

SPECIES DETECTION SURVEY PROTOCOLS

AMPHIBIAN AUDITORY SURVEYS



Fish and Wildlife Branch Technical Report No. 2014-1.0
December 2014



Government
— of —
Saskatchewan

saskatchewan.ca/environment

AMPHIBIAN AUDITORY SURVEY PROTOCOL

First Edition 2014

PUBLISHED BY:

Fish and Wildlife Branch
Ministry of Environment
3211 Albert Street
Regina, Saskatchewan S4S 5W6

SUGGESTED CITATION FOR THIS MANUAL

Saskatchewan Ministry of Environment. 2014. Amphibian auditory survey protocol. Fish and Wildlife Branch Technical Report No. 2014-1.0. 3211 Albert Street, Regina, Saskatchewan. 11pp.

ACKNOWLEDGEMENTS

Alberta's Environment and Sustainable Resource Development Ministry is gratefully acknowledged for provision of their Sensitive Species Inventory Guidelines April 2013 document and permission to adapt the guidelines for Saskatchewan. The document provided a base reference and content source for personnel conducting respective species surveys in Saskatchewan.

Saskatchewan Amphibian Auditory Survey Protocol Acknowledgements: Sue McAdam has compiled much of the respective Saskatchewan species-specific survey protocol parameters and lead edits of the Saskatchewan protocol versions based on the Alberta Sensitive Species Inventory Guidelines April 2013. The Research Permit Process Renewal working group (Karyn Scalise, Sue McAdam, Ben Sawa, Jeff Keith, Andrea Benville and Ed Beveridge) has also contributed to reviews of the Saskatchewan protocol along with additional ministry-external reviewers.

COVER PHOTO CREDITS

Canada Toad (*Anaxyrus hemiophrys*), Matthew Weiss, Ministry of Environment

CONTACT

ENV.researchpermit@gov.sk.ca

COPYRIGHT

Brand and product names mentioned in this document are trademarks or registered trademarks of their respective holders. Use of brand names does not constitute an endorsement.

Except as noted, all illustrations are copyright 2014, Ministry of Environment.

1.0 AMPHIBIAN AUDITORY SURVEY PROTOCOL

1.1 INTRODUCTION

This survey protocol provides instruction on collecting data for the occupancy (presence/not-detected) of amphibians that can be identified by their call. Call surveys are an imperfect method of detection and lack of calling does not necessarily mean an absence of anurans in the area (MacKenzie et al. 2002). Call surveys, combined with shore-based egg, larvae and young surveys, maximize detection of amphibians while minimizing disturbance to amphibians and their habitats. A separate Amphibian Visual Survey Protocol exists for anurans that cannot be detected by call (Saskatchewan Ministry of Environment 2014a).

1.1.1 Inventory Group

Saskatchewan has eight known species of amphibians. Until 2012, there were seven species documented in the province. Plains spadefoot (*Spea bombifrons*), Great Plains toad (*Anaxyrus cognatus*), tiger salamander (*Ambystoma mavortium*), Canadian toad (*Anaxyrus hemiophrys*), boreal chorus frog (*Pseudacris maculata*), northern leopard frog (*Lithobates pipiens*) and the wood frog (*Lithobates sylvaticus*). In addition, observation record cards for gray tree frogs (*Hyla versicolor*) were submitted by Peter Taylor to the Royal Saskatchewan Museum in 2008 and 2009 (R.G. Poulin pers. comm.).

1.1.2 Status and Distribution

Over the past 50 years, many species of amphibians throughout the world have experienced population declines and, in some cases, have become extirpated or extinct. There is global concern about these declines, which take place even in undisturbed areas. However, the extents of the declines are not well known (Collins and Storer 2003). The annual population size for many species is quite variable and this is especially evident for two irruptive species: the Great Plains toad and the plains spadefoot. For further information on the status of amphibians in Saskatchewan, please visit the [Saskatchewan Conservation Data Centre \(SKCDC\)](#). Additional information may be provided in [Committee on the Status of Endangered Wildlife in Canada \(COSEWIC\) Status Reports](#) and in the [Species at Risk Act \(SARA\) Registry](#) documents.

Seven Saskatchewan amphibians are found predominantly in the southern extent of the province. Plains spadefoot (*Spea bombifrons*), Great Plains toad (*Anaxyrus cognatus*) and the tiger salamander (*Ambystoma mavortium*) inhabit only in the southern part of the province. Conversely, the Canadian toad (*Anaxyrus hemiophrys*), boreal chorus frog (*Pseudacris maculata*), northern leopard frog (*Lithobates pipiens*) and wood frog (*Lithobates sylvaticus*) are also found in the northern part of the province (CARCNET 2011). Several records for gray tree frogs (*Hyla versicolor*) were reported near Armit in the eastern part of Saskatchewan (Taylor 2009). Unconfirmed locations for gray tree frogs reported by Ron Hooper, include Fort Qu'Appelle and Katepwa (Taylor 2009). Most species are at the northern edge of their global range, with a few species (e.g., wood frogs) extending their distribution into the territories. Increased search effort may provide new locations for the gray tree frog.

1.1.3 Biology

Amphibians develop from gilled larvae that are completely aquatic to primarily terrestrial adults that breathe air. Their skin remains permeable, keeping them closely tied to water and leaving them susceptible to environmental contaminants. Terrestrial habitats must offer cover and moisture. They are both ectothermic and poikilothermic (i.e., body temperature mainly controlled by the external environment, with considerable variation in internal temperature).

Amphibian habitat requirements vary with species (Table 1.1). Amphibians are small, primarily nocturnal and are widely dispersed for most of their active period. They are dormant throughout the winter, hibernating usually alone in protected terrestrial habitats, subterranean burrows, or mud at the bottom of standing or slow-flowing water. Mima mounds created by pocket gophers (*Thomomys talpoides*), may be used by species such as the Canadian toad where thousands of individuals may hibernate together (Elliott et al. 2009).

Table 1.1. Description of amphibian habitat.

Species	Habitat (Russell and Bauer 1993, Fisher et al. 2007, Elliott et al. 2009)
Great Plains toad	A prairie species, frequents sandy areas near irrigation canals, ephemeral ponds, dugouts and flood plains. Identifiable during years of high precipitation.
Canadian toad	Associated with sandy soils. Can be found in borders of shallow lakes, ponds and ephemeral wetlands in prairies and open aspen groves.
Gray tree frog	Nocturnal and arboreal, may be found on trees and shrubs near permanent water. Prefer mature or second growth forests. Daytime retreats are tree cavities in wet wooded areas.
Boreal chorus frog	Can be found in almost any waterbody. Located in grassy pools, lakes, marshes, flooded fields, ponds and roadside ditches during the breeding season.
Plains spadefoot	Primarily in native prairie, near permanent or temporary bodies of water (Class 2, 3 and 4 wetlands; Stewart and Kantrud 1971). Usually in areas with soil that is suitable for burrowing - such as sand. Strongly associated with years of high precipitation.
Northern leopard frog	Inhabits springs and permanent waterbodies with abundant vegetation. Generally found where sufficient ground cover from vegetation is available. Requires shallow waterbodies with emergent vegetation for breeding; moist meadows, pastures, or scrublands for foraging, and; deep, permanent waterbodies that do not freeze to the bottom for overwintering.
Wood frog	Primarily found in wooded areas, marshy areas, wet meadows and open ponds.

In Saskatchewan, amphibians typically congregate for breeding from early April to mid-June. Waterbodies used for breeding lack fish and are permanent or semi-permanent. An early breeding period allows larvae to take advantage of high algal productivity and, if breeding in ephemeral waterbodies, to complete metamorphosis before the water dries up.

Population sizes can fluctuate dramatically from year to year and may be weather dependant. Maturation is delayed for most species in Saskatchewan. Furthermore, amphibians can store resources internally, not breeding every year if conditions are poor.

1.2 SURVEY STANDARDS

The standards provide instructions on the areal extent of surveys to be conducted. They provide information on experience, capabilities, minimum equipment needs, survey conditions and permit requirements.

1.2.1 Survey Area Extent

Surveys must be conducted in areas with SKCDC observations as well as in any areas that provide suitable habitat for the species in question. The proposed project area, plus the appropriate setback distances, must be assessed. All suitable habitat within this area must be surveyed. Setback distances identified in the [Saskatchewan Activity Restriction Guidelines for Sensitive Species](#) (Saskatchewan Ministry of Environment 2014b) are based on the species and the level of disturbance associated with the project.

1.2.2 Personnel

Personnel must be able to identify amphibians by call and by sight, identify suitable habitat and be familiar with the survey methodology (Table 1.2). They must also have the ability to estimate the approximate number of amphibians calling at one time and from what direction. Knowledge of specific amphibian biology, behaviour and preferred habitat allows for more accurate results. Observers must have no hearing impairments. If surveys are conducted by remote recording systems, the recordings must be interpreted by people with expertise in interpreting amphibian recordings.

Table 1.2. Call descriptions for Saskatchewan amphibians.*

Species	Breeding call description (Russell and Bauer 1993, Fisher et al. 2007, Elliott et al. 2009)
Great Plains toad	Advertisement call: very loud, repeated harsh chiga-chiga-chiga clatter like a pneumatic drill with 15 pulses per second of great intensity and long duration (up to 50 seconds); males have release call if handled.
Canadian toad	Advertisement call: short (1-5 seconds) melodic soft trill, repeated after about 20 - 30 seconds.
Gray tree frog	Advertisement call: short melodious trill (1/2 second) repeated every few seconds that may be mistaken for bird song; Courtship call: 1 or 2 long calls; Aggressive call: squeaky chirp or weep notes; Release calls: like aggressive call.
Boreal chorus frog	Advertisement call: ±1 second long series rising in pitch and sounds like running a finger over a plastic comb. Calls are repeated with 2 or 3 seconds of rest between series.
Plains spadefoot	Advertising call: short, duck-like squawk of 0.2-0.7 seconds, similar to snoring, repeated once every 1 or 2 seconds.
Northern leopard frog	Advertising call: a drawn-out rattling snore lasting >3 seconds, followed by soft grunts or chuckled notes. Comparable to sound produced by rubbing wet finger on a well-inflated balloon to produce low, snore-like sounds that start soft and increase in volume, then trail off. Call begins with 3 or more of these, followed by interspersed grunting and chuckling sounds.
Wood frog	Advertising call: higher pitched, relatively soft, less intense and shorter than the northern leopard frog call, almost duck-like ca-ha-ha-ca, ca-ha-ha-ca, ca-ha-ha-ca sometimes in a rolling series.

*An excellent source of information, including audio clips of frog calls, is the [Frogwatch Saskatchewan website](#).

Surveys may be conducted by one individual but two are preferred. This is both for the purposes of confirming the identification of calling amphibians on site and for safety reasons.

1.2.3 Survey Effort

At least three call surveys (Mossman et al. 1998) that are spaced to cover the calling season must be conducted. Once target species are detected, subsequent survey visits are not necessary. However, if additional surveys are not conducted to detect additional individuals, presence is assumed in suitable habitat throughout the project area and the appropriate setback distances in the Saskatchewan Activity Restriction Guidelines must be applied.

1.2.4 Time of Year

Surveys must be conducted between the second week of April and the second week of June, with the exception of surveys for the Great Plains toad and the plains spadefoot (See Section 1.2.6.4). Each species has different triggers, such as heavy rain events, that may initiate the calling period. A rough estimate of calling period for Saskatchewan species is depicted in Figure 1.1.

Environmental factors such as rain events and habitat between overwintering sites and breeding ponds, can all affect the start time for the breeding season. An early spring can result in early activity patterns for amphibians. For some species, calling will be initiated as soon as some areas of the waterbody are ice-free.

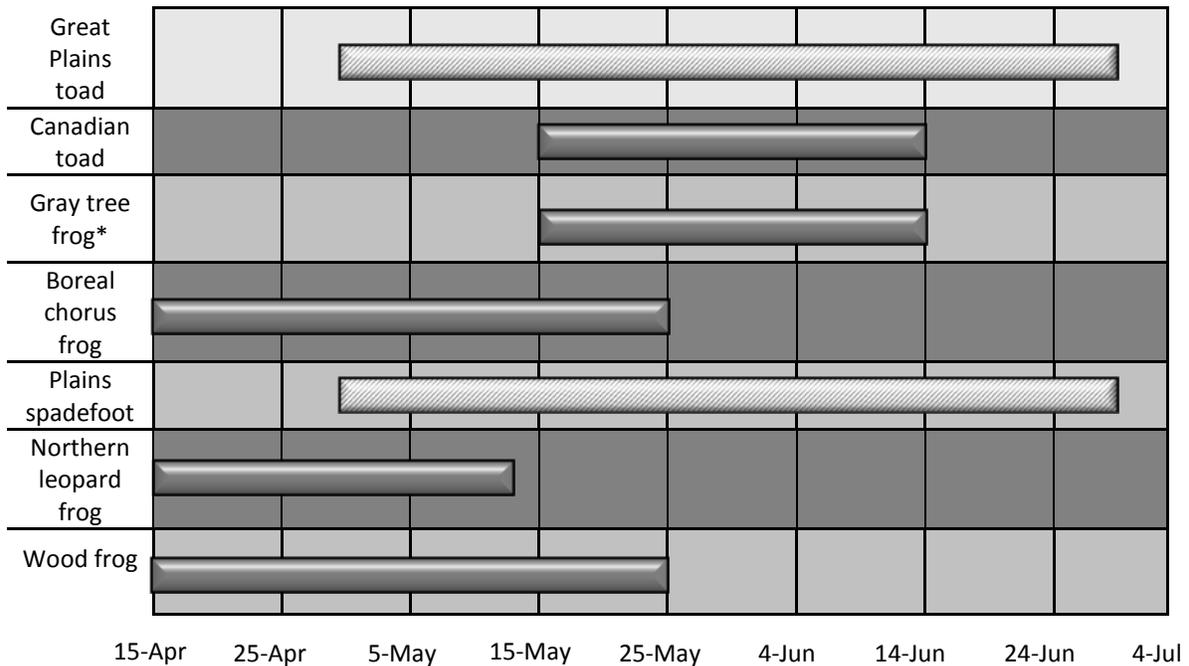


Figure 1.1. Approximate calling periods for Saskatchewan amphibians. NOTE: The hatched bars represent species that are highly dependent on heavy precipitation events and may call at any point of that period if the conditions are suitable for breeding.

*The Manitoba Herp Atlas. Undated.

It is not appropriate to use call surveys outside of the breeding season. Various types of surveys can be conducted at different times of year, including egg mass and young-of-the-year searches. An amphibian visual survey protocol is available for conducting visual surveys of amphibians (Saskatchewan Ministry of Environment 2014a).

1.2.5 Time of Day

Call surveys must be initiated no earlier than 30 minutes after sunset and must be completed no later than 01:00 (Kendell 2002, USGS 2010). After this time, the frequency of calling tends to decrease rapidly.

1.2.6 Environmental Conditions

A compendium of environmental condition standards (Saskatchewan Ministry of Environment 2014c) has been prepared to complement the survey protocols for Saskatchewan. The full range of values for the respective environmental condition (e.g., temperature, precipitation, cloud cover, noise, etc.) has been provided in the standards document with the expectation that appropriate value range(s) will be applied as per the survey protocol parameters.

1.2.6.1 Temperature

Temperature is one of the most important factors in stimulating calling from amphibians (Heyer et al. 1994). Call surveys must be spread throughout the projected calling period (see Figure 1.1), but it will be dependent on appropriate survey conditions and weather. The USGS (2010) sampling rate is as follows:

- Run 1: Minimum air temperature: 6°C
- Run 2: Minimum air temperature: 10°C
- Run 3: Minimum air temperature: 13°C

1.2.6.2 Noise

In order to minimize extraneous noise, the wind must not be higher than a Beaufort level 3 (ACA and ASRD 2010, USGS 2010) with a preference to conduct surveys with a Beaufort level of ≤ 2 . If the winds are approaching 20 km/h, it is preferable to survey downwind from a waterbody to allow the wind to carry the sounds of the calls to the surveyor (Kendell 2002).

Additionally, if call surveys are conducted near busy roads, the sounds of calling amphibians may be drowned out by traffic noises. Observers must be aware of this issue and all other outside distractions that may reduce the quality or success of their survey.

1.2.6.3 Precipitation

Precipitation levels have a large influence on amphibian activity and reproductive cycles (Heyer et al. 1994). Call surveys must not be conducted during heavy rain events, but they may take place during light rain (Kendell 2002, USGS 2010) provided the sound of the rain hitting the water does not impede the ability to hear calling amphibians. Conversely, more calling may occur when there is no rain (Johnson and Batie 2001). Typically, conditions following precipitation events are ideal for surveying for calling amphibians.

1.2.6.4 Required Conditions for Great Plains Toad and Plains Spadefoot Surveys

The Great Plains toad and plains spadefoot are irruptive breeders and may not breed for several years until suitable conditions occur. Generally, the plains spadefoot congregates at breeding ponds after 50 mm of rainfall within one to five days (Taylor and Downey 2003). The Great Plains toad generally congregates at breeding ponds after a short period precipitation event with approximately 100 mm of rain.

1.2.7 Equipment List

- GPS receiver
- Binoculars
- Recording device to record uncertain species for future clarification
- Omnidirectional recorder with recording of anuran calls for remote surveys
- Headlamps/flashlights
- Disinfectant for boots and equipment: use Clorox®-type bleach (5.25% sodium hypochlorite concentration) and mix it with water to produce a 20% bleach-to-water solution. Non-chlorine bleach is unsuitable for decontaminating field gear (Kendell pers. comm.)
- Stopwatch
- Thermometer or environmental data logger
- Amphibian Auditory and Visual Survey Loadform

1.2.8 Permit Requirements

Notification is requested for amphibian auditory surveys. Notification implies the appropriate survey protocol(s) will be used and data loadforms submitted. Survey protocols and loadforms are available on the ministry Research Permit downloads webpage. Please refresh your internet browser to clear any cached websites or bookmarks for this website to ensure you have the most up-to-date information and document versions. Properly conducted surveys and reliable data submissions are vital tools required to understand and manage wildlife populations and their habitat. Data submissions also facilitate and expedite environmental assessment reviews by Fish and Wildlife Branch.

1.3 SURVEY METHODS

The Survey Methods section describes the procedures for conducting amphibian auditory surveys.

1.3.1 Procedures

The procedures include two recognized and widely used methods for detecting amphibians: auditory surveys or automated bio-acoustic call recording.

1.3.1.1 Auditory Surveys

Many wetlands in Saskatchewan are small enough that one survey station is sufficient to cover the area. However, survey station spacing depends upon wetland extent, topography and vegetation cover. Survey stations are to be spaced 800 m apart unless vegetation or terrain interferes with hearing and viewing amphibians (Mossman et al. 1998). In areas with visual or auditory interference (e.g., hills, coulees) survey points may need to be moved closer together to ensure full coverage of the suitable habitat.

Upon arrival at a survey station, observers must record the required fields in the Amphibian Auditory Survey Loadform. Any changes in the weather throughout the survey must also be recorded. The survey must last for at least three (3) minutes (ACA and ASRD 2010).

Once the survey has begun, record all amphibian species that are calling during the three-minute interval. Calls must be recorded using an index adapted from the widely accepted protocol developed by Mossman et al. (1998) (Table 1.3) unless automated recorders are used.

Table 1.3. Abundance index.

Calling Index	Description
0	No amphibians of a given species calling
1	Individual calls, not overlapping (estimate of 1-5 individuals calling at a site)
2	Calls are overlapping, but individuals are still distinguishable (estimate of 6-10 individuals calling at a site)
3	Numerous calls can be heard; chorus is constant and overlapping (estimate of more than 10 individuals)

1.3.1.2 Automated Bio-acoustic Call Recorders/Song Meters

Provided survey standards are met, digital recording devices are an acceptable alternative. This method is good for areas with poor access and for minimizing disturbance by observers. Abiotic data, such as temperature, can be recorded using an environmental data logger (Saenz et al. 2006). These devices can be placed in appropriate locations to record calling amphibians for any length of time, up to an entire breeding season. Once recorded, a well-trained person can review the data using appropriate software. Auditory recordings provide a back-up to confirm field observations (Downes et al. 2000) and are recommended for all observers.

1.3.1.2.1 Recording Equipment

Use an omnidirectional microphone and recording device to record amphibian vocalizations. Position the recording equipment in a north/south direction. With the right microphone on the east side, arrange the recording device and microphone as far apart as possible to ensure noise made by the observer is equally delivered to both microphones. Consult the manual to determine the appropriate recording level of the microphone being used.

1.3.1.2.2 Standardized Recording Procedure

Ensure recording levels are standardized to allow for comparisons and to reduce the chance of poor quality recordings. Recordings must be made at ≥ 320 kbps. At the start of each point count recording, state the date, observer name, point count location and time. Recordings must be interpreted by an expert in identifying amphibians from audio recordings.

1.4 SUBMISSIONS

Please refer to the [Submissions](#) section under the Standard Permit Conditions on the Ministry of Environment website. Observations should be submitted using the appropriate loadform from the [Biodiversity webpage](#). Any incidental wild species (plant or animal) observations should also be submitted to the ministry (ENV.researchpermit@gov.sk.ca) using the Plant or Wild Species Loadform respectively.

[iMapInvasives](#) is the provincial system for submitting the occurrence of invasive plant or animal species. Any observations of prohibited, noxious or nuisance weeds, along with observations of any other invasive species, should be submitted using this website. An account is not required to submit observations. If you have any questions, please contact the [SKCDC](#) for more information.

1.5 ADDITIONAL RESOURCES

[Alberta Northern Leopard Frog Recovery Plan](#)

[Alberta Species at Risk Reports](#)

[Alberta Status Reports](#)

[Canadian Amphibian and Reptile Conservation Network \(CARCNET\)](#)

[COSEWIC Assessment and Update Status Report on the Northern Leopard Frog *Lithobates pipiens*: Rocky Mountain population, Western Boreal/Prairie populations, Eastern populations in Canada.](#)

[Declining Amphibian Task Force \(DAFTA\) Fieldwork Code of Practice](#)

[FrogWatch Saskatchewan](#)

[Saskatchewan Activity Restriction Guidelines](#)

[Saskatchewan Activity Restriction Guidelines for Sensitive Species Background Information](#)

[Saskatchewan Conservation Data Centre \(SKCDC\)](#)

[Status of Canadian Toad in Alberta](#)

[Status of Plains Spadefoot in Alberta](#)

[Status of the Plains Spadefoot \(*Spea bombifrons*\) in Alberta](#)

[Stewart and Kantrud 1971 Wetland Classification System](#)

[The Encyclopedia of Saskatchewan](#)

[The Manitoba Herp Atlas](#)

1.6 LITERATURE CITED

Alberta Conservation Association and Alberta Sustainable Resource Development. 2010. Alberta volunteer amphibian monitoring program – participants guide. Alberta Conservation Association, Edmonton, AB. 46 pp.

- Alberta Sustainable Resource Development. 2003. Status of the northern leopard frog (*Rana pipiens*) in Alberta: Update 2003. Alberta Sustainable Resource Development, Fish and Wildlife Division and Alberta Conservation Association, Wildlife Status Report No. 9 (Update 2003), Edmonton, AB. 61pp. [Online]
<http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/DetailedStatus/documents/nlfrog.pdf>. Accessed October 17th, 2011.
- Alberta Sustainable Resource Development. 2010. The general status of Alberta wild species 2010. Alberta Sustainable Resource Development, Fish and Wildlife Division, Edmonton, AB. [Online]
<http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/GeneralStatusOfAlbertaWildSpecies/GeneralStatusofAlbertaWildSpecies2010/Default.aspx> Accessed October 17th, 2011.
- Alberta Sustainable Resource Development. 2011a. Recommended land use guidelines for protection of selected wildlife species and habitat within grassland and parkland natural regions of Alberta. [Online]
<http://srd.alberta.ca/FishWildlife/WildlifeLandUseGuidelines/documents/WildlifeLandUse-SpeciesHabitatGrasslandParkland-Apr28-2011.pdf> . Accessed October 17th, 2011.
- Government of Alberta. 2012. Integrated standards and guidelines, enhanced approval process. Sustainable Resource Development, Lands Division. Edmonton, AB. [Online]
<http://srd.alberta.ca/FormsOnlineServices/EnhancedApprovalProcess/EAPManualsGuides/documents/EAP-IntegratedStandardsGuide-Jul16-2012.pdf>. Accessed August 15th, 2012.
- ASRD and ACA. 2009. Status of the Great Plains toad (*Bufo [Anaxyrus] cognatus*) in Alberta: Update 2009. Alberta Sustainable Resource Development. Wildlife Status Report No. 14 (Update 2009). Edmonton, AB. 25 pp. [Online]
<http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/DetailedStatus/documents/StatusOfGreatPlainsToadInAlberta-14-Update-Dec-2009.pdf>. Accessed August 15th, 2012.
- Browne, C.L. 2009. Distribution and population trends of Canadian toad (*Anaxyrus hemiophrys*) in Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division. Alberta Species at Risk Report No. 126, Edmonton, AB. 30 pp.
- CARCNET. 2011. Canadian amphibian and reptile network. Saskatchewan. University of Guelph.
<http://www.carcnet.ca/english/amphibians/tour/province/amphSK.php> Accessed July 4, 2013.
- Collins, J.P. and A. Storfer. 2003. Global amphibian declines: sorting the hypotheses. Diversity and Distributions 9(2): 89–98.
- COSEWIC. 2011. Canadian wildlife species at risk. Committee on the Status of Endangered Wildlife in Canada. [Online] http://www.cosewic.gc.ca/eng/sct0/rpt/rpt_csar_e.pdf. Accessed October 17th, 2011.

- Elliott, L., C. Gerhardt and C. Davidson. 2009. The frogs and toads of North America: A comprehensive guide to their identification, behaviour and calls. Houghton Mifflin Co. New York. 343pp.
- Fisher, C.,A. Joynt and R.J. Brooks. 2007. Reptiles and amphibians of Canada. Lone Pine Publishing. Edmonton, AB. 208 pp.
- Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek and M.S. Foster (eds.). 1994. Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Institution Press, Washington. 364 pp.
- Johnson, D.H. and R.D. Batie. 2001. Surveys of calling amphibians in North Dakota. USGS Northern Prairie Research Center Paper 156.
<http://digitalcommons..uni.edu/usgsnpwrc/156> Prairie Naturalist. 33:227-247.
- Kendell, K. 2002. Survey protocol for the northern leopard frog. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 43, Edmonton, AB. 33 pp. [Online]
<http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/documents/SAR43-NorthernLeopardFrogSurveyProtocol.pdf>. Accessed October 17th, 2011.
- MacKenzie, D.I., J.D. Nichols, G.B. Lachman, S. Droege, J.A. Royle and C.A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. *Ecology*. 83(8): 2248-2255.
- Mossman, M.J., L.M. Hartman, R. H. Hay, J. R. Sauer and B. J. Dhuey. 1998. Monitoring long-term trends in Wisconsin frog and toad populations. Pp. 169-198 *In* M. J. Lannoo (Ed.). Status and Conservation of Midwestern Amphibians. University of Iowa Press, Iowa City, Iowa.
- Russel, A.P. and A.M. Bauer. 1993. The amphibians and reptiles of Alberta. University of Calgary Press. Calgary, AB. 253 pp.
- Saenz, D., L.A. Fitzgerald, K.A. Baum and R.N. Conner. 2006. Abiotic correlations of anuran calling phenology: the importance of rain, temperature and season. *Herp. Monolog*. 20: 64-82.
- Saskatchewan Ministry of Environment. 2014a. Amphibian visual survey protocol. Fish and Wildlife Branch Technical Report No. 2014-2.0. Ministry of Environment, Regina, Saskatchewan. 8pp.
- Saskatchewan Ministry of Environment. 2014b. Saskatchewan activity restriction guidelines for sensitive species. 8pp.
- Saskatchewan Ministry of Environment. 2014c. Fish and Wildlife Branch scientific research permit environmental condition standards. Fish and Wildlife Branch Technical Report No. 2014-21. 3211 Albert Street, Regina, Saskatchewan. 60pp.

- Stewart, R.E. and H.A. Kantrud. 1971. Classification of natural ponds and lakes in the glaciated prairie region. Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Washington, D.C., USA. Resource Publication 92. 57 pp.
<http://www.npwrc.usgs.gov/resource/wetlands/pondlake/index.htm> Accessed October 19, 2013
- Takats, L. and C. Prestley. 2002. Alberta amphibian call surveys. A pilot year. Final report. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 53. Edmonton, AB. 28 pp. [Online]
<http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/documents/SAR53-AmphibianCallSurveys.pdf>. Accessed October 17th, 2011.
- Taylor, B.N. and B.A Downey. 2003. Amphibian surveys of the Milk River basin. Pages 93-103 *in* Quinlan, R. W., B. A. Downey, B. N. Taylor, P. F. Jones and T. B. Clayton. A multi-species conservation strategy for species at risk in the Milk River basin: year 1 progress report. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 72. Edmonton, AB. [Online]
<http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/documents/SAR72-MilkRiverBasinStrategyYear1.pdf>. Accessed September 15th, 2011.
- Taylor, P. 2009. An extension of gray treefrog range in Manitoba and into Saskatchewan. *Blue Jay*. 67(4):235-241.
- The Manitoba Herps Atlas. Undated. http://www.naturenorth.com/Herps/MHA_Treefrogs.html
Accessed October 16, 2013.
- United States Geological Service (USGS). 2010. North American amphibian monitoring program NAAMP. United States Geological Service. [Online] <http://www.pwrc.usgs.gov/naamp/>. Accessed September 15th, 2011.

1.7 PERSONAL COMMUNICATION

- Kris Kendall. Alberta Conservation Association. Sherwood Park. AB
Ray Poulin, Ph.D., Royal Saskatchewan Museum. Saskatchewan Ministry of Parks, Culture and Sport. Regina, SK