Survey Protocol for Queensnake (*Regina septemvittata*) in Ontario

August 2015

Ontario Ministry of Natural Resources and Forestry

Ontario

Recommended Citation:
Ontario Ministry of Natural Resources and Forestry (OMNRF). 2015. Survey Protocol for Queensnake (*Regina septemvittata*) in Ontario. Species Conservation Policy Branch. Peterborough, Ontario. ii + 16 pp.

Cover illustrations: Photographs by Joe Crowley, Herpetology Species at Risk Specialist, Ontario Ministry of Natural Resources and Forestry

Cette publication hautement spécialisée, protocole de suivi de la couleuvre à royale (*Regina septemvittata*) en Ontario n'est disponible qu'en anglais en vertu du Règlement 671/92 qui en exempte l'application de la Loi sur les services en français. Pour obtenir de l'aide en français, veuillez communiquer avec le ministère des Richesses naturelles au 705-755-1788.

Le présent document vise à établir un protocole normalisé et efficace pour la réalisation d'études sur le terrain sur la couleuvre à royale en Ontario. Ce protocole décrit les aspects de la biologie de l'espèce qui sont associés à sa détectabilité et à son identification, son aire de répartition, les méthodes d'étude qui conviennent, les qualifications de l'expert et les normes de communication des données en Ontario. Il décrit aussi les conditions qui sont nécessaires pour déduire avec suffisamment d'assurance que l'espèce en question est absente dans une région donnée. Le protocole vise à éclairer le travail réalisé sur la couleuvre à royale conformément aux exigences ou aux conditions de la *Loi ontarienne sur les espèces en voie de disparition*, mais il peut aussi être appliqué dans d'autres situations où des études sur la couleuvre à royale doivent être entreprises en Ontario.

ISBN 978-1-4606-4774-5 (PDF)

TABLE OF CONTENTS

FIGURES

APPENDICES

1. INTRODUCTION

Effective protection and recovery of species at risk and their habitat requires comprehensive and up-to-date knowledge of species' occurrence and distribution. However, there have been few large-scale surveys and inventories for most of Ontario's species at risk, and recent, detailed occurrence data are not available for many of these species throughout the province. In the absence of existing detailed occurrence data, field surveys are necessary to determine if a species is present at a particular site. However, many species at risk are inherently rare, occur at low densities and are very cryptic, making detection of these species difficult. Furthermore, the detection probability of some species varies considerably with time of year, weather and search method. This survey protocol was developed in response to the need for reliable, science-based survey methods for species at risk in Ontario.

In addition to providing survey methodology, the protocol also identifies the level of search effort that is necessary to determine, with reasonable confidence, that Queensnakes are absent from a site. This level of search effort is recommended when survey data are used to inform assessments of species' absence. This protocol does not provide methodology to determine population abundance or monitor changes over time. For information about determining species abundance, population monitoring and other field methodology for reptiles see McDiarmid et al. 2012.

This survey protocol is based on the best available scientific and technical information at the time of publication, including information from several expert Ontario herpetologists. This protocol may be subject to change should new information become available.

This survey protocol provides a recommended approach to assess presence / absence at a site. However, determining if regulated habitat under the Endangered Species Act, 2007 (ESA) is present at a site is a complex process that is not limited to presence / absence surveys. For example, even at sites where survey results are negative, general or regulated habitat of a species at risk may still be present at the site based on nearby occurrences of the species (e.g., on an adjacent property) or the manner in which the habitat is defined within the regulation. At sites where the species has been previously documented and where regulated habitat applies, five consecutive years of documented non-use (using the methods and search effort in this survey protocol) are necessary to demonstrate that habitat is no longer depended on by the species (OMNRF 2013).

2. SPECIES INFORMATION

2.1. Identification

Appearance/Characteristics

- Medium-sized snake with average adult length of 45-65 cm (S. Gillingwater unpublished Data) and a maximum length of 92 cm (Harding 1997)
- Slender body with keeled scales, a small head, and round pupils
- Olive-brown dorsal colouration with 3 dark dorsal stripes (may be faded or absent in older adults) and a creamy-yellow lateral stripe on scale rows 1 and 2
- Creamy-yellow labial scales, chin, throat and belly
- Four rusty-brown ventral stripes that merge towards the tip of the tail (may become mottled with age; the outer two ventral stripes flank the yellow lateral stripes)

Similar Species

No other snake in Ontario has a longitudinally striped belly. Although gartersnakes and ribbonsnakes have similar yellow lateral stripes, they differ from Queensnakes by having a light mid-dorsal stripe, an undivided anal plate, and no ventral stripes. Other rare gartersnake colour morphs (e.g., melanistic) will lack the dorsal stripe as well as the lateral and ventral stripes. Northern Watersnakes in comparison to Queensnakes are more robust with a blotched dorsal pattern (which may become obscured or darkened with age) and a ventral pattern of crescent-like shapes.

2.2. Distribution

The Queensnake occurs in southern Ontario and the surrounding US states south to northern Florida. The distribution of the species in Ontario is patchy and limited to the extreme south-west portion of the province. It is an uncommon and cryptic species and it's distributions is not well documented. Populations that are currently known to be extant in Ontario include those on the Ausable, Detroit, Grand, Maitland, and Thames Rivers, the Northern Bruce Peninsula, and at the Longpoint National Wildlife Area.

2.3. Seasonal Movements and Timing of Behaviour

Timing windows are based on data collected from a long-term mark-recapture study along the Thames River in Ontario (Gillingwater and Piraino 2002; Piraino and Gillingwater 2003-2007; Gillingwater 2008-2011). The timing of activities varies with latitude as well with seasonal weather variation. For example, the active season will begin much earlier in a year with an early spring). General timing windows are given but specific calendar dates should be used only as a general guide. In Ontario, Queensnakes are typically active from mid-April to mid-October:

- Emergence from hibernation: Mid to late April (earliest record April 15th)
- Movement from hibernacula to shoreline habitats: Late April to mid-May
- Mating: May and possibly September/October
- Gestation (embryo development): Typically early June to late August
- Parturition (birthing): Mid-August to late September
- Movement back to hibernacula: Mid-September to mid-October

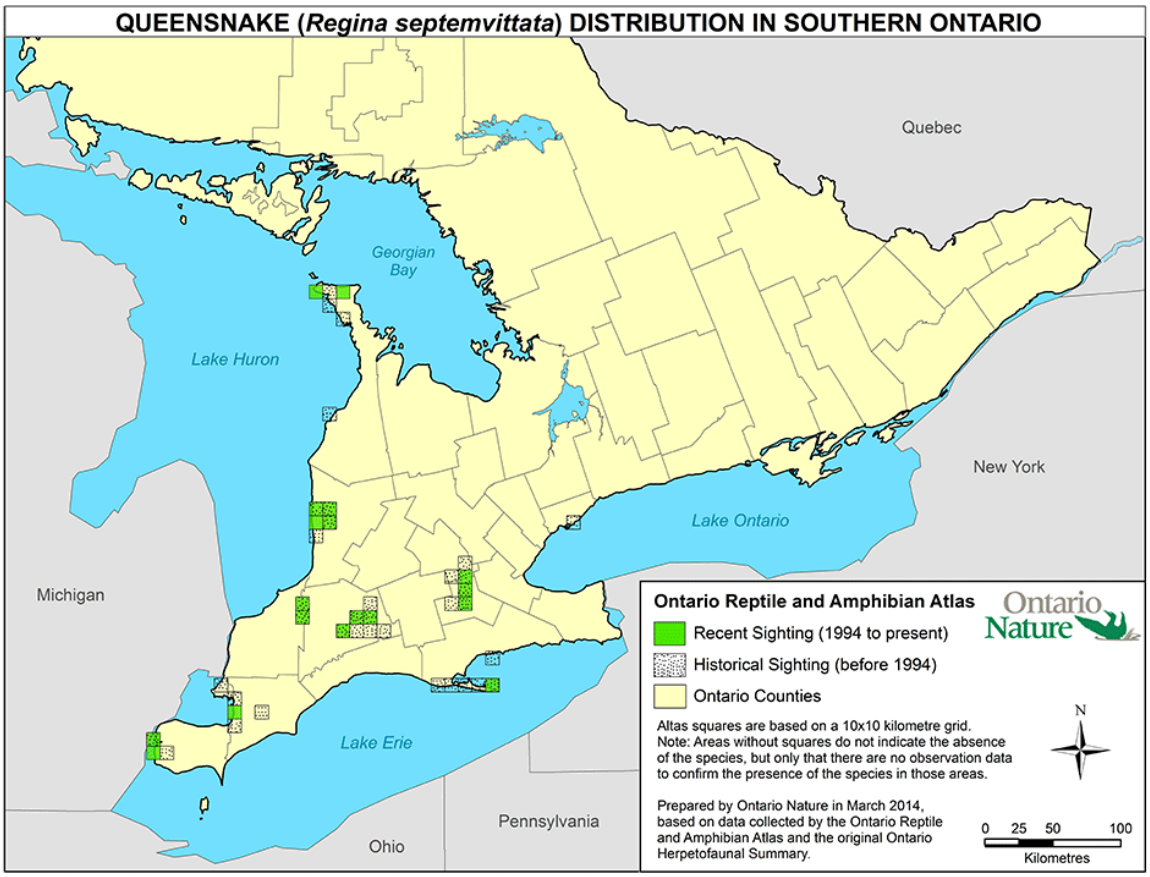


Figure 1. Known distribution of the Queensnake in Ontario (Ontario Nature 2014).

3. SURVEY METHODOLOGY

3.1. Qualifications

Surveyor experience can affect the probability of species detection when surveying for reptiles (BCMELP 1998; Casper et al. 2001), and surveys carried out by inexperienced surveyors are more likely to result in false negatives (Casper et al. 2001; S. Gillingwater pers. comm. 2012; J. Litzgus pers. comm. 2012). Thus, reptile surveys should be carried out by individuals who have a general understanding of reptile biology and ecology and prior experience with the species in question (BCMELP 1998; Casper et al. 2001; DSEWPC 2011; S. Gillingwater pers. comm. 2012; J. Litzgus pers. comm. 2012). If individuals who are experienced with Queensnake are not available, it is highly recommended that the lead surveyor have the following qualifications:

- Prior experience conducting wildlife surveys
- Knowledge of the biology, ecology and habitat use of Queensnakes
- Experience and demonstrated competence with other snake species
- Training from a Queensnake expert or through a formal training course that includes Queensnake field techniques
- The ability to distinguish Queensnakes from other similar species in Ontario

A Queensnake expert is someone that has carried out Queensnake research through a university or other academic institution or is recognized within the scientific community as having expertise with this species.

Surveyors should also have the ability to navigate, record the survey track, and geo-reference observations using a Global Positioning System (GPS) unit.

An authorization under the ESA, 2007 and a Wildlife Scientific Collectors Authorization under the Fish and Wildlife Conservation Act, 1997 may be required to carry out surveys for Queensnake in Ontario. Additional permits may be required from Ontario Parks or Parks Canada Agency if surveys are carried out in provincial or national parks, respectively.

3.2. Records Review

A records review should be carried out prior to field surveys. Existing occurrence records may help to better scope the field survey or, if extensive data are already available for a site, existing records may eliminate the need for a field survey. The absence of occurrence records from an area does not indicate that the species is absent; suitable habitat should be adequately surveyed before concluding that Queensnake is absent. The following sources can be consulted for information on Queensnake distribution and occurrence records within Ontario:

- OMNRF Natural Heritage Information Centre (NHIC)
  www.ontario.ca/nhic; e-mail: nhicrequests@ontario.ca
- Ontario Reptile and Amphibian Atlas (ORAA)
  www.ontarionature.org/atlas
- Local Conservation Authorities
  www.conservationontario.ca
- Status reports from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC); available through the SARA Public Registry
  www.sararegistry.gc.ca/default.asp
- Other information sources such as, but not limited to species experts, OMNRF offices, site-related environmental impact or screening reports, published scientific literature and natural history inventories

3.3. Environmental Conditions

Environmental conditions are among the most important considerations when planning and carrying out snake surveys. Snakes are ectotherms and regulate their body temperature through behavioural thermoregulation (e.g., basking or seeking shelter from the heat). Ontario's snakes have preferred body temperatures within the range of 25-34 °C, and they select microhabitats that allow them to maintain body temperatures as close as possible to this preferred range (Brown and Weatherhead 2000; Blouin-Demers and Weatherhead 2001; Row and Blouin-Demers 2006b; Harvey and Weatherhead 2010). Snakes are most likely to bask on sunny days when ambient temperature is lower than preferred body temperature (Row and Blouin-Demers 2006; Harvey 2008), especially when these conditions follow several days of inclement weather. Basking

tends to be highest in the spring due to low environmental temperatures and the need to increase metabolic activity after hibernation. Further, snake activity levels are dependent on the ambient temperature and the snakes' ability to thermoregulate (Blouin-Demers et al. 2003; Harvey and Weatherhead 2010). In Ontario, snakes are most active when air temperature is between 15 °C and 30 °C. On sunny days, ground temperature can be much higher than air temperature and may exceed a species' upper thermal limit when air temperature is above 25-30 °C.

By influencing microhabitat use and activity levels, environmental conditions have a significant effect on detectability. For example, consider how the following environmental conditions affect detectability:

- Cool overcast (or stormy) conditions: snakes cannot warm up and are likely to be inactive and remain hidden (low detectability).
- Warm conditions: snakes can be encountered moving throughout habitat (moderate to high detectability)
- Cool sunny conditions: snakes will select microhabitats that facilitate basking (high detectability)
- Hot sunny periods: Queensnakes will reside in aquatic habitat or will seek out cool microhabitats and shelter (low-moderate detectability)

Environmental conditions at the time of the survey should always be documented so that survey results can be accurately interpreted. Suitable environmental conditions for snake surveys are described for each survey method below.

3.4. Identification of Survey Sites

Queensnakes are highly aquatic and Ontario populations occupy rivers, shorelines of lakes and occasionally wetlands. These aquatic habitats tend to be permanent and have relatively shallow water that is still to moderately flowing, rock or gravel substrates, temperatures of 18 °C or greater during the majority of the active season and abundant crayfish populations (Wood 1949; Jalava 2009). Shorelines are typically open-canopy with abundant rocks, shrubs, or other vegetation for thermoregulation and cover. The following resources provide detailed information on Queensnake habitat use and ecology and should be used as reference material to accompany this survey protocol.

- Habitat Regulation for the Queensnake under the Ontario Endangered Species Act http://files.ontario.ca/environment-and-energy/species-at-risk/mnr_sar_hr_queensnake_en.pdf
- Rowell, J. 2012. The Snakes of Ontario; Natural History, Distribution, and Status. pp vi + 411
- COSEWIC status reports; available through the SARA Public Registry www.sararegistry.gc.ca/default.asp
- Queensnake species account in the Ontario Reptile and Amphibian Atlas (ORAA) www.ontarionature.org/atlas
- Queensnake species account on the Canadian Herpetological Society website www.canadianherpetology.ca

Scientific literature and consultation with species experts (including OMNRF staff) can also be a valuable resource. Specifically, consultation with local experts and naturalists can be critical in understanding the local species ecology and habitat use, which often varies among regions.

Survey sites should be identified using a two-step process:

- Prior to site visits, identify potential habitat using high resolution aerial photographs, orthophotos or other available land cover information (such as Ecological Land Classification maps).
- A site visit should be carried out to assess habitat identified in step 1 and to confirm the presence of suitable habitat. If detailed maps or other habitat information is not available to assist in step one, the entire site should be thoroughly searched to identify suitable Queensnake habitat. All suitable habitat should be described or mapped and this information should inform the survey design.

3.5. Visual Encounter Surveys

This species forages for crayfish in calm shallow waters near shore (Piraino and Gillingwater 2003). When not foraging, Queensnakes are most often found beneath cover objects along shore or basking in shoreline vegetation, especially on shrub branches overhanging the water (Branson and Baker 1974; Piraino and Gillingwater 2003-2007; Casper et al. 2011; Harvey et al. 2012). Thus, surveys entail searching for individuals basking, foraging or hiding beneath cover materials in aquatic habitat and within five metres of the water. Cover materials may also provide necessary habitat for gestation, thermoregulation and parturition, so great care must be taken during surveys. Information on survey technique is based on long-term research conducted by Scott Gillingwater, survey methodology developed by the OMNRF (Guelph District), survey guidelines developed by Wisconsin Department of Natural Resources (2012) and survey recommendations from Casper et al. 2011.

Survey Technique

Surveys should be conducted on foot while moving upstream. This will limit the amount of sediment obscuring the view through the water. When possible, surveys should be conducted by two people: one person searching terrestrial habitat within five metres of the shoreline and the other person searching aquatic habitat within three metres of the shoreline. Both surveyors should move at a similar pace to stay close together. If surveys are carried out by a single person, the surveyor should move between terrestrial and aquatic areas, covering both thoroughly (i.e., if 100 m of shoreline takes two people one hour to survey then it should take one person two hours). Queensnake distribution can be highly clustered and individuals may only be found in small sections of the habitat (Casper et al. 2011). Thus, the full extent of suitable habitat should be searched during each survey to ensure that occupied areas are not overlooked (Casper et al. 2011). Terrestrial surveyors:

- Survey terrestrial vegetation within five m of the shoreline. When basking in shoreline vegetation, Queensnakes are typically perched at heights of less than one metre.

- Surveyors should constantly scan the shoreline vegetation further upstream for basking individuals; this will help surveyors detect snakes prior to their escape response.
- Carefully watch and listen for any movement that may be caused by snakes retreating into the vegetation or dropping into the water as you approach.
- Queensnakes may also be observed basking atop logs and rocks or within root masses, undercut banks, or in open areas along shore.
- Thoroughly search under all suitable cover objects that are within five metres of the shoreline. Suitable cover objects provide access points beneath them and include rocks (as small as eight cm in diameter), logs, geotextile, scrap metal and any other debris (Ernst and Ernst 2003; G. Casper pers. comm. 2012; S. Gillingwater unpublished data).

Aquatic surveyors:

- Search under rocks, logs, and other debris within three metres of the shoreline and up to a depth of 50 cm.
- Search through areas of emergent, submerged and floating vegetation.
- Regularly scan ahead for swimming snakes or snakes with their heads protruding from the water.
- Polarized sunglasses are essential for detecting snakes under water and binoculars are helpful when scanning ahead for snakes at the water's surface.

When searching under rocks or other cover:

- Do not step on rocks or other cover materials before you have checked beneath them. Crushing injuries and deaths from human activities have occurred at a number of Ontario sites. Remember that Queensnakes (or other wildlife) can be under cobble-sized rocks as small as eight cm in diameter.
- Lift rocks slowly and carefully so that they do not suddenly shift, potentially crushing snakes or other creatures hiding beneath them.
- Do not lower rocks back into the water until the water has cleared and you can confirm that no snakes or other wildlife are beneath them. In areas with heavy sediment, checking beneath rocks with your hand before returning the rock to its original position will limit wildlife injuries/mortality. If an animal is located beneath a rock, remove the animal, lower the rock back into place and then release the animal at the edge of the rock.
- Do not lift rocks that may be at risk of slipping due to weight, water or algae. Be prepared to brace rocks with one hand if a snake is located, or if manual searches in sediment-heavy water are required. Alternatively, one surveyor can lift large rocks while another searches under them.
- All cover materials should be returned to the state in which they were found, ensuring previously existing gaps are maintained.

Survey Period

In Ontario, surveys should be carried out between May 15th and September 15th when Queensnakes are present in their summer foraging habitat along the shoreline. As much as possible, survey dates should be spread out across the season in order to increase detection probability as Queensnakes are known to utilize different microhabitats within their range at different times of the year (S. Gillingwater unpublished data (1996-2012). However, at least two of the surveys should occur between May 15th and June 15th. At sites that have dense riparian vegetation, Queensnakes are easier to detect in May and June before the vegetation obscures cover objects and/or basking snakes.

Survey Conditions

Recommended survey conditions are adapted from S. Gillingwater unpublished data (1996-2012); and Casper et al. (2011). Visual surveys should take place on sunny/partly sunny days when air temperature is above 12 °C and below 30 °C. Surveys should be carried out between 10 am to 5 pm; however, surveys should be conducted between 9 am and 12 pm during hot days (>25 °C). Ideal survey conditions are produced when sunny periods follow inclement weather (rain, overcast conditions); these conditions encourage basking, which significantly increases detection probability.

Search Effort

Snake populations can have very low detection probabilities, and considerable search effort is often required to assess absence of cryptic snake species (Casper et al 2001; Harvey 2005; Casper et al. 2011; Durso et al. 2011). Queensnakes are rare in Ontario, individuals are cryptic and populations are spatially clustered and can occur at low densities, making their detection very difficult. Several surveys by experienced Queensnake surveyors are often required in order to successfully detect this species (Casper et al. 2011; S. Gillingwater pers. comm. 2012). Based on recent results from a Queensnake study on the Maitland River in Ontario, detection probability (DP) for this species ranged from 0.2 to 0.8 and averaged 0.3 (Aarts and Choquette 2015). With nine surveys, a negative search result can be considered significant with ≥ 95% confidence for populations with detection probabilities of 0.3 or higher (Casper 2010). Although this DP is likely representative of many Ontario sites, data from several Ontario sites where the species is known to be abundant yielded higher DP (Nature Conservancy of Canada unpublished data 2012; S. Gillingwater unpublished data 1996-2012) and other Ontario populations are known to have exceptionally low DP (S. Gillingwater pers. comm. 2012). Based on these detection probabilities, nine surveys are required to determine with reasonable confidence that Queensnakes are absent from an area. However, if survey sites are within close proximity to other occupied sites where DP is known to be high (e.g. > 0.5) and the sites are similar (e.g. same stretch of river and similar habitat), a search effort of five surveys is likely sufficient to assess absence.

It is recommended that surveys be spread over at least eight weeks. If surveys are carried out over multiple years, a minimum of five surveys spread over at least four weeks should be completed each year.

The time required for each survey depends on the size of the area and the habitat structure. As a general guideline, the search time should be approximately two person hours per 100 m stretch of river (both sides), or one person hour if only surveying one 100 m stretch of shoreline (e.g. a lake shoreline). Complex sites with a high density of rocks may take longer than this, while sites with very little structure (cover objects or vegetation) will take less time.

Additional considerations when assessing absence:

- One survey is the amount of effort required to thoroughly search all suitable habitat. If the site is large, several site visits or trips may be required to adequately cover the entire area and complete one survey.
- If surveys are not carried out according to the methods outlined in this protocol (e.g., time of year, weather conditions), negative survey results may be inconclusive and lead to a requirement for additional surveys.
- The detection probabilities used to calculate search effort in this protocol are based on survey results from experienced surveyors. If surveys are carried out by individuals who are inexperienced with the species or who have not received training (see surveyor qualifications), the required search effort to confirm absence of the species with 95% confidence is likely higher than what is recommended in this protocol.

3.6. Crayfish Surveys

Since Queensnakes feed almost exclusively on crayfish, it is recommended that surveyors make note of crayfish species presence and general density, which will assist in determining the suitability of a site to maintain Queensnake populations. The Ontario Crayfish Identification Guide produced by Ontario Nature, the Toronto Zoo and Bishop Mills Natural History Centre is a helpful resource for crayfish identification.

3.7. Hibernacula Surveys

Survey Technique
Search for basking Queensnakes near potential hibernacula features within 50 m of the shoreline. Queensnakes often aggregate communally near hibernation areas. Such aggregations may occur in shrubs, between grasses, or beneath cover materials.

Survey Period
Grey and Bruce counties: April 20th to May 20th and September 15th to October 15th.
South of Grey and Bruce counties: April 10th to May 10th and September 25th to October 25th.

Survey Conditions:
Sunny periods with air temperatures ≥12 °C. On cool spring and fall days, hibernacula surveys are best carried out in the afternoons when it is warmer.

Search Effort
There is a narrow window of time (approximately one to two weeks) when Queensnakes will be basking at or near the hibernacula in the spring and the fall, and the precise timing of this window will depend on annual weather variation. In order to ensure sufficient effort during this window (and that the window is not missed altogether), four surveys should be evenly spaced throughout each of the spring and fall survey periods for a total of eight surveys.

Due to the short survey window and the low detectability of this species, hibernacula surveys should be completed for a minimum of two years before concluding that a structure is unlikely to be a hibernaculum. However, it is very difficult to confirm whether a feature is an active hibernaculum and only one hibernaculum has been identified to-date in Ontario; seven years of surveys were needed to confirm this Queensnake hibernaculum (Gillingwater 2009). As such, great caution should be applied when determining whether or not a feature may be a Queensnake hibernaculum. If a Queensnake is observed away from water in the early spring or late fall, it should be assumed that a potential hibernacula is nearby, even if the snake was not confirmed entering/exiting a feature.

4. DOCUMENTATION AND REPORTING

Due to the threat of illegal collection, harassment and habitat disturbance, specific location information should not be published in publicly available documents or reports.

4.1. Documentation

The following information should be documented for each Queensnake survey (regardless of whether or not Queensnakes were observed):

- Date, time and duration of Queensnake survey (beginning and end),
- Transect length (m) and a map that delineates survey locations or routes,
- Number of surveyors and relevant experience with Queensnake,
- Number of rocks/cover items searched during timed search period,
- Documentation of potential hibernacula habitat (GPS location, type of feature),
- Weather conditions (cloud cover, wind, air temperature, water temperature; record at the beginning and end of each survey),
- Result (positive, negative, number of snakes, etc.),
- Occurrence and abundance of crayfish and zebra mussels,
- Photographs of the habitat and general comments regarding habitat quality,
- Incidental observations of other herpetofauna species and species at risk.

When a Queensnake is observed, the following information should be collected:

- Name of observer and contact information,
- Time and date of observation,
- Number of individuals observed,
- Basic biological data (if surveyors are handling the snake), including sex, length, weight, signs of injury, etc.
- Photograph of the snake (with scale reference if possible) to confirm identification
- GPS coordinates, including accuracy. If multiple individuals of the same species are observed and are more than ten m away from each other, separate GPS coordinates should be submitted for each individual.
- Location description and directions to the site,
- A description of the habitat, including habitat type, approximate water depth, type/density of aquatic/emergent vegetation, distance to shoreline, etc.

A recommended survey form is provided in Appendix 2.

4.2. Reporting

Species at risk occurrence data should be reported to the OMNRF NHIC (www.ontario.ca/nhic). The NHIC is Ontario's conservation data centre and maintains the provincial record of Ontario's species at risk occurrences. Negative survey results should also be submitted to the NHIC. Data should be submitted in digital format (spreadsheet or shape files with associated tabular data) as per instructions on the NHIC website. The district OMNRF office or the Ontario Parks Zone Ecologist responsible for the area in question should also be provided with a copy of the data (but please indicate to them if it has already been submitted to NHIC).

Opportunistic observations of other species at risk should also be reported to the NHIC. Observations of all reptile and amphibian species can be submitted to the Ontario Reptile and Amphibian Atlas (www.ontarionature.org/atlas).

5. REFERENCES

5.1. Literature Cited

Aarts, M. and J. Choquette. 2015. Distribution, Abundance, and Survivorship of Queensnakes (Regina septemvittata) in Huron County. Huron Stewardship Council, Goderich, ON. 38 pp.

Blouin-Demers, G. and P.J. Weatherhead. 2001. Thermal ecology of black rat snakes (Elaphe obsoleta) in a thermally challenging environment. Ecology 82, 3025-3043.

Blouin-Demers, G.P., J. Weatherhead and H.A. McCracken. 2003. A test of the thermal coadaptation hypothesis with black rat snakes (Elaphe obsoleta) and northern water snakes (Nerodia sipedon). Journal of Thermal Biology 28: 331-340

Branson, B.A. and E.C. Baker. 1974. An ecological study of the queensnake, Regina septemvittata (say) in Kentucky. Tulane Studies in Zoology and Botany 18(4): 153-171.

British Columbia Ministry of Environment, Lands and Parks (BCMELP). 1998. Inventory Methods for Snakes. Standards for Components of British Columbia's Biodiversity, No. 38. Resources Inventory Branch, Ministry of Environment, Lands and Parks, Vancouver, BC. xi + 50 pp.

Brown, G.P. and P.J. Weatherhead. 2000. Thermal ecology of northern water snakes, Nerodia sipedon: population patterns and variation in relation to sexual size dimorphism. Ecological Monographs 70: 311-330.

Casper, G.S., T.G. Anton, R.W. Hay, A.T. Holycross, R.S. King, B.A. Kingsbury, D. Mauger, C. Parent, C.A. Phillips, A. Resetar, R.A. Seigel and T.P. Wilson. 2001. Recommended standard survey protocol for the Eastern Massasauga, *Sistrurus catenatus catenatus*. US Fish and Wildlife Service. Fort Snelling, MN. 9 pp. Available at: http://www.fws.gov/midwest/Endangered/reptiles/eama-survey.html

Casper, G. 2010. Confidence levels for a given detection probability and effort. Article produced for the University of Wisconsin-Milwaukee Field Station. 2pp.

Casper, G., W. Smith, and R. Staffen. 2011. Queensnakes on the edge: final report state wildlife grant 09-CAT1-015. Technical report to Wisconsin DNR, Bureau of Endangered Resources, BOX 7921, ER/6, Madison, WI. 27pp., 12 figures, 3 appendices.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPC). 2011. Survey Guidelines for Australia's Threatened Reptiles; Guidelines for detecting reptiles listed as threatened under the Environmental Protection and Biodiversity Conservation Act 1999. 104 pp.

Durso, A.M., J.D. Willson, and C.T. Winne. 2011. Needles in haystacks: Estimating detection probability and occupancy of rare and cryptic snakes. Biological Conservation 144 (2011) 1508–1515.

Ernst, C. H., and E. M. Ernst. 2003. Snakes of the United States and Canada, Smithsonian Institution Press, Washington, D. C. 668 pp.

Gillingwater, S.D. 1996-2012. Unpublished data. Species at Risk Biologist, Upper Thames River Conservation Authority, London, ON.

Gillingwater, S. D. and T.J. Piraino. 2002. Rare Reptile Research of the Thames River Watershed. Final report submitted to the Ontario Ministry of Natural Resources and the UTRCA. (Revised, 2004) 50 pp.

Gillingwater, S.D. 2008. Species At risk Reptile research and education in the Upper Thames River Watershed. Final report to the Ontario Ministry of Natural Resources and the UTRCA.

Gillingwater, S.D. 2009. Species At risk Reptile research and education in the Upper Thames River Watershed. Final report to the Ontario Ministry of Natural Resources and the UTRCA.

Gillingwater, S.D. 2010. Species At risk Reptile research and education in the Upper Thames River Watershed. Final report to the Ontario Ministry of Natural Resources and the UTRCA.

Gillingwater, S.D. 2011. Species At risk Reptile research and education in the Upper Thames River Watershed. Final report to the Ontario Ministry of Natural Resources and the UTRCA.

Harding, J.H. 1997. Ammphibians and Reptiles of the Great Lakes Region. University of Michigan Press.

Harvey, D.S. 2005. Detectability of a large-bodied snake (*Sistrurus c. catenatus*) by time constrained searching. Herpetological Review 64: 413-415.

Harvey, D.S. 2008. Massasauga monitoring – analysis and recommendations v. 1.2. Reported submitted to the Bruce Peninsula National Park / Fathom Five National Marine Park, Parks Canada Agency, Ontario.

Harvey, D.S. and P. J. Weatherhead. 2010. Habitat selection as the mechanism for thermoregulation in a northern population of massasauga rattlesnakes (*Sistrurus catenatus*). Ecoscience 17(4): 411-419.

Harvey, D., M. Ihrig, J. McCarter, E. Milne, and T. Pulfer. 2012. Survey of province-wide Queensnake occurrence: Interim Report. Unpublished report for the Nature Conservancy of Canada.

Jalava, J. 2009. Hydro-riparian Species at Risk Inventory Bruce Peninsula National Park. Prepared for Parks Canada Agency Bruce Peninsula National Park /Fathom Five National Marine Park.

Nature Conservancy of Canada. 2012. Unpublished data from Queensnake surveys on the Maitland River in Ontario. Guelph, ON.

Ontario Ministry of Natural Resources and Forestry (OMNRF). 2013. Habitat Protection Summary for Queensnake. Available at: http://files.ontario.ca/environment-and-energy/species-at-risk/mnr_sar_hr_queensnake_en.pdf

Ontario Nature. 2014. Ontario Reptile and Amphibian Atlas. Web application, updated March, 2014. Available at: www.ontarionature.org/atlas

Piraino, T.J. and S.D. Gillingwater. 2003. Biology and Ecology of the Queen Snake *Regina septemvittata* Along the Upper Thames River Watershed. Final report to the Ontario Ministry of Natural Resources and the UTRCA.

Piraino, T. J. and S.D. Gillingwater. 2004. Softshell Turtles and Queen Snakes along the Upper Thames River. Final report to the Ontario Ministry of Natural Resources and the UTRCA.

Piraino, T. J. and S.D. Gillingwater. 2005. Softshell Turtles and Queen Snakes along the Upper Thames River. Final report to the Ontario Ministry of Natural Resources and the UTRCA.

Piraino, T. J. and S.D. Gillingwater. 2006. Queen Snakes and Spiny Softshell Turtles along the Upper Thames River. Final report to the Ontario Ministry of Natural Resources and the UTRCA.

Piraino, T. J. and S.D. Gillingwater. 2007. The Queen Snake (*Regina septemvittata*) and Spiny Softshell Turtle (*Apalone spinifera spinifera*) along the Upper Thames River. Final report to the Ontario Ministry of Natural Resources and the UTRCA.

Row, J.R. and G. Blouin-Demers. 2006. Thermal quality influences effectiveness of thermoregulation, habitat use, and behaviour in milk snakes. Oecologia (2006) 148: 1–11.

Wisconsin Department of Natural Resources. 2012. Wisconsin Queensnake Species Guidance. Bureau of Endangered Resources, Wisconsin Department of Natural Resources, Madison, Wisconsin. Available at http://dnr.wi.gov/files/PDF/pubs/er/ER0673.pdf

Wood, J. T. 1949. Observations on *Natrix Septemvittata* (Say) in Southwestern Ontario. The American Midland Naturalist 42(3):744-750.

5.2. Authorities Cited

Casper, G. 2012. Personal Communication to T. Piraino. Associate Scientist at University of Wisconsin, Milwaukee Field Station, WI, USA

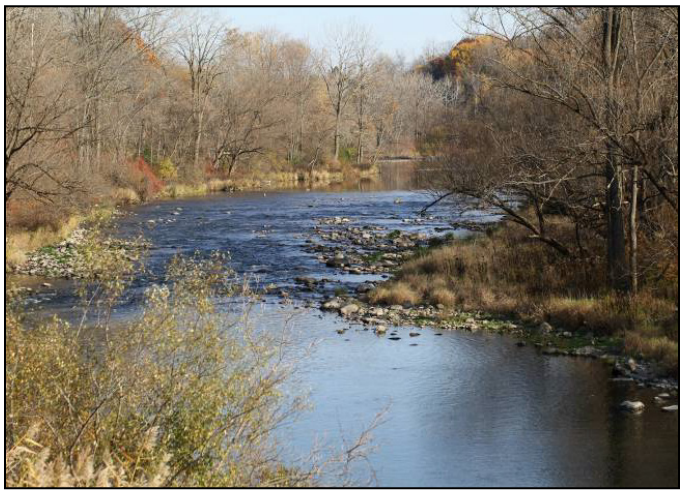
Gillingwater, S. 2012. E-mail correspondence to Joe Crowley. Species at Risk Biologist, Upper Thames River Conservation Authority.

Litzgus, J.D. 2012. E-mail correspondence with Megan Rasmussen and James Paterson. Professor, Laurentian University.

6. ACKNOWLEDGEMENTS

The information in this document, particularly the survey methodology, is based on the cumulative knowledge and experience of several Queensnake experts, including Scott Gillingwater, Teresa Piraino and Gary Casper. Several OMNRF and Ontario Parks staff also kindly took the time to review this document and provide feedback. The Nature Conservancy of Canada provided data that was critical for the determination of detection probability. Teresa Piraino developed the first drafts of this document, and the final document was prepared by Joe Crowley, Herpetology Species at Risk Specialist, OMNRF.

APPENDIX 1: Examples of Queensnake Habitat in Ontario



Photographs by Teresa Piraino

APPENDIX 2: Queensnake Survey Form

Project Information _____ Date: _____

Surveyors _____

Location Description _____ Photo #s_____ UTM Zone _____

Start UTM: Easting _____ Northing _____ End UTM: Easting _____ Northing _____

Start Time _____ End Time _____ Search Duration (h) _____ Transect Length (m) _____ Map Attached ☐

Air Temp: Start _____ End _____ Precipitation: Start _____ End _____

Water Temp: Start _____ End _____ Wind: Start (Beaufort) _____ Wind End (Beaufort) _____

Cloud Cover: Start _____ End _____ Other Weather Notes _____

Substrate: ☐organic/detritus ☐mud ☐clay ☐silt ☐sand ☐gravel ☐cobble ☐boulders ☐bedrock

Aquatic Habitat _____ Waterbody Flow _____

Riparian Habitat (ELC code if possible) _____ # Rocks Searched Under _____

Queensnake Observations:

Easting	Northing	Accuracy (m)	Time	Behaviour Code	Age Category	Water Depth (cm)	Distance to Shoreline (m)	Photo #s

Crayfish: ☐none ☐few ☐medium (under every few rocks) ☐high (beneath most rocks and darting about in water)

Notes (additional habitat info, invasive species observed, etc.) _____

_____

_____

Incidental Observations of Other Species or Important Habitat Features (e.g. SAR, other herps, potential hibernacula):

Species/Feature	#	Easting	Northing	Accuracy (m)	Comments

Behaviour Codes:
Basking on shrub – BS
Basking between shoreline vegetation – BV
Basking in Shallow Water – BSW
Foraging – F
Hiding under rock – UR
Hiding under erosion control blanket – UB
Hiding under log - UL
Hiding under debris - UD
Swimming – S
Wandering on land - W

Beaufort Wind Scale:
0 = calm, smoke rises vertically (0-2km/hr)
1 = Light air movement, smoke drifts (3-5)
2 = Slight breeze, wind felt on face; leaves rustle (6-11)
3= Gentle breeze, leaves & twigs in constant motion (12-19)
4= Moderate breeze, small branches moving, raises dust & loose paper (20-30);
5= Fresh breeze, small trees begin to sway (31-39)
6= Strong breeze, large branches in motion (40-50)

Age Codes:
Adult (>45cm) - **A**
Juvenile (>30cm and <45cm) - **J**
Young of Year (>23 and <30cm found in spring) - **yoy**
Neonate (<23cm found in late summer) - **N**