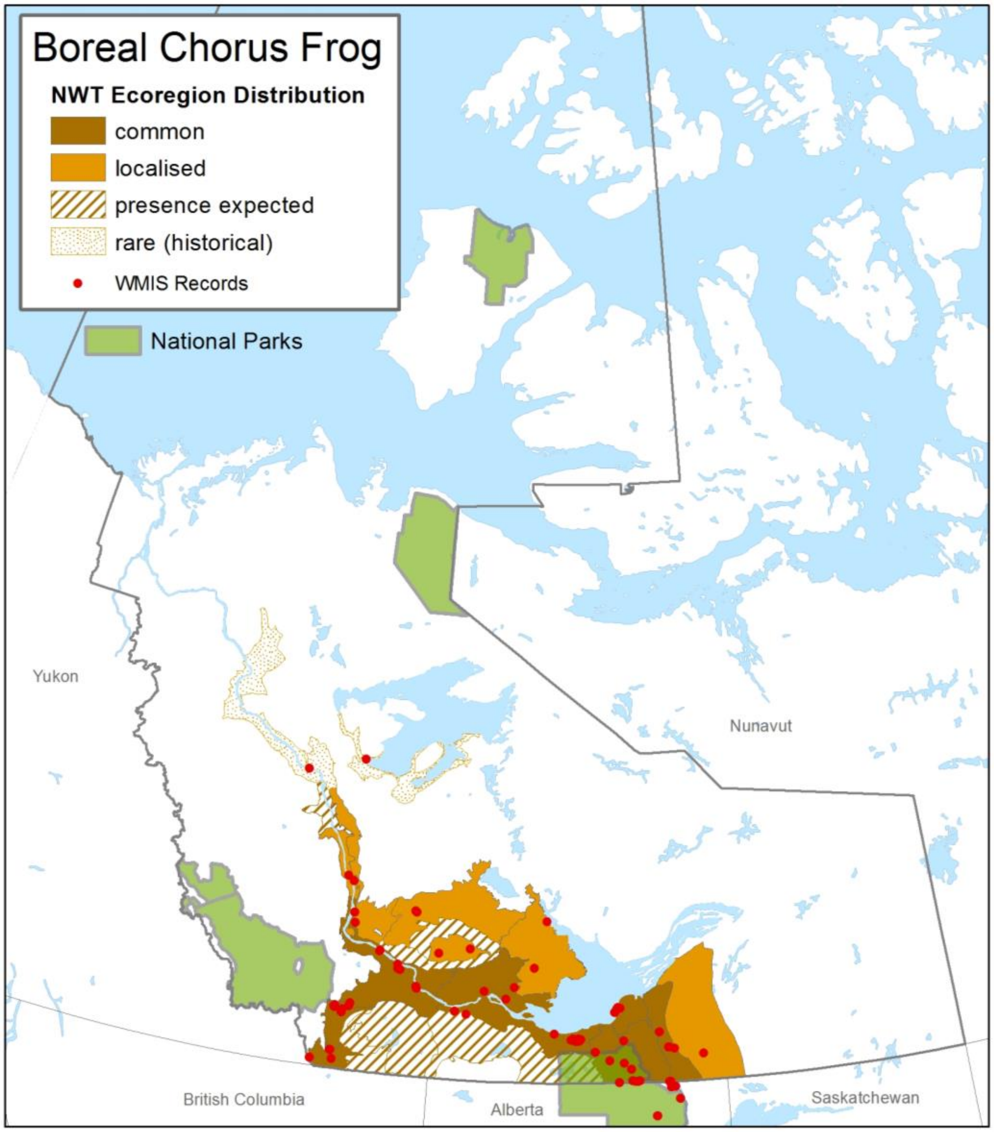

Figure 6. Distribution of boreal chorus frog in Northwest Territories. Map prepared by Bonnie Fournier, Northwest Territories Department of Environment and Natural Resources. Data provided by Department of Environment and Natural Resources (unpubl. data 2016).

The boreal chorus frog is a small, slender frog whose colour ranges from grey to brown to green. It has a dark stripe extending from the snout through the eye to the groin. There are also frequently three broken, irregular dark stripes on the back. It has a white stripe on its upper jaw and frequently a pale, triangular patch between the eyes. Its underside is a light cream colour and its skin has a pebbly texture (Figure 4). Adults are between 2 and 4 cm in length. Tadpoles are dark olive green with yellow spots (Russell *et al*. 2000; Schock 2009).The call of the boreal chorus frog is a drawn-out rising "*kreeeeeeep*", similar to the sound a thumbnail moving slowly over the teeth of a stiff pocket comb.

Boreal chorus frogs are found in North America east of the continental divide, from southeast Yukon to Quebec, and southward to New Mexico and Missouri (Figure 5). Boreal chorus frogs are widely distributed in the southern NWT ((Figure 6; Schock 2009; 2010). It is uncertain how far north their range extends down the Mackenzie Valley, as historical records from the Sahtu region may be inaccurate (Fournier 1997). Recent surveys in Norman Wells did not detect boreal chorus frogs (Schock 2009).

Boreal chorus frogs are generally found in damp, grassy or wooded areas. They can tolerate some freezing which allows them to overwinter on land where there is adequate snow cover for insulation, buried under leaf litter and vegetation (MacArthur and Dandy 1982; Storey and Storey 1996). They may overwinter in upland sites near water bodies (IUCN SSC Amphibian Specialist Group 2015e).

In early spring, the boreal chorus frog begins the breeding season when there may still be ice on the ponds. Breeding in the NWT likely takes place from late May to early June (Slough and Mennell 2006; Ouellet et al. 2009; Schock 2009) but can be later in June if spring arrives late (Schock 2010). Courtship displays consist of the males gathering around pools and calling to the females during both the day and night. They usually breed in shallow, fishless pools that may be temporary or permanent and usually contain some underwater vegetation (IUCN SSC Amphibian Specialist Group 2015e; Schock 2009). In the NWT, boreal chorus frogs have been documented breeding in a variety of roadside ponds, gravel pits, other ponds, sloughs and lake edges (Schock 2009; 2010).

After fertilization, the female lays 150 to 1,500 eggs over several days, in small clumps attached to underwater vegetation. Tadpoles develop and transform into adults over about two months; they reach maturity and reproduce the year after they are hatched. Boreal chorus frogs are short-lived and probably breed only once. They do not live more than one or two years in the wild (Russell *et al.* 2000).

The global population of boreal chorus frogs is generally thought to be large and stable (Appendix A; IUCN SSC Amphibian Specialist Group 2015e). In the NWT, there are no population estimates for boreal chorus frogs. They are thought to be relatively common within their range but less abundant than wood frogs (Schock 2009; 2010).

1.2.3 Wood Frog (*Lithobates sylvaticus*)

Figure 7a. Wood Frog (Photo courtesy of D. Schock, 2009).

Figure 7b. Wood Frog with spotted colouration (Photo courtesy of D. Schock, 2009).

Figure 8. Distribution of wood frog in North America. Data from NatureServe and IUCN (2014).

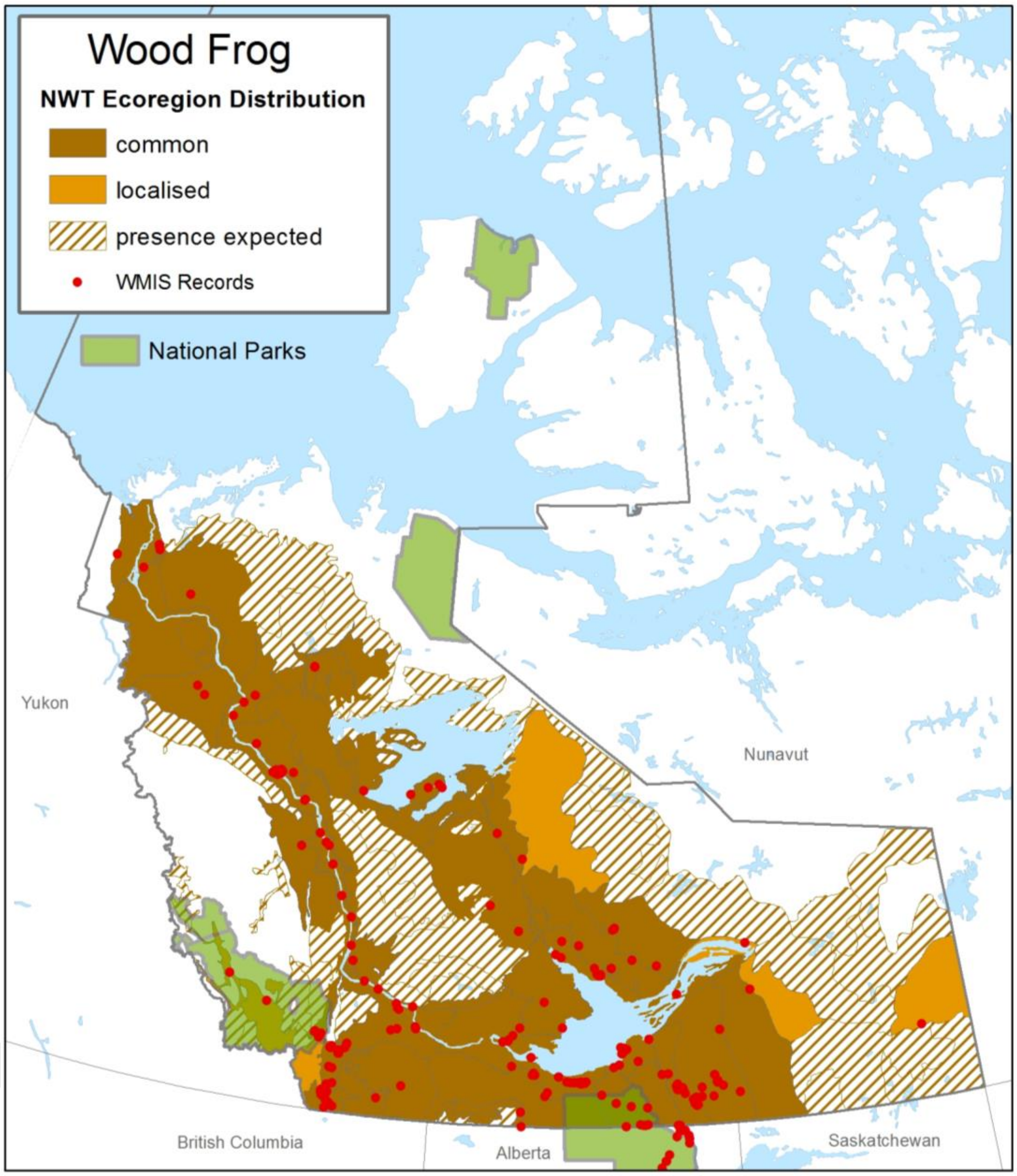

Figure 9. Distribution of wood frog in Northwest Territories. Map prepared by Bonnie Fournier, Northwest Territories Department of Environment and Natural Resources. Data provided by Department of Environment and Natural Resources (unpubl. data 2016).

The wood frog is a small to medium-sized frog between 3-6 cm long. The wood frog's skin is relatively smooth and varies in colour from brown, tan or grey to pinkish. A useful feature for identification is the dark brown or black mask that runs from the snout, through the eye to the top of the front leg; this dark mask is often bordered below by a white jaw stripe. Otherwise the colour patterns of wood frogs are highly variable (Figure 7 a,b). Sometimes there may be a light stripe running down the middle of the back and/or dark spots on the frog's sides (Russell *et al.* 2000; Schock 2009). The call of the wood frog sounds like a low, often rapid "*quack*" and is sometimes mistaken for a duck. Wood frog tadpoles are brown to green in colour. They have a creamy underside, a faint line running along the edge of the mouth, an arched tail fin, and a tail with a pointed tip (Russell *et al.* 2000).

The wood frog is well adapted to a cold climate and is found further north than any other North American amphibian. The range of the wood frog extends across most of Alaska and Canada below the tree line, as well as the northeastern U.S. (Figure 8). In the NWT wood frogs are widespread throughout forested regions from the Alberta border north to the Mackenzie Delta (Figure 9).

The wood frog can tolerate some freezing (Storey and Storey 1986; Larson et al. 2014). It overwinters under leaves and other debris on the forest floor, or under logs or rocks, and depends on snow cover to insulate its overwintering sites. Wood frogs may overwinter at upland sites near breeding pools (Reed et al. 2003).

Wood frogs breed early in spring, sometimes before ice has melted from breeding ponds – for example, in late April or early May. Breeding usually takes place in shallow, fishless pools that can include roadside ponds, gravel pits, other ponds, sloughs and lake edges (Slough and Mennell 2006; Schock 2009; 2010). To initiate breeding, males congregate at breeding pools and call to females during the day and night. The eggs are laid in the water, in rounded masses that are often attached to vegetation (Slough and Mennell, 2006). In a single mass, the number of eggs may vary from 2,000 to 3,000 (Russell *et al.* 2000).

Wood frogs develop rapidly from eggs to adults (in about 7 to 13 weeks; Edge et al. 2012). After metamorphosis, males take one year to reach maturity, whereas females take two years. Both sexes live up to three or four years (Berven 1990).

Adult wood frogs are commonly observed foraging far from water sources. After breeding, wood frogs move to damp woodland areas but may remain around pond margins for much of the summer. Prey availability and factors that create a suitable environment for the frogs, such as leaf litter or moss that prevent drying out, are probably important in determining habitat use. The ability to move between breeding and non-breeding habitats is also important (Rittenhouse and Semlitsch 2007; Baldwin et al. 2006).

Globally, the wood frog is widespread and abundant and its population is thought to be stable (Appendix A; IUCN SSC Amphibian Specialist Group 2015d). It is the most abundant amphibian species in the NWT (Schock 2009; 2010).

1.3 Toads

1.3.1 Western Toad (*Anaxyrus boreas*)

Figure 10. Western Toad (Photo courtesy of F. Bertrand).

Figure 11. Distribution of western toad in North America. Map prepared by Bonnie Fournier, Northwest Territories Department of Environment and Natural Resources. Data provided by Department of Environment and Natural Resources (unpubl. data 2016).

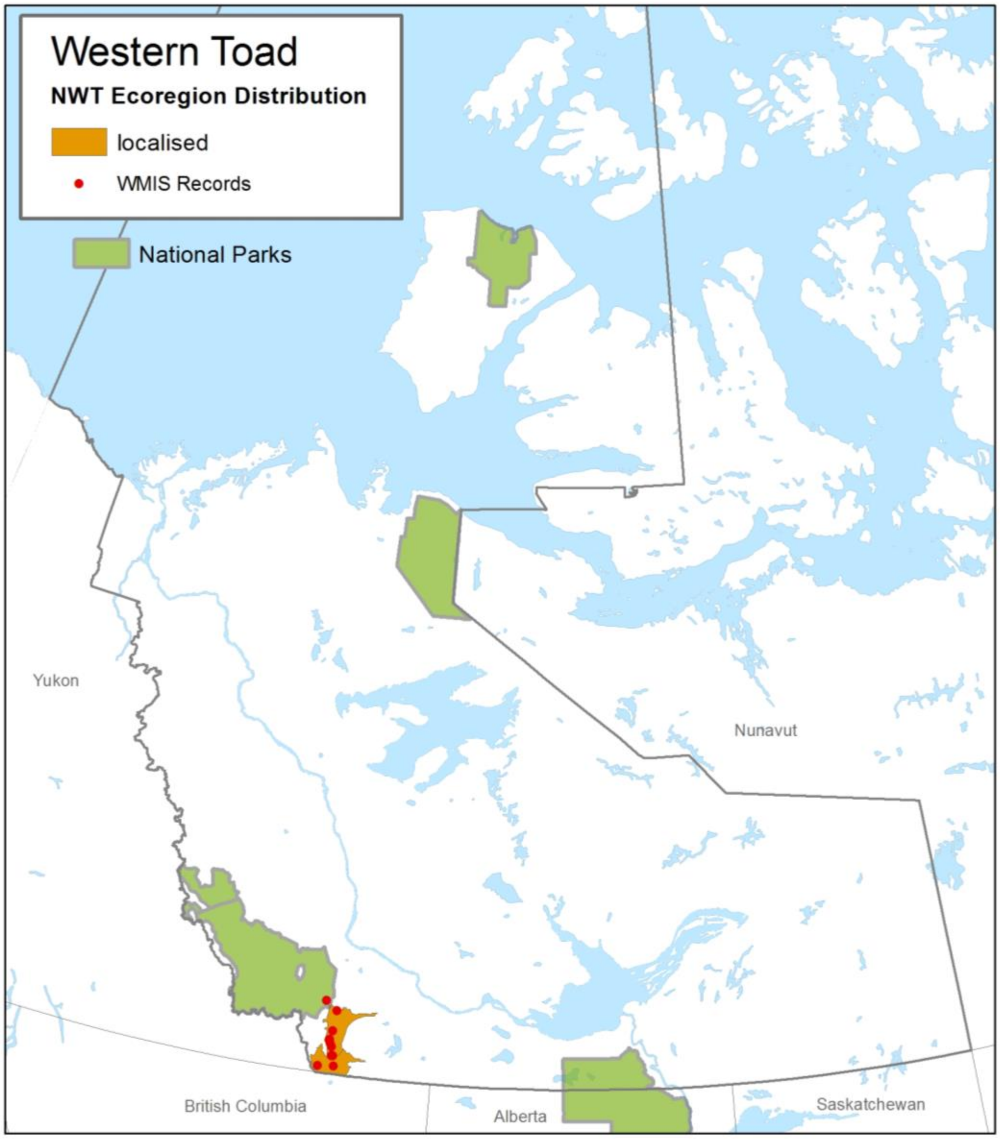

Figure 12. Distribution of western toad in Northwest Territories. Map prepared by Bonnie Fournier, Northwest Territories Department of Environment and Natural Resources. Data provided by Department of Environment and Natural Resources (unpubl. data 2016).

The western toad is a large toad with a light stripe down the middle of the back and small round or oval 'warts' on the back, sides and upper limbs (Figure 10). Western toads are usually green or brown, but their colour varies from olive green to reddish brown or black. Adults in the north grow up to about 9 cm in length (Slough 2004 unpubl. data cited in SARC 2014; Schock 2009). Newly hatched tadpoles and young toads are black (Russell and Bauer 2000; Matsuda *et al*. 2006). Unlike most western toads in Alberta, western toads in the NWT belong to the 'non-calling population' (Pauly

2008; COSEWIC 2012). The males do not make loud advertisement calls during the breeding season.

Western toads are found in western North America from California to Alaska (Figure 11). In the NWT, western toads are known to occur in the Liard River basin (Figure 12). This population is likely continuous with upstream populations in the Yukon and British Columbia. Western toads have been confirmed at six sites in the NWT but there are probably more undiscovered sites (Figure 12; Schock 2009; SARC 2014).

The western toad has a strong fidelity to seasonal habitats used for breeding, summer foraging and overwintering, meaning it tends to return to the same sites year after year (Browne and Paszkowski 2010; Palmieri-Miles 2012).

Because of their intolerance to freezing, western toads overwinter below the frost line, typically either underground or in natural cavities (middens, crevices, abandoned beaver lodges, etc.). These locations tend to be near water to avoid drying out (Bull 2006; Browne and Paszkowski 2010; Palmieri-Miles 2012). Early deep snow accumulation is thought to be important for providing insulation (Cook 1977; SARC 2014). A single over-wintering site may be used by many individuals (Browne and Paszkowski 2010).

Western toads breed in a wide variety of wetlands such as shallow, sandy or silty margins of lakes, ponds, lake shores, roadside ditches streams, rivers and marshes. Human-made habitats like roadside ditches and borrow pits are also commonly used (Jones et al. 2005; COSEWIC 2012; SARC 2014). In the NWT, breeding has only been documented in one place so far – in a gravel pit (Schock 2009; SARC 2014). Western toads gather together to breed in large temporary groups. This, combined with their tendency to return to the same breeding sites again and again, may mean that only a small number of the potentially available sites are used for breeding (Slough 2004; Bull and Carey 2008; SARC 2014).

Based on tadpole development observed in late June, it is estimated that breeding in the NWT occurs in late May or earlier (Schock 2009; SARC 2014). The eggs are laid in long, intertwined, paired strings, at the bottom of shallow lake or pond edges or on vegetation or branches in the water (Jones *et al*. 2005; COSEWIC 2012). Observations in the north suggest that clutches of less than 3,000 eggs are laid, compared to clutch sizes of 1,200 to 20,000 reported in the south (Maxell et al. 2002; Slough 2004, 2005). Tadpoles are usually found grouped together, but the size of groups reported in the north is smaller compared to in the south (Slough 2004, 2005, 2009, Schock 2009). Metamorphosis (transformation) is complete by July or August.

After breeding, western toads may stay and forage in the wetland edges of their breeding site, or they may disperse to other wetlands, forests, shrublands or meadows.

They are known to travel long distances (Bartelt et al. 2004; Schmetterling and Young 2008). Adults are often found far away from known breeding sites (Mennell and Slough 1998; Slough 2004, 2005). Sometimes adults and young toads move together in large groups – this is called a ‘mass movement event’. During these events western toads are vulnerable to many threats (Carr and Fahrig 2001).Western toads repeatedly use small habitat sites that provide protective cover, temperature regulation or moist soil patches. These sites may be very important to western toads (Long and Prepas 2012).

Male western toads may mate more than once per season, and sometimes in consecutive years. However, most females mate only once in their lifetimes. Sexual maturity occurs in males at 3 to 4 years of age, whereas females take 4 to 6 years to mature. Males can live for up to 11 years, and females up to 9 years. Their life-history characteristics (long lifespan, delayed maturity of females, and females breeding only once a lifetime) limit the western toad’s ability to recover from population declines (Campbell 1970; Olsen1988; Carey 1993; Blaustein et al. 1995; Matsuda et al. 2006; SARC 2014).

Globally, western toad has a large distribution and large population size (Appendix A; IUCN SSC Amphibian Specialist Group 2015b). The western toad is a species of special concern in Canada due to population declines and range loss in southern B.C. and the U.S., as well as its vulnerability to threats (COSEWIC 2012). Western toad is threatened in the NWT because of its small range and concern about threats (SARC 2014). The population size of western toads in the NWT is unknown but believed to be quite small; it has been crudely estimated as between 200-8,000 mature individuals (Carriere pers. comm. 2014 as cited by SARC 2014). Population trends in the NWT are not known.

1.3.2 Canadian Toad (*Anaxyrus hemiophrys*)

Figure 13. Canadian Toad (Photo courtesy of D. Schock, 2016).

Figure 14. Distribution of Canadian toad in North America. Data from IUCN et al. (2008b).

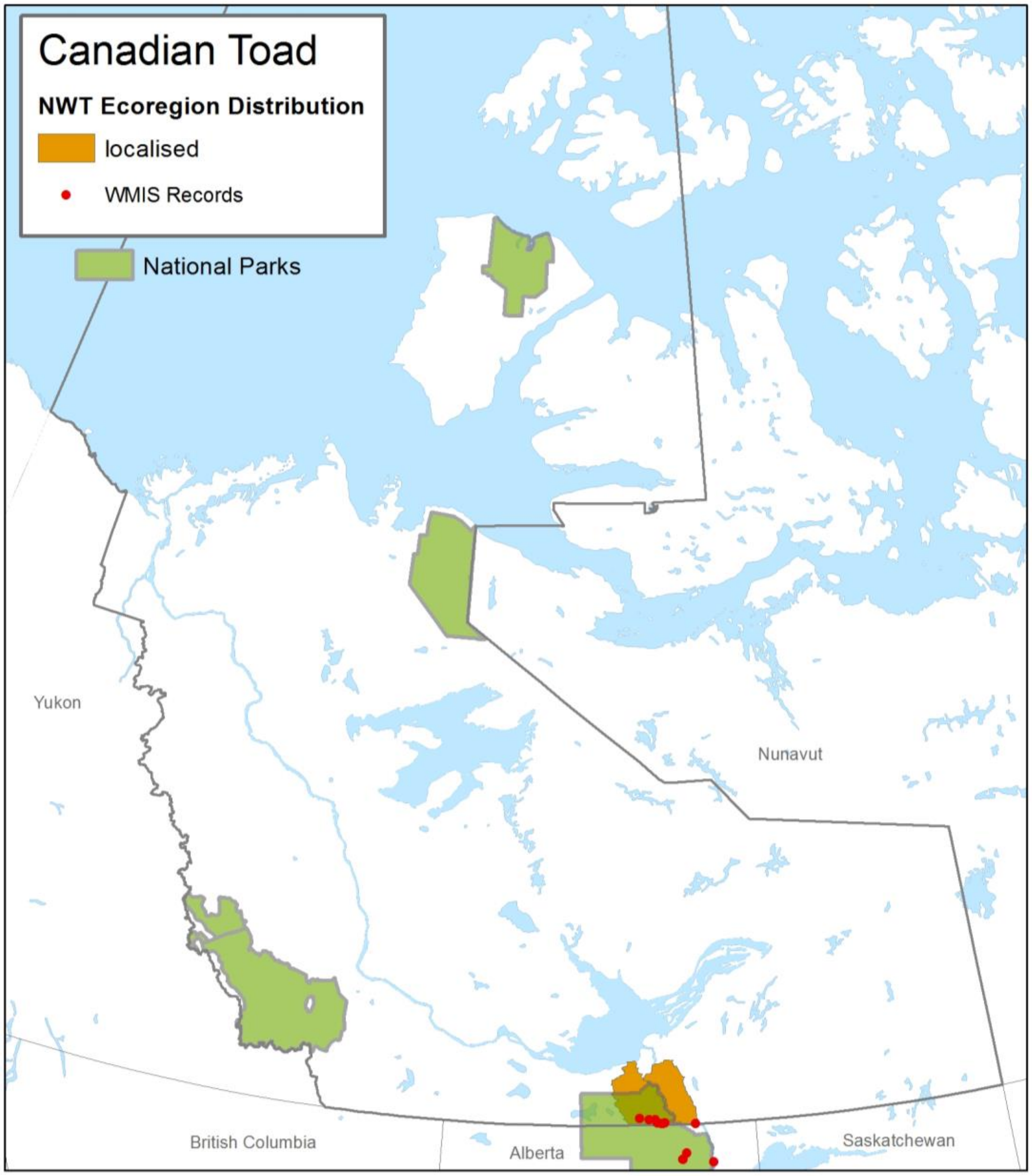

Figure 15. Distribution of Canadian toad in Northwest Territories. Map prepared by Bonnie Fournier, Northwest Territories Department of Environment and Natural Resources. Data provided by Department of Environment and Natural Resources (unpubl. data 2016).

The Canadian toad is relatively small for a toad, about 4 to 8 cm long. It is short-legged, thick-skinned and rough in appearance. It is covered in wart-like bumps and has prominent oval or kidney-shaped glands over the shoulders (Figure 13). It has two bony crests on the top of the skull which are either parallel or joined together to form a bump between its eyes (Russell et al. 2000). It is generally grey-green or brown, and the belly is paler with greyish spots. There are two prominent tubercles (hard bumps) on its hind feet that are used for burrowing. The call of the Canadian toad is a short, soft trill that repeats about every 30 seconds. Tadpoles are small and black.

Canadian toads are found in Alberta, Saskatchewan and Manitoba as well as the north-central United States (Figure 14; IUCN SSC Amphibian Specialist Group 2015c). Their range extends northward into the NWT in the Fort Smith area, near the NWT/Alberta border (Figure 15). Their known range in the NWT is small and is probably continuous with populations in northern Alberta (COSEWIC 2003). They are not freeze-tolerant and are probably limited to areas where the ground freezes only to a relatively shallow depth and they can burrow easily. Canadian toads dig backwards using a shuffling motion so they sink into the ground.

Canadian toads typically overwinter either underground or in natural cavities (middens, crevices, abandoned beaver lodges, etc.). Overwintering sites are usually found in sandy soils in upland areas, where the toads can burrow easily (Hamilton et al. 1998; Breckenridge and Tester 1961; Tester and Breckenridge 1964). Canadian toads tend to return to specific wintering sites year after year (Kelleher and Tester 1969). In northern regions, overwintering sites often contain many individuals (Hamilton et al. 1998). One Canadian toad overwintering site in the NWT, in Wood Buffalo National Park near Fort Smith, is estimated to house several hundred individuals (Kuyt 1991; Breckenridge and Tester 1961; Timoney 1996; Hamilton *et al*. 1998).

In the boreal forest, Canadian toads begin calling between mid-May and early June (Hamilton et al. 1998). Canadian toads breed in a wide variety of shallow, permanent or temporary wetlands. These can include shallow areas of lakes, natural ponds, streams, roadside wetlands, and borrow pits (Roberts and Lewin 1979; Hamilton et al. 1998; Schock 2010). At least four breeding sites have been documented in Wood Buffalo National Park, NWT (Schock 2010). Eggs are laid in a single, long strand that can contain up to 7,000 eggs per strand (Seburn 1993; COSEWIC 2003). Depending on water temperature, tadpoles will transform into juvenile toads around 6 to 9 weeks after the eggs are laid (Alberta Environment and Parks 2009).

After the breeding season, Canadian toads tend to move away from breeding ponds and into upland areas (Hamilton et al. 1998). Canadian toads are generally active in the day but if the evenings are warm enough they may be active at night. They sometimes burrow in the ground to avoid drying out and to regulate temperature (COSEWIC 2003; Alberta Environment and Parks 2009).

The global population of Canadian toads is generally thought to be stable (Appendix A; IUCN SSC Amphibian Specialist Group 2015c). Although there have been population declines in south-central Alberta (Hamilton et al. 1998; COSEWIC 2003), the national status of Canadian toad was assessed as not at risk in 2003 because the species was numerous and widely distributed in Canada (COSEWIC 2003). There are no population estimates for the NWT but Canadian toads have been found only in a small area, therefore the NWT population is likely small.

1.4 Salamanders

1.4.1 Long-toed Salamander (*Ambystoma macrodactylum*)

Figure 16. Long-toed Salamander (Photo courtesy of M. Thompson, 2006).

Figure 17. Distribution of Long-toed Salamander in North America. Data from IUCN et al. (2008a).

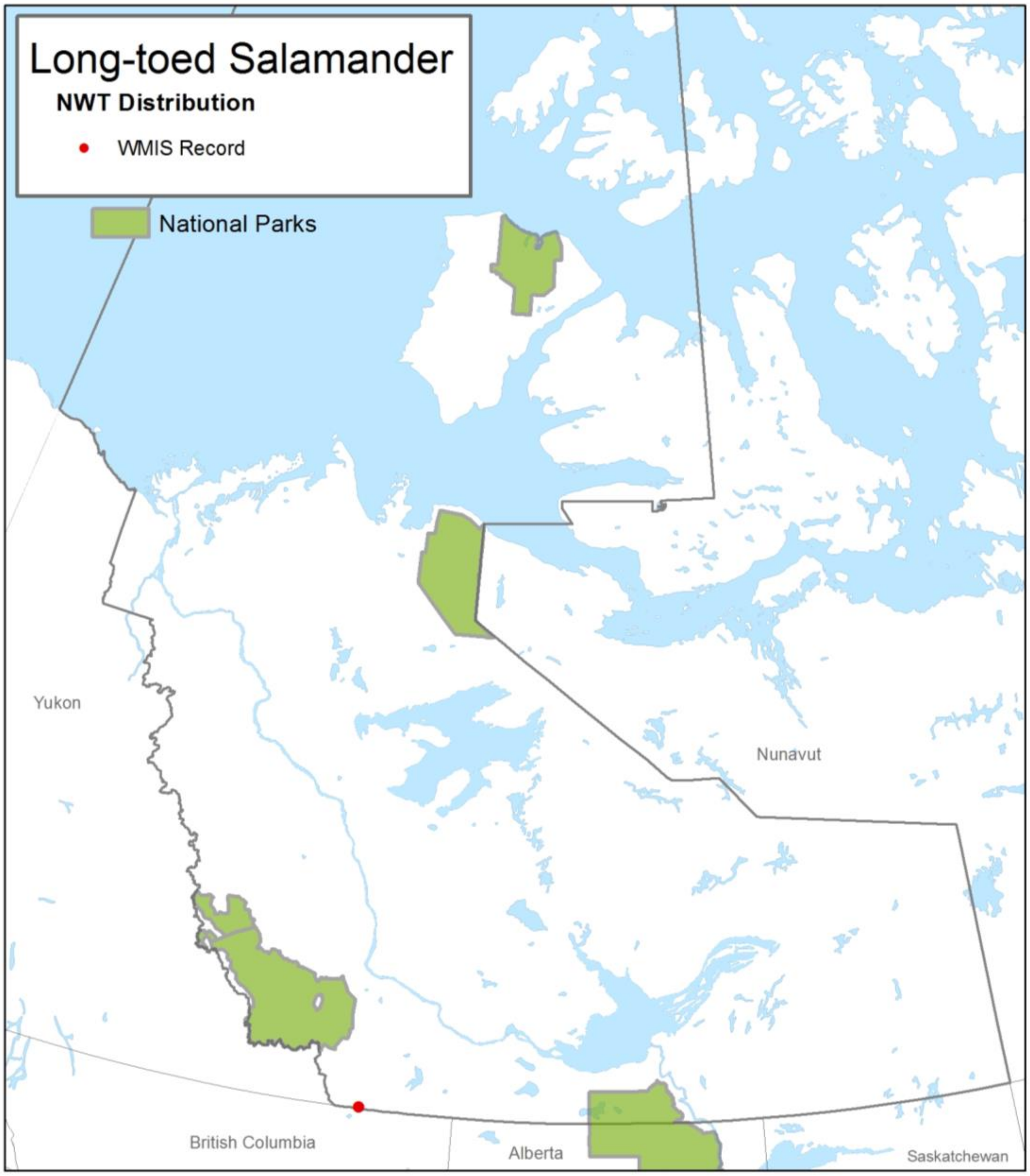

Figure 18. Distribution of Long-toed Salamander in Northwest Territories. Map prepared by Bonnie Fournier, Northwest Territories Department of Environment and Natural Resources. Data provided by Department of Environment and Natural Resources (unpubl. data 2016).

The long-toed salamander can be recognized by its slender, brown to black body with a vivid yellow stripe down its back. It has white flecks on its sides and feet (Figure 16). The fourth toe on the hind foot is noticeably longer than the other toes (COSEWIC 2006). Long-toed salamanders can reach a length of up to 14 cm. Hatchlings and larvae are buff-coloured with feathery gills (COSEWIC 2006).

Long-toed salamanders are found in south-eastern Alaska, British Columbia, the northwest United States, and eastward to the foothills of Alberta (Figure 17; IUCN SSC Amphibian Specialist Group 2015a). There have been no confirmed records (photographs, captures or specimens) of long-toed salamanders in the NWT but people from Fort Liard have reported seeing salamanders. This suggests the species may be found along the shores of rivers in the southern Liard River valley, just north of the NWT border (A. Bourque pers. comm. 1999 as cited in GNWT 2016; D. Allaire pers. comm.).

Long-toed salamanders are not freeze-tolerant. They overwinter underground, deep enough for the temperature to remain above freezing. They are not capable of burrowing so they overwinter in existing natural cavities such as rodent burrows (Semlitsch 1983; COSEWIC 2006).

Most long-toed salamanders likely spend their whole lives near the pond where they were hatched and return to the same breeding site again and again (Blaustein et al. 1994; Fukumoto 1995; Graham 1997). They breed mainly in standing water that may be seasonal or permanent. Breeding sites can include lakes, ponds, flooded meadows, borrow pits, and very slow-moving streams (Corkran and Thoms 1996; Powell et al. 1997; Petranka 2001). Long-toed salamanders are not adapted to fast-flowing water (COSEWIC 2006).

Long-toed salamander eggs are laid singly or in clusters, in water up to 1.5 m deep (Corkran and Thoms 1996; COSEWIC 2006). Reproductive output may be about 100-400 eggs per female and mature long- toed salamanders may not breed every year (Anderson 1967; Fukumoto 1995; Howard and Wallace 1985).

Transformation into the terrestrial adult form could take as little as 3 months or as long as 26 months (Howard and Wallace 1985). Following transformation, long-toed salamanders move from the water to adjacent habitats on land. They can use a wide variety of habitats including forests of various successional stages (Graham 1997).They may be found in the forested understory, hiding under rocks or rotting logs or in small rodent burrows. Vegetated corridors between breeding sites are important for dispersal (Graham and Powell 1999; COSEWIC 2006). Sexual maturity may be reached at 2 or 3 years and their life span may be up to 6 years, or 10 at the most (Russell et al. 1996).

The global population of long-toed salamanders is generally thought to be stable (Appendix A; IUCN SSC Amphibian Specialist Group 2015a). Despite habitat loss in southwestern B.C., the Canadian status of long-toed salamander was assessed as not at risk in 2006 because the species was widespread and abundant in most of its range (COSEWIC 2006). It is still uncertain whether or not long-toed salamanders occur in the NWT.

2. LIMITING FACTORS, THREATS, AND POSITIVE INFLUENCES

2.1 Natural Limiting Factors

Habitat availability and climate limit where amphibians can live in the NWT. The main factors that naturally limit amphibian population growth are predation and breeding failure due to unpredictable environmental events. Population declines are more likely to be caused by predictable factors such as disease or human impacts (see *Threats*).

Habitat and climate:

In the NWT, amphibians are at the northern-most limit of their range in the world. While boreal chorus frogs and wood frogs are freeze-tolerant and hibernate within the frost zone, Canadian toads, western toads and northern leopard frogs do not have this advantage and must hibernate below the frost zone. This difference directly influences the distribution and abundance of NWT amphibians, with boreal chorus and wood frogs being abundant and widespread and the Canadian toad, western toad, and northern leopard frog being comparatively rare and with a restricted distribution (Fournier 1997). All amphibian species require insulation from snow cover to overwinter in the NWT. The availability of suitable overwintering sites in the required temperature range, with early deep snow accumulation, probably limits their distribution.

Summer length may also limit the northward distribution of amphibians, as the summer must be long enough to accommodate egg laying, development, and metamorphosis. As long as suitable overwintering sites can be found, summer length is the most likely determinant of northward range limits (Hodge 1976).

Amphibian distribution in the NWT may also be limited by the availability of suitable breeding sites or by wetland isolation (separation of wetlands by large distances), but the importance of these factors in the NWT is not known.

Stochastic (unpredictable) environmental events:

NWT amphibians tend to breed and/or overwinter communally, depending on the species. They are vulnerable to events occurring at sites where many individuals are concentrated such as breeding sites (adults, eggs, tadpoles and juveniles), migration routes to and from breeding sites, and overwintering sites. NWT amphibians also tend to breed synchronously (many individuals breeding at the same time) and the breeding season is often short, sometimes occurring over just a few warm, calm days. These behaviours have benefits for reproduction and survival, but they also come with risks. An event such as drought, flooding, a pond drying up, or late spring freezing can cause mortality or breeding failure for a group, a generation, or even an entire local population (SARC 2013). Local extinction may occur, followed by recolonization (provided that migrants are available and can move between sites; Smith and Green 2005). Climate change could alter the frequency and severity of these events (see *Threats: Climate change*).

<u>Predation</u>

Amphibians are vulnerable to predators at every life stage from egg to adult. Terrestrial predators in the NWT include birds (e.g. owls, raptors, herons, crows), mammals (e.g. coyotes, foxes, skunks, raccoons, mink, weasels, shrews) and garter snakes. Additional predators of the aquatic life stages include aquatic insects (e.g. diving bugs, diving beetles, dragonflies, horseflies) and many fish (COSEWIC 2003, 2006; SARC 2013, 2014; Dibble et al. 2009).

Predation is an important natural mortality factor for amphibians, especially at early life stages. It is one of the main limits to population growth (SARC 2013, 2014). Outside the NWT, unnatural mortality due to predation by introduced and/or stocked fish has been shown to be a significant limiting factor on amphibian populations (e.g. Funk and Dunlap 1999; Monello and Wright 2001; Tyler et al. 1998a; Pearson 2004a). However, this is not thought to be a significant threat in the NWT at this time.

2.2 Threats

Amphibians face many threats globally and are declining more rapidly than either birds or mammals (Stuart et al. 2004). Their reliance on both aquatic and terrestrial environments, as well as their permeable skin and exposed eggs, contribute to their vulnerability. Major global threats to amphibians include: habitat loss and fragmentation; traffic mortality; collection for food, bait, medicine and education; acid rain; chemical contaminants and pesticides; introduction of exotic competitors and predators and diseases from non-native fish; emerging diseases (e.g., chytrid fungus and ranaviruses); ultraviolet (UV-B) radiation; global climate change (affecting water levels, temperature and weather events); or combinations of these factors (Daszak *et al.* 1999).

Amphibians with naturally small and/or isolated populations, such as northern leopard frog, western toad and Canadian toad in the NWT, are especially vulnerable to threats and declines. Small populations are more likely to be negatively affected by a single threat. Isolated populations are less likely to be 'rescued' (recolonized) from elsewhere following a decline or local extinction. The western toad's ability to recover from population declines is further limited because of its life history characteristics (long lifespan, delayed maturity of females, and females breeding only once a lifetime).

<u>Diseases (chytrid fungus and ranavirus):</u>

Diseases, particularly chytrid fungus and ranaviruses, are the most important current threats to amphibians in the NWT. So far, no disease-related die-offs of amphibians have been recorded in the NWT. However, there is evidence of high mortality and rapid effects associated with these diseases elsewhere (Daszak et al. 1999; Kieseker et al. 2001; Green et al. 2002; Muths et al. 2003; Greer et al. 2005; Harp and Petranka 2006; Skerratt et al. 2007; Gray et al. 2009; Miller et al. 2011). During the assessment of northern leopard frog and western toad (SARC 2013, 2014), the Species at Risk Committee considered the probability of a die-off affecting the NWT's entire population of these species to be high, due to one or a combination of these diseases.

Ranavirus is widespread in the Dehcho and Sahtú regions of the NWT; it was detected there in wood frogs but not in other species. Ranavirus testing is ongoing for samples obtained from amphibians in the South Slave Region (Schock 2009, 2010). Abundant species such as wood frogs can be sources of infection for other rare amphibian species that share their habitat (Schock et al. 2008; Schock 2009). There is currently no treatment or vaccine for ranavirus (CWHC and NWDC 2015b).

Chytridiomycosis, caused by the chytrid fungus *Batrachochytrium dendrobatidis* (Bd), is widespread in amphibians across North America (Ouellet *et al.* 2005; CWHC and NWDC 2015a). Bd has been found in amphibians in Alberta and BC, and on wood frogs, western toads, and boreal chorus frogs near Fort Liard, NWT. Bd testing is ongoing for samples obtained from amphibians from the South Slave Region of the NWT (Schock 2009, 2010). There is evidence that Bd can have negative consequences for amphibian populations (Skerratt et al. 2007), but there is also evidence that Bd is widespread in areas where there is little evidence of harm or where Bd is regularly found in apparently stabilized populations (Ouellet *et al.* 2005; Longcore *et al.* 2007; Pearl *et al.* 2007; Pearl *et al.* 2009; Pilliod *et al.* 2010; Voordouw et al. 2010). There are treatment options for chytridiomycosis in captive amphibians however it is very difficult to treat amphibians in the wild using current methods (CWHC and

NWDC 2015a). New possible treatment options may be emerging (Woodhams et al. 2016).

A third amphibian disease, called “red leg”, is caused by bacterial infection (often *Aeromonas hydrophilia*, but can also be caused by other bacteria). The bacteria are often found in water samples and healthy individuals, but infection is thought to be triggered by environmental stressors such as poor water quality or overcrowding (CWHC 1994). Red leg disease has not been reported in the NWT however it did cause high mortality in northern leopard frogs in Alberta in 1976 (Roberts 1992).

Co-stressors such as increased UV-B radiation, habitat degradation, climate change, or water mold (*Saprolegnia*) may make amphibians more vulnerable to infections and the diseases more harmful (Kiesecker et al. 2001; Gray et al. 2009).

Disease agents can be transmitted between species and apparently healthy individuals can be carriers, so transporting amphibians from site to site can spread disease. Humans may also be agents of disease transmission between wetland sites on gear such as waders and research equipment. Therefore, there is concern that research, monitoring and resource development activities might increase access to amphibian habitat and lead to disease spread. Following protocols of sterilization and disinfection can help to prevent human-assisted spread (CWHC and NWDC 2015a, 2015b).

Currently, the primary management need is to prevent the human-assisted spread of chytrid fungus and ranavirus within the NWT. Other options are emerging for disease prevention and for managing disease in infected populations (e.g. Woodhams et al. 2016). While not currently considered feasible or necessary in the NWT, these options could be considered if and when they become more widely used,

<u>Habitat loss, degradation and fragmentation:</u>

Habitat loss has a clear and well understood impact on populations of amphibians (Lesbarrères et al. 2014). They need multiple habitat types for different life stages and/or seasons, such as shallow water bodies, foraging grounds and overwintering habitat, and corridors that link these habitats are important as well (Ficetola 2015). Removing or modifying even one of the necessary habitat types could lead to the landscape no longer being able to support the species (Pope et al. 2000).

Wetland loss or modification, including activities that alter water flow, can damage or destroy amphibian breeding habitat. For example, hydroelectric development that leads to decreased water levels might result in the loss of breeding ponds or in ponds drying up before metamorphosis (Environment and Natural Resources 2016). Altering water flows can also create new habitat, however these sites could have a negative effect on population persistence if they turn out to be population sinks. Reduced flows on the Slave River in spring and summer (due to dams and reservoirs upstream) may have already had an impact on northern leopard frog breeding habitats, and concerns were raised about potential further impacts if the proposed Taltson Basin Hydroelectric Expansion Project is pursued (Dezé Energy Corporation 2007, 2009; SARC 2013). Amphibians may also be vulnerable to activities that clear vegetation from around waterbodies; these effects may be mitigated by maintaining vegetation buffers (Hamilton *et al*. 1998).

Amphibian habitat may be fragmented if land clearing (e.g. roads, cutblocks, transmission corridors) makes the habitat unsuitable for amphibians to move through (e.g., too dry) or block migration and dispersal. Sites that become isolated by landscape disturbance are less likely to be recolonized after a local decline or extinction (Marsh and Trenham 2001). Species with relatively limited dispersal abilities, such as northern leopard frog and boreal chorus frog, are more vulnerable to disruption of movement and dispersal corridors compared to the western toad, which can forage in and cross open areas (Smith and Green 2005). Additional effects of roads can include road kill mortality (see *Accidental human-caused mortality*) and expansion of invasive species (Lesbarrères et al. 2014). A possible link between road density and increased predation has also been proposed (Reeves et al. 2008).

Wood frogs appear to be vulnerable to the effects of logging activities that reduce vegetative cover, uncompacted forest litter and coarse woody debris (IUCN SSC Amphibian Specialist Group 2015d).

Amphibians including the northern leopard frog, western toad and Canadian toad commonly use human-made habitats such as roadside ditches, road ruts, tailings ponds, and borrow pits (Jones *et al*. 2005; COSEWIC 2009; COSEWIC 2012). Although human-made habitats may attract amphibians and be colonized by breeding individuals, they can sometimes be ‘population sinks’ that result in a negative effect on population persistence (Stevens and Paszkowski 2006). Such sites may also dry up too soon or provide poor overwintering or foraging habitat. Amphibians using human-made habitats are also vulnerable to mortalities from equipment use, overburden removal, changes in water availability and vehicles (see *Accidental human-caused mortality*). Thus, breeding effort at these sites may be wasted (Seburn *et al.* 1997; Stevens and Paszkowski 2006). The only known breeding sites of western toad in the NWT are in a gravel pit, all in close proximity, but it is unknown whether use of these sites leads to reproductive success (Schock 2009).

The overall effects of habitat loss, degradation and fragmentation on amphibians in the NWT are probably localized and small scale at this time. However, there can be a large effect on a population if important sites are impacted (e.g. breeding ponds or overwintering sites used by many individuals, year after year), especially where the species has a small range or limited habitat (e.g. western toad, northern leopard frog, Canadian toad).

<u>Accidental human-caused mortality</u>

Amphibians can be killed by vehicles, including ATVs (Fahrig et al. 1995; Carr and Fahrig 2001; Eigenbrod et al. 2008). This may be an under-reported and possibly important threat to amphibians in the NWT. Mortality is related to the degree of traffic. It is of particular concern where traffic on roads or trails overlaps with areas where amphibians are concentrated, such as breeding ponds and overwintering sites.

Adults and juveniles of western toads and Canadian toads are vulnerable to road kill near breeding, foraging and hibernation sites, especially during mass movement events. Recent mass mortality events caused by vehicles have been reported for western toads at several sites in B.C. (COSEWIC 2012) and Canadian toads are expected to be vulnerable to these sorts of events as well (COSEWIC 2003). In the NWT, Schock (2009) reported ATV use in and around western toad breeding ponds and Kuyt (1991) reported road-killed Canadian toads near overwintering sites in Wood Buffalo National Park. There is also some evidence that northern leopard frogs are negatively affected by road traffic (Carr and Fahrig 2001; Eigenbrod et al. 2008).

Compaction or removal of snow by snowplows or snowmobiles at overwintering sites can increase frost penetration and potentially lead to amphibian mortality (Tester and Breckenridge 1964). This has been raised as a concern for Canadian toads in Wood Buffalo National Park (Timoney 1996; Hamilton et al. 1998) and could be an issue for other amphibians if winter traffic overlaps with overwintering sites (D. Schock pers. comm. 2015).

<u>Pollution:</u>

Amphibians are known to be sensitive to chemical contaminants from industrial wastes, agricultural effluents and other sources that are transported by water and air. Pollution has not been identified as a serious threat to amphibians in the NWT at this time (SARC 2013, 2014). However, there is a high level of community concern about water contamination and airborne pollutants in general, and contaminants in the Slave River in particular (Dagg 2016).

Although it is not conclusively known whether contamination from the Alberta oil sands is having downstream and downwind effects on amphibians in the NWT, oil sand process-affected substrates and water have been shown to have negative effects on wood frog egg and tadpole survival, growth and development (Gupta 2009). Environment Canada (2011) is currently evaluating the health of wild amphibian populations close to and at varying distances from oil sands operations, including study sites in the NWT near Fort Smith and Fort Resolution.

Acidification of wetlands from airborne sources may be a source of abnormalities and increased mortality in developing amphibians (Vertucci and Corn 1996). Airborne sulphur from oil and gas extraction in northeast BC and AB is associated with acidification (Austin *et al*. 2008). Heavy metals including zinc, cadmium and copper can have negative effects on amphibian growth, development and survival (Glooschenko *et al*. 1992; Brinkman 1998). Heavy metals are also transported by air.

Amphibians are also vulnerable to pesticides, herbicides and fertilizers (Bishop 1992). 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, and atrazine can disrupt sexual development (Hayes 2004). Nitrogen-based fertilizers such as ammonium nitrate have been shown to affect survival and behavior of frogs (Burgett et al. 2007). In the NWT, permits are required for non-domestic pesticide or herbicide use. Herbicides are occasionally used; for example, along railway corridors and at certain locations along pipelines (Martin pers. comm. 2013 cited in SARC 2014). However, large scale agricultural development is unlikely to occur within the NWT.

Road salts can cause lethal or sublethal effects in amphibians (Harfenist et al. 1989). Sublethal effects of road salts on wood frogs include reduced tadpole activity and weight, and physical abnormalities (Sanzo and Hecnar 2005). Road salt may also affect vegetation types or water quality. Road salt (sodium chloride, NaCl) is used to increase traction on paved roads; its use is planned and monitored in the NWT (Department of Transportation [DOT] 2011). A very low level of calcium chloride (CaCl) is used for dust control on selected roads in the NWT to create a thin and dust-free crust on the highway (Suwala pers. comm. 2013 cited in SARC 2014).

Airborne environmental contaminants have been found in wildlife in the Dehcho region of the NWT as a result of the Fukushima nuclear power plant explosion in Japan in

2011. Contaminants found include very low levels of DDT and Chlordane, perfluorinated and brominated compounds as well as radionuclides (N. Larter pers. comm. 2012 cited in SARC 2014).

Contaminants and UV-B radiation may act synergistically with other environmental stressors and suppress the immune system of amphibians, making them more vulnerable to disease (Carey 1993).

<u>Climate change:</u>

Environmental changes due to global climate change may be a future threat to amphibians in the NWT; however, potential impacts are speculative or ambiguous (Ovaska 1997; Lesbarrères et al. 2014; see also *Factors that may have a positive influence*).

Potential negative impacts of climate change on amphibians could include changes in food availability, changes to wetland habitats (due to altered precipitation, evaporation or permafrost melt), changes to snow insulation for overwintering sites, and reduced connectivity across the landscape (due to drying). Warmer temperatures could also lead to northward expansion of diseases (Hamilton et al. 1998; Muths et al. 2008; Lesbarrères et al. 2014; SARC 2014).

<u>UV-B radiation:</u>

Ultraviolet (UV-B) radiation is a current threat to amphibians in the NWT. A thinner ozone layer is allowing more biologically damaging UV-B radiation to reach the Earth's surface. Increasing UV-B radiation has been proposed as a potential cause of amphibian declines through direct effects on hatching success and survival, as well as interactions with other threats (Blaustein et al. 1998; Blaustein et al. 2003; Blaustein et al. 2005).

The magnitude of the impact in the NWT is believed to be low at this time, but the impact may be higher in combination with other environmental stressors. UV-B may interact with other stressors to encourage infection by pathogens or to induce lethal and sublethal effects such as reduced anti-predator behaviour (Kats *et al.* 2000; Kiesecker et al. 2001). UV-B could be especially problematic in species that lay their eggs in shallow water or near the water's surface or that have a poor ability to repair UV-induced DNA damage, such as the western toad (Blaustein *et al*. 1998).

<u>Collection:</u>

Some personal collection of tadpoles and adult amphibians as ‘pets’ or for bait may occur in the NWT, but likely at a low level (Schock 2009; Côté pers. comm., cited in Rescan 2008). This activity has the potential to impact local populations. The loss of tadpoles at a low level would have much less impact on a population than the removal of breeding adults. Releasing captured individuals at novel ponds could result in the spread of pathogens.

<u>Non-native species:</u>

Non-native species pose very little threat to amphibians in the NWT at the present time. Unlike other parts of Canada, the NWT does not have significant issues associated with fish stocking such as introduced predators, competitors or diseases (COSEWIC 2012; SARC 2013, 2014; see *Natural limiting factors: Predation*). There are invasive plant species in the NWT but there is no evidence of impacts on amphibians.

2.3 Factors that may have a positive influence

Research and increased awareness in recent years has added to our knowledge of amphibians in NWT and the challenges they face (see *How do we know about amphibians?*). Other positive influences on amphibians are factors that may promote population growth.

Environmental changes due to global climate change may have a positive influence on amphibians in the NWT. Like the negative impacts, the potential positive impacts are speculative or ambiguous. A warming climate should favour earlier breeding of amphibians and faster growth rates, maximizing the probability that tadpoles will develop successfully into adults during the brief summer season, and allowing northward range expansion (Corn 2003; Lesbarrères et al. 2014). Increased snow depths, as predicted by the International Panel on Climate Change (IPCC) (2007), may also permit range expansion where overwintering habitat is limited by snow depth. A warmer, moister climate could make it easier for amphibians to move across 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).

There are various land conservation initiatives in the range of NWT amphibians, including proposed and finalized protected/conservation areas and land use plan zones (see www.nwtpas.ca; www.dehcholands.org; www.sahtulanduseplan.org; www.gwichinplanning.nt.ca; www.tlicho.ca; www.pc.gc.ca). Some amphibian habitat is protected from human impacts by restrictions on industrial activities within these areas and zones. These restrictions could have positive impacts on amphibian populations by reducing human impacts.

For amphibians that are species at risk, legislation describes how the impacts on these species and their habitats should be considered through the regulatory process during preliminary screenings and environmental assessment. For species assessed or listed as at risk in the NWT, sections 76 and 77 of the *Species at Risk (NWT) Act* require the Minister of Environment and Natural Resources to make a submission to the body responsible for assessing the potential impacts of a proposed development, or for considering a land use permit or water licence application, respecting the potential impacts of the proposed development, permit or licence application on the species or its habitat. For nationally listed species, section 79 of the federal *Species at Risk Act* states that during an assessment of effects of a project, the adverse effects of the project on listed wildlife species and its critical habitat must be identified, that measures are taken to avoid or lessen those effects, and that the effects need to be monitored.

2.4 Knowledge Gaps

Much basic research is still required for all NWT amphibians. Important breeding sites and overwintering sites should be identified; very few are currently known. Given the limited search effort, and inherent difficulties in surveying a low density or patchily distributed species, there is the potential for many undiscovered breeding populations. Detailed information on range, abundance, habitat and population trends, limiting factors, movements, habitat use and reproduction is mostly lacking for amphibians across the NWT. Quantitative information on environmental contaminants in water and sediments are also lacking. Additional research could include daily and seasonal activity periods, rates of growth, sexual maturity, and the impacts of climate change (Fournier 1997).

Detecting trends in amphibian numbers requires long-term data because amphibian populations naturally fluctuate and are vulnerable to random events. Single surveys can greatly bias apparent trends and repeated surveys are required to monitor trends. Restricting surveys to historic breeding sites does not distinguish between population losses and site-switching or the occupation of new habitats.

3. MANAGEMENT, CONSERVATION AND RECOVERY

3.1 Goal and Objectives

Goal/Vision:

The management, conservation and recovery goal is to maintain a healthy and viable population for each amphibian species across its NWT range.

Objectives:

1. Improve knowledge about NWT amphibians, including traditional, community and scientific knowledge, to inform sound management decisions.
2. Identify and maintain key amphibian habitats.
3. Mitigate, monitor and manage the effects of disease and other important threats to amphibians.
4. Increase public awareness and stewardship of amphibians and their habitats.
5. Manage amphibians using an adaptive and collaborative approach, and the best available information.

3.2 Approaches to Achieve Objectives

This management plan recommends approaches to achieve the objectives for amphibians. The recommended approaches are described below and summarized in Table 1.

The approaches are relevant to all amphibians, but some are noted to be especially important for 'at risk' amphibians. This means species that are endangered, threatened or special concern. As of 2016 this includes northern leopard frog and western toad, but the list of at risk amphibians could change in the future.

The relative priority and timeframe for each approach is provided in Table 1.

Objective #1: Improve knowledge about NWT amphibians, including traditional, community and scientific knowledge, to inform sound management decisions.

The focus of Objective #1 is to improve our knowledge of amphibians in the NWT and fill information gaps by encouraging research, monitoring, and reporting. Information and knowledge is required for sound, well-informed management decisions. This includes traditional, community and scientific knowledge respecting amphibian distribution, population trends and threats in the NWT – as well as how these are changing through time.

1.1 Identify knowledge gaps and encourage research and monitoring focused on amphibian health/disease, biology, population, distribution, habitat, threats, climate change, and cumulative effects.
1.2 Periodically survey known breeding sites, especially for at risk amphibian species.
1.3 Encourage people to report observations of amphibians to WILDLIFEOBS@gov.nt.ca, and periodically compile all records.
1.4 Encourage the collection and recording of traditional and community knowledge about amphibians.

Objective #2: Identify and maintain key amphibian habitats.
The focus of Objective #2 is to identify key amphibian habitats that are important to maintaining healthy and viable populations, such as breeding sites and overwintering sites. These sites may be important if they are used by many individuals or if suitable habitat of that type is limited. Identifying key habitats would permit the targeted and effective protection of these areas so that human impacts are minimized, and would also facilitate ongoing monitoring. This objective would benefit all amphibians but is particularly important for at risk amphibian species.

2.1 Identify and map key amphibian habitats using information from 1.1 to 1.4.
2.2 At key sites where amphibians are concentrated, promote measures to prevent mass mortality from motorized vehicles.
2.3 Identify and then avoid or mitigate human impacts on key amphibian habitats through the regulatory process (permitting, screening and environmental assessment), legislation, land use planning, conservation areas, stewardship or other effective mechanisms.
2.4 Develop standard advice for industry and government to mitigate the impacts of development projects, timber harvesting and roads on amphibians.

Objective #3: Mitigate, monitor and manage the effects of disease and other important threats to amphibians.

The focus of Objective #3 is to ensure that chytrid fungus, ranaviruses and other important threats are monitored and appropriately managed. Currently, the primary management need is to prevent the human-assisted spread of chytrid fungus and ranavirus within the NWT. Protocols to prevent spread should be followed and, if necessary, updated for the NWT (CWHC and NWDC 2015a, 2015b). Other options are emerging for disease prevention and for managing disease in infected populations (e.g. Woodhams et al. 2016). While not currently considered feasible or necessary in the NWT, these options could be considered if and when they become more widely used, or the impacts of disease in the NWT become more significant. Monitoring to keep track of diseases and their impacts will enable this sort of adaptive management.

Introduction of non-native fish is not currently a concern in the NWT, but care should be taken to avoid or mitigate impacts on amphibians if fish stocking is considered in the future.

3.1 Monitor amphibian diseases (chytridiomycosis and ranavirus) and their impacts in the NWT.
3.2 Develop and/or adopt best practices to prevent the spread of disease in wetlands and ponds.
3.3 Ensure that any introductions of live fish follow the National Code on Introductions and Transfer of Aquatic Organisms[1]; and consider potential impacts on amphibians.

Objective #4: Increase public awareness and stewardship of amphibians and their habitats.

The focus of Objective #4 is to increase public knowledge and interest, and to encourage people to take responsibility for the conservation of amphibians and their habitat. Fostering stewardship behavior can lead to conservation benefits for the species. It can also help to improve information as people become more likely to notice amphibians and report their observations.

4.1 Raise awareness of NWT amphibians and the threats they face through various means (e.g., posters, brochures, web, social media, interpretive signs, presentations, school programs).

[1] http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/code-eng.htm

4.2 Encourage and support stewardship projects that benefit amphibians and their habitat.

Objective #5: Manage amphibians using an adaptive and collaborative approach, and the best available information.

The focus of Objective #5 is to have the Government of the Northwest Territories and co-management partners periodically review the latest information on the state of amphibians in the NWT. Regular check-ins would help ensure that the management plan is actively used and that management actions are adjusted if needed. Co-management is required under land claim and self-government agreements. Collaboration also fosters information-sharing and helps to ensure that all groups who can have an impact on amphibians are engaged.

5.1 Collaborate with other jurisdictions and research institutions on management, monitoring and information sharing.

5.2 Encourage flow of information among researchers, co-management partners, regulatory boards and the public.

5.3 Conduct periodic co-management reviews of new information, management actions and progress made toward meeting management objectives.

3.3 Measuring Progress

At least every five years, the Government of the Northwest Territories, in cooperation with co-management partners, will report on the actions undertaken to implement this management plan and progress made towards meeting its objectives. The first such report will be due in 2022. The management plan may also be updated at this time.

Management will be considered successful if the goal is achieved; that is, if a healthy and viable population is maintained for each amphibian species across its NWT range.

Overall success can be measured through population trends (population stable, increasing, or not indicative of ongoing decline); species distributions (species continues to be found in its historical range and range recession has not occurred); and species status (species has not become at risk or further at risk when assessed/re-assessed). These are long-term indicators of success.

The performance measures in Table 1 may be used to measure progress on the approaches in the short term.

Table 1. Recommended approaches for the management, conservation and recovery of NWT amphibians

Objective	Management Approaches	Relative Priority[2] / Time frame[3]	Performance Measures[4]
Objective #1: **Improve knowledge about NWT amphibians, including traditional, community and scientific knowledge, to inform sound management decisions.**	1.1 Identify knowledge gaps and encourage research and monitoring focused on amphibian health/disease, biology, population, distribution, habitat, threats, climate change, and cumulative effects.	Necessary/ Ongoing	Research and monitoring are conducted and results are shared. New knowledge on amphibians in the NWT is learned.
	1.2 Periodically survey known breeding sites, especially for at risk amphibian species.	Critical/ Ongoing	Known breeding sites for northern leopard frog and western toad are periodically surveyed.

[2] **Relative priority** can be *critical*, *necessary* or *beneficial*. *Critical* approaches are the highest priority for the conservation of amphibians and should be implemented sooner rather than later. *Necessary* approaches are important to implement for the conservation of amphibians but with less urgency than *critical*. *Beneficial* approaches help to achieve management goals but are less important to the conservation of the species compared to *critical* or *necessary.*

[3] **Relative timeframe** can be short-term, long-term, or ongoing. Short-term approaches should be completed within five years and long-term approaches require more than five years to complete. Ongoing approaches are long-term approaches help to achieve management goals but are less important to the conservation of the species compared to critical or necessary.

[4] Implementation of this co-management plan and companion document is subject to appropriations, priorities, and budgetary constraints of the participating management organizations. This table represents guidance from all partners as to the priority of the approaches and appropriate measure of performance.

Objective	Management Approaches	Relative Priority[2] / Time frame[3]	Performance Measures[4]
	1.3 Encourage people to report observations of amphibians to WILDLIFEOBS@gov.nt.ca, and periodically compile all records.	Beneficial/ Ongoing	The number of reported observations increases and records are maintained in a database.
	1.4 Encourage the collection and recording of traditional and community knowledge about amphibians.	Necessary/ Ongoing	Information is collected and documented and results are shared.
Objective #2: **Identify and maintain key amphibian habitats.**	2.1 Identify and map key amphibian habitats using information from 1.1 to 1.4.	Critical/ Ongoing	The number of known key sites increases.
	2.2 At key sites where amphibians are concentrated, promote measures to prevent mass mortality from motorized vehicles.	Necessary/ Short term	Measures are in place at sites where vehicle traffic is identified as a concern.
	2.3 Identify and then avoid or mitigate human impacts on key amphibian habitats through the regulatory process, legislation, land use planning, conservation areas, stewardship or other effective mechanisms.	Critical/ Ongoing	Key sites are recognized and considered in decision-making; key sites persist and are not destroyed.

Objective	Management Approaches	Relative Priority[2] / Time frame[3]	Performance Measures[4]
	2.4 Develop standard advice for industry and government to mitigate the impacts of development projects, timber harvesting and roads on amphibians.	Beneficial/ Short term	Standard advice is in place and is being used in the regulatory process.
Objective #3: **Mitigate, monitor and manage the effects of disease and other important threats to amphibians.**	3.1 Monitor amphibian diseases (chytridiomycosis and ranavirus) and their impacts in the NWT.	Necessary/ Ongoing	Diseases monitoring is taking place.
	3.2 Develop and/or adopt best practices to prevent the spread of disease in wetlands and ponds.	Critical/ Short term	There is compliance with best practices.
	3.3 Ensure that any introductions of live fish follow the National Code on Introductions and Transfer of Aquatic Organisms; and consider potential impacts on amphibians.	Beneficial/ Long term	Any introductions are compliant with the National Code.
Objective #4: **Increase public awareness and stewardship of amphibians and their habitats.**	4.1 Raise awareness of NWT amphibians and the threats they face through various means (e.g., posters, brochures, web, social media, interpretive signs, presentations, school programs).	Necessary/ Ongoing	Communication is taking place and knowledge/interest among the public is increasing.

Objective	Management Approaches	Relative Priority[2] / Time frame[3]	Performance Measures[4]
	4.2 Encourage and support stewardship projects that benefit amphibians and their habitat.	Necessary/ Ongoing	Number of stewardship projects increases.
Objective #5: **Manage amphibians using an adaptive and collaborative approach, and the best available information.**	5.1 Collaborate with other jurisdictions and research institutions on management, monitoring and information sharing.	Necessary/ Ongoing	Collaborative research/monitoring projects and management initiatives are taking place.
	5.2 Encourage flow of information among researchers, co-management partners, regulatory boards and the public.	Necessary/ Ongoing	Information is being shared.
	5.3 Conduct periodic co-management reviews of new information, management actions and progress made toward meeting management objectives.	Critical/ Ongoing	Periodic co-management reviews are taking place.

3.4 Socioeconomic and Environmental Effects of Management

Collection and harvest of amphibians may occur at a low level in the NWT, but they are not generally considered important as food for humans. Therefore, management of amphibians is not expected to have a significant impact on cultural practices or the exercise of Aboriginal or treaty rights.

Maintaining key amphibian habitats (Objective 2) could have a negative impact on development or recreation opportunities if planned activities overlap with key habitat sites. However, key habitat sites will likely be small and specific, so any potential conflicts should be localized. Identifying and then avoiding or mitigating impacts through the regulatory process, legislation, land use planning, conservation areas, stewardship or other effective mechanisms would involve consideration of socioeconomic impacts through each of those processes as appropriate. This approach is also consistent with the species at risk-related legislative requirements already in place for northern leopard frog and western toad (section 76-77 of the *Species at Risk (NWT) Act* and section 79 of the federal SARA).

Humans are a likely vector of amphibian disease by moving infections among waterbodies on clothing or equipment. An increase in research and monitoring in amphibian habitats could increase the risk of human-assisted disease transmission. Appropriate protocols should be followed to prevent disease spread (CWHC and NWDC 2015a, 2015b).

Collection of large numbers of at risk amphibians for research and monitoring could prove detrimental to the survival of the species. If at risk amphibians are collected for these purposes, care should be taken to ensure that the total number taken is small relative to total population size.

The recommended approaches in this management plan are not expected to have significant negative impacts on other species. Maintaining key amphibian habitats could potentially benefit other wetland species that share those habitats.

4. NEXT STEPS

Management partners will use this plan to help in assigning priorities and allocating resources in order to manage amphibians in the NWT.

This management plan will be followed by a consensus agreement by the Conference of Management Authorities that will lay out the actions the participating management authorities intend to undertake to implement it. This management plan does not commit any party to actions or resource expenditures; implementation of this plan is subject to appropriations, priorities, and budgetary constraints.

Success in the management, conservation and recovery of NWT amphibians depends on the commitment and cooperation of various groups involved in directing this plan and cannot be achieved by the Government of the Northwest Territories or any one agency alone. All NWT residents are invited to join in supporting and implementing this plan for the benefit of amphibians and NWT society as a whole.

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List to be completed as a final step once the management plan is finalized.

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APPENDIX 1: STATUS SUMMARY OF NWT AMPHIBIANS

Species	**Jurisdiction**	**Status Rank NatureServe**[5] (Coarse filter – to prioritize)	**Status Assessment**[6] (Fine filter – to provide advice)	**Legal Listing**[7] (To protect under species at risk legislation)
Northern Leopard Frog	**NWT**	S1S2 – Critically Imperiled - Imperiled[8]	Threatened - 2013	Threatened - 2015
	Canada	N5 – Secure (2011)	Special Concern - 2009	Special Concern - 2005
	Global	G5 - Secure (2002)	LC - Least Concern[9]	N/A

[5] The NatureServe Ranking definitions are based on the NatureServe conservation status assessments that determine the extinction risk of species and elimination risk of ecosystems at global scales, as well as their extirpation risk at national and subnational scales: http://explorer.natureserve.org/

[6] Status assessments are independent biological assessments. A status assessment in the NWT is determined by the NWT Species at Risk Committee (SARC) http://www.nwtspeciesatrisk.ca/SARC . Status in Canada is assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC): http://www.cosewic.gc.ca/ and the species status assessment can be found at: www.sararegistry.gc.ca . Global status is assessed by IUCN Species Survival Commission (SSC) and is found on the IUCN Red List of Threatened Species: http://www.iucnredlist.org/

[7] Legal Listing is the legal status of the species on the NWT List of Species at Risk under the territorial *Species at Risk (NWT) Act*: www.nwtspeciesatrisk.ca and on Schedule 1 of the national Species at Risk Act: www.sararegistry.gc.ca. There is no global legal listing.

[8] For NatureServe definitions of rankings, (including *Critically Imperiled* and *Imperiled*), see: http://www.natureserve.org/conservation-tools/conservation-status-assessment

Species	Jurisdiction	Status Rank NatureServe[5] (Coarse filter – to prioritize)	Status Assessment[6] (Fine filter – to provide advice)	Legal Listing[7] (To protect under species at risk legislation)
Boreal Chorus Frog	**NWT**	S4 – Apparently Secure	Not assessed	Not listed
	Canada	N5 – Secure (2011)	Not assessed	Not listed
	Global Status	G5 – Secure (2008)	LC – Least Concern (2008)	N/A
Wood Frog	**NWT**	S4S5 – Apparently Secure-Secure	Not assessed	Not listed
	Canada	N5 - Secure (2011)	Not assessed	Not listed
	Global Status	G5 – Secure (2008)	LC-Least Concern (2014)	N/A
Western Toad	**NWT**	S2S3 – Imperiled-Vulnerable	Threatened - 2014	Threatened - 2015
	Canada	N4 – Apparently Secure (2011)	Special Concern - 2012	Special Concern - 2005
	Global Status	G4 – Apparently Secure (2008)	LC-Least Concern	N/A

Species	**Jurisdiction**	**Status Rank NatureServe**[5] (Coarse filter – to prioritize)	**Status Assessment**[6] (Fine filter – to provide advice)	**Legal Listing**[7] (To protect under species at risk legislation)
Canadian Toad	**NWT**	S3 – Vulnerable	Not assessed	Not listed
	Canada	N4N5 – Apparently Secure-Secure (2015)	Not at risk - 2003	Not listed
	Global Status	G4G5 – Apparently Secure-Secure (2015)	LC-Least Concern	N/A
Long-toed Salamander	**NWT**	Not ranked	Not assessed	Not listed
	Canada	N4N5 – Apparently secure-Secure (2015)	Not at risk (2006)	Not listed
	Global Status	G5 – Secure (2015)	LC-Least Concern (2004)	N/A