FINAL REPORT

Integrated Collection Assessment and Planning Workshop

December 2021

Canadian Snakes

IUCN SSC Species Survival Commission

CONSERVATION PLANNING SPECIALIST GROUP
Changing the Future for Wildlife

CANADIAN SPECIES INITIATIVE

Gabriel Evans-Cook

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A PDF of Integrated Collection Assessment and Planning Workshop for Canadian Snakes final report can be downloaded at:
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Miigwetch | Thank you

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Joe Crowley

Executive Summary

The purpose of this workshop was to evaluate potential ex situ conservation roles for 39 snake taxa native to Canada and begin to plan for integrated conservation actions.

Thirty-nine snake taxa in three families are considered native to Canada. Snakes in Canada face multiple combined threats including habitat loss and degradation, intentional persecution, disease, road mortality, and climate change, among others. Many snake taxa in Canada are found at the northern extent of their range, and more than 60% are currently considered at some level of risk nationally (COSEWIC 2020; extirpated, endangered, threatened, or special concern). Many conservation activities are in place to help counteract known threats. The potential use of ex situ conservation actions is explicitly noted in the recovery plans for four taxa, Blue Racer (Coluber constrictor foxii), Eastern Massasauga (Sistrurus catenatus) – Carolinian population, Gray Ratsnake (Pantherophis spiloides) – Carolinian population, and Queensnake (Regina septemvittata), and a formal Association of Zoos and Aquariums (AZA) Species Survival Plan® (SSP®) exists for Eastern Massasauga. Ambassador animals currently held ex situ in Canada and the United States, with provenance varying from wild, to captive bred, confiscated, or rescued snakes, may provide additional conservation opportunities. Future zoo collection planning can also be improved by incorporating the conservation needs of species to ensure maximum conservation benefit of ex situ programs.

The Integrated Collection Assessment and Planning (ICAP) process brings in situ and ex situ communities together to apply the decision-making process of the IUCN SSC Guidelines on the Use of Ex situ Management for Species Conservation to the task of regional or global collection planning, in the spirit of the One Plan Approach (Traylor-Holzer et al. 2018). These guidelines outline a five-step decision-making process for evaluating ex situ activities for effective species conservation. The ICAP workshop for Canadian snake species brought together a diverse group of over 60 in situ and ex situ regional experts including zoo staff, government and First Nations representatives, academics, and other species experts from across Canada, the United States and Mexico to assess potential ex situ activities within Canada for the 39 native snake taxa. The workshop, which took place virtually in nine sessions over three days (March 8-10, 2021), was organized and facilitated by the IUCN SSC Conservation Planning Specialist Group (CPSG) and the Canadian Species Initiative (CSI), which additionally serves as CPSG's Regional Resource Center in Canada. While all ex situ animals and facilities were considered, the potential role of Canada's Accredited Zoos and Aquariums (CAZA) members and their sustainability partners was of particular focus.

Executive Summary Continued

All 39 snake taxa were assessed for potential ex situ conservation action, regardless of their current ex situ status. Before the workshop, an information sheet was prepared for each taxon that included a summary of the in situ status and threats, ex situ status (globally and regionally), and previous recommendations for ex situ management for conservation as stated in existing recovery documents. During the ICAP workshop the participants reviewed this information, considered additional expert knowledge from participants, and through a series of facilitated discussions identified potential ex situ conservation roles for each taxon. Each potential role was rated with respect to its relative conservation benefit to the taxon, as well as the relative feasibility and risks of developing an ex situ program to meet the role. Based on a rapid analysis of the benefits versus feasibility and risks, the group reached consensus on which of the potential ex situ roles identified (if any) are recommended for each taxon, and formulated recommendations.

Threatened taxa: At least two ex situ conservation roles were recommended for all 11 threatened taxa with large ex situ populations. Some level of ex situ population management (long-term breeding programs and/or release programs) was recommended for three endangered taxa with some of the largest ex situ populations. ICAP recommendations broadened existing ex situ roles and options and helped to identify regional priorities for these taxa.

Fifteen threatened taxa have small or no existing ex situ populations. For three of these taxa, no ex situ conservation roles were recommended at this time and in general, development of managed ex situ populations was not recommended for this group, with the exception of short-term rescue populations as necessary and on a case-by-case basis for three taxa (e.g., where regional threats to small subpopulations could pose a significant risk to the entire local population). Conservation-based research, training, and education were recommended as priority roles for these taxa with the caveat that animals be obtained locally and opportunistically (e.g., through wildlife rehabilitators) and/or use existing animals in captivity.

Non-threatened taxa: Only two non-threatened taxa are held in relatively large numbers within zoos, and both taxa were recommended as models for targeted research, training, and conservation education for threatened species locally and/or snakes in general.

Training and education were also recommended for most of the seven non-threatened taxa with small or no ex situ populations. Research was recommended for two taxa to explore specific husbandry questions and local adaptations.

Executive Summary Continued

Several general or multi-species recommendations were put forward:

- Ex situ conservation activities have value in the conservation of Canadian snakes and should be used, when appropriate, to enhance recovery efforts, particularly for threatened taxa with an existing large ex situ population.
- Conservation-based education is important for changing negative perceptions and behaviours towards snakes which contribute to important threats to snakes in general.
- All ex situ roles that involve releases of animals must include research to evaluate success of these efforts and be integrated with in situ conservation efforts to address primary threats.
- In general, ex situ conservation-based research, training, and education should not proactively capture snakes from the wild, and should instead rely on opportunities from rescue, rehabilitation and/or confiscation. Where these opportunities are unlikely or unfeasible, wild collection may be necessary for specialized situations.
- There is a need to coordinate native snake collections and share husbandry knowledge on a national scale, to most effectively serve conservation-based research, training and education priorities. Further, there is a need for improved and continuous communication between in situ and ex situ communities regarding evolving species conservation needs and priorities.
- Acquiring animals for potential ex situ roles should not be used as the justification for a salvage operation to occur for development mitigation; all options to avoid the impact should always be considered first.
- Rescued snakes should be returned to their original location as the first priority; reinforcement, reintroduction and retention in captivity may be considered on a case-by-case basis, e.g., if the original habitat is no longer suitable.

This report is designed to provide a basis for ex situ actions to be developed that best contribute to conserving these species in the wild, based upon best available data and logical decision making and evaluation within a transparent, collaborative process involving both in situ and ex situ experts. Actions identified in the workshop will complement in situ conservation efforts. More detailed plans will be developed by CSI, CAZA's Conservation Committee and members, interested workshop participants, and additional in situ and ex situ collaborators as necessary using the information presented here. By providing a facilitated process for implementation of the IUCN ex situ guidelines, the ICAP resulted in a variety of recommendations that were tailored to the conservation needs of the species as determined by consensus among an international group of in situ and ex situ experts. This process also increased knowledge and understanding amongst all participants of the full spectrum of possible ex situ roles and how they can contribute to conservation.

Abbreviations, Acronyms, & Definitions

AB	Alberta
AZA	Association of Zoos and Aquariums
BC	British Columbia
BC MoE	BC Ministry of Environment
CAZA	Canada's Accredited Zoos and Aquariums
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPSG	Conservation Planning Specialist Group
CSI	Canadian Species Initiative
DU	Designatable Unit: taxonomic entities below the species level such as subspecies, varieties or geographically or genetically distinct populations recognized by COSEWIC
ECCC	Environment and Climate Change Canada
ED	Evolutionary distinctiveness: the expected amount of unique evolutionary history (in millions of years) contributed by a species that would be lost if the species were to go extinct. The Canadian ED score compares the species to all native squamate species in Canada. The Global ED score compares the species to all squamate species globally (Kominek et al. In review).
EN	Endangered
EX	Extirpated
GL/SL	Great Lakes/St. Lawrence Designatable Unit
IUCN	International Union on the Conservation of Nature
MB	Manitoba
M.F.U	Number of males.females.unknown sex in a captive collection
NAR	Not at risk
NAS	Not assessed
NB	New Brunswick
NS	Nova Scotia
NWT	Northwest Territories
MECP	Ontario Ministry of Environment, Conservation, and Parks
MNDMNRF	Ontario Ministry of Northern Development, Mines, Natural Resources & Forestry
ON	Ontario
PEI	Prince Edward Island
QC	Quebec
SARA	*Species at Risk Act*, *2002* (Canada)
SC	Special Concern
SFD	Snake Fungal Disease
SSC	Species Survival Commission
SSP®	Species Survival Plan®
SK	Saskatchewan
sp. (spp.)	Species (plural)
ssp.	Subspecies
TH	Threatened
ZIMS	Zoological Information Management Software (Species360)

Integrated Conservation Planning

Rationale for integrated planning for Canadian snakes

The need for integrated conservation planning is particularly apparent for Canadian snakes, a highly at-risk group of wildlife in Canada, with many populations experiencing declines and some even facing local extinction (COSEWIC 2020). Snakes provide many benefits to the ecological community. As mesopredators, they maintain ecological balance by controlling small animal populations, thereby controlling rodent-borne diseases, and protecting plants, and are important prey for raptors and other predators. Unfortunately, in addition to existing biological constraints due to living at the northern extent of their range, snakes in Canada face multiple combined threats including habitat loss, degradation, and fragmentation, intentional persecution, disease, and road mortality among others, as well as emerging threats such as climate change. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recognizes 35 Designatable Units of snakes, representing 39 distinct taxa, more than 60% of which are currently at some level of risk (COSEWIC 2020; extirpated, endangered, threatened, or special concern).

While extensive *in situ* conservation work is occurring across Canada for many threatened and endangered snake species, some form of hands-on intervention has been identified in federal recovery strategies or by species experts as being necessary to ensure the survival of four at-risk snake taxa, Blue Racer (*Coluber constrictor foxii)*, Eastern Massasauga (*Sistrurus catenatus*) – Carolinian population, Gray Ratsnake (*Pantherophis spiloides*) – Carolinian population, and Queensnake (*Regina septemvittata*). In most cases, however, these species are still at the stage of needing a feasibility assessment for potential reintroductions and only one species currently has active *ex situ* efforts underway that are integrated with wild population recovery goals (Eastern Massasauga). A formal Species Survival Plan (SSP) currently exists only for Eastern Massasauga. Ambassador animals currently held *ex situ* in Canada and the United States, with provenance varying from wild, to captive bred, confiscated, or rescued snakes, may provide additional opportunities to effectively contribute to conservation. Future zoo collection planning can also be improved by incorporating the conservation needs of species to ensure maximum conservation benefit of *ex situ* programs.

Ex situ *conservation assessment*

Effective species conservation planning should consider all options when assessing actions to address the conservation pressures facing a particular species. In addition to actions directed at reducing or eliminating particular threats, such as habitat loss or capture of snakes for the pet trade, other management strategies may be needed to prevent severe decline or extinction, especially when wild populations are small and isolated. Addressing important knowledge gaps can also promote more effective conservation. *Ex situ* management is one possible option that can contribute to the conservation of threatened species. *Ex situ* refers to conditions under which individuals (or live biological samples) are held in artificial conditions and managed to some degree by humans, outside of their natural conditions and habitat. *Ex situ* settings include zoos, aquariums, botanical gardens, wildlife rescue or rehabilitation centers, biobanks, and other facilities that hold animals or plants. The range of *ex situ* scenarios and tools is diverse and can target different conservation needs and roles and, therefore, serve various purposes.

Ex situ conservation activities can directly support species conservation and prevent extinction in a variety of ways (Traylor-Holzer *et al*. 2019), by:

Offsetting the impact of threats. *Ex situ* activities can improve the demographic and/or genetic viability of a wild population by counteracting the impacts of primary or stochastic threats on the population, such as reduced survival, poor reproduction, and genetic isolation – for example, through head-start programs that remove juveniles from the wild for *ex situ* care and return them once they are less vulnerable, or through releases to genetically augment isolated populations.

Addressing the causes of primary threats. *Ex situ* activities can help reduce primary threats such as habitat loss, exploitation, invasive species, or disease through specifically designed research, training or conservation education activities that directly and effectively impact the causes of these threats – for example, through *ex situ* research to detect, combat or treat disease.

Buying time. Establishment of a genetically diverse and sustainable *ex situ* rescue or insurance population may be critical in preventing species extinction when the wild population is declining and primary threats are not under control – for example, populations facing widespread disease epidemics or decimation by invasive species.

Restoring wild populations. Once the primary threats have been sufficiently addressed, *ex situ* populations can be used to re-establish wild populations.

The *ex situ* conservation assessment process is structured around the IUCN SSC *Guidelines on the Use of Ex situ Management for Species Conservation*, which utilizes a five-step decision process to determine if and which *ex situ* activities might be appropriate to be included in the overall conservation strategy for the species (IUCN 2014; McGowan *et al*. 2017):

1. Compile a status review of the species, including a threat analysis, to understand its conservation needs.
2. Identify the potential role(s) that *ex situ* management might play in the overall conservation of the species and its relative conservation value.
3. Determine the characteristics of the *ex situ* population and program needed to fulfil each potential conservation role.
4. Define the resources and expertise needed for the *ex situ* program to meet each potential role and appraise the feasibility and risks.
5. Make a decision that is informed (i.e., uses the information gathered above) and transparent (i.e., demonstrates how and why the decision was taken) regarding *ex situ* roles and activities, if any, to support conservation of the taxon.

Integrated Collection Assessment and Planning (ICAP) is a rapid application of these five steps to a group of related taxa to identify priorities for *ex situ* conservation activities and programs and help inform *ex situ* collection planning.

While the primary focus is to assess potential direct conservation roles of *ex situ* management, an ICAP may identify other indirect ways the *ex situ* community can support species conservation, such as providing equipment, expertise, human resources, or funds. Other important non-conservation roles for the taxon, such as high exhibition value, may also be recorded.

ICAP workshop process for Canadian snakes

This workshop focused on assessing *ex situ* roles for 39 taxa of snake native to Canada, representing 35 Designatable Units (DUs) as identified by COSEWIC, and their potential to effectively contribute to species conservation and recovery in the wild. The workshop occurred virtually, through a series of plenary and breakout taxa-specific discussions and included a diverse group of over 60 participants (see full list of participants and institutions in Appendix I; agenda in Appendix II). The involvement of both *in situ* and *ex situ* species experts in all stages of the process was essential to fully evaluating the conservation needs, opportunities, risks, and feasibility of the various *ex situ* roles. This assessment was developed in concert with existing recovery plans as part of a One Plan Approach to conservation of the species (Traylor-Holzer *et al*. 2019)

Prior to the workshop, the following information was compiled into taxon sheets: 1) status of and threats to Canadian snake populations; 2) existing *in situ* conservation actions; 3) existing recommendations for *ex situ* conservation roles; and 4) existing *ex situ* populations and/or conservation actions. The data sheets were shared as briefing materials prior to the workshop and served as reference material during the virtual sessions (see *Species-Specific Status and Recommendations* section). Participants were also provided with a Workshop Companion Guide to help familiarize themselves with the ICAP process, types of *ex situ* conservation roles, and questions to consider during the evaluation of potential roles (Appendix III). All workshop materials, including spreadsheets compiled during workshop sessions and suggested further readings, were made available to participants via a workshop specific Google Drive.

Two weeks prior to the workshop, participants were invited to a 1.5-hour webinar to help familiarize them with the ICAP process, facilitation tools to be used in the virtual environment, as well as address any questions about the process.

The workshop workflow of the ICAP process was structured around the five-step decision process of the IUCN SSC *Guidelines on the Use of Ex situ Management for Species Conservation*. Participants discussed the impact of threats to Canadian snakes across their native range and identified important knowledge gaps in species biology, threats and their impacts, and population management. Participants reviewed the list of potential conservation roles for *ex situ* activities to identify those that might address conservation challenges and/or priority knowledge gaps for Canadian snake taxa.

The conservation benefit (value), feasibility and risks of each of the potential *ex situ* roles were then discussed for each of the 39 Canadian snake taxa. For each taxon the following process was followed:

1. Brief summary presentation of the previously gathered information on the taxon sheet. Suggested comments/changes/additions from the workshop participants were recorded.
2. Facilitated discussion to identify potential direct *ex situ* conservation roles, and rating of the benefit to the conservation of the species of any roles proposed.
3. If at least one role was identified, facilitated discussion to:
    a. Confirm the general program characteristics of the *ex situ* population needed to fulfil the identified role(s);
    b. Rate the feasibility (considering, for example, existing *ex situ* population, husbandry challenges, technical or logistical challenges, availability of skilled staff, availability of sufficient financial and other resources) and risks (e.g., consequences for wild population, occupying *ex situ* space needed by other species at risk, human health, and safety risks, political or social risks) of each proposed role.

4. Reaching consensus on which of the potential *ex situ* roles identified (if any) are recommended, based on an analysis of the benefits vs feasibility and risks.
5. Recommendations for next steps, as appropriate.

This was the first ICAP workshop to be held virtually by CPSG. Accommodations were made to modify the ICAP process to the virtual environment, including:

- Background materials, including taxon data sheets and a recording of the pre-workshop webinar, were made available on Google Drive for participants to review and become familiar with.
- In place of an in-person social event, Padlet was used as a platform for workshop participants and the planning committee to introduce themselves virtually and connect with other participants.
- To enable as much participation as possible from species experts, short (2-hour) sessions were scheduled for species groups.
- An anonymous shared "live" Google spreadsheet was used as a facilitation tool to capture participant thoughts and gauge agreement/dissent on level of need, risk, and feasibility and to document decisions. During the first plenary session, participants were able to practice and familiarize themselves with the spreadsheet and process on an imaginary taxon. Each participant was assigned an anonymous animal name prior to the workshop which they used throughout to interact with the spreadsheets.
- Multiple co-facilitators from the planning committee supported the lead facilitator in monitoring comments and discussion in the chat, responses from group, communicating with participants, taking notes, managing virtual tools (i.e., Google spreadsheets), and additional technical aspects. A detailed facilitators agenda was used to assign roles and note when links or other information needed to be shared in the chat to participants.

In Situ Status Assessment and Threat Analysis

An understanding of the factors affecting wild snake populations in Canada is essential to identifying the conservation needs of these species and thus the potential ways, if any, that *ex situ* activities might contribute to meeting these needs. While many species of Canadian snakes are geographically widespread at the species level, individual populations are often small and fragmented, and genetically or taxonomically distinct (Figures 1-3). Of the 39 distinct taxa of snake native to Canada, more than 60% are currently at some level of risk (COSEWIC 2020; extirpated, endangered, threatened, or special concern).

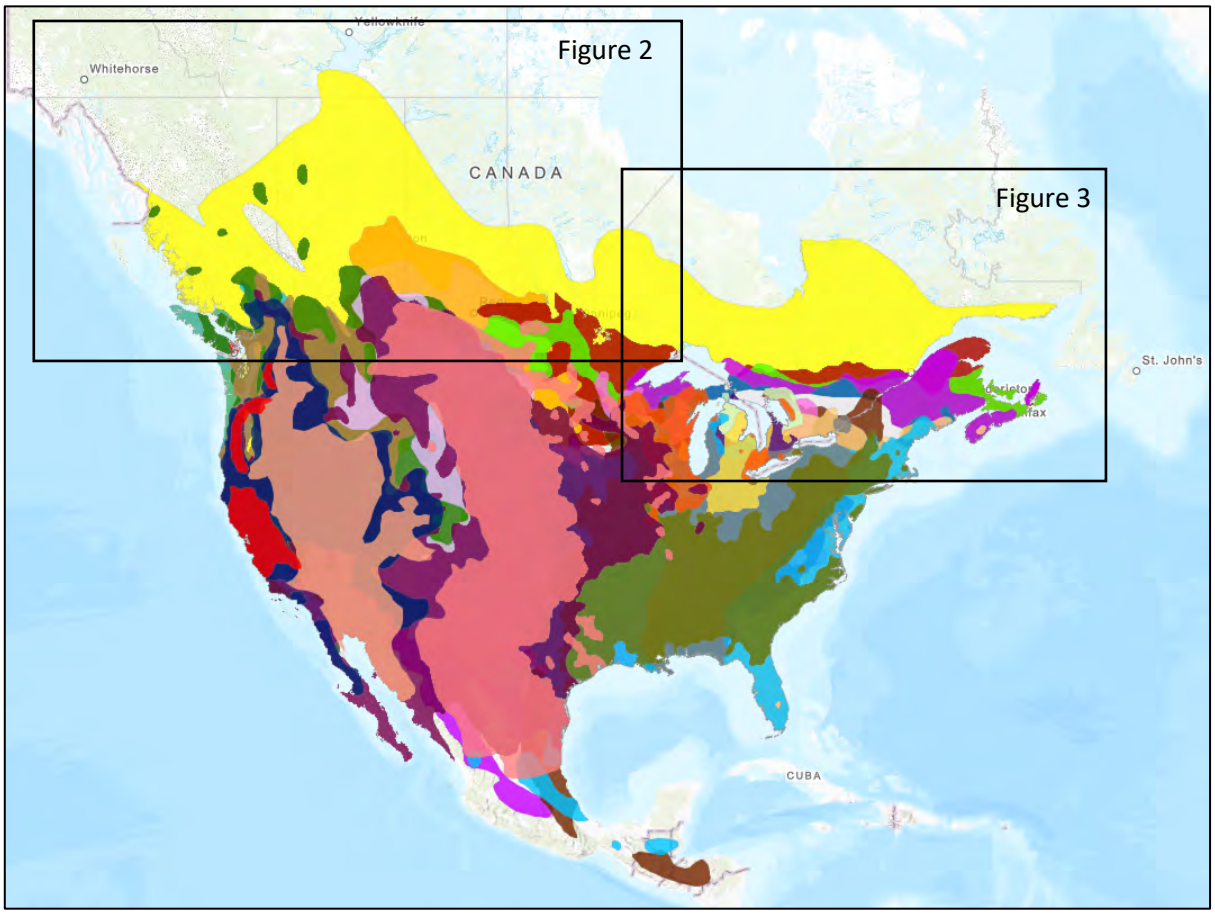


Figure 1. Global ranges of the 26 species of snake that occur in Canada. Insets of western and eastern Canada shown in Figures 2 and 3 below along with species legend. (Range maps compiled from IUCN Red List: https://www.iucnredlist.org/ [accessed 25 Oct 2021] and iNaturalist: https://www.inaturalist.org/ [accessed 9 Nov 2021])

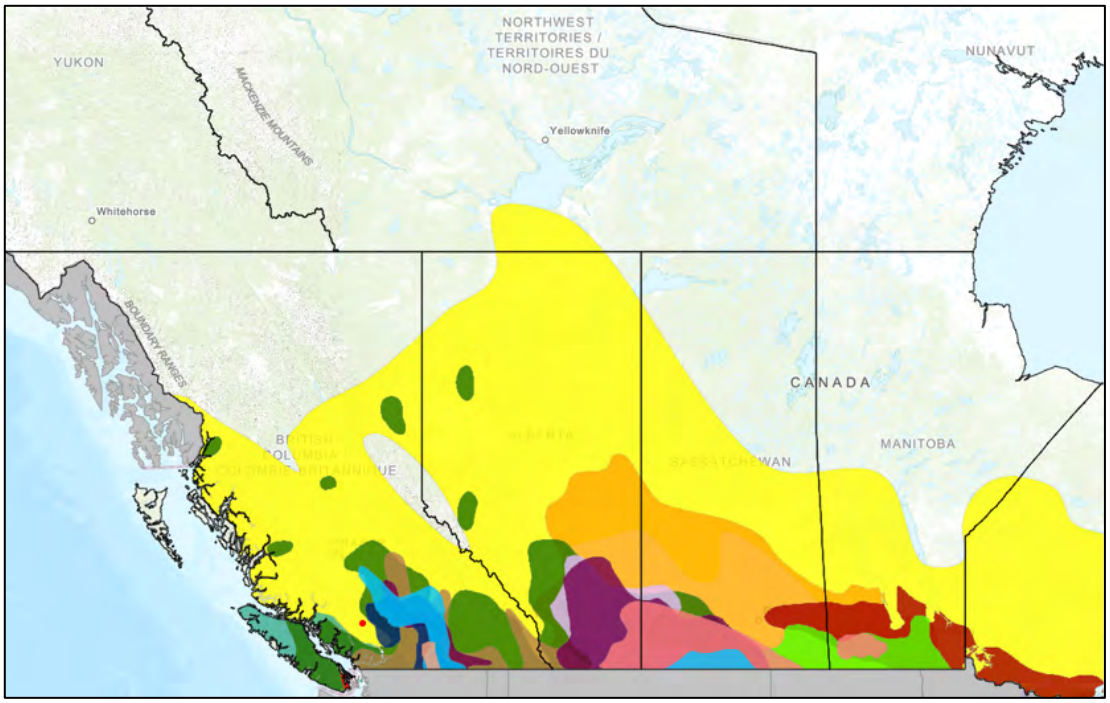


Figure 2. Ranges of snake species in western Canada (Pacific, Prairie, and Northern Regions).

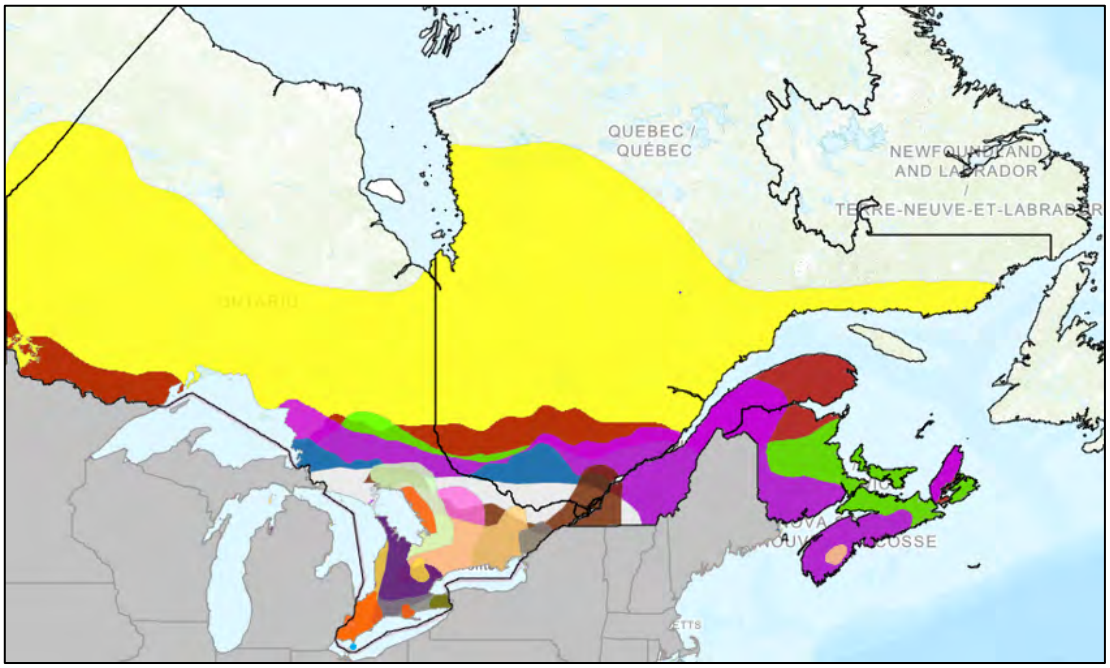


Figure 3. Ranges of snake species in eastern Canada (Central and Atlantic Regions).

Legend

- Sharp-tailed Snake
- Northwestern Gartersnake
- Desert Nightsnake
- Northern Rubber Boa
- Western Rattlesnake
- North American Racer
- Gophersnake/Bullsnake
- Prairie Rattlesnake
- Western Terrestrial Gartersnake
- Plains Hog-nosed Snake
- Smooth Greensnake
- Red-bellied Snake
- Plains Gartersnake
- Common Gartersnake
- Eastern Foxsnake
- Timber Rattlesnake
- Butler's Gartersnake
- Gray Ratsnake
- Queensnake
- Eastern Massasauga
- Eastern Ribbonsnake
- Eastern Hog-nosed Snake
- DeKay's Brownsnake
- Eastern Milksnake
- Watersnake
- Ring-necked Snake

Prior to the workshop, information on the status and threats to Canadian snake populations, recommended recovery actions and existing conservation actions were compiled into taxa-specific data sheets which served as reference material during the virtual sessions (see *Species-Specific Status and Recommendations* section). While the data sheets provided a general overview of the status of snake populations in the wild and *ex situ* as well as existing or past conservation actions, they are not a comprehensive review of all information available for a given taxon.

In compiling this information, some patterns and commonalities emerged. Most recovery strategies for snakes listed the following recommended recovery actions:

- Habitat protection and enhanced connectivity
- Monitoring and research on population demographics and ecology
- Quantification of threats
- Education and awareness

Several types of conservation measures currently exist for all snakes across Canada, although there may be some differences by province. These include:

- Critical habitat is designated and protected on federal lands for endangered and threatened species listed under SARA.
- Snakes are listed as protected wildlife under provincial wildlife acts (i.e., Ontario *Endangered Species Act, 2007*). Generally, it is illegal to kill, harm, harass snakes or destroy their residence or habitat.
- Conservation Data Centres (CDCs) hold provincial/regional databases of species at-risk snake observation locations, including roadkill locations. Opportunistic presence surveys for snakes contribute to CDC databases as well as provincial atlases and community science projects, such as iNaturalist.
- Provincial guidelines, regulations, and/or best management practices specific to reptiles/snakes exist for mitigating effects of roads, industrial development (e.g., oil and gas), and residential development, including measures such as habitat setbacks and conservation easements.
- Snake education/outreach/awareness/appreciation programs and materials are offered through zoos and other *ex situ* facilities (e.g., Scales Nature Park, Sciensational Sssnakes, etc.) or *in situ*-based organizations (e.g., national and provincial parks, conservation areas, land conservancies, etc.).
- The Canadian Wildlife Health Cooperative (CWHC) collects reports of sick or dead wildlife throughout Canada and will test samples from live snakes showing clinical signs of snake fungal disease (SFD) or carcasses in high risk areas (i.e., Ontario).

During the workshop, participants were asked to identify threats or other issues affecting the viability of wild snake populations in Canada, using the virtual equivalent of sticky notes in the program Mural. The group then discussed what life stage(s) was most impacted by each threat, and the specific mechanism leading to population declines. Specific knowledge gaps were also identified for known threats, particularly with respect to the severity and scope. Figure 4 depicts the resulting diagram of these discussions, which, while done quickly without detailed explanation, provided a framework for participants to evaluate the relative conservation benefits of potential *ex situ* activities. It was recognized that most threats impact snakes in a variety of ways. For example, human-subsidized predation affects primarily eggs and juvenile snakes but can also impact adults; loss of these life stages impacts population viability. Diseases and pathogens threaten all life stages, but in addition to loss of individuals they can additionally reduce reproductive success. The

discussion focused on main/major impacts to better target recommended conservation actions, since these will likely have cascading effects.

The primary threats identified fell into several categories (not prioritized). Additional notes from group discussion not captured in the threat analysis diagram are provided below.

Habitat loss and/or fragmentation

- Can be caused by various activities such as urban development, forestry, agriculture, etc. and includes increasing human activities (i.e., recreation in 'protected areas'), even if that does not manifest itself as visible changes in habitat.

Construction

- Comprises disturbance of habitat and populations of snakes due to any type of construction (e.g., roads, infrastructure, urban development, etc.)

Transport corridors, i.e., roads, railways

- Permeability of transport corridors is highly variable and impacts, such as mortality and disrupted connectivity, depend on factors such as traffic level, type of road, etc. (e.g., secondary roads often create artificial nesting habitat that functions as an ecological trap and increases risk to egg-laying females and neonates), and knowledge gaps exist around these impacts.

Persecution (i.e., direct killing of snakes) *and/or collection by public*

- Rates can be difficult to quantify, but all species of snake of all age classes are impacted by these threats (including at hibernacula); although:
    - Larger/adult snakes and venomous/look-alike species are more highly persecuted
    - Higher “value” snake species (e.g., endangered or threatened species, venomous species) are more often targeted for collection

Agriculture

- Initially results in habitat loss, but depending on the type of agriculture, could include several additional stressors:
    - Direct mortality from machinery or activities, pollution, prey availability

Human-subsidized predation

- Consists of predators such as domestic pets or wild predators (e.g., racoons) that are at greater density due to human activities and impact snakes.

Diseases and pathogens

- Effects depend on the disease as some pathologies will have morbidity instead of mere mortality or lead to less reproductive value. Knowledge gaps exist around population-level impacts.

Climate change

- Particularly important for species reaching their limits of distribution in Canada (i.e., most snake species in Canada); however, effects are largely unknown (e.g., predator-prey interactions). Likely impacts include shifts in moisture and temperature patterns causing changes in hibernaculum stability, wetland permanence, and snow insulation, increased overwintering mortality, variable prey availability, and flooding/drying of nests.

Most threats identified affect all life stages i.e., no single threat was seen to affect one life stage more than any other. However, loss of adults was considered of greatest importance to population

viability, particularly to long-lived species, with loss of adult females having the greatest impact. There were some regional differences noted on degree of impact, e.g., collection for the pet trade is less of a concern in western Canada versus Ontario.

Having a full understanding of the factors affecting a species' viability *in situ* enables a better understanding of its conservation needs. Stakeholders can then better identify the *ex situ* conservation roles that may help to address these needs. For example, if a population is largely threatened by loss of eggs or juveniles, demographic manipulation such as head-starting may assist in bolstering this age class, while a species restricted to a small, isolated population may benefit from the establishment of an insurance population for future reinforcement and/or reintroduction needs. Human persecution of venomous snakes may be mitigated by a zoo-led conservation education program targeted at local communities within the species range. The discussion of threats helped provide valuable context for assessment of potential *ex situ* conservation roles.

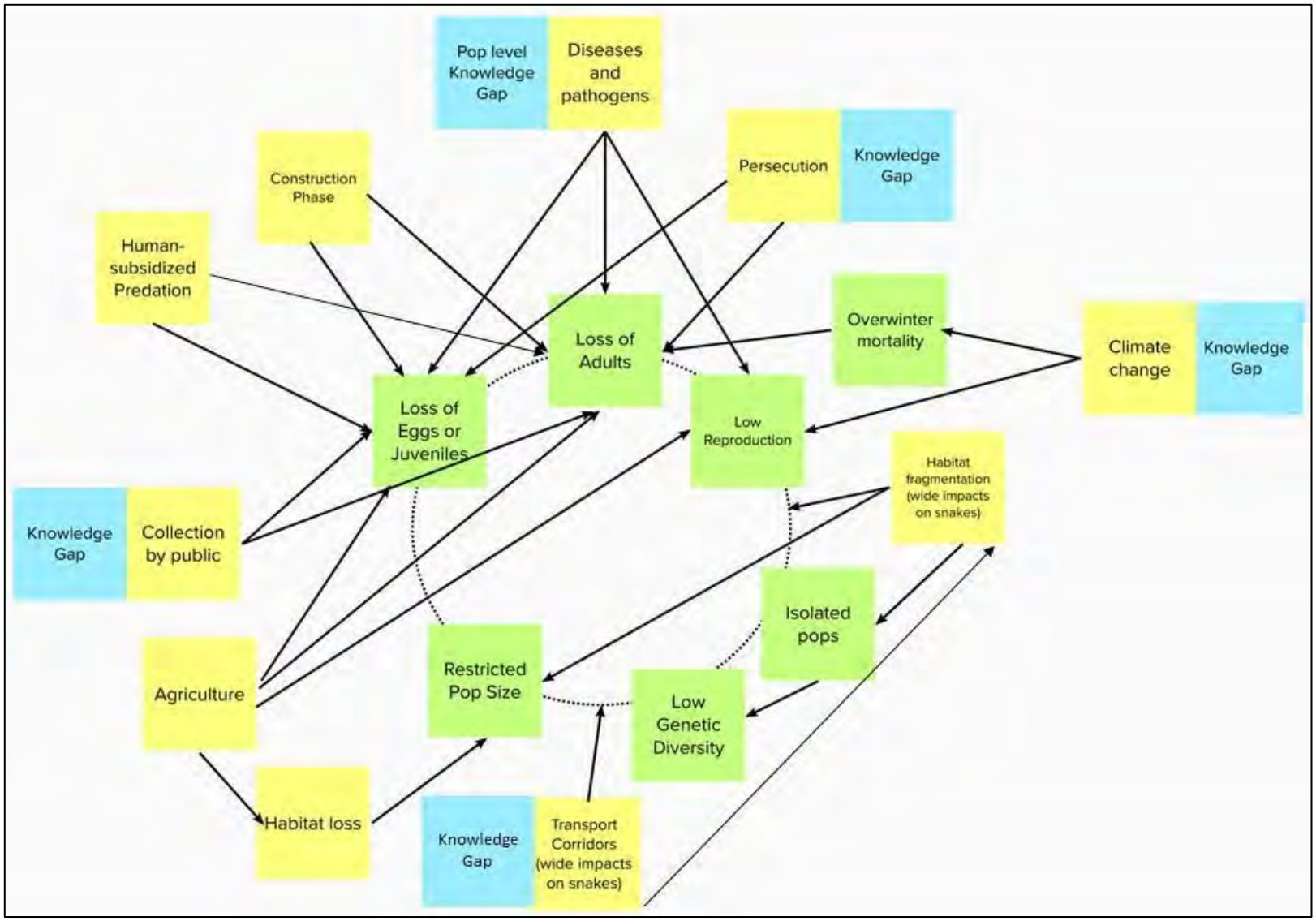


Figure 4. Threats to Canadian snake taxa identified by workshop participants (yellow = threat; green = mechanism of impact; blue = knowledge gap).

Ex Situ Status and Prior *Ex Situ* Recommendations

Prior to the workshop the current *ex situ* status of Canadian snakes and existing *ex situ* actions were compiled into the taxa-specific data sheets (see *Species-Specific Status and Recommendations* section). Where *ex situ* conservation actions were explicitly recommended in published recovery documents, these were noted in the taxa-specific data sheets. Other recommendations that could potentially be served by *ex situ* roles, although not explicitly stated, were also noted (e.g., training, research, and education, increasing population abundance and distribution, restoring populations).

Only the Eastern Massasauga Rattlesnake (*Sistrurus catenatus*) has a formal Species Survival Plan. Very few additional species called explicitly for *ex situ* intervention in recovery documents, and in most cases the recommendation was to assess or investigate their feasibility (summarized in Table 1).

Table 1. Published recommended *ex situ* recovery actions.

Species	Recommended *Ex situ* Conservation Action
Eastern massasauga *Sistrurus catenatus* (Carolinian DU)	Ojibway Prairie subpopulation: Implement population management actions, including removing remaining individuals to protect genetic stock in captivity, maintaining a captive population, and augmenting population with neonates through captive-breeding and reintroductions, as deemed appropriate. Evaluate the effectiveness of actions taken and conduct research to refine husbandry and release techniques. Wainfleet Bog subpopulation: Investigate the need and feasibility of recruitment techniques to support the population. If necessary and feasible, implement, evaluate, and improve recruitment techniques, such as a head-starting program, with consideration for Massasauga ecology (MECP 2018, Parks Canada 2015).
Gray Ratsnake *Pantherophis spiloides* (Carolinian DU)	Investigate potential approaches to augmenting population (ECCC 2020, MNDMNRF 2016).
Blue Racer *Coluber constrictor foxii*	Conduct feasibility assessment for repatriating historic sites in southern Ontario, including assessing threats and suitability of future possible repatriation site(s) (ECCC, MECP 2019).
Queensake *Regina septemvittata*	Investigate the feasibility of population supplementation or reintroduction of Queensnake to parts of its current and historic range and develop and implement a reintroduction program if restoration is deemed feasible (ECCC 2016).

Information on the status of *ex situ* populations of Canadian snakes in U.S. and Canadian facilities was mostly acquired from Species360 records in ZIMS, with effort made to supplement this with additional information from known snake-holding facilities in Canada that do not use this record keeping system; information provided is current as of November 2020. A species' current *ex situ* population size was considered against the species' status in the wild in Canada (Table 2). While several extirpated, endangered, and threatened species had large *ex situ* holdings of greater than 70 animals, most Canadian snakes have small or non-existent *ex situ* populations (<30 animals), regardless of status. Table 2 was reviewed with participants during each session to inform discussions especially related to feasibility.

Table 2. Threat category and captive population size of Canadian snake taxa by family and subfamily.

		***In situ* population status (Canada)**			
		Endangered or Extirpated	**Threatened**	**Special Concern**	**Not at risk/ not assessed**
Viperidae (5 DUs)					
***Ex situ* population size (Canada & US)**	**None in captivity**				
	<25 individuals		• Western Rattlesnake (10)	• Prairie Rattlesnake (19)	
	25-55 individuals				
	>55 individuals	• Eastern Massasauga, Carolinian (98) • Timber Rattlesnake (130)	• Eastern Massasauga, Great Lakes/St. Lawrence (98)		
Colubrinae (12 DUs)					
***Ex situ* population size (Canada & US)**	**None in captivity**		• Western Yellow-bellied Racer (0)		
	<25 individuals	• Pacific Gophersnake (10) • Blue Racer (18)	• Eastern Yellow-bellied Racer (1) • Great Basin Gophersnake (20)		• Smooth Greensnake (4)
	25-55 individuals			• Eastern Milksnake (29) • Bullsnake (47)	
	>55 individuals	• Eastern Foxsnake, 2 DUs (57) • Gray Ratsnake, Carolinian (95)	• Gray Ratsnake, Great Lakes/St. Lawrence (95)		

		In situ population status (Canada)			
		Endangered or Extirpated	**Threatened**	**Special Concern**	**Not at risk/ not assessed**
Natricinae (16 DUs)					
***Ex situ* population size (Canada & US)**	**None in captivity**	• Queensnake (0) • Butler's Gartersnake (0)			• Red-bellied Snake (0) • Maritime Gartersnake (0) • Puget Sound Gartersnake (0)
	<25 individuals		• Eastern Ribbonsnake, Atlantic (20)	• Lake Erie Watersnake (6) • Eastern Ribbonsnake, Great Lakes (20)	• Northwestern Gartersnake (1) • Valley Gartersnake (1) • Dekay's Brownsnake (2) • Plains Gartersnake (17) • Terrestrial Gartersnake (21)
	25-55 individuals				• Red-sided Gartersnake (30) • Eastern Gartersnake (33)
	>55 individuals				• Northern Watersnake (74) • Common Gartersnake (115)
Dipsadinae (5 DUs)					
***Ex situ* population size (Canada & US)**	**None in captivity**	• Sharp-tailed Snake (0)			• Ring-necked Snake (0)
	<25 individuals	• Desert Nightsnake (8)	• Eastern Hog-nosed Snake (15)		
	25-55 individuals				
	>55 individuals			• Plains Hog-nosed Snake (104)	
Boidae (1 DU)					
***Ex situ* population size (Canada & US)**	**25-55 individuals**			• Northern Rubber Boa (26)	

Potential *Ex Situ* Roles and General Program Characteristics

Classification of roles and general program characteristics

The Workshop Companion Guide provided to participants (Appendix III) provided an initial description of 11 different potential *ex situ* conservation roles. Workshop participants reviewed the descriptions and discussed the general program specifications for each as it relates to Canadian snakes, considering scale, scope and management requirements. Each role may have different requirements for capture, breeding and/or rearing, release, type of facilities needed, and program length. For example, while education and training may be achieved with a small number of individuals and include handling and public displays, an insurance population will require a long-term intensively managed breeding population of sufficient size to maintain genetic diversity. Programs that include releases of animals to the wild may require off-exhibit holdings and minimal handling.

Roles were grouped and considered in three broad categories depending on their general conservation function and overall characteristics (Table 3). In the interest of time in this rapid assessment process, program characteristics were not discussed individually for most taxa unless the needs varied significantly from these descriptions; those cases are noted in the *Species-Specific Status and Recommendations* section.

Table 3. General categories of potential *ex situ* conservation roles and program characteristics considered for Canadian snakes.

	Timeframe / Management / Goal	Facilities and Handling
i. Long-term breeding programs (i.e., multiple generations) requiring intensive population management with demographic goals, and of sufficient size to maintain genetic diversity (unless maintained only as a genetic biobank). Designed to guard species extinction and provide future conservation options.		
Ark Population	Long-term breeding with genetic and demographic management of the entire remaining population of a taxon. Possible source for other conservation roles in the future.	No special requirements
Insurance Population	Long-term breeding with genetic and demographic management and target population size. Possible source for other conservation roles in the future.	No special requirements
ii. Programs that include eventual release of animals to reinforce existing populations or establish new ones. These roles assume some level of population management, and genetic management may be required depending on the length of the program. Program should consider the influence of human exposure on animal behaviour and risk of disease when releasing animals.		
Rescue Population	Capture due to imminent threat in the wild. Short- or long-term *ex situ* holding for release (includes holding *in situ* over winter, e.g., artificial hibernacula, forced hibernation).	Minimal human contact/off-exhibit/*in situ*

	Timeframe / Management / Goal	Facilities and Handling
Demographic Manipulation	Short-term rearing of wild-origin animals for release (e.g., headstarting of eggs or juveniles)	Minimal human contact/off-exhibit
Reintroduction Reinforcement Ecological Replacement Assisted Colonization	Long-term breeding for the purposes of release. At least one generation in captivity, producing more animals to be released.	Minimal human contact/off-exhibit
iii. No specific population management required. Animals may need to be handled and/or located close to the target audience. Model species may be used as alternatives.		
Conservation-based Research	No specific population management required; however, breeding may be required depending on research questions (e.g., reproduction, longevity, genetics)	Depends on specific research needs
Conservation-based Training	No specific population management required	Handling during outreach/training
Conservation-based Education	No specific population management required	On public display/ exhibit and may require handling by staff

Potential ex situ *roles for the conservation of Canadian snakes*

While the process began with the definitions of potential *ex situ* roles as described in the Companion Guide, the common understanding of participants evolved over the course of the workshop and some definitions were further refined for clarity. Refined definitions of the *ex situ* roles considered and how they were interpreted and applied for Canadian snakes for the purposes of this workshop are presented below and apply throughout this report.

1. **Ark population** - All remaining individuals of a species are taken into captivity to form an *ex situ* population, which is maintained long-term as a preparation for reintroduction or assisted colonization if and when feasible. Species is extinct in the wild. Conscious decision to purposely take into captivity to preserve the species, rather than a reaction to an imminent threat (as in rescue).
2. **Insurance population** – Long-term *conservation breeding program* for purposes of preserving genetic and demographic options *in the future* as assurance against extinction or severe decline in the wild. An *ex situ* population may be desired as an insurance population from which individuals can be taken for genetic and/or demographic supplementation or other conservation translocations as required, but these are *not yet* actively planned for the foreseeable future.
3. **Rescue population** (temporary or long term) - An *entire* population, or *a significant portion of it*, is brought into captivity due to imminent threats that will severely impact the viability of that taxa in the wild. Animals are held *ex situ* for a length of time - short or long - then *released* back into the wild, usually to their original location. Rescued animals could also be used for reinforcement or reintroduction. Rescue is not the same as salvage of individual or

small groups of snakes in imminent threat at a particular site; there needs to be a species or local population scale impact. Two categories of rescue were identified:

   I. Population level (range wide): imminent threat will affect viability of entire species/taxa in the wild, e.g., small, isolated populations rescued for conservation purposes
   II. Local, regional level: local sub-population is unique, e.g., local adaptation, genetically distinct or regionally rare and could be considered for rescue if under imminent threat.

4. **Demographic manipulation** - Used to improve a demographic rate (survival or reproduction) or status (e.g., skewed sex ratio) in the wild, often of a particular age, sex, or life stage. In all instances for snakes, this referred to headstarting where eggs or neonates are reared short-term *ex situ* to reduce high mortality during this life stage and then released to the wild, typically to natal habitat.
5. **Population restoration: Reintroduction** - A *conservation breeding program* producing animals for *release* into the wild into former habitat in their native range where they have been extirpated. For the purposes of this workshop, this does not include wild-to-wild translocation.
6. **Population restoration: Reinforcement** - A *conservation breeding program* producing animals for *release* into the wild to supplement existing populations. For the purposes of this workshop, this does not include wild-to-wild translocation.
7. **Conservation introduction: Ecological replacement** - Introduce the species outside of its indigenous range to re-establish a lost ecological function and/or modify habitats. This may involve species that are not themselves threatened but that contribute to the conservation of other taxa through their ecological role.
8. **Conservation introduction: Assisted colonization** - Introduce the species outside of its indigenous range to avoid extinction of populations of the species, e.g., in response to climate change projections.
9. **Conservation-based research** - Use of an *ex situ* population for research that will directly benefit conservation of the species, or a similar species, in the wild. The research must address specific questions essential for success of the overall conservation strategy for the species. This can include non-threatened species serving as a model for threatened species or establishing *ex situ* populations of a threatened species to gain important species-specific husbandry and breeding expertise that is likely to be needed in the future to conserve the species.
10. **Conservation-based training** - Use of an *ex situ* population for training that will directly benefit conservation of the species, or a similar species, in the wild. Training must address expertise essential for success of the overall conservation strategy for the species, e.g., training conservation officers, biologists or wildlife managers in restraint, handling and/or health assessment techniques. This can include non-threatened species serving as a model for threatened species.
11. **Conservation education** - The *ex situ* population forms the basis of an education and awareness program addressing specific threats or constraints to the conservation of the species or its habitat. Education must be targeted towards specific human behavioural changes that are essential for the success, and an integral part of, the overall conservation strategy for the species, e.g., discouraging persecution or wild collection by the public. This primarily involves *ex situ* locations visited by the intended human audience or used in mobile presentations in target communities. This can include non-threatened species serving as a model for threatened species, or as ambassador for snakes in general if the threat is widespread.

The participants considered if any of these roles might address conservation challenges and/or priority knowledge gaps for any of the 39 snake taxa given the threats identified in the threat analysis, or whether any could be eliminated from further discussion at this time (i.e., not relevant, or applicable to any Canadian snake taxa). It was decided that all roles should be given consideration in further taxa-specific evaluations.

Summary of ICAP Workshop Results

Rather than making assumptions about *ex situ* conservation roles based on numbers of individuals currently in zoos and the *in situ* status alone, the ICAP process allowed for more detailed discussion considering threats to taxa and which potential roles could contribute to conservation needs, if any. Programs to meet those needs were then recommended and can be incorporated into zoo collection planning at both an institutional and national scale. This approach resulted in more specific and variable recommendations across the 39 taxa. A reflection of this is the several categories of recommendations that emerged by the end of the workshop, as defined below:

- **Recommended** - no caveats.
- **Recommended with restrictions** - specific restrictions on the *ex situ* program to meet the recommended role, as described in the *Species-Specific Status and Recommendations.* Restrictions largely had to do with the source of animals, with *ex situ* program needs being met only through existing captive stock, or local animals that come into captivity opportunistically (i.e., through confiscation or wildlife rehabilitation). For conservation-based research, restrictions constrained this role to specific priority research questions.
- **Recommended case-by-case** - not recommended across the board for the taxa but may be beneficial on a case-by-case basis, e.g., unique/distinct subpopulation, regional differences in status/threats, if a specific opportunity presents itself.
- **Recommended as model** - role has no direct conservation value for the species but using it in an *ex situ* program could benefit other species that may be at greater risk or where a program is less feasible.
- **Not recommended at this time** - re-evaluate if situation changes.

General ex situ *recommendations for Canadian snakes*

Some common or overarching actions were identified as relevant to most or all the focal taxa:

- ***Ex situ* conservation activities have value in the conservation of Canadian snakes and should be used, when appropriate, to enhance recovery efforts, particularly for threatened taxa with an existing large *ex situ* population.** ICAP recommendations broadened existing *ex situ* roles and options for threatened taxa beyond what exists in published recovery documents and helped to identify regional priorities.

- **Conservation-based education is important for changing negative perceptions and behaviours towards snakes which contribute to important threats to snakes in general.** Both direct and indirect conservation education can help support increased awareness, foster more positive attitudes, and create behaviour change that can benefit Canadian snakes. Zoos in the region have the potential to contribute to these efforts. Major threats that can be addressed through targeted education and outreach programs include human persecution, unauthorized collection by the public, and road mortality. Additional beneficial messaging includes keeping common species common and encouraging people to learn to identify and report sightings of species to contribute to knowledge of population distributions and trends. Conservation education programs can include non-threatened species serving as a model for threatened species, or as ambassadors for snakes in general if the threat is widespread.

- **All *ex situ* roles that involve releases of animals must include research to evaluate success of these efforts and be integrated with *in situ* conservation efforts to address primary threats.** This includes *ex situ* population restoration efforts as well as releases of animals from rescues, confiscation, and rehabilitation. Releases should have proper protocols in place (e.g., release at artificial hibernacula), and include monitoring and follow-up of released animals to determine the effectiveness of these actions both short and long term, with methods adapted to improve chances of success (i.e., increase feasibility, decrease risk). Information should be widely shared to promote learning from release efforts within the snake conservation community, and to build evidence-based best practices that can inform permits/policies to reduce irresponsible releases (e.g., Randall et al. 2018).

- **In general, *ex situ* conservation-based research, training, and education should not proactively capture snakes from the wild, and should instead rely on opportunities from rescue, rehabilitation and/or confiscation. Where these opportunities are unlikely or unfeasible, wild collection may be necessary for specialized situations.** Removing animals from the wild specifically to support *ex situ* efforts can present risks to wild population persistence, especially for threatened taxa or populations with unknown abundance, trends, or threats. Additional risks may also come from unknowledgeable groups collecting from the wild inappropriately, or repeatedly due to poor husbandry, and negatively impacting wild populations. Therefore, collection solely for education, training, or research purposes is generally not recommended. To limit impacts to wild populations as much as possible, it is recommended that alternatives to wild collection be pursued for these efforts. This includes using existing snakes in captivity, non-target species as models, opportunities from non-releasable animals sourced from rescue, confiscation, or rehabilitation activities, and using technology such as 3D printing, images, videos, etc. However, the group recognized that there may be times when the conservation value of having a snake in captivity outweighs the risk of removing a few individuals e.g., common species from large, stable populations (e.g., Eastern Gartersnake, *Thamnophis s. sirtalis*) or to mitigate disease concerns from imported captive snakes (e.g., Eastern Hog-nosed Snake, *Heterodon platirhinos*). In all such cases, proper authorizations must be in place. Using captive snakes for training and education purposes is preferred over short-term capture and release of wild snakes as it prevents risks of disease transmission and negative impacts on the individual's fitness and ensures availability of animals outside of the active season.

- **There is a need to coordinate native snake collections and share husbandry knowledge on a national scale, to most effectively serve conservation-based research, training, and education priorities. Further, there is a need for improved and continuous communication between *in situ* and *ex situ* communities regarding evolving species conservation needs and priorities.** Zoos and other *ex situ* facilities need to prioritize their collections based on limited resources (space, funding, etc.). Coordination of collections on a national scale can help reduce redundancies in species representation in captivity and facilitate transfers of specimens between organizations to meet local priorities for education and research, reducing the need to consider collection from wild populations. Mechanisms need to be developed to facilitate knowledge transfer on successful species-specific husbandry amongst Canadian *ex situ* institutions, e.g., accessible repository with standardized template. This could help identify knowledge gaps and needs for effective species-specific husbandry protocols. To ensure that *ex situ* facilities and their collections continue to effectively support priority conservation needs, continued dialogue between *in situ* and *ex situ* practitioners is necessary.

- **Acquiring animals for potential *ex situ* roles should not be used as the justification for a salvage operation to occur for development mitigation; all options to avoid the impact should always be considered first.** In order to maintain persistence of populations on the landscape it is critical to maintain habitat and prevent disturbance to wild populations. If a salvage operation is required, any injured or otherwise non-releasable animals could be considered for *ex situ* roles as appropriate; consideration of individuals for *ex situ* roles will be situation-specific. While permits require salvage of threatened snakes in construction areas, developers should be obliged to at least remove all animals from imminent harm regardless of conservation status. A salvage operation in the face of construction/ development is not a rescue requiring *ex situ* intervention for taxon-level conservation; a conservation-based rescue occurs only when a significant proportion of the population is under imminent threat. Permit requirements related to species at risk should prevent a development project from triggering the need for a rescue.
- **Rescued snakes should be returned to their original location as the first priority; reinforcement, reintroduction and retention in captivity may be considered on a case-by-case basis, e.g., if the original habitat is no longer suitable.** The fate of rescued snakes should be re-evaluated if the viability of the population or specific subpopulations changes.

Summary of species-specific workshop recommendations

The potential *ex situ* roles of Ark Population, Ecological Replacement and Assisted Colonization, while discussed briefly in several instances, were not recommended at this time for any Canadian snake taxa.

Threatened taxa: At least two *ex situ* conservation roles were recommended for all 11 threatened taxa with large *ex situ* populations (size range: 26-130; Table 4). Some level of *ex situ* population management (i.e., long-term breeding programs and/or release programs) was recommended for three endangered taxa with some of the largest *ex situ* populations (size range: 57-98). All three of these taxa, Eastern Massasauga (*Sistrurus catenatus*), Eastern Foxsnake (*Pantherophis vulpinus*), and Gray Ratsnake (*Pantherophis spiloides*), are Carolinian DUs (i.e., exist in the same geographic region of Ontario). The Eastern Massasauga and Gray Ratsnake already have published recommended *ex situ* recovery actions (Table 1), and the Eastern Massasauga currently represents the only established SSP for a Canadian snake. ICAP recommendations broadened existing *ex situ* roles and options and helped to identify regional priorities for these taxa.

Fifteen threatened taxa have small or no existing *ex situ* populations. For three of these taxa, Pacific Gophersnake (*Pituophis c. catenifer*), Lake Erie Watersnake (*Nerodia sipedon insularum*), and Sharp-tailed Snake (*Contia tenuis*), no *ex situ* conservation roles were recommended at this time due to low feasibility, high risk, and/or the option of using a non-threatened taxon as a model. In general, development of managed *ex situ* populations was not recommended for this group, with the exception of establishing short-term rescue populations on a case-by-case basis for three taxa of natricines with small local populations where regional threats could pose a significant risk to the entire local population, Queensnake (*Regina septemvittata*), Butler's Gartersnake (*Thamnophis butleri*), Eastern Ribbonsnake (*Thamnophis sauritus*) - Atlantic DU. Conservation-based Research, Training, and Education were recommended as priority roles for these taxa to directly address threats and/or improve feasibility and risk for other *ex situ* conservation roles with the caveat that animals be obtained locally and opportunistically (e.g., confiscations, rehabilitations) or use existing animals in captivity/captive-bred animals.

Non-threatened taxa: Only two non-threatened taxa are held in relatively large numbers within zoos (size range: 74-179): the Common Gartersnake (*Thamnophis sirtalis*), which comprises five separate subspecies, and the Northern Watersnake (*Nerodia s. sipedon*). Both taxa were recommended as models for targeted research, training, and conservation education for threatened species locally and/or snakes in general. Training and Education were also recommended for most of the seven non-threatened taxa with small or no *ex situ* populations, with an emphasis on either maintaining the existing *ex situ* population or establishing small, local populations through other captive sources (i.e., non-releasable animals). Research was recommended for two taxa, Terrestrial Gartersnake (*Thamnophis elegans*) and Smooth Greensnake (*Opheodrys vernalis*), to explore specific husbandry questions and local adaptations. Rescue Population was the only role requiring management of an *ex situ* population that was assessed for non-threatened taxa and was not recommended for any at this time.

Species-specific assessment, discussion, and recommendations follow in the *Species-Specific Status and Recommendations* section. Recommendations were approved through consensus by all participants unless otherwise noted. Table 5 provides a summary of recommendations for each taxon.

Table 4. Number of taxa recommended for each *ex situ* conservation role by size of *ex situ* population in Canada and US and by conservation status (threatened taxa = extirpated, endangered, threatened, and special concern as assessed by COSEWIC; non-threatened taxa = not at risk or not assessed by COSEWIC).

	Threatened taxa (26 total)		**Non-threatened taxa (9 total; common gartersnake subspecies considered one taxon)**	
	Large *ex situ* population: 26-130 (11 taxa)	Small *ex situ* population: 0-20 (15 taxa)	Large *ex situ* population: 74-179 (2 taxa)	Small *ex situ* population: 0-21 (7 taxa)
Long-term breeding programs with intensive population management				
Insurance	2	0	-	-
Release programs with some level of population management				
Rescue	2	3	0	0
Demographic Manipulation	2	0	-	-
Reintroduction	1	0	-	-
Reinforcement	2	0	-	-
Programs with no specific population management				
Research	7	11	2	2
Training	9	11	2	7
Conservation Education	9	10	2	6

Post-workshop follow-up: Implementation of recommendations

This report is designed to provide a basis for *ex situ* actions to be developed that best contribute to conserving Canadian snake species in the wild, based upon best available data and logical decision making and evaluation within a transparent, collaborative process involving both *in situ* and *ex situ* experts. The result of this national ICAP workshop is intended to enhance the conservation of native Canadian snake species by: i) providing guidance to zoos and aquariums on conservation priorities for collection planning, conservation education messaging, research, and integration of *in situ* and *ex situ* efforts; and ii) promoting collaboration among Canadian zoos and aquariums and field-based conservationists. Some preliminary initial actions were recommended for many of the taxa. More detailed plans will be developed by CSI, CAZA's Conservation Committee and members, interested workshop participants, and additional *in situ* and *ex situ* collaborators as necessary using the information presented in this report.

Table 5. Summary of recommendations for *ex situ* conservation roles for all Canadian snakes. Five recommendation categories were used: recommended; recommended with restrictions; recommended case-by-case; recommended as model; and not recommended at this time (description of categories found on page 21). Grey cells indicate roles that were not considered or evaluated for that taxon. Species grouped and assessed together: Eastern Ribbonsnake – GL/SL DU, Terrestrial Gartersnake, Plains Gartersnake, Northwestern Gartersnake, and Common Gartersnake; Lake Erie Watersnake and Northern Watersnake; DeKay's Brownsnake and Red-bellied Snake.

SPECIES - Designatable Unit (COSEWIC status, *ex situ* population size in CAN & US)	**Insurance Population**	**Rescue**	**Demographic Manipulation**	**Reintroduction**	**Reinforcement**	**Research**	**Training**	**Conservation Education**
Viperidae								
Eastern Massasauga – Carolinian (EN, 98)	Recommend	Recommend	Recommend	Recommend	Recommend	Recommend (restrictions)	Not at this time	Not at this time
Eastern Massasauga - GL/SL (TH, 98)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Recommend as model	Recommend as model	Recommend as model
Western Rattlesnake (TH, 10)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Recommend (restrictions)	Recommend (restrictions)	Recommend (restrictions)
Prairie Rattlesnake (SC, 19)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Recommend	Recommend (restrictions)	Recommend (restrictions)
Timber Rattlesnake (EX, 130)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Recommend as model	Recommend (restrictions)
Colubrinae								
Eastern Foxsnake - Carolinian (EN, 57)	Recommend (case by case)	Not at this time	Not at this time	Not at this time	Not at this time	Recommend (restrictions)	Recommend (restrictions)	Recommend (restrictions)
Eastern Foxsnake - GL/SL (EN, 57)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Recommend (restrictions)	Recommend
Gray Ratsnake - Carolinian (EN, 95)	Not at this time	Recommend (case by case)	Recommend (restrictions)	Not at this time	Recommend (restrictions)	Recommend (restrictions)	Not at this time	Not at this time
Gray Ratsnake - GL/SL (TH, 95)	Not at this time	Not at this time	Not at this time		Not at this time	Recommend (restrictions)	Recommend	Recommend

SPECIES - Designatable Unit (COSEWIC status, *ex situ* population size in CAN & US)	**Insurance Population**	**Rescue**	**Demographic Manipulation**	**Reintroduction**	**Reinforcement**	**Research**	**Training**	**Conservation Education**
Blue Racer (EN, 18)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Recommend (restrictions)	Recommend (restrictions)	Recommend (restrictions)
Eastern Yellow-bellied Racer (TH, 1)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Recommend (restrictions)	Recommend (restrictions)	Recommend (restrictions)
Western Yellow-bellied Racer (TH, 0)	Not at this time	Not at this time	Not at this time	Not at this time		Recommend (restrictions)	Recommend (restrictions)	Recommend (restrictions)
Great Basin Gophersnake (TH, 20)	Not at this time	Not at this time	Not at this time		Not at this time	Recommend (restrictions)	Recommend (restrictions)	Recommend (restrictions)
Bullsnake (SC, 47)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Recommend (restrictions)	Recommend (restrictions)	Recommend (restrictions)
Pacific Gophersnake (EX, 10)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time
Eastern Milksnake (SC, 29)						Recommend (restrictions)	Recommend	Recommend
Smooth Greensnake (NAS, 4)		Not at this time				Recommend (restrictions)	Recommend (restrictions)	Recommend (restrictions)
Natricinae								
Queensnake (EN, 0)	Not at this time	Recommend (case by case)	Not at this time	Not at this time	Not at this time	Recommend	Not at this time	Not at this time
Butler's Gartersnake (EN, 0)	Not at this time	Recommend (case by case)		Not at this time	Not at this time	Recommend (case by case)	Recommend (case by case)	Recommend (case by case)
Eastern Ribbonsnake - Atlantic (TH, 20)	Not at this time	Recommend (case by case)				Recommend	Recommend	Recommend

SPECIES - Designatable Unit (COSEWIC status, *ex situ* population size in CAN & US)	**Insurance Population**	**Rescue**	**Demographic Manipulation**	**Reintroduction**	**Reinforcement**	**Research**	**Training**	**Conservation Education**
Eastern Ribbonsnake - Great Lakes (SC, 20)		Not at this time				Not at this time	Recommend as model	Recommend as model
Terrestrial Gartersnake (NAS, 21)		Not at this time				Recommend (restrictions)	Not at this time	Not at this time
Plains Gartersnake (NAS, 17)		Not at this time				Not at this time	Recommend as model	Recommend as model
Northwestern Gartersnake (NAR, 1)		Not at this time				Not at this time	Recommend as model	Recommend as model
Common Gartersnake – 5 ssp. (NAS, 179)		Not at this time				Recommend as model	Recommend as model	Recommend as model
Lake Erie Watersnake (SC, 6)		Not at this time				Not at this time	Not at this time	Not at this time
Northern Watersnake (NAR, 74)						Recommend	Recommend	Recommend
DeKay's Brownsnake (NAR, 2)							Recommend (restrictions)	Recommend (restrictions)
Red-bellied Snake (NAS, 0)							Recommend (restrictions)	Recommend (restrictions)
Dipsadinae								
Sharp-tailed Snake (EN, 0)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time
Desert Nightsnake (EN, 8)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Recommend (restrictions)	Recommend (restrictions)	Recommend (restrictions)

SPECIES - Designatable Unit (COSEWIC status, *ex situ* population size in CAN & US)	**Insurance Population**	**Rescue**	**Demographic Manipulation**	**Reintroduction**	**Reinforcement**	**Research**	**Training**	**Conservation Education**
Eastern Hog-nosed Snake (TH, 15)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Recommend (restrictions)	Recommend (restrictions)	Not at this time
Plains Hog-nosed Snake (SC, 104)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Recommend (restrictions)	Recommend (restrictions)
Ring-necked Snake (NAS, 0)							Recommend (restrictions)	Recommend (restrictions)
Boidae								
Northern Rubber Boa (SC, 26)	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Not at this time	Recommend (restrictions)	Recommend (restrictions)

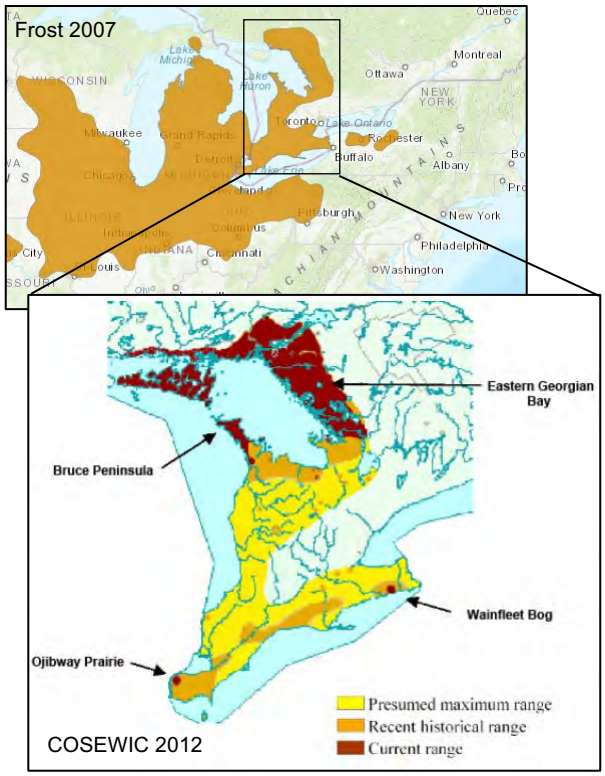
Species-Specific Status and Recommendations
Viperidae

Photo: Eastern Massasauga (*Sistrurus catenatus*), Mike Kent

EASTERN MASSASAUGA (Carolinian)
Sistrurus catenatus (Viperidae)

SPECIES STATUS
Global: **Vulnerable** (NatureServe 2015), Least Concern (IUCN Red List 2007)
Canada: **Critically Imperiled** (NatureServe 2015), **Endangered** (COSEWIC/SARA 2012)
Provincial: **Critically Imperilled** (ON; NatureServe 2015)

Evolutionary Distinctiveness†:
Global: 14.929, Canada: 34.665



Canadian Distribution and Population Trend:
Niagara Peninsula and Windsor area of Southern Ontario (8-10% of global range); Declining (COSEWIC/SARA 2012)

Wild Population

Abundance of the Massasauga Carolinian population is estimated at 80 (±30) mature individuals in two separate subpopulations. Extinction of the Ojibway subpopulation is considered imminent with abundance estimated to be fewer than 10 adults (MECP 2018) and as of 2020, the Ojibway subpopulation is suspected to contain 0-5 individuals (J. Choquette, pers. comm. 2021). The Wainfleet Bog subpopulation is estimated to be 40-70 mature individuals (MECP 2018). The loss of these subpopulations, the only known surviving occurrences in the Canadian Carolinian region, would reduce the extent of occurrence in Canada and create an extensive range gap between Canadian and U.S. populations (COSEWIC 2012).

Threats and Limitations

Main threats consist of habitat loss and fragmentation from agricultural development, urbanization, drainage of wetlands, and natural succession, as well as road mortality and human persecution. Additional threats include snake fungal disease, climate change, forest management, peat and mineral extraction, recreational vehicle use, and the pet trade. Small size makes subpopulations extremely sensitive to threats (COSEWIC 2012, Frost 2007).

In situ Conservation Actions

Of the 263 sites with information indicating the presence of an extant population in the US and Canada, 65% occur on public or private lands that are considered protected from development, many of which are managed by governmental conservation agencies and/or receive ongoing conservation management to address threats (Szymanski et al. 2016). A project in Big Rock Valley, Michigan, managed by the Eastern Massasauga Rattlesnake Species Survival Plan (SSP), is studying a healthy population to help inform conservation plans (2009 - present).

In Canada, the Massasauga Recovery Team was active from the late 1990s to the mid 2010s. In 2020 discussions began to reinvigorate a recovery and implementation team and are ongoing. Recovery actions include population monitoring, habitat protection/connectivity/restoration, hibernation habitat research, road barrier fencing and mortality surveys, and public outreach (Parks Canada 2015). Long-term population monitoring and recovery projects are ongoing at Ojibway (2013 - present) and Wainfleet Bog (1998 - present).

Prior Recommended *Ex situ* Conservation Actions

Ojibway Prairie subpopulation: Implement population management actions, including removing remaining individuals to **protect genetic stock in captivity**, **maintaining a captive population**, and **augmenting population** with neonates through **captive-breeding** and **reintroductions**, as deemed appropriate. Evaluate the effectiveness of actions taken and conduct research to refine husbandry and release techniques.

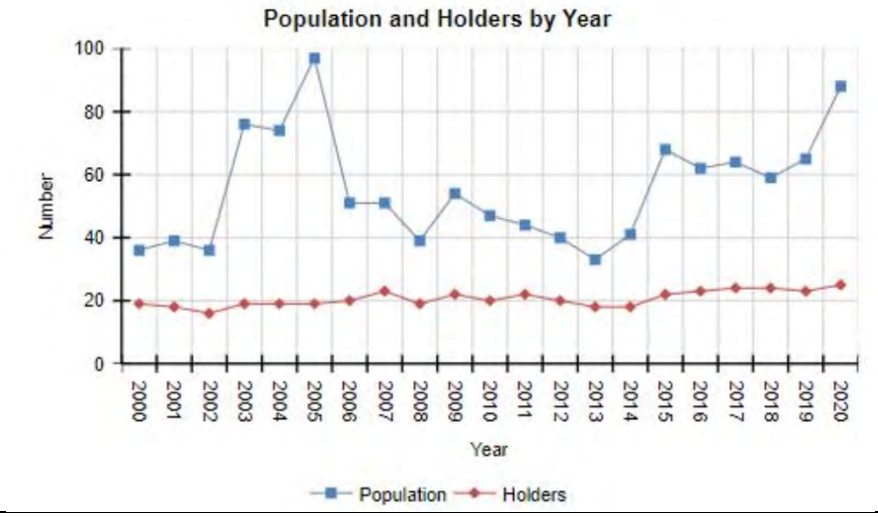
Wainfleet Bog subpopulation: Investigate the need and **feasibility of recruitment techniques to support population**. If necessary and feasible, implement, evaluate, and improve recruitment techniques, such as a **head-starting program**, with consideration for Massasauga ecology (MECP 2018, Parks Canada 2015).

Existing *Ex situ* Conservation Actions

An existing captive breeding population is managed by multiple North American zoos as part of the AZA Eastern Massasauga Rattlesnake Species Survival Plan (SSP; http://www.emrssp.org/). Primary roles of the SSP are to maintain an insurance population, to support research (reproduction, disease, and nutrition), and for education and outreach. Six neonates were transferred from the Wainfleet Bog Carolinian population in 2020 and 12 neonates were transferred in 2021 to improve the conservation potential of the SSP (H. McCurdy-Adams, pers. comm. 2021).

In 2003, four massasaugas were rescued from an imminent development project at Ojibway and housed in captivity, where two gravid females gave birth. In 2006, 27 of the captive-born massasaugas were repatriated into the Ojibway Prairie Provincial Nature Reserve but were unable to successfully colonize the area. In 2011, the Massasauga Recovery Team resolved that given the current population estimate for Ojibway, the remaining individuals should be captured and brought into captivity, to prevent the loss of this genetic stock; however, approval for this activity was only granted in 2020, and permits are pending for releases/population augmentation. An analysis of multiple factors related to future population management activities (e.g., population augmentation, head-starting) was completed (Choquette 2015) and preparation for long-term population augmentation using conservation breeding and translocation is ongoing and includes research on artificial hibernation and habitat suitability for both subpopulations.

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *S. catenatus*	38 (11.11.16)	60 (28.21.11)	1 (1.0.0)	99 (40.32.27)
Number of institutions	3	22	1	26
Breeding status	Breeding recorded in captivity since 2001 (including in 2020 in Canada)			
Living wild-born	28 (11.7.8) confirmed in Canada (9 from Georgian Bay population) and in US			
Generation time (yr)	8 (COSEWIC 2012: range 6-10)			
Potential surrogates(s)	Western massasauga (*S. c. tergeminus*), Common gartersnake (*Thamnophis sirtalis*); also the following similar looking species: Eastern Foxsnake (*Pantherophis vulpinus*), Eastern Milksnake (*Lampropeltis triangulum*), Eastern Hog-nosed Snake (*Heterodon platirhinos*), Northern Watersnake (*Nerodia sipedon sipedon*)			
Husbandry notes	small, late maturing temperate viperid, venomous, viviparous, 3-20 neonates, biennial+ reproductive cycle. See: AZA Eastern Massasauga Rattlesnake Care Manual			
Historical holdings in North America (2000-2020) * *S. catenatus*				

Ex Situ Conservation Assessment

Summary of Discussion

The Carolinian and Great Lakes/St. Lawrence (GL/SL) DUs have different conservation needs, severity of threats, and strategies for management and protection. The Carolinian DU is isolated and fragmented. The province of Ontario wants to maintain lineages by using Carolinian individuals (or individuals containing at least some Carolinian lineage) for any future releases within the Carolinian range. The SSP is managed as one group at the species level (i.e., maintaining separate "pure" lineages is not possible due to the small size of the SSP population). The SSP lists all captive Eastern Massasauga in the US and Canada, and there is a subset of managed snakes at participating organizations (i.e., maintains a larger list than just those managed in the SSP). The number of Carolinian individuals in the SSP is low, although the SSP is currently working with institutions in Canada to maintain a subset Carolinian population within the SSP. This is a difficult species to breed; an AZA Care Manual exists, and further husbandry information is available through the SSP institutions. Sources of Carolinian Massasaugas are limited as they cannot be transferred from the US where the species is designated endangered, and in Canada, the Ojibway subpopulation is possibly extirpated while the viability of the Wainfleet subpopulation would be compromised if adults were collected. The best source of founders for the Carolinian lineage is likely from collecting several neonates from large litters at Wainfleet. The limited availability of animals affects the feasibility of *ex situ* conservation roles. Political will, regulatory requirements, suitable release habitat and disease risk may also affect the feasibility/risk of release (e.g., reintroduction/reinforcement).

The conservation needs, feasibility, and risk for the Ojibway and Wainfleet subpopulations are different and average ratings were used unless otherwise noted in the *Ex Situ Assessment and Recommendations* table below. The Ojibway subpopulation is likely functionally extirpated therefore all *ex situ* conservation roles for population restoration are of critical conservation value with the goal to re-establish or augment the former population to be demographically viable. The Wainfleet subpopulation is actively managed *in situ* and a long-term solution to the threat of sink habitat due to flooding/constant fluctuations of water and the impact over time is needed. Rescue is ongoing through forced hibernation in suitable habitat areas (i.e., rescue from sink habitat, short-term holding in artificial hibernacula in the field over winter, then release). One third of the Wainfleet subpopulation was lost due to a recent flood event which may have impacted genetic diversity and demographic manipulation through the addition of males to the subpopulation is recommended to increase the lost genetic diversity. There is higher risk to the Wainfleet population for roles that require removing individuals from the wild (e.g., ark, insurance) as this could potentially lower the viability of the wild population.

There is conservation value for research, training, and education for the Carolinian DU; however, given the endangered status of the Carolinian DU, it is recommended that the GL/SL DU and other species be used as models/surrogates as much as possible, while Carolinian animals should be retained for roles with critical conservation value (e.g., reintroduction). Hence, these three roles are not recommended at this time other than research questions that can only be answered by Carolinian snakes to ensure results are applicable and then only as an additional role for an established captive population. Captive animals should be used to reduce risk (e.g., continual disturbance of wild animals) and improve feasibility (e.g., availability of animals throughout the year). It is recommended that existing captive snakes such as confiscations/injuries (i.e., non-releasable and meeting welfare threshold) or similarly behaved captive vipers, if available and depending on needs, be prioritized followed by wild GL/SL snakes. The Wainfleet rescue snakes can continue to be used for training as an additional role, but snakes from the GL/SL DU should be considered for other training purposes. Education programs should be focused within the Carolinian area even if using snakes from other areas.

Research topics applicable to Carolinian DU: Inbreeding depression (assess genetic profile), improve captive breeding output and reliability (can potentially use GL/SL as model), comparison/confirmation of data collected *in situ* and knowledge gaps in demography such as fecundity, longevity, maturity, etc. (may need captive breeding program to answer questions although population management not necessary), improve release methods to ensure high survival rates, viability of introducing snakes from other DU, rattling behaviour habituation

Training needs: Field personnel handling, blood sampling, train agricultural/farm/construction workers/etc. to call upon staff members trained in snake handling to move snakes (i.e., short distance translocations) instead of killing

Indirect conservation opportunities: Workshops, funding/fundraising, advice, field assistance (monitoring, collecting), community science, conservation education materials, broad promotion of *ex situ* conservation to garner support for the *in situ* measures required to allow the captive animals to survive when released into the wild.

Recommended Actions

Conduct a conservation planning workshop for Massasaugas to discuss use of *ex situ* roles among/within the species e.g., structure/organization of training/education population, management of SSP population, actions to reduce risks and increase feasibility of reintroduction, as part of an integrated conservation plan for the species.

Ojibway subpopulation:

- Bring last remaining individuals from Ojibway subpopulation into captivity, if possible.
- Re-establish Ojibway subpopulation (if extirpated) and ensure follow-up research is part of any reintroduction to learn effective methods to reduce risk and increase feasibility of future reintroduction efforts.

Wainfleet subpopulation:

- Increase Carolinian genetics in SSP through non-releasable/injured individuals and possibly surplus neonates from Wainfleet subpopulation.
- Assess population trend and evaluate risk of removing snakes from Wainfleet subpopulation to establish captive population.
- Continue the use of forced hibernation to evaluate mitigation of population sink and training with captive animals as additional role.

Table 6. *Ex Situ* Conservation Assessment and Recommendations for Eastern Massasauga (*Sistrurus catenatus*) – Carolinian DU

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Ark	Ojibway - Critical	Moderate-Low	Ojibway - Low Wainfleet - High	Not recommended at this time (but see rescue)
Insurance	Critical	Moderate-Low (Ojibway – Low)	Ojibway - Low Wainfleet - Moderate	**Recommended**
Rescue	Critical-High (Wainfleet - Critical)	High-Moderate	Moderate-Low	**Recommended** for entire Ojibway subpopulation and overwinter for individuals at Wainfleet
Demographic Manipulation	Critical-High (Ojibway - Critical)	Moderate	Moderate	**Recommended**
Reintroduction	Critical-High (Ojibway - Critical)	Low, can be improved	Moderate	**Recommended**
Reinforcement	Critical-High (Ojibway - Critical)	Low, can be improved	Moderate	**Recommended**

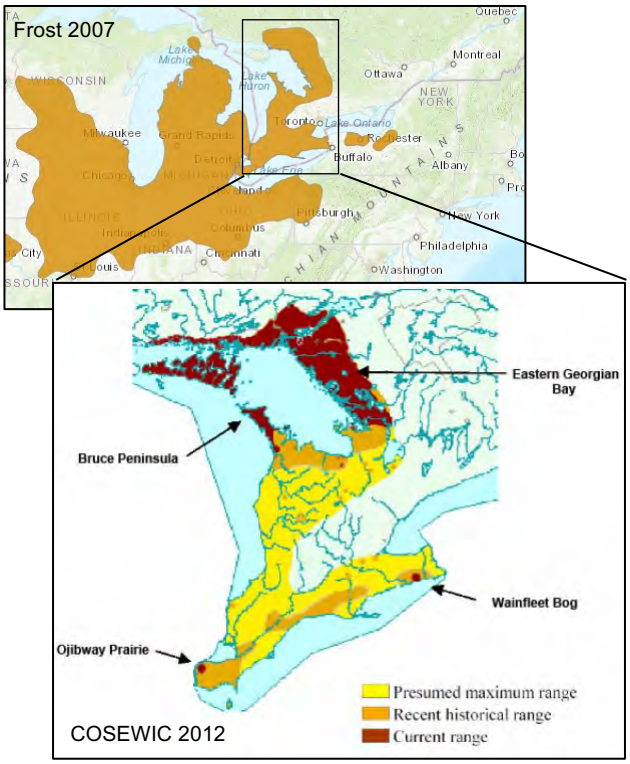
Assisted Colonization	Low	Low, difficult to improve	High	Not recommended at this time
Research	High	Low, can be improved	High-Moderate	**Recommended, with restrictions** As additional role only using existing captive snakes
Training	Moderate-Low	Low, difficult to improve	High-Moderate	Not recommended at this time (but see GL/SL DU)
Education	Critical-High	Low, difficult to improve	High-Moderate	Not recommended at this time (but see GL/SL DU)

Resources

AZA Eastern Massasauga Rattlesnake SSP. 2013. Eastern Massasauga Rattlesnake (Sistrurus catenatus catenatus) Care Manual. Association of Zoos and Aquariums, Silver Spring: MD. **AZA Snake Advisory Group. 2016**. Regional Collection Plan. 4th Edition. Eds. C. Peeling, I. Recchio. **Choquette et al. 2015**. Ecological and socioeconomic feasibility of recovering the Ojibway Prairie population of Eastern Massasauga. Report to Environment Canada and Ontario Ministry of Natural Resources and Forestry. **COSEWIC. 2012.** COSEWIC assessment and status report on the Massasauga Sistrurus catenatus in Canada. **Frost, D.R., Hammerson, G.A. & Santos-Barrera, G. 2007.** Sistrurus catenatus. The IUCN Red List of Threatened Species 2007: e.T64346A12772707. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T64346A12772707.en. **Harvey et al. 2014**. Moving Massasaugas: Insight into rattlesnake relocation using Sistrurus c. catenatus. Herpetol Conserv Bio 9(1):67-75. **NatureServe**. 2015. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.884611/Sistrurus_catenatus_pop_2. (Accessed: Oct 14, 2020). **Ontario Ministry of the Environment, Conservation and Parks. 2018.** Massasauga (Carolinian and Great Lakes - St. Lawrence populations) Ontario Government Response Statement. **Ministry of Northern Development, Mines, Natural Resources & Forestry. 2016**. Recovery Strategy for the Massasauga (Sistrurus catenatus) – Carolinian and Great Lakes – St. Lawrence populations in Ontario. **Parks Canada Agency. 2015**. Recovery Strategy for the Massasauga (Sistrurus catenatus) in Canada. Species at Risk Act Recovery Strategy Series. Parks Canada Agency. Ottawa. ix + 37pp. **Szymanski et al. 2016.** Species Status Assessment for the Eastern Massasauga Rattlesnake (Sistrurus catenatus). US Fish and Wildlife Service.

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

EASTERN MASSASAUGA (Great Lakes/St. Lawrence) *Sistrurus catenatus* (Viperidae)



SPECIES STATUS
Global: **Vulnerable** (NatureServe 2015), Least Concern (IUCN Red List 2007)
Canada: **Vulnerable** (NatureServe 2015), **Threatened** (COSEWIC/SARA 2012)
Provincial: **Vulnerable** (ON; NatureServe 2015)

Evolutionary Distinctiveness†:
Global: 14.929, Canada: 34.665

Canadian Distribution and Population Trend:
Eastern shore of Georgian Bay and northern Bruce Peninsula in Southern Ontario (8-10% of global range); Declining (COSEWIC/SARA 2012)

Wild Population

The eastern Georgian Bay and Bruce Peninsula Massasauga populations are believed to be the largest and most secure found anywhere across the eastern subspecies global range; however, the number of adults may be <10,000 and is declining because of continued threats. The GL/SL DU supports the only Canadian representatives of alvar and rock barren populations (COSEWIC 2012).

Threats and Limitations

Main threats consist of habitat loss and fragmentation from agricultural development, urbanization, and drainage of wetlands, as well as road mortality and human persecution. Additional threats include snake fungal disease, climate change, fire, forest management, peat and mineral extraction, recreational vehicle use, and the pet trade. Low reproductive rates and low dispersal rates reduce the ability of subpopulations to recover from ongoing threats (COSEWIC 2012, Frost 2007).

In situ Conservation Actions

Of the 263 sites with information indicating the presence of an extant population in the US and Canada, 65% occur on public or private lands that are considered protected from development, many of which are managed by governmental conservation agencies and/or receive ongoing conservation management to address threats (Szymanski et al. 2016). A project in Big Rock Valley, Michigan, managed by the Eastern Massasauga Rattlesnake Species Survival Plan (SSP), is studying a healthy population to help inform conservation plans (2009 - present).

In Canada, the Massasauga Recovery Team was active from the late 1990s to the mid 2010s. In 2020 discussions began to reinvigorate a recovery and implementation team that are ongoing. Yearly recovery actions include at least three long term mark-recapture monitoring projects (plus two short term), widespread presence surveys (including road mortality), habitat suitability research, habitat restoration, road mortality mitigation, public outreach, and education. Wildlife rehabilitation capacity has improved in last few years. Detection probability project was conducted in 2017-2018 to inform provincial standardized snake survey protocol. Mitigation translocation trials and research have occurred over the last decade. National and provincial parks such as Bruce Peninsula National Park, Georgian Bay Islands National Park, and Killbear Provincial Park engage in conservation activities including population monitoring, road mortality mitigation, identification, and protection of critical habitat, relocating snakes, and public outreach (H. McCurdy-Adams, pers. comm. 2021, Parks Canada 2016a, 2016b).

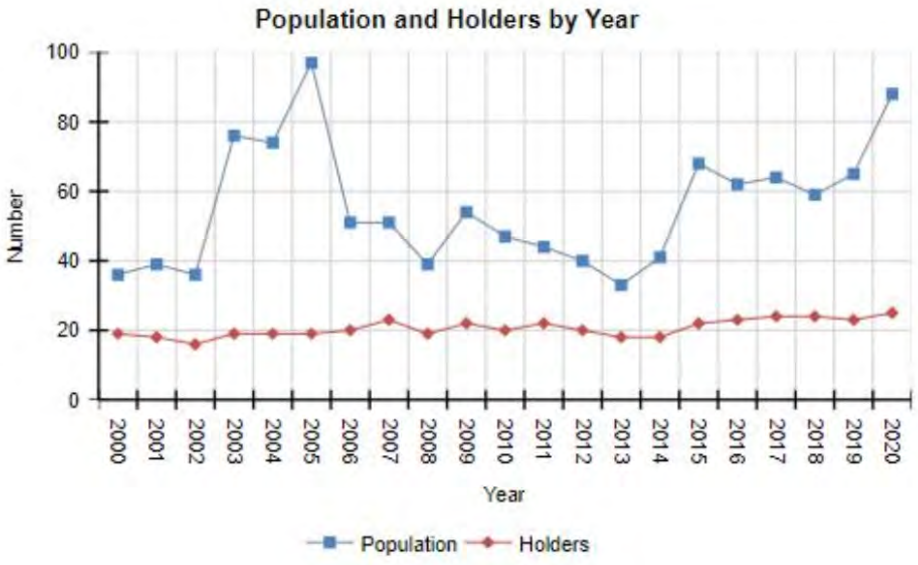
Prior Recommended *Ex situ* Conservation Actions

None known for the Great Lakes/St. Lawrence population

Existing *Ex situ* Conservation Actions

An existing captive breeding population is managed by multiple North American zoos, including the Toronto Zoo, as part of the AZA Eastern Massasauga Rattlesnake Species Survival Plan (SSP; http://www.emrssp.org/). Primary roles of the SSP are to maintain an insurance population, to support research (reproduction and nutrition), and for education and outreach. Ten neonates from the Great Lakes/St. Lawrence population of Eastern Massasuagas were added to the SSP in 2020 and 25 were added in 2021 to improve the conservation potential (H. McCurdy-Adams, pers. comm. 2021). Conservation training for handling and short-distance mitigation translocations is regularly provided by at least six organizations/individuals in Ontario.

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *S. catenatus*	38 (11.11.16)	60 (28.21.11)	1 (1.0.0)	99 (40.32.27)
Number of institutions	3	22	1	26
Breeding status	Breeding recorded in captivity since 2001 (including in 2020 in Canada).			
Living wild-born	28 (11.7.8) confirmed in Canada (9 from Georgian Bay population) and in US			
Generation time (yr)	8 (COSEWIC 2012: range 6-10)			
Potential surrogates(s)	Western massasauga (*S. c. tergeminus*), Common gartersnake (*Thamnophis sirtalis*); also the following similar looking species: Eastern Foxsnake (*Pantherophis vulpinus*), Eastern Milksnake (*Lampropeltis triangulum*), Eastern Hog-nosed Snake (*Heterodon platirhinos*), Northern Watersnake (*Nerodia sipedon sipedon*)			
Husbandry notes	small, late maturing temperate viperid, venomous, viviparous, 3-20 neonates, biennial+ reproductive cycle. See: AZA Eastern Massasauga Rattlesnake Care Manual			
Historical holdings in North America (2000-2020) * *S. catenatus*				

Ex Situ Conservation Assessment

Summary of Discussion

The GL/SL DU consists of a large, intact population and the conservation value of *ex situ* roles for Massasauga is largely for the more imperiled Carolinian DU. *Ex situ* roles have lower value for the GL/SL DU unless the status changes over time, or, as in the case of rescue as noted below, there is a specific need. Research is needed to determine the degree to which the GL/SL DU can assist efforts in the Carolinian DU (e.g., isolation by distance) and should be undertaken using the existing *ex situ* population as possible.

An insurance population is not recommended at this time for the GL/SL DU; however, there is high conservation value, but low feasibility, for an insurance population for the Carolinian DU. Thus, an insurance population is recommended on a higher conservation level for the **species**. Snakes from the GL/SL DU could be used as source for the overall SSP which is an insurance population at the global species scale (i.e., both DUs represented in global SSP) with caveats regarding use and source population. The SSP population needs to be managed more intensively (most of the SSP is from the GL/SL DU). An alternative option to a captive population is translocation between the two DUs, but research is needed to determine whether interchanging or mixing DUs is an appropriate and viable option. Extensive movement research indicates that moving Massasaugas outside of their range reduces survival, therefore long-range movements would be high risk and are not recommended at this time.

Biological, socio-political factors, permitting limits, and inability to get funding result in low feasibility for most population restoration measures for the GL/SL DU (rescue, demographic manipulation, reintroduction, reinforcement, ecological replacement, assisted colonization). Notably there is a lack of government support for these roles for the GL/SL DU given the current population status and there is great divergence in opinion around feasibility and risk. Demographic manipulation, reintroduction, and reinforcement are not recommended for the GL/SL DU but snakes from this DU may serve as a source for the species elsewhere (e.g., source for Ojibway subpopulation efforts as part of SSP); however, feasibility is unknown (i.e., lack of scientific data) and risk of disease transmission to local snake populations needs to be considered. Temporary rescue where snakes are returned to their original activity range is considered low risk.

There is conservation value for conservation-based research, training, and education to serve both Massasauga DUs (e.g., educational workshops for cottage country residents in GL/SL range). It is recommended that every effort be made to use animals already in captivity, including those confiscated by federal and provincial governments that are non-releasable, before taking new individuals out of the wild to supplement these activities. Depending on where the education or training is being conducted GL/SL snakes can be used as models for Carolinian snakes. Research topics should focus on reproduction and genetic variation.

Recommended Actions

Conservation planning workshop for Massasaugas to discuss use of *ex situ* roles among/within the species e.g., structure/organization of training/education population, management of SSP population, and further discussion on appropriateness of different population restoration measures.

Detailed assessment of genetics to determine degree of similarity of GL/SL to other populations and possibility of mixing lineages in SSP.

Table 7. *Ex Situ* Conservation Assessment and Recommendations for Eastern Massasauga (*Sistrurus catenatus*) – GL/SL DU				
Conservation Role (Direct)	**Conservation Value**	**Feasibility**	**Risk**	**Decision**
Insurance	Moderate-Low	High	Low	Not recommended at this time
Rescue	Critical-High	High-Moderate	Moderate-Low	Not recommended at this time
Demographic Manipulation	Low	Divergent	Low	Not recommended at this time
Reintroduction	Low	Low, can be improved	Divergent	Not recommended at this time
Reinforcement	Low	Low, can be improved	Divergent	Not recommended at this time
Ecological Replacement	Low	Low, difficult to improve	High-Moderate	Not recommended at this time
Assisted Colonization	Low	Low, difficult to improve	High-Moderate	Not recommended at this time
Research	High-Moderate	High	Low	**Recommended,** including as model
Training	High	High	Low	**Recommended,** including as model
Education	High	High	Low	**Recommended,** including as model

Resources

AZA Eastern Massasauga Rattlesnake SSP. 2013. Eastern Massasauga Rattlesnake (Sistrurus catenatus catenatus) Care Manual. Association of Zoos and Aquariums, Silver Spring: MD. **AZA Snake Advisory Group. 2016**. Regional Collection Plan. 4th Edition. Eds. C. Peeling, I. Recchio. **COSEWIC. 2012.** COSEWIC assessment and status report on the Massasauga Sistrurus catenatus in Canada. **Frost, D.R., Hammerson, G.A. & Santos-Barrera, G. 2007**. Sistrurus catenatus. The IUCN Red List of Threatened Species 2007: e.T64346A12772707. **Harvey et al. 2014.** Moving Massasaugas: Insight into rattlesnake relocation using Sistrurus c. catenatus. Herpetol Conserv Bio 9(1):67-75. **Miller P. 2006**. Population viability assessment for the Eastern Massasauga Rattlesnake on the Bruce Peninsula, Ontario, Canada. Report prepared by IUCN/SSC Conservation Breeding Specialist Group in collaboration with participants of the Third International Eastern Massasauga Symposium. **NatureServe**. 2015. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.884608/Sistrurus_catenatus_pop_1. (Accessed: Oct 14, 2020). **Ontario Ministry of the Environment, Conservation and Parks. 2018**. Massasauga (Carolinian and Great Lakes – St. Lawrence populations) Ontario Government Response Statement. **Parks Canada Agency. 2015.** Recovery Strategy for the Massasauga (Sistrurus catenatus) in Canada. Species at Risk Act Recovery Strategy Series. Parks Canada Agency. Ottawa. Ix + 37pp. **Parks Canada Agency. 2016a**. Multi-species Action Plan for Bruce Peninsula National Park and Fathom Five National Marine Park of Canada. Species at Risk Act Action Plan Series. Parks Canada Agency, Ottawa. V + 22 pp. **Parks Canada Agency. 2016b**. Multi-species Action Plan for Georgian Bay Islands National Park of Canada. Species at Risk Act Action Plan Series. Parks Canada Agency, Ottawa. Iv + 14 pp. **Szymanski et al. 2016.** Species Status Assessment for the Eastern Massasauga Rattlesnake (Sistrurus catenatus). US Fish and Wildlife Service.

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

WESTERN RATTLESNAKE
Crotalus oreganus (Viperidae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2007)
Canada: **Vulnerable** (NatureServe 2016), **Threatened** (COSEWIC/SARA 2015)
Provincial: **Imperiled** (BC; NatureServe 2016)

Evolutionary Distinctiveness†:
Global: 5.325, Canada: 27.746

Canadian Distribution and Population Trend:
Arid valleys in southern interior British Columbia (<5% of global range); Declining (COSEWIC 2015)

Wild Population

Restricted to five geographic regions within British Columbia separated from each other by unsuitable habitat and with low genetic connectivity, indicating limited natural movement of individuals between areas (Schmidt 2020). Updated estimate of the population size of rattlesnakes in British Columbia based on long-term mark-recapture studies and habitat suitability modelling is forthcoming (D. Kirk pers. comm. 2021). Continued habitat loss and other threats, including road mortality, and documented extirpations of known hibernacula suggest that the population is declining (M. Atkins pers. comm. 2020, COSEWIC 2015).

Threats and Limitations

The main threats to rattlesnake populations in BC are road mortality, persecution and disturbance by people, and habitat loss and fragmentation from urban and agricultural developments. Threats to the species are exacerbated by migrations between seasonal habitats, high habitat fidelity, and congregations at hibernacula. Loss of hibernacula can lead to subpopulation collapse. Population recovery from disturbance or additive mortality is limited by slow life history traits (Winton 2020 & 2018, Maida 2020, Lomas 2019, COSEWIC 2015, Hammerson 2007).

In situ Conservation Actions

Substantial habitat is protected on federal and provincial crown land, and in private land conservancies; however, habitat protection alone is not sufficient to prevent population decline (Winton 2020, Harvey 2015). Research to help better delineate the range, identify threats, and provide information on population biology is ongoing, including three long-term population monitoring and research projects in the South and North Okanagan, range-wide hibernacula monitoring project and opportunistic hibernaculum surveys, and incidental roadkill data collection. Additional recovery efforts include mitigation and monitoring at priority roadkill hotspots, snake fences in residential areas and vineyards, artificial refugia in vineyards, outreach & education (ECCC 2019).

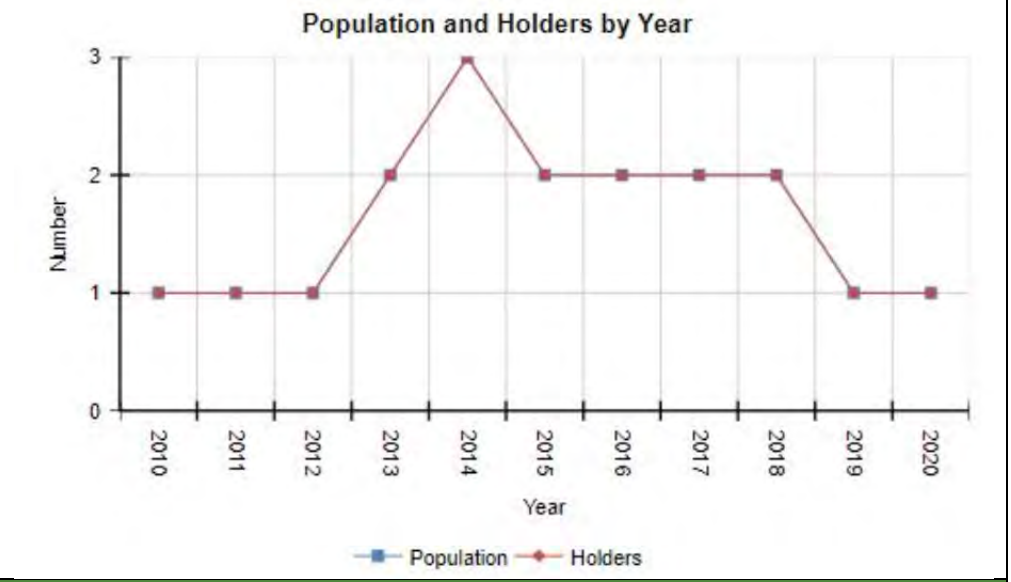
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

Education and outreach programs through conservation and stewardship organizations in BC targeting vineyards and landowners to reduce persecution (ECCC 2019).

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *C. oreganus and C. o. oreganus*	2 (0.2.0)	8 (2.4.2)	1 (0.0.1)	11 (2.6.3)
Number of institutions	1	7	1	9
Breeding status	None documented in captivity			
Living wild-born	None confirmed			
Generation time (yr)	14-16 (COSEWIC 2015: mean 15.6, range 7.1-25.8; Maida et al. 2018: mean 13.7, range 9.3-23.7)			
Potential surrogates(s)	*C. oreganus* ssp. Including Arizona Black Rattlesnake (*C. o. cerberus*), Southern Pacific Rattlesnake (*C. o. helleri*), and Great Basin Rattlesnake (*C. o. lutosus*)			
Husbandry notes	large, late maturing temperate viperid, venomous, viviparous, 1-8 neonates, biennial+ reproductive cycle, long lifespan, feed on small mammals, crepuscular			
Historical holdings in North America (2010-2020) * *C. o. oreganus*				

Resources

COSEWIC. 2015. COSEWIC assessment and status report on the Western Rattlesnake Crotalus oreganus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Xi + 44 pp. **Environment and Climate Change Canada. 2019**. Recovery Strategy for the Western Rattlesnake (Crotalus oreganus), the Great Basin Gophersnake (Pituophis catenifer deserticola) and the Desert Nightsnake (Hypsiglena chlorophaea) in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. Part 1, 28 pp., Part 2, A. 37 pp., B. 36 pp., C. 28 pp. **Hammerson, G.A., Frost, D.R. & Hollingsworth, B. 2007.** Crotalus oreganus. The IUCN Red List of Threatened Species 2007: e.T64326A12769216. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T64326A12769216.en. **Harvey JA. 2015**. Thermal influences on summer habitat use by western rattlesnakes (Crotalus oreganus) in British Columbia (MSc Thesis, Thompson Rivers University). **Lomas E, Maida JR, Bishop CA, Larsen KW. 2019.** Movement ecology of northern Pacific rattlesnakes (Crotalus o. oreganus) in response to disturbance. Herpetologica. 75(2):153-61. https://doi.org/10.1655/D-17-00060. **Maida JR, Kirk DA, McKibbin OW, Row JR, Larsen KW, Stringam CH, Bishop CA. 2018**. Population estimate, survivorship and generation time of the Northern Pacific Rattlesnake (Crotalus o. oreganus) at its northern-most range limits. Herpetological Conservation and Biology. 13(3):662-72. **Maida JR, Bishop CA, Larsen KW. 2020.** Migration and disturbance: impact of fencing and development on Western Rattlesnake (Crotalus oreganus) spring movements in British Columbia. Canadian Journal of Zoology. 98(1):1-2. https://doi.org/10.1139/cjz-2019-0110. **NatureServe**. 2016. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.104250/Crotalus_oreganus. (Accessed: Oct 14, 2020). **Schmidt DA, Govindarajulu P, Larsen KW, Russello MA. 2020.** Genotyping-in-thousands by sequencing reveals marked population structure in Western Rattlesnakes to inform conservation status. Ecology and Evolution. 10(14):7157-72. https://doi.org/10.1002/ece3.6416. **Winton SA, Taylor R, Bishop CA, Larsen KW. 2018**. Estimating actual versus detected road mortality rates for a northern viper. Global Ecology and Conservation. 16:e00476. https://doi.org/10.1016/j.gecco.2018.e00476. **Winton SA, Bishop CA, Larsen KW. 2020**. When protected areas are not enough: low-traffic roads projected to cause a decline in a northern viper population. Endangered Species Research. 41:131-9. https://doi.org/10.3354/esr01017

† Kominek A, Cornies O, McCurdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

In BC, the Western Rattlesnake range is broken into two portions separated by ~50km and the southern portion is contiguous with Washington. The overall population trend is decreasing in the wild, but no subpopulations are at imminent risk of extirpation. There are minimal animals currently in captivity (although there may be more in *ex situ* facilities not listed in ZIMS) with low feasibility of acquiring additional animals. Despite extensive *in situ* research, many knowledge gaps exist, and research is needed to determine if *ex situ* roles are viable tools (e.g., feasibility, likelihood of success, survival of reintroduced animals). Reintroduction success from *ex situ* breeding versus translocation (which has had low success for this species) may vary and there may be an opportunity for pilot programs (e.g., headstarting) if captive snakes become available opportunistically, although the general consensus is to keep animals in the wild.

Two programs exist in BC that provide valuable conservation-based research, training, and education with a small number of non-releasable animals (i.e., confiscations). However, there is a need for greater effort for this species to address persecution and increase awareness, but the existing programs do not currently have the capacity to increase activity. The potential to scale up existing programs to meet the species' conservation needs more effectively is limited by funding, resources, facility space, permit limitations, available animals, etc. The number of animals needed will depend on the research questions, goals, and required effort (e.g., number of presentations/day/year) and animal welfare considerations. A breeding program may not be needed to achieve the required captive population if additional captive snakes are available opportunistically (e.g., confiscations, salvages/rescues, rehabilitated individuals). The captive population would provide high value for many knowledge gaps such as impacts of climate change (e.g., overwintering), demographic parameters, and release techniques. Surrogates may be used for some roles (e.g., training with non-venomous gophersnakes).

Recommended Actions

Develop a plan to assess and improve feasibility/efficacy of conservation education, training, and research population. Recommend that these efforts be better funded in recognition of value.

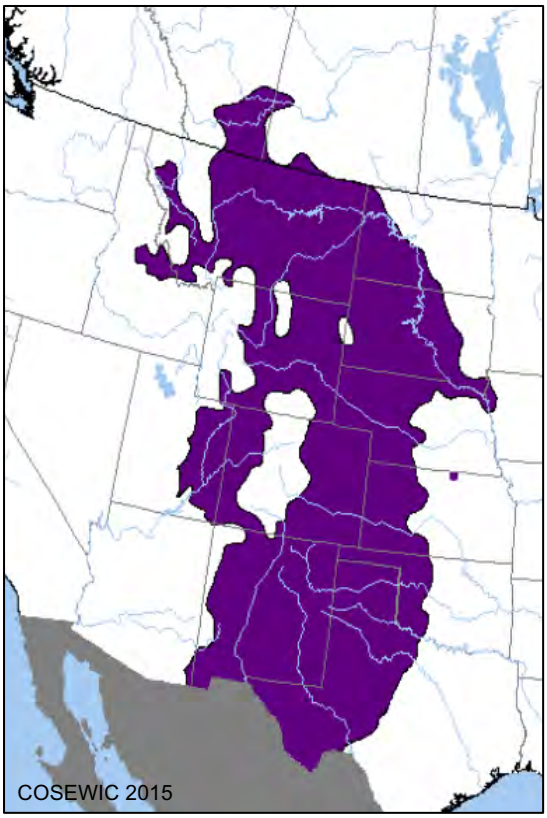
Table 8. *Ex Situ* Conservation Assessment and Recommendations for Western Rattlesnake (*Crotalus oreganus*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Moderate-Low	Low, can be improved	Moderate-Low	Not recommended at this time
Rescue	Low	Moderate-Low	Moderate-Low	Not recommended at this time
Demographic Manipulation	Low	Low, can be improved	Moderate	Not recommended at this time
Reintroduction	Low	Low, can be improved	Moderate	Not recommended at this time
Reinforcement	Low	Low, can be improved	Moderate	Not recommended at this time
Research	High-Moderate	Moderate-Low	Low	**Recommended with restrictions** locally and opportunistically with existing animals in captivity
Training	High	Moderate-Low	Low	**Recommended with restrictions** locally and opportunistically with existing animals in captivity
Education	High	Moderate-Low	Low	**Recommended with restrictions** locally and opportunistically with existing animals in captivity

PRAIRIE RATTLESNAKE
Crotalus viridis (Viperidae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2007)
Canada: **Special Concern** (SARA 2019; COSEWIC 2015), **Vulnerable** (NatureServe 2016)
Provincial: **Vulnerable** (AB, SK; NatureServe 2016)

Evolutionary Distinctiveness†:
Global: 6.056, Canada: 27.746



Canadian Distribution and Population Trend:
Major river valleys in southeastern Alberta and southwestern Saskatchewan (3-4% of global range); Declining (SARA 2019; COSEWIC 2015)

Wild Population
Historical range declines in Canada primarily from large-scale habitat loss due to cultivation. There are ~230 documented hibernacula in Canada, and although the range has remained relatively stable since the 1970s and increased search efforts have detected previously unknown hibernacula, recent monitoring of local populations show substantial declines (~30% decline in number of locations) that are projected to continue due to ongoing serious threats impacting persistence and habitat availability (COSEWIC 2015).

Threats and Limitations
Impacted by loss, degradation, and fragmentation of native prairie habitat and mortality due to intensive agriculture, road networks, oil & gas drilling, residential development, and intentional persecution. Long distance seasonal migrations, high site fidelity, and reliance on communal hibernacula increase vulnerability to disturbance (anthropogenic or natural); low reproductive capacity limits recovery. Genetic barriers may exist between subpopulations but have not been substantiated (AEP 2016, COSEWIC 2015, Frost 2007).

In situ Conservation Actions
Habitat protected on federal lands and provincial parks and protected areas, which contain many known occurrences. Destruction of hibernacula is prohibited under the Alberta Wildlife Act and Saskatchewan Wildlife Act and provincial development guidelines recommend set-back distances from known hibernacula; however, setbacks are not adequate to protect summer foraging habitat and rookery sites. Collection of incidental observations and hibernacula monitoring ongoing since 1980s with recent increased survey efforts and a mark-recapture study at one site (AEP 2016).

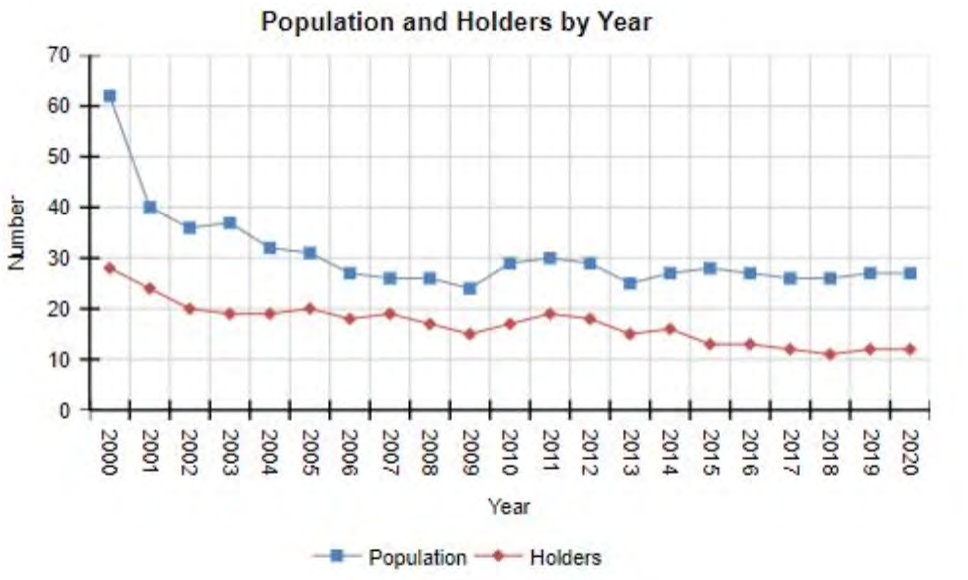
Prior Recommended *Ex situ* Conservation Actions

Targeted education to government, industry, public and landowners on the importance of prairie rattlesnakes in the ecosystem and how to co-exist safely in rattlesnake habitat to reduce mortality and increase habitat management measures on private land (AEP 2016).

Existing *Ex situ* Conservation Actions

Outreach and education activities at provincial parks and some municipalities. Previous translocations of individuals from urban development areas to an artificial hibernaculum has been replaced with short-distance translocations to existing hibernacula (AEP 2016, Ernst & Quinlan 2006).

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *C. viridis and C. v. viridis*	4 (2.0.2)	15 (10.2.3)	2 (0.0.2)	21 (12.2.7)
Number of institutions	2	10	1	13
Breeding status	Breeding recorded in captivity (between 2000-2011).			
Living wild-born	16 (9.3.4) *C. viridis* confirmed (in North America)			
Generation time (yr)	13-14 (COSEWIC 2015)			
Potential surrogates(s)	Hopi rattlesnake (*C. v. nuntius*)			
Husbandry notes	large, late maturing temperate viperid, venomous, viviparous, biennial+ reproductive cycle, avg. 10 neonates, long lifespan, crepuscular, prey on small mammals			
Historical holdings in North America (2000-2020) * *C. viridis*				

Resources

Alberta Environment and Parks. 2016. Prairie Rattlesnake Conservation Management Plan 2016-2021. Alberta Environment and Parks. Species at Risk Conservation Management Plan No.12. Edmonton, AB. 10 pp. **COSEWIC. 2015**. COSEWIC assessment and status report on the Prairie Rattlesnake Crotalus viridis in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. X + 69 pp. **Ernst RD, Quinlan RW. 2006.** Rattlers and People: Conserving rattlesnakes in Lethbridge. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 109, Edmonton, AB. 36pp. **Frost, D.R., Hammerson, G.A. & Santos-Barrera, G. 2007**. Crotalus viridis. The IUCN Red List of Threatened Species 2007: e.T64339A12771847. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T64339A12771847.en. **NatureServe**. 2016. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.768819/Crotalus_viridis. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

The population size of the Prairie Rattlesnake in Canada may be greater than estimated in the COSEWIC assessment. Although it has a large distribution area, and it seems abundant, there is value in more research. Further research is needed on relocating to new hibernacula, release techniques, variation in ecological dynamics and response to climate change in extremes of distribution. Guidelines/protocols need to be developed before population augmentation options are pursued.

Widespread education and training would help this species and it can serve as a model for other crotalid species; therefore, conservation-based education and training have high value, and are recommended if the opportunity presents (i.e., availability of animals from e.g., rescue). There is limited feasibility for conducting training due to a lack of qualified local people, but the target groups, ranchers, and agriculture managers (whom are not likely to be transitory), could be trained through a "train-the-trainer" method that would enable them to train new temporary workers annually.

Recommended Actions

Develop guidelines/protocols for how to minimize risk and maximize success of population restoration/augmentation.

Table 9. *Ex Situ* Conservation Assessment and Recommendations for Prairie Rattlesnake (*Crotalus viridis*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Low	Low, can be improved	Moderate-Low	Not recommended at this time
Rescue	Moderate-Low	Low, can be improved	Divergent	Not recommended at this time
Demographic Manipulation	Low	Low, can be improved	Moderate-Low	Not recommended at this time
Reintroduction	Low	Moderate-Low	Moderate	Not recommended at this time
Reinforcement	Moderate-Low	Moderate-Low	Moderate	Not recommended at this time
Research	Moderate	Moderate-Low	Low	**Recommended**
Training	Moderate-Low	Low, can be improved	Moderate-Low	**Recommended with restrictions** (if opportunity presents)
Education	High	Moderate-Low	Low-None	**Recommended with restrictions** (if opportunity presents)

TIMBER RATTLESNAKE
Crotalus horridus (Viperidae)

SPECIES STATUS

Global: Apparently Secure (NatureServe 2014), Least Concern (IUCN Red List 2007)
Canada: **Extirpated** (NatureServe 2014; COSEWIC/SARA 2010)
Provincial: **Presumed Extirpated** (ON; NatureServe 2014)

Canadian Distribution and Global Population Trend:
Historical range throughout southern Ontario, including much of the Niagara Escarpment, and possibly southern Quebec (COSEWIC 2001); Declining (IUCN Red List 2007)

Evolutionary Distinctiveness†:
Global: 10.618, Canada: 32.270

Wild Population

No confirmed sightings in Canada since 1941 (COSEWIC 2001). Declining or extirpated in all northeastern states and considered extirpated in Rhode Island and Maine (Hammerson 2007).

Threats and Limitations

Deliberate human persecution (including historical bounty hunting), habitat destruction (due to resource exploitation and residential development), and road mortality. Snake fungal disease is a concern (Januszkiewicz 2019). Limited by availability of rookery sites and slow life history traits (COSEWIC 2001, Hammerson 2007, ECCC 2010).

In situ Conservation Actions

None known in Canada. Require stronger protection throughout range (Hammerson 2007).

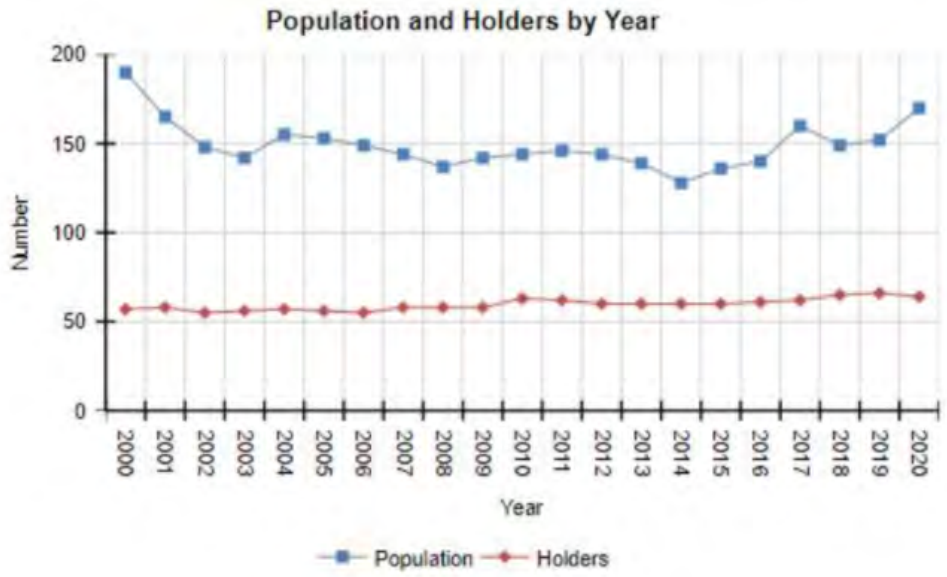
Prior Recommended *Ex situ* Conservation Actions

Recovery not technically or biologically feasible. While US populations could potentially assist with reintroduction in Canada, there is not sufficient habitat, and threats and recovery techniques are not fully understood (ECCC 2010).

Existing *Ex situ* Conservation Actions

None known in Canada. Research on reintroduction techniques and translocation survival and efficacy occurring in US (e.g., Bryan 2019, Walker et al 2009, Reinhart and Rupert 1999).

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *C. horridus and C. h. horridus*	5 (1.1.3)	125 (35.33.57)	4 (0.3.1)	134 (36.37.61)
Number of institutions	3	45	3	51
Breeding status	Breeding recorded in captivity (between 2000-2020). None documented in Canada.			
Living wild-born	49 (16.17.16) confirmed globally			
Generation time (yr)	6 (COSEWIC 2010)			
Potential surrogates(s)	Canebrake rattlesnake (*C. h. atricaudatus*)			
Husbandry notes	large, late maturing temperate viperid, venomous, viviparous, 2-6 year reproductive cycle, avg. 10 neonates, long lifespan, feed on small mammals			
Historical holdings (2000-2020) * *C. horridus*				

Resources

Bryan D. 2019. Translocations of Nuisance Timber Rattlesnakes (Crotalus horridus): A Possible Management Solution. Biology of Pitvipers 3. Rodeo, NM. July 2019. **COSEWIC. 2001**. COSEWIC assessment and status report on the Timber Rattlesnake Crotalus horridus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Vi + 24 pp. **COSEWIC 2010**. Status Appraisal Summary on the Timber Rattlesnake Crotalus horridus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Ix pp. **Environment Canada. 2010**. Recovery Strategy for the Timber Rattlesnake (Crotalus horridus) in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. V + 17 pp. **Hammerson, G.A. 2007.** Crotalus horridus. The IUCN Red List of Threatened Species 2007: e.T64318A12765920. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T64318A12765920.en. Downloaded on 08 February 2021. **Januszkiewicz E, Chinnici N, LaDuke TC, Huffman J. 2019.** Detection of Snake Fungal Disease Caused by Ophidiomyces ophiodiicola Among Timber Rattlesnakes (Crotalus horridus) in Pennsylvania. Biology of Pitvipers 3. Rodeo, NM. July 2019. **NatureServe**. 2014. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.100455/Crotalus_horridus. (Accessed: Oct 14, 2020). **Reinert HK, Rupert Jr RR. 1999.** Impacts of translocation on behavior and survival of timber rattlesnakes, Crotalus horridus. Journal of Herpetology. 1:45-61. **Walker ML, Dorr JA, Benjamin RJ, Pisani GR. 2009**. Successful Relocation of a Threatened Suburban Population of Timber Rattlesnakes (Crotalus horridus): Combining Snake Ecology, Politics, and Education. IRCF Reptiles & Amphibians. Vol 16, No 4.

† Kominek A, Cornies O, M[c]Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

No Timber Rattlesnakes exist in the wild in Canada, so rescue and ark are not recommended at this time. The Timber Rattlesnake requires a large home range, and the amount of appropriate habitat no longer exists in Ontario (i.e., former range in a heavily populated area). Further the species is secure in other parts of its range (i.e., in some US states), so work to reintroduce this species in Canada is not recommended at this time.

There were divergent opinions around the conservation value of an insurance population and reintroduction. Options discussed included establishing an insurance population in Canada for eventual reintroduction, or sourcing animals (adults or neonates) from the US (captive population not necessarily needed.) There was agreement with the SARA Recovery Strategy that reintroduction is not technically or biologically feasible for this species in Canada due to insufficient habitat in native range, and ongoing specific threats to rattlesnake that are not mitigated. Further, reintroduction techniques do not yet exist and the political will for reintroduction/release in Ontario is low. There is possibly a need for another feasibility assessment for reintroduction (i.e., analysis on availability of suitable habitat, ecological niche modelling, or feasibility of habitat restoration for reintroduction), but the consensus is that not enough habitat remains for reintroduction to be feasible or have any value.

There is high educational value for other snake species in Ontario and other rattlesnake species in Canada (especially the Eastern Massasauga) for using existing captive Timber Rattlesnakes as a cautionary tale. Educational messaging should focus on helping people understand that we have lost this species already and we should try harder to not lose others (e.g., what could result from current threats, model of what not to do, how to prevent other species from becoming extirpated). Timber Rattlesnakes are also recommended as a model for training for Eastern Massasaugas. However, the use of Timber Rattlesnake as a model for research is not recommended at this time (model species are generally a more common species that can represent a more endangered species). While animals cannot be sourced from the wild in Canada, there are existing captive individuals in Canada and US (and likely more in private collections) that can be used for conservation-based education and training. CAZA zoos could potentially add snakes from the US to their collections to assist with training and education roles (some zoos are working on this already).

Recommended Actions

Targeted educational messaging as a cautionary tale to increase support for conservation of other species.

Table 10. *Ex Situ* Conservation Assessment and Recommendations for Timber Rattlesnake (*Crotalus horridus*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Ark	Low	Low, difficult to improve	Not assessed	Not recommended at this time
Insurance	Divergent	Low, difficult to improve	Not assessed	Not recommended at this time
Rescue	Low	Low, difficult to improve	Not assessed	Not recommended at this time
Demographic Manipulation	Low	Low, difficult to improve	Not assessed	Not recommended at this time
Reintroduction	Divergent	Low, difficult to improve	Not assessed	Not recommended at this time
Reinforcement	Low	Low, difficult to improve	Not assessed	Not recommended at this time
Ecological Replacement	Low	Low, difficult to improve	Not assessed	Not recommended at this time

Assisted Colonization	Low	Low, difficult to improve	Not assessed	Not recommended at this time
Research	Moderate-Low	Low, difficult to improve	Not assessed	Not recommended at this time
Training	Moderate-Low	Low, can be improved	Not assessed	**Recommended as model**
Education	High	Low, can be improved	Not assessed	**Recommended with restrictions** existing animals in captivity

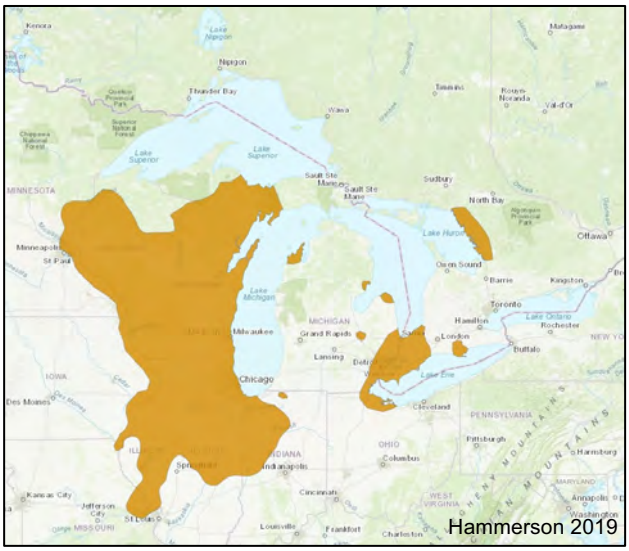
Species-Specific Status and Recommendations

Colubridae

Colubrinae

Photo: Western Yellow-bellied Racer (*Coluber constrictor mormon*), Marcus Atkins

EASTERN FOXSNAKE (Carolinian)
Pantherophis vulpinus (Colubrinae)



SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2016)
Canada: **Imperiled** (NatureServe 2016), **Endangered** (COSEWIC/SARA 2008)
Provincial: **Imperiled** (ON; NatureServe 2016)

Next COSEWIC status assessment:
December 2021

Canadian Distribution and Population Trend:
Two disjunct areas of occupation in southwestern Ontario located in the Essex-Kent and Haldimand-Norfolk regions (10-13% of global range); Declining (COSEWIC/SARA 2008)

Evolutionary Distinctiveness†:
Global: 4.288, Canada: 22.447

Wild Population

The Carolinian populations are confined to a few small increasingly disjunct areas that are subject to persistent threats from increasing human activities. There is no evidence of recent gene flow among these populations and high probability of extirpation for fragmented populations (COSEWIC 2008).

Threats and Limitations

Main threats are road mortality, habitat loss & degradation (especially of hedgerows and wetlands), direct persecution & illegal collection, and other inadvertent effects caused by human activities, such as subsidized predation, due to intensive agriculture, high human populations, and extremely high densities of roads. Snake fungal disease has been confirmed in Eastern Foxsnakes in Ontario. Slow life history traits and specific habitat requirements may increase probability of mortality and severity of threats as well as predispose populations to demographic fluctuations from disturbances (ECCC 2020, CWHC 2017, COSEWIC 2008).

In situ Conservation Actions

Measures to protect habitat are in place on public and private lands, including identification of Critical Habitat and securement of tallgrass prairie habitat. Most remaining intact habitat is located within protected areas, however, there is minimal connectivity between areas. Habitat restoration and creation is being undertaken on Pelee Island along with mark-recapture surveys. Since the early 1970s several mark-recapture and radio-telemetry studies have been conducted to address knowledge gaps in species ecology and threats and extensive awareness and education programs are run by several organizations in the region. A project at Rondeau Provincial Park used radio telemetry to investigate ecology, habitat, and threats (including road mortality and snake fungal disease). Point Pelee National Park conducts population monitoring, snake fungal disease monitoring and treatment, habitat restoration, creation of nesting and hibernation habitat, educational messaging, road mortality mitigation, and poaching and predation prevention. Snake exclusion, salvage, and relocation as well as mitigation and habitat creation/restoration were undertaken for a major highway development and ongoing monitoring is being conducted through a mark-recapture study (T. Degazio pers. comm. 2021, ECCC 2020, Parks Canada 2016, MNDMNRF 2016).

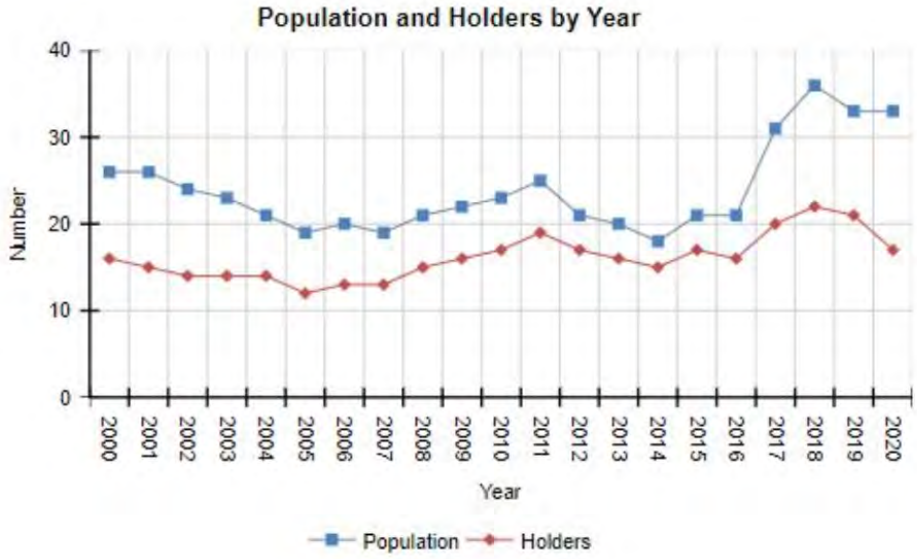
Prior Recommended *Ex situ* Conservation Actions

No specific *ex situ* recovery actions recommended; however, long-term approaches to recovery include the development and implementation of a strategy to enhance, restore and/or reconnect populations. Other recovery goals include research on disease, ecology, and genetics as well as strengthening education and outreach including training workshops and materials for wildlife officers (ECCC 2020).

Existing *Ex situ* Conservation Actions

Education and snake appreciation programs through zoos and other *ex situ* facilities.

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *P. vulpinus and P. gloydi*	33 (14.11.8)	24 (9.3.12)	4 (2.0.2)	61 (25.14.22)
Number of institutions	4	16	2	22
Breeding status	Breeding recorded in captivity including in Canada (in 2020)			
Living wild-born	10 (4.3.3) confirmed in Canada (1 from Toronto) and in US			
Generation time (yr)	5 (COSEWIC 2008)			
Potential surrogates(s)	Western Foxsnake (*P. ramspotti* or *P. obsoletus*)			
Husbandry notes	Oviparous, 15–20 eggs, arboreal, mainly eat small mammals			
Historical holdings (2000-2020) * *P. vulpinus*				

Resources

Canadian Wildlife Health Cooperative. 2017. Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp. **COSEWIC. 2008**. COSEWIC assessment and update status report on the Eastern Foxsnake Elaphe gloydi, Carolinian population and Great Lakes/St. Lawrence population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Vii + 45 pp. **DiLeo MF, Row JR, Lougheed SC. 2010**. Discordant patterns of population structure for two co-distributed snake species across a fragmented Ontario landscape. Diversity and Distributions. 16(4):571-81. https://doi.org/10.1111/j.1472-4642.2010.00667.x. Environment **and Climate Change Canada. 2020**. Recovery Strategy for the Eastern Foxsnake (Pantherophis gloydi), Carolinian and Great Lakes/St. Lawrence populations, in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. 3 parts, 38 pp. + vi + 39 pp. + 5 pp. **Ministry of Northern Development, Mines, Natural Resources & Forestry. 2016**. Five-year review of progress towards the protection and recovery of Ontario's species at risk – 2016: Eastern Foxsnake (Carolinian and Georgian Bay). Government of Ontario. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.883934/Pantherophis_vulpinus_pop_2. (Accessed: Oct 14, 2020). **Parks Canada Agency. 2016.** Multi-species Action Plan for Point Pelee National Park of Canada and Niagara National Historic Sites of Canada. Species at Risk Act Action Plan Series. Parks Canada Agency, Ottawa. Iv + 39 pp. **Row JR, Blouin-Demers GA, Lougheed SC. 2010**. Habitat distribution influences dispersal and fine-scale genetic population structure of eastern foxsnakes (Mintonius gloydi) across a fragmented landscape. Molecular ecology. 19(23):5157-71. https://doi.org/10.1111/j.1365-294X.2010.04872.x

† Kominek A, Cornies O, M[c]Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

The two DUs of Eastern Foxsnake were assessed separately. The Carolinian DU is more widespread and the population abundance is higher than the GL/SL DU, but threats are more intense (e.g., roads, habitat loss) so the conservation value of most roles was generally higher for the Carolinian DU.

The species was assessed using the current legislative taxonomy (SARA/COSEWIC 2008), however, given recent taxonomic changes, it is possible that the global population of this species in the wild is larger than the current legislative assessment and that there are already individuals in captivity that are considered Western Foxsnakes (*P. ramspotti*).

The species is easily managed and bred in captivity, however, there is an issue of genetic bottleneck occurring after 3-4 generations of captive breeding. Obtaining a wider gene pool may help address the issue but is currently exceedingly difficult. Several needs were identified:

- Need more information on provenance of captive individuals (e.g., confiscations)
- Need to address legal conditions that prohibit captive breeding
- Potential need for genetic analysis of captive populations (e.g., genetic drift, origin of snakes)

Eastern Foxsnakes are at risk from snake fungal disease. Any individuals added to *ex situ* populations for genetic diversity need testing for SFD. An additional difficulty to obtaining wild founders is potential collection harm to the wild population.

Some subpopulations within the Carolinian DU have low viability, but genetic data shows genetic fragmentation across a large area. Priority is to connect populations/reconnect isolated populations, not rescue individual pockets or demographic manipulation.

In general, salvage has higher importance for this taxon than for other taxa due to the high and constant pressure of development in the region. Current salvages mostly involve translocation of snakes to reinforce existing populations or reintroduce to restored areas. Wild to wild short-distance translocations are preferred for population reinforcement, as long-distance translocations have higher risk due to lower survival when moving animals to new areas (e.g., overwinter mortality).

To date there has been low government support for reintroduction projects (possibly higher for reinforcement). Proof of concept, habitat restoration, and mitigation of ongoing threats (e.g., development, roads, persecution, feral and free-ranging pet cats) needed before pursuing population restoration measures.

Conservation-based research topics:

- Success of salvage operations, demographic manipulation, reintroduction, and reinforcement
- Overwintering
- SFD research
- Feasibility assessment/pilot program of demographic manipulation

Training and education needed to identify differences from rattlesnakes. Non-conservation roles include exhibition (attractive colour/pattern, easy to handle, calm, good at pest management).

Recommended Actions

Develop the current captive population into an insurance population.

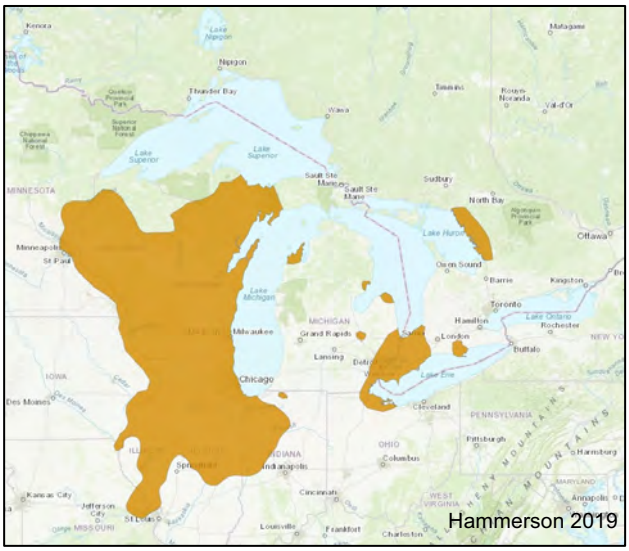
- Caveat: as snakes become available opportunistically (e.g., rehabilitation, confiscation/surrender)
- Determine appropriateness of current captive populations for *ex situ* population management roles (e.g., reintroduction, reinforcement) and the nature and composition of captive populations to serve these roles (i.e., as far as the 2 DUs, and Canada vs. US).

Develop a plan to approach the government regarding the restrictions around breeding captive individuals (i.e., confiscations/surrenders).

Develop protocols for disease screening and to reduce risk of transmission between captive and wild populations.

Table 11. *Ex Situ* Conservation Assessment and Recommendations for Eastern Foxsnake (*Pantherophis vulpinus*) – Carolinian				
Conservation Role (Direct)	**Conservation Value**	**Feasibility**	**Risk**	**Decision**
Insurance	Moderate-Low	Moderate-Low	Moderate	**Recommended** Case by case (as snakes become available)
Rescue	High	High-Moderate	Moderate	Not recommended at this time
Demographic Manipulation	Moderate	Moderate	Low	Not recommended at this time
Reintroduction	Moderate	Low, can be improved	Moderate	Not recommended at this time
Reinforcement	Moderate	Moderate-Low	Low	Not recommended at this time
Research	Moderate	Moderate	Low	**Recommended with restrictions** (Existing animals in captivity)
Training	Moderate	High-Moderate	Low	**Recommended with restrictions** (Existing animals in captivity)
Education	High	High	Low	**Recommended with restrictions** (Existing animals in captivity)

EASTERN FOXSNAKE (Great Lakes/St. Lawrence) *Pantherophis vulpinus* (Colubrinae)



SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2016)
Canada: **Vulnerable** (NatureServe 2016), **Endangered** (COSEWIC/SARA 2008)
Provincial: **Vulnerable** (ON; NatureServe 2016)

Next COSEWIC status assessment:
December 2021

Canadian Distribution and Population Trend:
In Ontario, located on the eastern shores of Georgian Bay and associated islands within ~1 km of shoreline (10-13% of global range); Declining (COSEWIC/SARA 2008)

Evolutionary Distinctiveness†:
Global: 4.288, Canada: 22.447

Wild Population

In the Great Lakes/St. Lawrence region, the species is confined to a thin strip of suitable shoreline habitat that is increasing fragmented and threatened by human activities (COSEWIC 2008). Genetic analysis indicates a possible bottleneck or founder effect within this population (Lougheed and Row 2006).

Threats and Limitations

Main threat due to increasing development and roads along the Georgian Bay coastline and islands destroying and fragmenting shoreline habitat. Also susceptible to mortality due to increasing boat and road traffic. Snake fungal disease has been confirmed in Eastern Foxsnakes in Ontario. Slow life history traits and specific habitat requirements may increase probability of mortality and severity of threats as well as predispose populations to demographic fluctuations from disturbances or stresses (ECCC 2020, CWHC 2017, COSEWIC 2008).

In situ Conservation Actions

Measures to protect habitat are in place on public and private lands, including identification of Critical Habitat and landowner agreements to protect hibernacula. Since the early 1970s several mark-recapture and radio-telemetry studies have been conducted to address knowledge gaps in species ecology and threats including a recent study assessing the effectiveness of road mortality mitigation. Extensive awareness and education programs are run by several organizations in the region. For example, Georgian Bay Islands National Park conducts outreach with private landowners to protect hibernacula and Killbear Provincial Park provides outreach and supports research and monitoring (ECCC 2020, Parks Canada 2016, MNDMNRF 2016, Paleczny 2005).

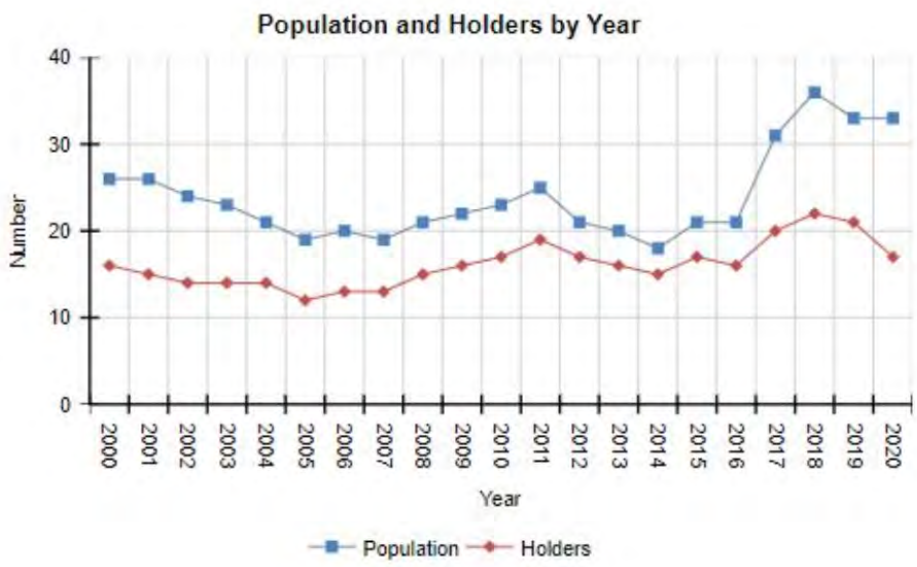
Prior Recommended *Ex situ* Conservation Actions

No specific *ex situ* recovery actions are recommended; however, long-term approaches to recovery include the development and implementation of a strategy to enhance, restore and/or reconnect populations. Other recovery goals include research on disease, ecology, and genetics as well as strengthening education and outreach including training workshops and materials for wildlife officers (ECCC 2020).

Existing *Ex situ* Conservation Actions

Education and snake appreciation programs through zoos and other *ex situ* facilities.

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *P. vulpinus and P. gloydi*	33 (14.11.8)	24 (9.3.12)	4 (2.0.2)	61 (25.14.22)
Number of institutions	4	16	2	22
Breeding status	Breeding recorded in captivity including in Canada (in 2020)			
Living wild-born	10 (4.3.3) confirmed in Canada (1 from Toronto) and in US			
Generation time (yr)	5 (COSEWIC 2008)			
Potential surrogates(s)	Western Foxsnake (*P. ramspotti* or *P. obsoletus*)			
Husbandry notes	Oviparous, 15–20 eggs, arboreal and highly aquatic, mainly eat small mammals			
Historical holdings (2000-2020) * *P. vulpinus*				

Resources

Baxter-Gilbert JH, Riley JL, Lesbarrères D, Litzgus JD (2015) Mitigating Reptile Road Mortality: Fence Failures Compromise Ecopassage Effectiveness. PloS ONE 10(3): e0120537. https://doi.org/10.1371/journal.pone.0120537. **Canadian Wildlife Health Cooperative. 2017.** Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp. **COSEWIC. 2008**. COSEWIC assessment and update status report on the Eastern Foxsnake Elaphe gloydi, Carolinian population and Great Lakes/St. Lawrence population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Vii + 45 pp. **Environment and Climate Change Canada. 2020**. Recovery Strategy for the Eastern Foxsnake (Pantherophis gloydi), Carolinian and Great Lakes/St. Lawrence populations, in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. 3 parts, 38 pp. + vi + 39 pp. + 5 pp. **Ministry of Northern Development, Mines, Natural Resources & Forestry. 2016**. Five-year review of progress towards the protection and recovery of Ontario's species at risk – 2016: Eastern Foxsnake (Carolinian and Georgian Bay). Government of Ontario. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.883934/Pantherophis_vulpinus_pop_1. (Accessed: Oct 14, 2020). **Paleczny et al. 2005.** Species at Risk and Park Development: The Eastern Foxsnake (*Elaphe* gloydi) and the Killbear Provincial Park Visitor Centre. Proceedings of the Parks Research Forum of Ontario. **Parks Canada Agency. 2016**. Multi-species Action Plan for Georgian Bay Islands National Park of Canada. Species at Risk Act Action Plan Series. Parks Canada Agency, Ottawa. Iv + 14 pp. **Row, J.R., and Lougheed, S. 2006.** Demography and landscape genetics of eastern Foxsnakes (Elaphe gloydi). Report prepared for Endangered Species Recovery Fund. 22pp.

† Kominek A, Cornies O, M©Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

The two DUs of Eastern Foxsnake were assessed separately using the current legislative taxonomy (SARA/COSEWIC). Risk and feasibility for *ex situ* conservation roles were similar between the two DUs (see Summary of Discussion for Carolinian DU); however, the GL/SL DU had lower conservation value for most roles as the wild population is less impacted by threats. Reintroduction was not discussed for the GL/SL DU (no evidence of range restriction or loss of subpopulations).

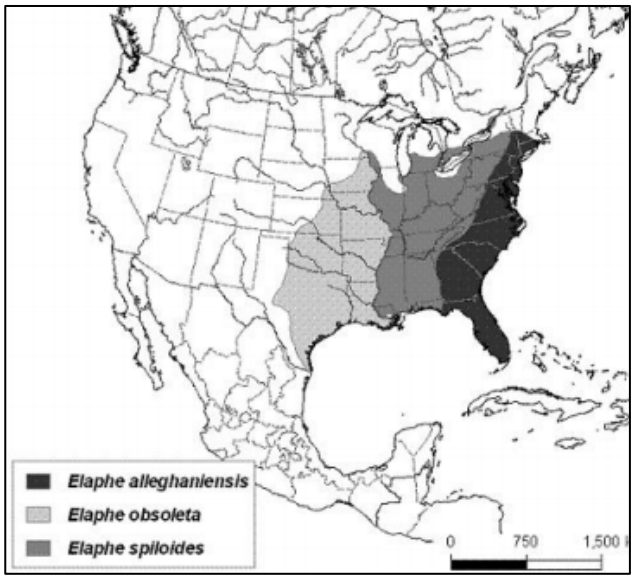
Recommended Actions

See Recommended Actions for Eastern Foxsnake – Carolinian DU.

Table 12. *Ex Situ* Conservation Assessment and Recommendations for Eastern Foxsnake (*Pantherophis vulpinus*) – GL/SL DU

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Moderate-Low	Low, can be improved	Low	Not recommended at this time
Rescue	High-Moderate	High-Moderate	Moderate	Not recommended at this time
Demographic Manipulation	Low	Moderate-Low	Low	Not recommended at this time
Reinforcement	Low	Moderate-Low	Moderate-Low	Not recommended at this time
Research	Low	Moderate	Low	Not recommended at this time
Training	Moderate	Moderate	Low	**Recommended with restrictions** (Existing animals in captivity, regardless of origin/DU, opportunistic and local)
Education	High	High	Low	**Recommended** (Existing animals in captivity)

GRAY RATSNAKE (Carolinian)
Pantherophis spiloides (Colubrinae)



COSEWIC 2018

SPECIES STATUS
Global: Apparently Secure (NatureServe 2016), Least Concern (IUCN Red List 2016)
Canada: **Endangered** (SARA 2020; COSEWIC 2018), **Critically Imperiled** (NatureServe 2007)
Provincial: **Critically Imperiled** (ON; NatureServe 2007)

Canadian Distribution and Population Trend:
Northern edge of Lake Erie in southwestern Ontario. Limited to two very small, isolated populations in Elgin, and Norfolk-Haldimand counties (<1% of global range); Declining (SARA 2020; COSEWIC 2018)

Evolutionary Distinctiveness†:
Global: 3.990, Canada: 22.447

Wild Population

Historically, there were four small subpopulations in the Carolinian region; however, two are now considered to be extirpated (within past 10 years). The two remaining, disjunct subpopulations are threatened by ongoing development, intensive agriculture, and expansion of road networks. Rough estimates indicate there are likely less than 250 mature individuals. Geographically isolated and genetically distinct from Great Lakes/St. Lawrence DU and from populations in the US, therefore valuable for the preservation of the total genetic diversity but rescue unlikely and persistence of remaining subpopulations threatened by small size and isolation (COSEWIC 2018).

Threats and Limitations

Very high cumulative threat ranking. Significant threats include direct mortality due to roads, intensive agricultural activities, and direct persecution, as well as habitat loss and fragmentation (including destruction of hibernacula) from energy production and mining, agriculture, and residential development. Snake fungal disease is a possible threat. Slow life-history characteristics make populations sensitive to anthropogenic sources of mortality and it is unknown if there is enough suitable habitat to support viable subpopulations in the Carolinian region. More research is needed to determine population viability (ECCC 2020, Hammerson 2019, COSEWIC 2018).

In situ Conservation Actions

Minimal research has been conducted on the Carolinian DU and there appears to be few large, protected areas with suitable habitat in southwestern Ontario. A radio-telemetry study of the Oriskany population is being undertaken, multi-year road mortality monitoring was conducted in the region, artificial hibernacula were constructed and monitored in the Long Point Basin area, and public communication and outreach is ongoing (COSEWIC 2018, MNDMNRF 2016).

Prior Recommended *Ex situ* Conservation Actions

Recovery objective to maintain and, where biologically and technically feasible, **increase the current abundance**, area of occupancy and habitat connectivity within the subpopulations of the Gray Ratsnake, Carolinian population. Investigate potential approaches to **augmenting population**. Other recovery goals include research on disease, ecology, and genetics as well as strengthening education and outreach including training workshops and materials for wildlife officers (ECCC 2020, MNDMNRF 2016).

Existing *Ex situ* Conservation Actions

None known

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *P. spiloides*	95 (25.37.33)	0	0	95 (25.37.33)
Number of institutions	7	0	0	7
Breeding status	Breeding recorded in captivity in Canada (in 2020)			
Living wild-born	None confirmed			
Generation time (yr)	10 (COSEWIC 2018)			
Potential surrogates(s)	Western Ratsnake (*P. obsoletus*), Eastern Ratsnake (*P. alleghaniensis*)			
Husbandry notes	Oviparous, 7–23 eggs, biennial+ reproductive cycle, exhibits multiple paternity, long-lived, adults require large arboreal enclosure, feeds mostly on small mammals			
Historical holdings *	No *P. spiloides* holdings known outside of Canada			

Resources

COSEWIC. 2018. COSEWIC assessment and status report on the Gray Ratsnake Pantherophis spiloides, Great Lakes / St. Lawrence population and Carolinian population in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Xvi + 44 pp. **Environment and Climate Change Canada. 2020.** Recovery Strategy for the Gray Ratsnake (Pantherophis spiloides), Carolinian and Great Lakes/St. Lawrence populations, in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. 3 parts, 47 pp. + vi + 23 pp. + 5 pp. **Hammerson, G.A. 2019.** Pantherophis spiloides. The IUCN Red List of Threatened Species 2019: e.T90069659A90069671. https://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T90069659A90069671.en. **Ministry of Northern Development, Mines, Natural Resources & Forestry. 2016**. Five-year review of progress towards the protection and recovery of Ontario's species at risk – 2016: Gray Ratsnake (Carolinian and Frontenac Axis). Government of Ontario. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.101345/Pantherophis_spiloides. (Accessed: Oct 14, 2020). **NatureServe. 2007**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.800942/Pantherophis_spiloides_pop_2. (Accessed: Oct 14, 2020). **Row JR, Blouin-Demers G, Weatherhead PJ. 2007.** Demographic effects of road mortality in black ratsnakes (Elaphe obsoleta). Biological Conservation. 137(1):117-24. https://doi.org/10.1016/j.biocon.2007.01.020

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

Similar issues and concerns to Eastern Foxsnake were identified for Gray Ratsnake (see Summary of Discussion for Eastern Foxsnake – Carolinian DU).

The two DUs of Gray Ratsnake are geographically disjunct and were assessed separately. There is uncertainty around the abundance of the Carolinian DU, but the population appears to have declined severely to a very small size and is at risk of extirpation. A greater understanding of the demographics and population status is needed. *Ex situ* roles had higher conservation values for the Carolinian DU than GL/SL DU.

The species is easily managed and readily breeds in captivity. A small number of animals could produce a large output; however, the genetics of the *ex situ* population needs to be considered. Obtaining individuals for a viable captive population of Carolinian stock may be a challenge (i.e., potential collection harm, political barrier to breed rescues, all current founders are US origin, space limitations at current institutions, risk of disease).

Given the estimated small size of the wild population in the Carolinian DU, concerns were raised about the impact on the population viability of taking animals from the wild to establish an *ex situ* insurance or captive breeding population. It was agreed that the priority for the Carolinian DU is to augment the population (i.e., through demographic manipulation and/or reinforcement) over reintroduction. Demographic manipulation (e.g., headstarting clutches from temporarily held wild gravid females) would be less risky than collecting animals for a captive breeding population. Retaining a few neonates per year from the largest subpopulation (e.g., Big Creek) to build up the *ex situ* population would likely have low collection risk to the wild population. Wild to wild translocations are preferred for population reinforcement, however.

Opinions diverged on the risk to the wild population from using snakes from Carolinian DU for *ex situ* research. Generally, it was agreed that snakes from the Carolinian DU are not required for research questions, and snakes already in captivity or acquired opportunistically through rehab/rescue (e.g., from flooding) or from other DUs, should be prioritized.

Research questions to explore concurrently with rescue, demographic manipulation, and reinforcement efforts:

- success of rescue and headstarting (e.g., neonates from wild clutches)
- impact of removing neonates from wild population
- genetic viability of introducing snakes from another DU
- overwintering (specifically neonate and juvenile)
- artificial hibernaculum and nesting structure use
- disease

Recommended Actions

Further discussion is needed:

Population reinforcement:

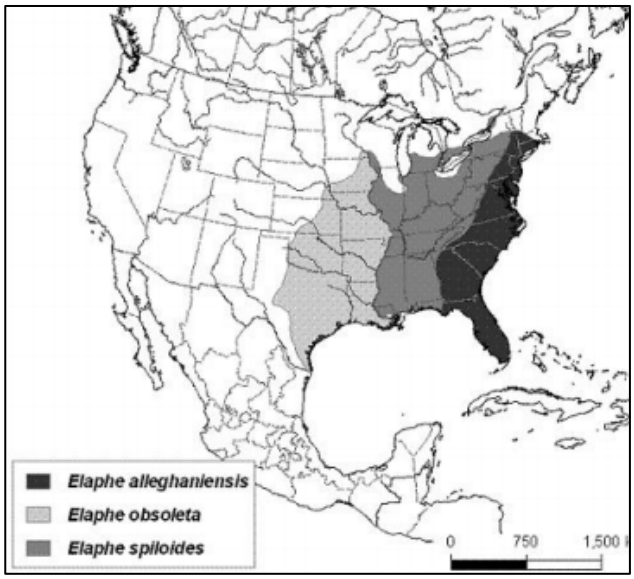
- What is the best method? (e.g., demographic manipulation, insurance population, using animals from another DU).
- Research needed to gain better knowledge on priority actions

Priorities:

- When to consider reintroduction or insurance (longer term)
- How to work towards establishing viable captive population (e.g., biobanking, non-releasable animals from rescue centres, retaining neonates, artificial insemination)

Table 13. *Ex Situ* Conservation Assessment and Recommendations for Gray Ratsnake (*Pantherophis spiloides*) – Carolinian DU				
Conservation Role (Direct)	**Conservation Value**	**Feasibility**	**Risk**	**Decision**
Insurance	High	Low, difficult to improve	High	Not recommended at this time
Rescue	High-Moderate	Moderate-Low	Moderate	**Recommended** (Case by case)
Demographic Manipulation	High	Low, can be improved	Low	**Recommended with restrictions** (Headstarting, small scale, short-term holding, proper source, assess demographic impact)
Reintroduction	High-Moderate	Low, can be improved	Moderate	Not recommended at this time
Reinforcement	High-Moderate	Low, can be improved	Moderate-Low	**Recommended with restrictions** (Small number of captive snakes to breed)
Research	Moderate	Low, can be improved	Divergent	**Recommended with restrictions** (Use existing captive snakes or ones from GL/SL DU – opportunistic and local, only concurrent with other ex situ efforts)
Training	Low	Low, difficult to improve	High-Moderate	Not recommended at this time
Education	Low	Low, difficult to improve	High	Not recommended at this time

GRAY RATSNAKE
(Great Lakes/St. Lawrence)
Pantherophis spiloides (Colubrinae)



COSEWIC 2018

SPECIES STATUS
Global: Apparently Secure (NatureServe 2016), Least Concern (IUCN Red List 2016)
Canada: **Threatened** (SARA 2020; COSEWIC 2018), **Vulnerable** (NatureServe 2007)
Provincial: **Vulnerable** (ON; NatureServe 2007)

Canadian Distribution and Population Trend:
Associated with the Frontenac Axis in Frontenac, Lanark, and Leeds and Grenville counties in southeastern Ontario (<1% of global range); Declining (SARA 2020; COSEWIC 2018)

Evolutionary Distinctiveness†:
Global: 3.990, Canada: 22.447

Wild Population

Geographically isolated and genetically distinct from Carolinian DU and from populations in the US, therefore valuable for the preservation of the total genetic diversity and rescue unlikely. Low to moderate gene flow among local subpopulations, that occupy an increasingly fragmented region and are threatened by ongoing development and by expansion of road networks. The extent of occurrence appears to have declined significantly and long-term monitoring at several sites indicates population declines (10% decrease in population size in 15 years; COSEWIC 2018).

Threats and Limitations

Road mortality poses a significant risk to subpopulations. Other threats include habitat loss and fragmentation (including destruction of hibernacula) from energy production and mining, agriculture, urban development, and recreational activities as well as snake fungal disease. Slow life-history characteristics make populations sensitive to anthropogenic sources of mortality (ECCC 2020, Hammerson 2019, COSEWIC 2018, Row 2007).

In situ Conservation Actions

Ecological research and long-term population monitoring ongoing in three locations (Queen's University Biological Station, Thousand Islands National Park, and Murphy's Point Provincial Park). While many occurrences are in protected areas, they are isolated by roads and unsuitable habitat. Other recovery actions include habitat enhancement and public communication and outreach such as the Murphy's Point Adopt-a-snake program (ECCC 2020, COSEWIC 2018, MNDMNRF 2016).

Prior Recommended *Ex situ* Conservation Actions

No specific *ex situ* recovery actions are recommended, but recovery goals include research on disease, ecology, and genetics as well as strengthening education and outreach including training workshops and materials for wildlife officers (ECCC 2020).

Existing *Ex situ* Conservation Actions

None known

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *P. spiloides*	95 (25.37.33)	0	0	95 (25.37.33)
Number of institutions	7	0	0	7
Breeding status	Breeding recorded in captivity in Canada (in 2020)			
Living wild-born	None confirmed			
Generation time (yr)	10 (COSEWIC 2018)			
Potential surrogates(s)	Western Ratsnake (P. obsoletus), Eastern Ratsnake (P. alleghaniensis)			
Husbandry notes	Oviparous, 7–23 eggs, biennial+ reproductive cycle, exhibits multiple paternity, long-lived, adults require large arboreal enclosure, feeds mostly on small mammals			
Historical holdings *	No *P. spiloides* holdings known outside of Canada			

Resources

COSEWIC. 2018. COSEWIC assessment and status report on the Gray Ratsnake Pantherophis spiloides, Great Lakes / St. Lawrence population and Carolinian population in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Xvi + 44 pp. **Environment and Climate Change Canada. 2020.** Recovery Strategy for the Gray Ratsnake (Pantherophis spiloides), Carolinian and Great Lakes/St. Lawrence populations, in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. 3 parts, 47 pp. + vi + 23 pp. + 5 pp. **Hammerson, G.A. 2019.** Pantherophis spiloides. The IUCN Red List of Threatened Species 2019: e.T90069659A90069671. https://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T90069659A90069671.en **Ministry of Northern Development, Mines, Natural Resources & Forestry. 2016**. Five-year review of progress towards the protection and recovery of Ontario's species at risk – 2016: Gray Ratsnake (Carolinian and Frontenac Axis). Government of Ontario. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.101345/Pantherophis_spiloides. (Accessed: Oct 14, 2020). **NatureServe. 2007**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.800939/Pantherophis_spiloides_pop_1. (Accessed: Oct 14, 2020). **Row JR, Blouin-Demers G, Weatherhead PJ. 2007.** Demographic effects of road mortality in black ratsnakes (Elaphe obsoleta). Biological Conservation. 137(1):117-24. https://doi.org/10.1016/j.biocon.2007.01.020

† Kominek A, Cornies O, McCurdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

The two DUs of Gray Ratsnake were assessed separately. The estimated population size for the GL/SL DU is considerably greater than the Carolinian population. The main conservation value of Gray Ratsnakes from the GL/SL DU is to support conservation efforts for the Carolinian DU (insurance, demographic manipulation, reinforcement). Reintroduction was not discussed for the GL/SL DU. Snakes from the GL/SL DU were recommended as a model for research, training, and education for the Carolinian DU. Snakes already in captivity or acquired opportunistically through rehabilitation or rescue should be prioritized for these roles, but, if the case is justified, a small number may be collected from the wild for a specific research project.

Recommended Actions

See Recommended Actions for Gray Ratsnake – Carolinian DU.

Table 14. *Ex Situ* Conservation Assessment and Recommendations for Gray Ratsnake (*Pantherophis spiloides*) – GL/SL DU

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Moderate-Low	Low, can be improved	Low	Not recommended at this time
Rescue	High-Moderate	High-Moderate	Moderate	Not recommended at this time
Demographic Manipulation	Low	Moderate-Low	Low	Not recommended at this time
Reinforcement	Low	Moderate-Low	Moderate-Low	Not recommended at this time
Research	Moderate	Moderate	Low	**Recommended with restrictions** (Model for Carolinian DU, opportunistic and local)
Training	Moderate	Moderate	Low	**Recommended** (Model for Carolinian DU)
Education	High	High	Low	**Recommended** (Model for Carolinian DU)

BLUE RACER
Coluber constrictor foxii
(Colubrinae)

SPECIES STATUS
Global: Secure (NatureServe 2005), Least Concern (*Coluber constrictor*; IUCN Red List 2012)
Canada: **Critically Imperiled** (NatureServe 2005), **Endangered** (COSEWIC/SARA 2012)
Provincial: **Critically Imperiled** (ON; NatureServe 2005)

COSEWIC 2012
Figure 2. Current and historical distribution of Blue Racer in Ontario.

Canadian Distribution & Population Trend:
Restricted to eastern portion of Pelee Island in southern Ontario (<1% of global range); Declining (COSEWIC/SARA 2012)

Evolutionary Distinctiveness†:
Global: 7.293, Canada: 31.337

Wild Population
Extremely restricted distribution on one island in Canada with ongoing habitat loss and disturbance. Small population estimated to be < 250. Extirpated from northern portion of range in southwestern Ontario (COSEWIC 2012).

Threats and Limitations
Threats include ongoing loss and fragmentation of habitat (development for tourism, vegetative succession), increasing road mortality, and deliberate persecution. Other potential threats may include snake fungal disease and predation by feral and free-ranging pet cats and introduced Wild Turkeys. Limited by small population size, geographic isolation, and rarity of specific primary habitat requirements (ECCC 2019, COSEWIC 2012).

In situ Conservation Actions
Many occurrences of *C. constrictor* throughout their range are in national parks and other protected areas (Hammerson 2015). Habitat protection, restoration, and public outreach are ongoing on Pelee Island. An assessment of habitat restoration and creation effectiveness and a road mortality hot spots analysis are being conducted. Annual surveys of Pelee Island population ongoing since 2002 and rigorous population assessment currently underway to accurately quantify population and threats. Genetic sequencing of Blue Racers across the species' range being conducted to assess genetic distinctiveness and effective population size of Pelee Island population (ECCC 2019, H McCurdy-Adams pers. comm. 2021, R Wolfe pers. comm. 2021).

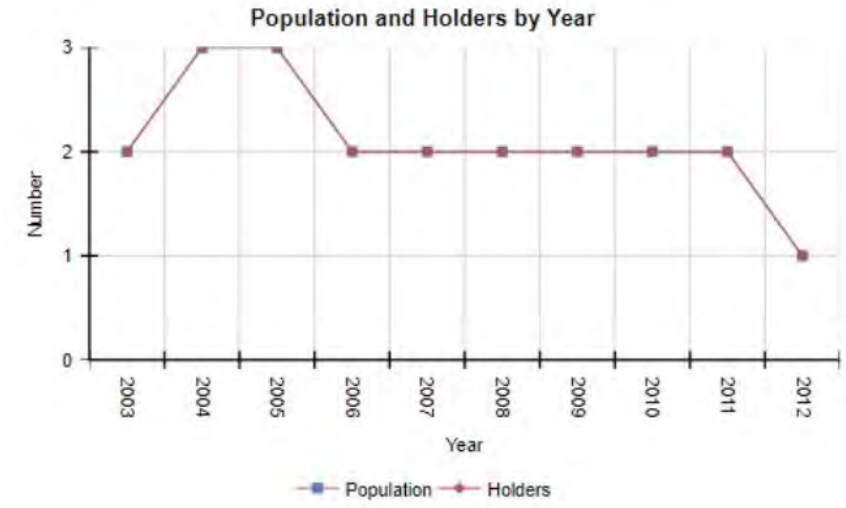
Prior Recommended *Ex situ* Conservation Actions

Feasibility assessment for repatriating historic sites in southern Ontario, including assessing threats and suitability of future possible repatriation site(s). [Priority to ensure viable, self-sustaining population and, if feasible, increase the abundance through natural expansion of the existing population by mitigating threats, and increasing habitat and connectivity]. Investigate the threat of snake fungal disease, including methods of disease control (ECCC, MECP 2019).

Existing *Ex situ* Conservation Actions

Previous feasibility assessments of reintroduction/captive release to Ontario mainland sites have indicated low likelihood of success due to insufficient habitat and unknown threats (COSEWIC 2012, Hecnar and Hecnar 2005, S Marks pers. comm. 2021)

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U)** *C. c. foxii*	18 (4.4.10)	0	0	18 (4.4.10)
Number of institutions	2	0	0	2
Breeding status	Breeding recorded in captivity in Canada (in 2020)			
Living wild-born	None confirmed			
Generation time (yr)	7 (COSEWIC 2013)			
Potential surrogates(s)	Blackmask racer (*C. c. latrunculus*), Mexican racer (*C. c. oaxaca*), Southern black racer (*C. c. priapus*)			
Husbandry notes	Oviparous, avg. 14 eggs, biennial reproductive cycle, long lifespan. Difficult to keep in captivity. Varied diet, difficult to start neonates eating, cannibalism is common.			
Historical holdings in North America (2003-2012) * *C. c. foxii*				

Resources

COSEWIC. 2012. COSEWIC status appraisal summary on the Blue Racer Coluber constrictor foxii in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Xvii pp. **Environment and Climate Change Canada. 2019**. Recovery Strategy for the Blue Racer (Coluber constrictor foxii) in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. 3 parts, 29pp+vi+35pp+18pp. **Hammerson, G.A., Acevedo, M., Ariano-Sánchez, D. & Johnson, J. 2013**. Coluber constrictor. The IUCN Red List of Threatened Species 2013: e.T63748A3128579. https://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T63748A3128579.en. Downloaded on 01 February 2021.
Hecnar, S.J. and D.R. Hecnar. 2005. Feasibility of Repatriation of Extirpated Herpetofauna to Point Pelee National Park. Final Report of Memorandum of Understanding CR02-51. Prepared for Point Pelee National Park. Department of Biology, Lakehead University. 268 pp. **Ministry of the Environment, Conservation and Parks. 2019.** Blue Racer, Lake Erie Watersnake and Small-mouthed Salamander and Unisexual Ambystoma (Small-mouthed Salamander dependent population) Ontario Government Response Statement. **NatureServe. 2005**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.79.732796/Coluber_constrictor_foxii. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

All three subspecies of racer were assessed in detail separately. The conservation values of *ex situ* roles for Blue Racers in Canada depends on genetic variation from the stable US wild population. The Canadian population on Pelee Island is likely unique and may experience small, isolated population effects, such as risk of low genetic diversity within the population leading to inbreeding depression. Outstanding knowledge gaps exist regarding population genetics, and while the wild population is relatively stable, genetic rescue is potentially necessary (e.g., collect live animals or cell lines from other populations).

There is no government support for reintroduction of Blue Racers to former range in mainland Ontario due to a lack of suitable habitat. Risks for any type of release include social and legal implications of habitat protection (e.g., push back from local community).

Conservation research topics include overwintering physiology and prey preference of neonates (questions with limited *ex situ* role: genetics, causes of extirpation). Restricted to captive-bred animals only (sharing amongst Canadian *ex situ* facilities/researchers underway) or secondary role of an established insurance population.

Recommended Actions

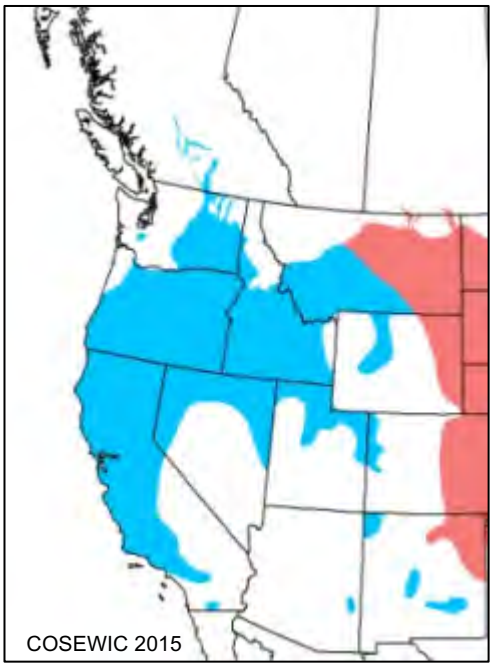
Further discussion needed:

- Assess need for genetic rescue of Pelee Island population, reassess *ex situ* conservation roles once genetics knowledge gap is addressed, and if needed, determine how to preserve genetics for supplementation (e.g., neonates, biosamples)
- Determine appropriateness of current captive populations for *ex situ* population management roles

Table 15. *Ex Situ* Conservation Assessment and Recommendations for Blue Racer (*Coluber constrictor foxii*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Moderate	Moderate-Low	Moderate	Not recommended at this time
Rescue	High-Moderate	Moderate	Moderate	Not recommended at this time
Demographic Manipulation	Moderate	Low, can be improved	Moderate	Not recommended at this time
Reintroduction	High-Moderate	Low, difficult to improve	High	Not recommended at this time
Reinforcement	Moderate	Low, can be improved	High	Not recommended at this time
Research	High-Moderate	Moderate	Low	**Recommended with restrictions** (Captive-bred animals)
Training	Moderate-Low	Moderate	Low	**Recommended with restrictions** (Captive-bred animals)
Education	High-Moderate	High	Low	**Recommended with restrictions** (Captive-bred animals)

WESTERN YELLOW-BELLIED RACER
Coluber constrictor mormon
(Colubrinae)



SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (*Coluber constrictor*; IUCN Red List 2012)
Canada: **Vulnerable** (NatureServe 2016), **Threatened** (COSEWIC 2015), **Special Concern, under consideration for status change** (SARA 2006)
Provincial: **Vulnerable** (BC; NatureServe 2016)

Canadian Distribution and Population Trend:
Arid valleys in southern interior British Columbia (<5% of global range); Declining (COSEWIC 2015)

Evolutionary Distinctiveness†:
Global: 7.293, Canada: 31.337

Wild Population
Restricted to five river valleys in the arid interior of BC with estimated population size < 10,000. Small, isolated subpopulations vulnerable to declines (COSEWIC 2015).

Threats and Limitations
Greatest threats are road mortality and loss and alteration of valley grassland habitat and south-facing slopes due to urban, rural, and commercial development, agriculture (e.g., vineyards) and livestock grazing, and recreational activities. High reliance on hibernation sites, limited ability to disperse, geographically isolated subpopulations, and relatively low reproductive rates increase vulnerability to disturbance and changes in land use (COSEWIC 2015).

In situ Conservation Actions
Population inventories, hibernacula monitoring, road mortality monitoring and mitigation, and snake fence monitoring occur at several sites in BC. In BC unregulated off-road vehicle use in sensitive grassland habitat is prohibited and the South Okanagan-Similkameen biodiversity conservation strategy and specific guidelines for amphibians and reptiles during road building and urban and rural development promote development away from potential hibernation/denning sites and south-facing rock outcrops, the installation of snake fencing, and outreach to reduce mortalities and obtain sightings. Habitat protection throughout range in parks and other protected or managed areas (Southern Interior Snake Recovery Team 2020, Hammerson 2015).

Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

Education and awareness at zoos and through conservation and stewardship organizations in BC. Ninety-two (92) Western Yellow-bellied Racers and Great Basin Gophersnakes displaced by pipeline construction project being held at wildlife rehabilitation centre until release in the spring of 2021 back at re-constructed hibernacula.

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *C. constrictor*	0	4 (0.1.3)	0	4 (0.1.3)
Number of institutions	0	2	0	2
Breeding status	None documented in captivity			
Living wild-born	None confirmed			
Generation time (yr)	7-8 (COSEWIC 2016)			
Potential surrogates(s)	Blackmask racer (*C. c. latrunculus*), Mexican racer (*C. c. oaxaca*), Southern black racer (*C. c. priapus*)			
Husbandry notes	Oviparous, 3-9 eggs, long lifespan, highly vagile, varied diet			
Historical holdings in North America *	None for *C. c. mormon*			

Resources

COSEWIC. 2015. COSEWIC assessment and status report on the Eastern Yellow-bellied Racer Coluber constrictor flaviventris and Western Yellow-bellied Racer Coluber constrictor mormon in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Xvii + 64 pp. **Environment Canada. 2015.** Management Plan for the Western Yellow-bellied Racer (Coluber constrictor mormon) in Canada. Species at Risk Act Management Plan Series. Environment Canada, Ottawa. 3 pp. + Annex. **Eye et al. 2018.** Snake Mortality and Cover Board Effectiveness along Exclusion Fencing in BC. The Canadian Field-Naturalist 132(1): 30-35. DOI: 10.22621/cfn.v132i1.2031. **Hammerson, G.A., Acevedo, M., Ariano-Sánchez, D. & Johnson, J. 2013.** Coluber constrictor. The IUCN Red List of Threatened Species 2013: e.T63748A3128579. https://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T63748A3128579.en. Downloaded on 01 February 2021. **Ministry of Environment and Climate Change Strategy, 2020.** Guidelines for Amphibian and Reptile Conservation during Road Building and Maintenance Activities in British Columbia. Version 1.0., March 30, 2020. **Ministry of Forests, Lands, Natural Resource Operations, and Rural Development, 2014.** Guidelines for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia. 2014 edition. Companion document to Develop with Care. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.105783/Coluber_constrictor_mormon. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, McCurdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

All three subspecies of racer were assessed in detail separately. Reinforcement was not assessed for the Western Yellow-bellied Racer.

Western Yellow-bellied Racers are not easily kept in captivity (e.g., difficult to get them to eat) and most conservation actions can be *in situ* with wild populations. Potential to keep individuals from opportunistic sources of animals (e.g., emergency salvage, rehab) if valid reason. A small-scale pilot project to test the feasibility of headstarting eggs or neonates to address road mortality and roadside nesting could be undertaken. Additional research topics include reproduction/breeding and improved husbandry. *Ex situ* animals are valuable for training and identification, although can be difficult to handle.

Emergency salvages are currently happening (short-term housing and release back to original habitat) but should be prevented if possible and recommend associated research requirements for permits.

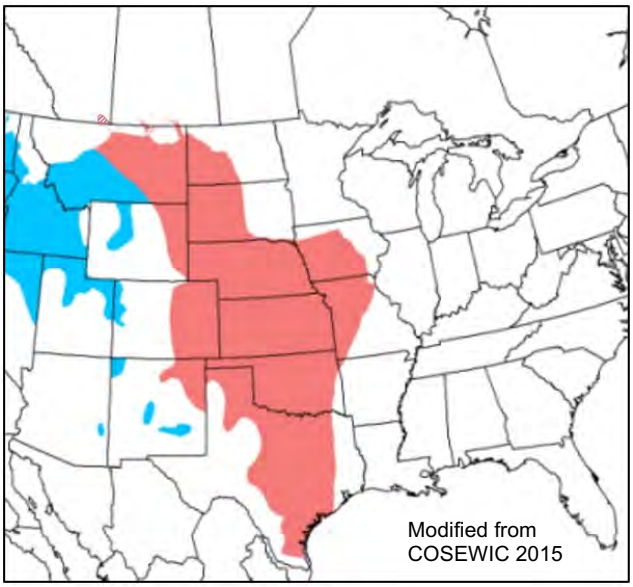
Recommended Actions

No specific actions recommended.

Table 16. *Ex Situ* Conservation Assessment and Recommendations for Western Yellow-bellied Racer (*Coluber constrictor mormon*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Low	Low, can be improved	Moderate	Not recommended at this time
Rescue	High-Moderate	Moderate	Moderate	Not recommended at this time
Demographic Manipulation	Low	Low, can be improved	Moderate	Not recommended at this time
Reintroduction	Low	Low, can be improved	High	Not recommended at this time
Research	Moderate-Low	Low, can be improved	Low	**Recommended with restrictions** Opportunistic (research dependent)
Training	Moderate	Low, can be improved	Moderate-Low	**Recommended with restrictions** opportunistic
Education	High-Moderate	Moderate	Low	**Recommended with restrictions** opportunistic

EASTERN YELLOW-BELLIED RACER
Coluber constrictor flaviventris (Colubrinae)



SPECIES STATUS

Global: Secure (NatureServe 2016), Least Concern (Coluber constrictor; IUCN Red List 2012)
Canada: **Imperiled** (NatureServe 2016), **Threatened** (COSEWIC/SARA 2015)
Provincial: **Critically Imperiled** (AB; NatureServe 2016), **Imperiled** (SK; NatureServe 2016)

Canadian Distribution and Population Trend:
Limited distribution in southwest Saskatchewan and extreme southeast Alberta (<1% of global range); Declining (COSEWIC 2015)

Evolutionary Distinctiveness†:
Global: 7.293, Canada: 31.337

Wild Population

Restricted to four river valleys in southern prairies with estimated population size < 10,000. Small isolated genetically distinct subpopulations vulnerable to declines (Somers 2017, COSEWIC 2015).

Threats and Limitations

Major threats include road mortality, native prairie habitat loss and degradation due to agricultural or industrial uses, and destruction of hibernacula from geological events. High reliance on hibernation sites, limited ability to disperse, geographically isolated subpopulations, and relatively low reproductive rates increase vulnerability to disturbance and changes in land use (COSEWIC 2015, ECCC 2017).

In situ Conservation Actions

Many occurrences of *C. constrictor* are in national parks and other protected areas (COSEWIC 2015, Hammerson 2015). Critical habitat around known hibernacula is protected in these areas, but protection of movement corridors and summering grounds is necessary for long-term persistence (ECCC 2017, Parks Canada 2016, COSEWIC 2015). Hibernacula and population monitoring is ongoing and additional measures to protect habitat, manage traffic, and engage landowners are being explored (ECCC 2017, Parks Canada 2016). Destruction of hibernacula is prohibited under the Alberta Wildlife Act and Saskatchewan Wildlife Act and provincial development guidelines recommend set-back distance of 500m from known hibernacula (Parks Canada 2010).

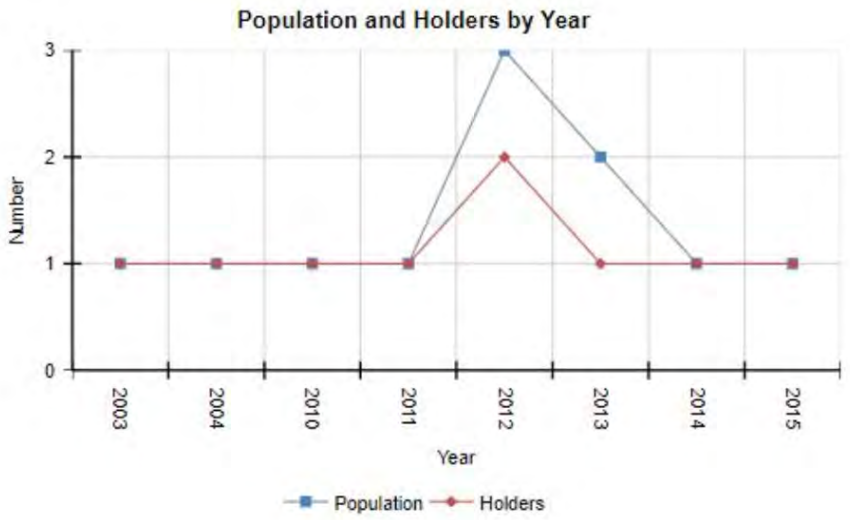
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

Conservation education through Parks Canada and research institutions in Saskatchewan.

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *C. c. flaviventris*	1 (1.0.0)	0	0	1 (1.0.0)
Number of institutions	1	0	0	1
Breeding status	None documented in captivity			
Living wild-born	None confirmed			
Generation time (yr)	7-8 (COSEWIC 2016)			
Potential surrogates(s)	Blackmask racer (*C. c. latrunculus*), Mexican racer (*C. c. oaxaca*), Southern black racer (*C. c. priapus*)			
Husbandry notes	Oviparous, 3-12 eggs, highly vagile, varied diet			
Historical holdings in North America (2003-2015) * *C. c. flaviventris*				

Resources

COSEWIC. 2015. COSEWIC assessment and status report on the Eastern Yellow-bellied Racer Coluber constrictor flaviventris and Western Yellow-bellied Racer Coluber constrictor mormon in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Xvii + 64 pp. **Environment and Climate Change Canada. 2017.** Action Plan for Multiple Species at Risk in Southwestern Saskatchewan: South of the Divide. Species at Risk Act Action Plan Series. Environment and Climate Change Canada, Ottawa. Xi + 127 pp. **Hammerson, G.A., Acevedo, M., Ariano-Sánchez, D. & Johnson, J. 2013.** Coluber constrictor. The IUCN Red List of Threatened Species 2013: e.T63748A3128579. https://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T63748A3128579.en. Downloaded on 01 February 2021. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.104215/Coluber_constrictor_flaviventris. (Accessed: Oct 14, 2020). **Parks Canada Agency. 2010.** Recovery Strategy for Eastern Yellow-bellied Racer (Coluber constrictor flaviventris) in Canada. Species at Risk Act Recovery Strategy Series. Parks Canada Agency. Ottawa. Vii + 22 pp. **Parks Canada Agency. 2016.** Multi-species Action Plan for Grasslands National Park of Canada. Species at Risk Act Action Plan Series. Parks Canada Agency, Ottawa. Iv + 57 pp. **Somers, C. M., Graham, C. F., Martino, J. A., Frasier, T. R., Lance, S. L., Gardiner, L. E., & Poulin, R. G. (2017).** Conservation genetics of the eastern yellow-bellied racer (Coluber constrictor flaviventris) and bullsnake (Pituophis catenifer sayi): River valleys are critical features for snakes at northern range limits. Plos one, 12(11), e0187322.

† Kominek A, Cornies O, M°Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

All three subspecies of racer were assessed in detail separately. The threats for Western and Eastern Yellow-bellied Racers are different. Eastern Yellow-bellied Racers are restricted to a small area in Alberta (only one known den) and Saskatchewan at northern extent of species' range and are genetically different from conspecifics in southern states, although there is a large range of populations throughout the US. The Canadian population is less genetically diverse and is likely locally adapted and more susceptible to extirpation. Potential for natural rescue from connected populations in Montana.

Feasibility of population restoration measures such as demographic manipulation, reintroduction, and reinforcement is low due to limited habitat availability and socio-political barriers. A future step would be to assess the biological and social/political feasibility and risks for the specific populations/species involved. Developing an insurance population has low conservation value as a wild source is readily available for potential restoration efforts.

Research, training, and education would require acquiring animals but should be opportunistic based on availability of snakes (e.g., rescues, do not encourage wild collection). Sharing of husbandry knowledge to local areas/from other racer species is needed. Less apparent *ex situ* research roles: demographics, climate change impacts.

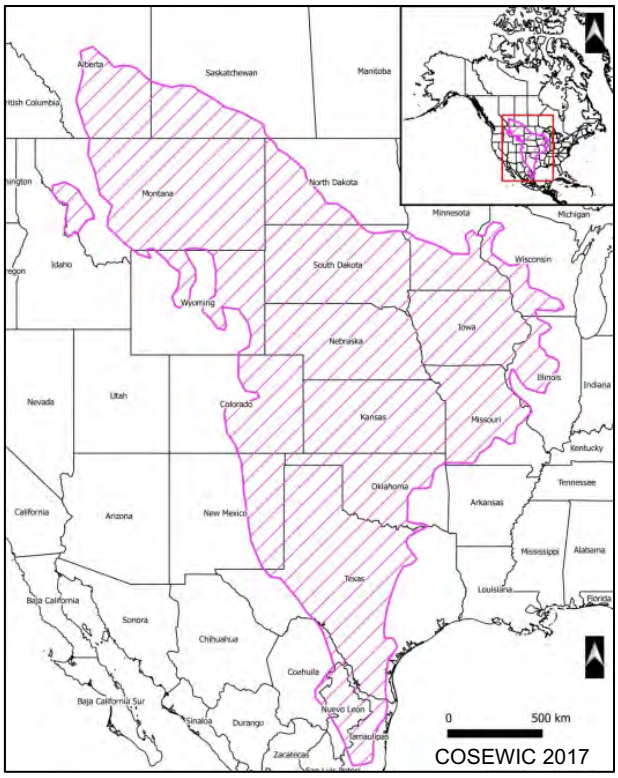
Recommended Actions

No specific actions recommended.

Table 17. *Ex Situ* Conservation Assessment and Recommendations for Eastern Yellow-bellied Racer (*Coluber constrictor flaviventris*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Low	Moderate-Low	Low	Not recommended at this time
Rescue	Moderate-Low	Moderate	Moderate-Low	Not recommended at this time
Demographic Manipulation	Low	Low, can be improved	Low	Not recommended at this time
Reintroduction	Low	Low, can be improved	Moderate-Low	Not recommended at this time
Reinforcement	Low	Low, can be improved	Moderate-Low	Not recommended at this time
Research	Moderate-Low	Moderate-Low	Low	**Recommended with restrictions** Opportunistic, share husbandry knowledge
Training	Moderate-Low	Moderate-Low	Low	**Recommended with restrictions** Opportunistic, share husbandry knowledge
Education	Moderate-Low	Moderate-Low	Low	**Recommended with restrictions** Opportunistic, share husbandry knowledge

BULLSNAKE
Pituophis catenifer sayi (Colubrinae)



SPECIES STATUS

Global: Secure (NatureServe 2016), Least Concern (*P. catenifer*; IUCN Red List 2007)
Canada: Not Listed, **under consideration for addition** (SARA 2018), **Special Concern** (COSEWIC 2017), Apparently Secure (NatureServe 2016)
Provincial: **Vulnerable** (AB; NatureServe 2016), Apparently Secure (SK; NatureServe 2016)

Canadian Distribution and Population Trend:
Southeastern Alberta and southwestern Saskatchewan (<10% of global range); Declining (COSEWIC 2017)

Evolutionary Distinctiveness†:
Global: 3.481, Canada: 22.757

Wild Population

Insufficient data exist to generate estimates of abundance or population trends. Declines are inferred from increasing road mortality, habitat loss, and declines in Prairie Rattlesnake populations. Bullsnakes appear to persist across their wide Canadian range but may become more vulnerable to decline if threats are not mitigated. Most occurrences are associated with drainages and adjacent grassland habitat. In Alberta, occurrences are relatively close together in the lower Red Deer, South Saskatchewan & Milk river valleys, suggesting habitat connectivity and that the population is probably not severely fragmented, but genetic analysis has not been conducted. In Saskatchewan, genetic analysis, and large distances between occurrences in the Big Muddy, Frenchman & South Saskatchewan river valleys support the existence of genetically discrete subpopulations (COSEWIC 2017).

Threats and Limitations

Overall impact of threats assessed to be low, but potentially significant. Threats include increasing road mortality, and habitat loss and degradation from agricultural practices, overgrazing, and oil and gas drilling. ~60% of native prairie is estimated to have been altered by human activities. Additional threats with potentially important local impacts include persecution, disturbance from recreational and military activities, natural system modifications such as wildfires, landslides, and invasive species, urban development, and poisoning. Critically important communal hibernacula may be limited on the landscape. Vulnerable to increased mortality because of low abundance, late maturity, and low rate of productivity (COSEWIC 2017).

In situ Conservation Actions

Recent research and monitoring include hibernaculum surveys and 5-year documentation of communal nesting area in Alberta, study of road mortality patterns in and around Dinosaur Provincial Park, Alberta, and a series of road surveys and hibernaculum surveys, as well as radio-telemetry studies on populations in and around Grasslands National Park, Saskatchewan. Additional studies are being conducted in the Big Muddy Valley and Saskatchewan Landing Provincial Park on habitat and space use at the northern limits of the species' range. Some landowners protect or relocate snakes to areas of high ground squirrel and pocket gopher activity as a means of pest control because of the perceived benefit of reducing rodent populations. Protected under the Alberta Wildlife Act and ~12% of the Canadian range is protected in national or provincial parks (COSEWIC 2017).

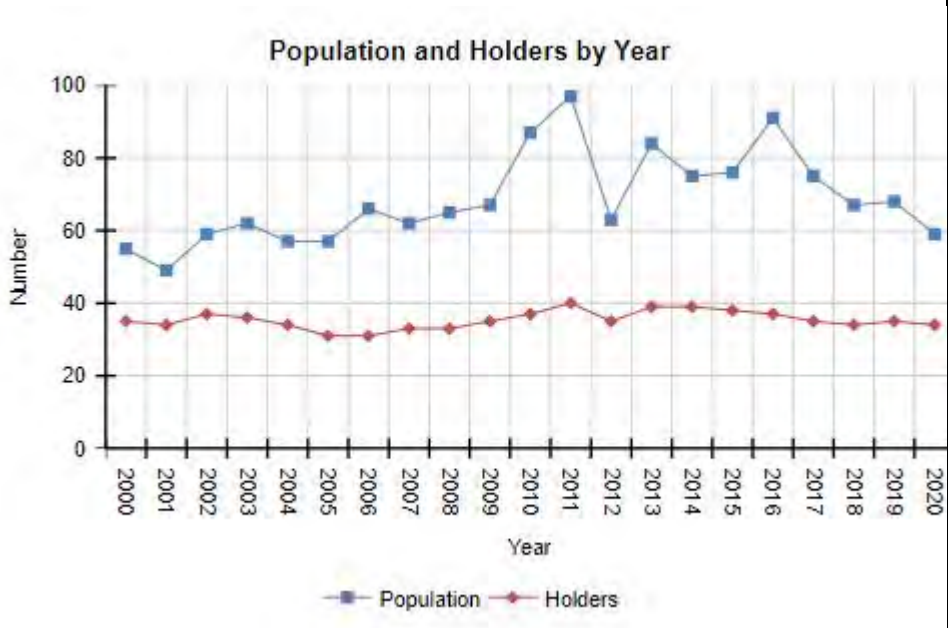
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

In the US, the Minnesota Zoo provided field staff support for in situ research on Bullsnakes and Plains Hog-nosed Snakes, and provided grant funding for telemetry gear, snake hibernacula protective equipment, temperature monitoring equipment, drift fences, and veterinary services.

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *P. c. sayi*	16 (9.6.1)	34 (11.8.15)	24 (5.2.17)	73 (25.16.33)
Number of institutions	6	23	10	39
Breeding status	Breeding recorded in captivity (from 2000-2020) including in Canada			
Living wild-born	13 (1.1.11) confirmed in captivity globally			
Generation time (yr)	8 (COSEWIC 2017)			
Potential surrogates(s)	*P. catenifer* ssp. Including Sonoran Gophersnake (*P. c. affinis*), San Diego Gophersnake (*P. c. annectens*), Pacific Gophersnake (*P. c. catenifer*), Santa Cruz Gophersnake (*P. c. pumilis*), Great Basin Gophersnake (*P. c. deserticola*)			
Husbandry notes	large, late maturing temperate colubrid, non-venomous, oviparous, avg. 16 eggs, primarily diurnal, varied diet but primarily eat small mammals, strong climbers			
Historical global holdings (2000-2020) * *P. c. sayi*				

Resources

COSEWIC. 2017. COSEWIC assessment and status report on the Bullsnake Pituophis catenifer sayi in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Xi + 34 pp. **Fortney AN, Poulin RG, Martino JA, Parker DL, Somers CM. 2013**. Proximity to hibernacula and road type influence potential road mortality of snakes in southwestern Saskatchewan. The Canadian Field-Naturalist. 126(3):194-203. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.104296/Pituophis_catenifer_sayi. (Accessed: Oct 14, 2020). **Somers, C. M., Graham, C. F., Martino, J. A., Frasier, T. R., Lance, S. L., Gardiner, L. E., & Poulin, R. G. 2017.** Conservation genetics of the eastern yellow-bellied racer (Coluber constrictor flaviventris) and bullsnake (Pituophis catenifer sayi): River valleys are critical features for snakes at northern range limits. Plos one, 12(11), e0187322.

† Kominek A, Cornies O, McCurdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

All three subspecies of *P. catenifer* were discussed separately. It was decided that the recommendations for the Bullsnake were the same as those for the Eastern Yellow-bellied Racer, although feasibility is likely generally higher for Bullsnake as it has greater extent and is more tractable in captivity.

Recommended Actions

No specific actions recommended.

Table 18. *Ex Situ* Conservation Assessment and Recommendations for Bullsnake (*Pituophis catenifer sayi*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Low	Moderate-Low	Low	Not recommended at this time
Rescue	Moderate-Low	Moderate	Moderate-Low	Not recommended at this time
Demographic Manipulation	Low	Low, can be improved	Low	Not recommended at this time
Reintroduction	Low	Low, can be improved	Moderate-Low	Not recommended at this time
Reinforcement	Low	Low, can be improved	Moderate-Low	Not recommended at this time
Research	Moderate-Low	Moderate-Low	Low	**Recommended with restrictions**
Training	Moderate-Low	Moderate-Low	Low	**Recommended with restrictions**
Education	Moderate-Low	Moderate-Low	Low	**Recommended with restrictions**

GREAT BASIN GOPHERSNAKE
Pituophis catenifer deserticola (Colubrinae)


M Atkins

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (*P. catenifer*; IUCN Red List 2007)
Canada: **Vulnerable** (NatureServe 2016), **Threatened** (COSEWIC/SARA 2013)
Provincial: **Vulnerable** (BC; NatureServe 2016)

Canadian Distribution and Population Trend:
Arid valleys in southern interior British Columbia (<5% of global range); Declining (COSEWIC 2013)

Evolutionary Distinctiveness†:
Global: 3.481, Canada: 22.757

Wild Population

Found in four disjunct areas in BC: Fraser–Thompson–Nicola (completely isolated from all other populations), Okanagan–Similkameen, Midway, and Grand Forks. Fragmented habitat connectivity due to transportation corridors, urbanization, and agricultural activities has presumably severed gene flow within some areas. Population sizes and trends are poorly known but are suspected to be declining due to high incidence of road mortality, loss and fragmentation of grassland habitats, and other human-caused threats. Local extirpations or rapid declines have been noted in areas close to major transportation corridors (COSEWIC 2013).

Threats and Limitations

Especially vulnerable to road mortality because of low reproductive rates, seasonal migrations, and attraction to roads. Other threats include ongoing habitat loss, fragmentation, and degradation from urban development, roads, agriculture and ranching, and fire suppression; direct mortality from secondary poisoning, human persecution, and recreation; potential diseases and predation from non-native species. Knowledge gaps on age at first reproduction, population densities and structure, survival, and dispersal (COSEWIC 2013).

In situ Conservation Actions

Recovery actions include ongoing population monitoring at two sites in the south Okanagan, incidental road mortality monitoring and collection, and opportunistic hibernaculum surveys throughout range. Research on various habitat, ecology, and population related topics completed and ongoing. Additional recovery efforts include mitigation and monitoring at priority roadkill hotspots, snake fences in residential areas and vineyards, artificial refugia in vineyards, and outreach and education programs. Overall, approximately 10% of the suitable habitat is located within protected or managed areas (ECCC 2019, COSEWIC 2013)

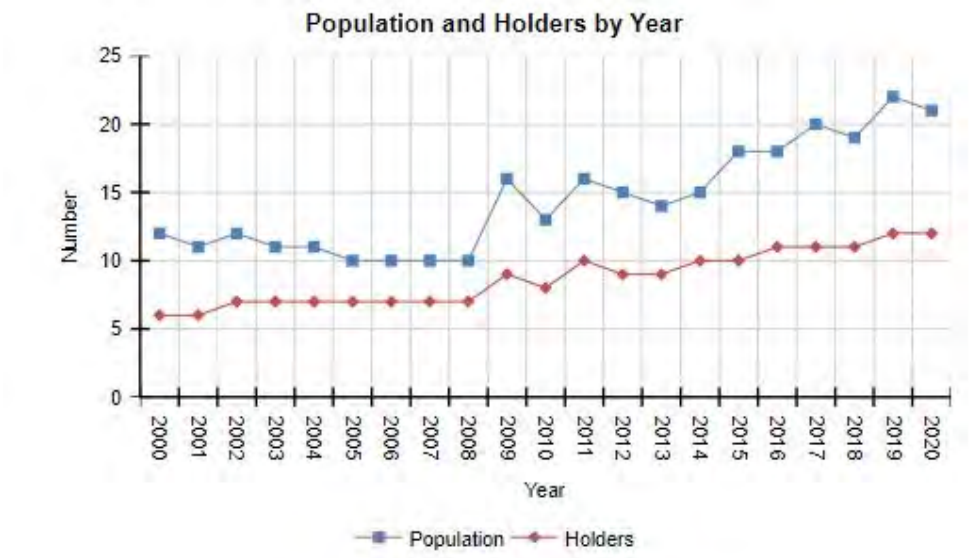
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

Education and awareness at zoos and outreach and training through conservation and stewardship organizations in BC to reduce persecution. Ninety-two (92) Great Basin Gophersnakes and Western Yellow-bellied Racers displaced by pipeline construction project being held at wildlife rehabilitation centre until release in the spring of 2021 back at re-constructed hibernacula.

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *P. c. deserticola*	3 (0.1.2)	17 (8.0.9)	1 (0.1.0)	21 (8.2.11)
Number of institutions	2	9	1	12
Breeding status	Breeding recorded in captivity			
Living wild-born	12 (3.1.8) confirmed in captivity globally			
Generation time (yr)	8 (COSEWIC 2013)			
Potential surrogates(s)	*P. catenifer* ssp. Including Sonoran Gophersnake (*P. c. affinis*), San Diego Gophersnake (*P. c. annectens*), Pacific Gophersnake (*P. c. catenifer*), Santa Cruz Gophersnake (*P. c. pumilis*), Bullsnake (*P. c. sayi*)			
Husbandry notes	large, late maturing temperate colubrid, non-venomous, oviparous, 2-8 eggs, biennial reproductive cycle, primarily diurnal, varied diet but primarily eat small mammals			
Historical holdings in North America (2000-2020) * *P. c. deserticola*				

Resources

Bertram, N., Larsen, K. W., & Surgenor, J. (2001). Identification of critical habitats and conservation issues for the Western Rattlesnake and Great Basin Gopher Snake within the Thompson-Nicola region of British Columbia. Prepared for the Ministry of Water, Land and Air Protection, Kamloops, BC and the Habitat Conservation Trust Fund of BC, Victoria, BC. **Bishop, C.A., Williams, K.E., Kirk, D.A. et al. 2016.** A population model of the impact of a rodenticide containing strychnine on Great Basin Gophersnakes (Pituophis catenifer deserticola). Ecotoxicology 25, 1390–1405. https://doi.org/10.1007/s10646-016-1690-2. **COSEWIC. 2013.** COSEWIC assessment and status report on the Great Basin Gophersnake Pituophis catenifer deserticola in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Xii + 53 pp. **Environment and Climate Change Canada. 2019.** Recovery Strategy for the Western Rattlesnake (Crotalus oreganus), the Great Basin Gophersnake (Pituophis catenifer deserticola) and the Desert Nightsnake (Hypsiglena chlorophaea) in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. Part 1, 28 pp., Part 2, A. 37 pp., B. 36 pp., C. 28 pp. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.102387/Pituophis_catenifer_deserticola. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Assessment

Summary of Discussion

All three subspecies of *P. catenifer* were discussed separately. Reintroduction was not assessed for Great Basin Gophersnake.

Concerns were raised about the risk to the wild population of establishing an *ex situ* insurance population. Rescue or demographic manipulation should be opportunistic and local and wild to wild translocations were preferred for reinforcement

Potential research topics include success of release, overwintering, disease, demographics (e.g., aging snakes can be explored further). Gophersnakes are easy to maintain in captivity and training/education should use existing captive animals. Opportunity to share captive individuals that cannot be released back to the wild (e.g., of unknown origin) with *ex situ* facilities outside of BC. Conservation value of education is critical-high as gophersnakes can also be used for education for Western Rattlesnakes since they face the same threats.

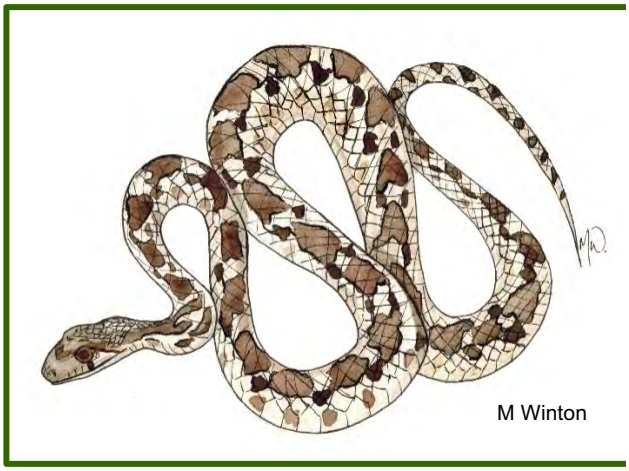
Recommended Actions

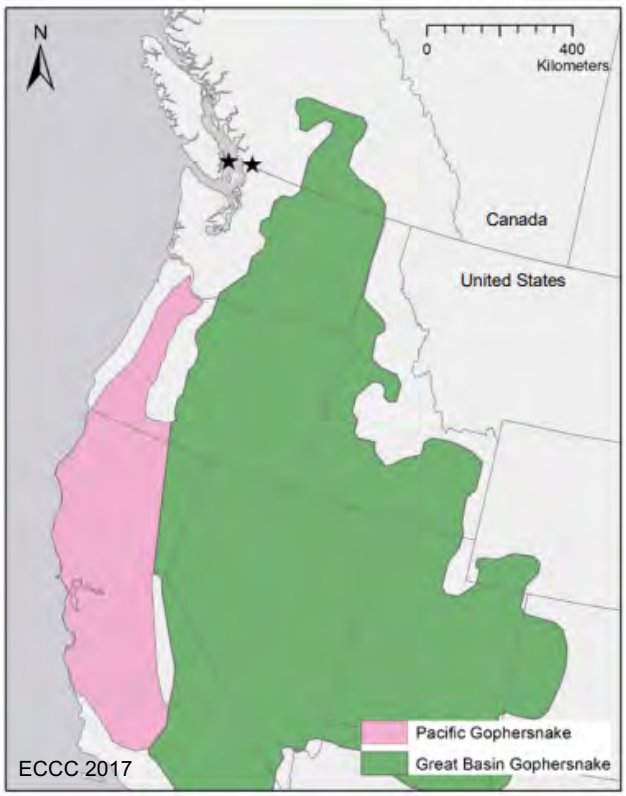
No specific actions recommended.

Table 19. *Ex Situ* Assessment and Recommendations for Great Basin Gophersnake (*Pituophis catenifer deserticola*)

Direct Conservation Role	Conservation Value	Feasibility	Risk	Decision
Insurance	Low	Low, can be improved	High	Not recommended at this time
Rescue	Moderate	Moderate	Moderate	Not recommended at this time
Demographic Manipulation	Moderate	Low, can be improved	Moderate	Not recommended at this time
Reinforcement	Low	Low, can be improved	Moderate	Not recommended at this time
Research	Moderate	Moderate	Low	**Recommended with restrictions** (Project dependent)
Training	High	Moderate	Low	**Recommended with restrictions** (Use existing captive animals)
Education	Critical-High	High	Low	**Recommended with restrictions** (Use existing captive animals)

PACIFIC GOPHERSNAKE
Pituophis catenifer catenifer (Colubrinae)


M Winton



SPECIES STATUS

Global: Secure (NatureServe 2016), Least Concern (*P. catenifer*; IUCN Red List 2007)
Canada: **Extirpated** (COSEWIC/SARA 2012); **Presumed Extirpated** (NatureServe 2016)
Provincial: **Presumed Extirpated** (BC; NatureServe 2016)

Evolutionary Distinctiveness†:
Global: 3.481, Canada: 22.757

Canadian Distribution and Global Population Trend:
Historical range on Galiano Island and in extreme southwestern BC; Global population stable with local declines (IUCN Red List 2007)

Wild Population

Considered extirpated from Canada as there have been no observations in the wild in more than 50 years and the habitat that could have been occupied has largely disappeared. Likely a relict population as only two records were ever made. The subspecies is most likely extirpated in Washington as well (ECCC 2017, (COSEWIC 2002).

Threats and Limitations

Historically, irreversible habitat loss due to urban development, agriculture, and invasive plant establishment was likely the primary threat that led to the subspecies decline in Canada. In other parts of the subspecies' range, it is susceptible to road mortality and human persecution. Canada is the northern range limit for the species and the colder climate limits the ability of populations to recover and the likelihood of successful translocations/reintroductions (ECCC 2017, COSEWIC 2002).

In situ Conservation Actions

No known occurrences in protected areas in BC (COSEWIC 2002).

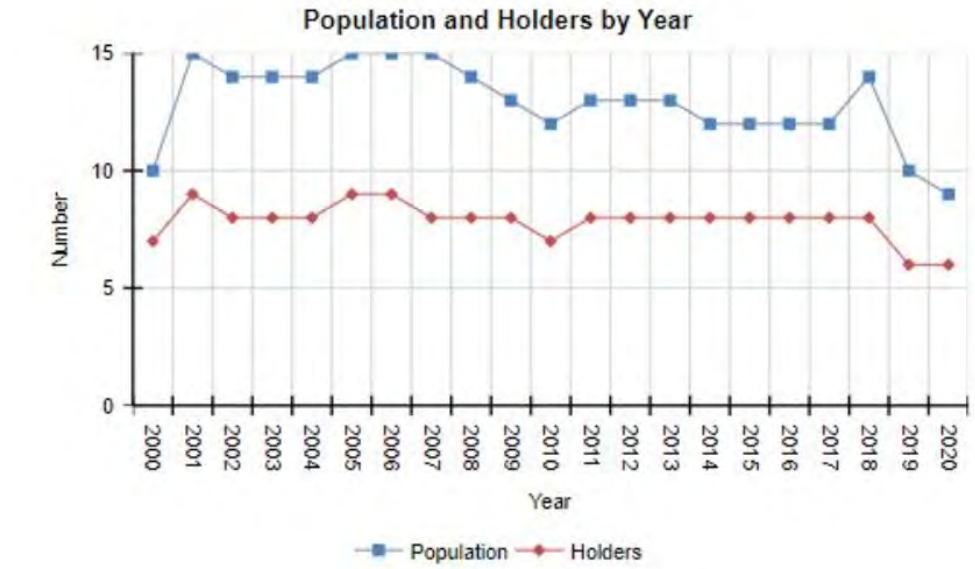
Prior Recommended *Ex situ* Conservation Actions

Recovery is not considered technically and biologically feasible at the present time due to the extreme geographic isolation from the nearest extant populations and lack of substantial suitable habitat. It is unlikely that reintroduction will be attempted, but if deemed feasible in the future, recovery efforts for *P. c. deserticola* could provide a framework (ECCC 2017).

Existing *Ex situ* Conservation Actions

None known in Canada

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *P. c. catenifer*	2 (0.1.1)	8 (3.2.3)	0	10 (3.3.4)
Number of institutions	2	5	0	7
Breeding status	Breeding recorded in captivity			
Living wild-born	4 (2.0.2) confirmed (in Canada and US)			
Generation time (yr)	6-8 (COSEWIC 2002 & 2013)			
Potential surrogates(s)	*P. catenifer* ssp. Including Sonoran Gophersnake (*P. c. affinis*), San Diego Gophersnake (*P. c. annectens*), Great Basin Gophersnake (*P. c. deserticola*), Santa Cruz Gophersnake (*P. c. pumilis*), Bullsnake (*P. c. sayi*)			
Husbandry notes	Large, late maturing temperate colubrid, non-venomous, oviparous, avg. 11 eggs (range 2-15), optimal incubation temp: 26-28°C in moist conditions, primarily diurnal, varied diet but primarily eat small mammals			
Historical holdings in North America (2000-2020) * *P. c. catenifer*				

Ex Situ Conservation Assessment

Summary of Discussion

All three subspecies of *P. catenifer* were discussed separately. The Pacific Gophersnake was not assessed in detail and no recommendations for *ex situ* conservation roles were made at this time.

The status of the Pacific Gophersnake is similar to the Timber Rattlesnake (i.e., no habitat left), and can be used as a cautionary tale for other snakes in BC (i.e., Great Basin Gophersnake).

Recommended Actions

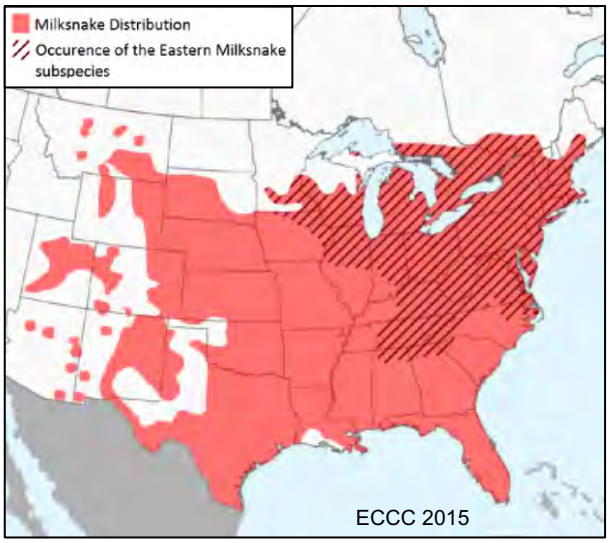
Any potential sightings of Pacific Gophersnakes within historical range should be reported and, if possible, captured for genetic testing.

Resources

COSEWIC 2002. COSEWIC assessment and status report on the Gophersnake Pituophis catenifer in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Vii + 33 pp**. Environment and Climate Change Canada. 2017**. Recovery Strategy for the Pacific Gophersnake (Pituophuis catenifer catenifer) in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. Vi + 10 pp. **Hammerson, G.A. 2007**. Pituophis catenifer. The IUCN Red List of Threatened Species 2007: e.T63869A12723241. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63869A12723241.en. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.102381/Pituophis_catenifer_catenifer. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

EASTERN MILKSNAKE
Lampropeltis triangulum (Colubrinae)



SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2016)
Canada: **Vulnerable** (NatureServe 2016), **Special Concern** (COSEWIC/SARA 2014)
Provincial: Apparently Secure (ON; NatureServe 2016), **Vulnerable** (QC; NatureServe 2016)

Canadian Distribution and Population Trend:
Southern and central Ontario (Great Lakes/St. Lawrence and Carolinian regions) and southwestern Quebec (~7% of global range); Declining (COSEWIC/SARA 2014)

Evolutionary Distinctiveness†:
Global: 4.425, Canada: 24.819

Wild Population
Relatively widespread and recently recorded in all jurisdictions within known range, but evidence of localized declines (and possible extirpations) in large urban centres and regions with intensive agriculture. Abundance estimates not available, but total adult population size is likely >10,000 adults based on rough estimates of density and area of occupancy. Abundance varies across range and in some areas the snake is rare or absent. Suspected decline based on trends in other large snakes in eastern Canada and susceptibility to ongoing threats (COSEWIC 2014).

Threats and Limitations
Major threats are habitat loss from expanding urbanization and intensification of agriculture, road mortality, human persecution, collection for the pet trade, and additive mortality from pets and other predators. Snake fungal disease is also a concern. Slow life history characteristics increase vulnerability to threats and potentially limited by temperature and by suitable habitat for egg-laying (CWHC 2017, ECCC 2015, COSEWIC 2014).

In situ Conservation Actions
Collaborative project to begin in spring 2021 to inventory and monitor snakes using provincial standardized protocols in a municipal park and private riparian areas near Granby, Quebec by Granby Zoo, Nature Conservancy, Appalachian Corridor, Ministère des Forêt, de la Faune et des Parcs Québec. Snake fungal disease surveillance program around Montreal established by Zoo Ecomuseum, ECCC, and University of Illinois. Recent research has been conducted on dispersal, ecology, genetics, and physiology. Road mortality assessment, mitigation, and monitoring projects have been undertaken at several locations. Ongoing field surveys, incidental observations, habitat acquisition and enhancement, awareness, outreach, and community science programs by First Nations communities, government agencies (including National Parks), and other conservation groups in both provinces. Occurrences confirmed in at least 40 protected areas, but unknown if adequate habitat is protected to ensure long-term survival (P. Pare, Granby Zoo, pers. comm. 2021, ECCC 2015, COSEWIC 2014).

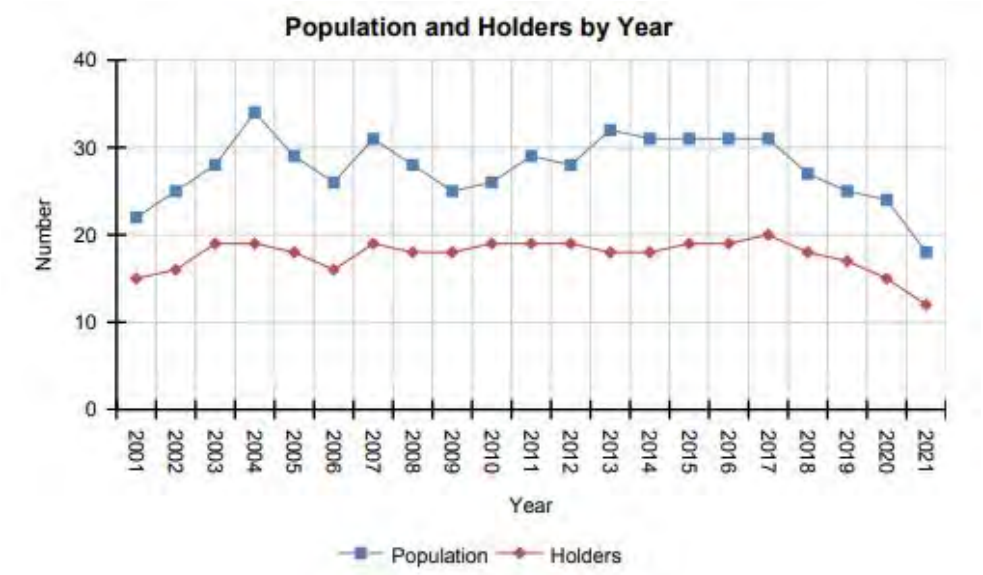
Prior Recommended *Ex situ* Conservation Actions

Create short training videos of capture and handling techniques and equipment that could assist with recommended conservation measures such as soliciting incidental observations of species-at-risk snakes from the public, inventory and monitoring programs, research to fill knowledge gaps, and development of educational outreach material to reduce persecution (P. Pare, Granby Zoo, pers. comm. 2021, ECCC 2015)

Existing *Ex situ* Conservation Actions

In Ontario, public presentations with live Eastern Milksnakes by several organizations (such as Sciensational Sssnakes!! and Scales Nature Park) significantly increase knowledge and attitude towards snakes addressing awareness and support of conservation issues and activities and decreasing persecution (COSEWIC 2015).

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *L. t. triangulum*	11 (6.4.1)	18 (9.6.3)	3 (1.1.1)	32 (16.11.5)
Number of institutions	4	11	2	17
Breeding status	Breeding recorded in captivity (between 2001-2017) including in Canada			
Living wild-born	7 (3.2.2) confirmed in US and Canada (from Sudbury, ON)			
Generation time (yr)	7-14 (COSEWIC 2014)			
Potential surrogates(s)	Milksnake (*L. triangulum*) and other subspecies (*L. triangulum* ssp.)			
Husbandry notes	Oviparous, 8-11 eggs, long-lived, feeds on mice, will eat other snakes if housed together			
Historical holdings (2001-2021) * *L. t. triangulum*				

Resources

Canadian Wildlife Health Cooperative. 2017. Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp. **COSEWIC. 2014.** COSEWIC assessment and status report on the Eastern Milksnake Lampropeltis triangulum in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 61 pp. **Environment Canada. 2015.** Management Plan for the Eastern Milksnake (Lampropeltis triangulum) in Canada. Species at Risk Act Management Plan Series. Environment Canada, Ottawa. iii + 27 pp. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.960858/Lampropeltis_triangulum. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

The following *ex situ* conservation roles were not discussed for Eastern Milksnake: ark, insurance, rescue, demographic manipulation, reintroduction, reinforcement, ecological replacement, assisted colonization.

It was noted that milksnakes are very useful for education and can be used as a model species for research, training, and education. Research should be opportunistic where animals exist in captivity and potential topics include overwintering. Milksnakes can be used to train groups such as students/biologists and construction workers to identify differences from rattlesnakes and can be a model for education about rattlesnakes.

Recommended Actions

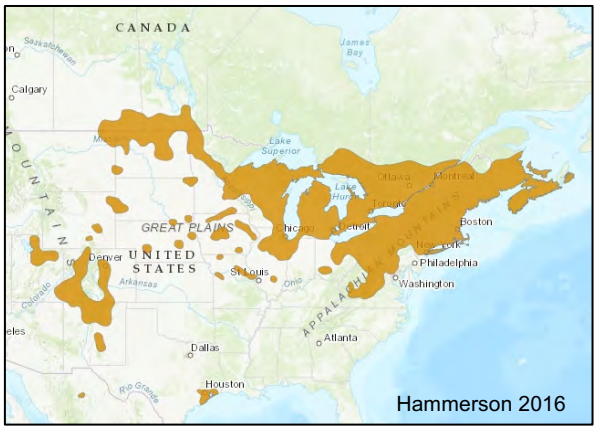
No specific actions recommended.

Table 20. *Ex Situ* Conservation Assessment and Recommendations for Eastern Milksnake (*Lampropeltis triangulum*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Research	Moderate-Low	Not assessed	Not assessed	**Recommended with restrictions** (opportunistic, existing captive snakes)
Training	Moderate	Not assessed	Not assessed	**Recommended**
Education	High-Moderate	Not assessed	Not assessed	**Recommended**

SMOOTH GREENSNAKE
Opheodrys vernalis (Colubrinae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2016)
Canada: Secure (NatureServe 2016), Not Assessed, **mid priority candidate for assessment** (COSEWIC)
Provincial: Secure (MB; NatureServe 2016), Apparently Secure (SK, ON, QC, NB, NS; NatureServe 2016), **Imperilled** (PEI; NatureServe 2016)



Canadian Distribution and Global Population Trend:
Southeastern Saskatchewan to Nova Scotia and PEI, absent from eastern Manitoba and western Ontario north of Lake Superior; Stable (IUCN Red List 2016)

Evolutionary Distinctiveness†:
Global: 10.684, Canada: 31.337

Wild Population
Local populations are threatened by habitat loss and degradation, but in general the species is not very threatened. Rare on PEI. Extent of occurrence, area of occupancy, number of occurrences or subpopulations, and population size are probably relatively stable or slowly declining (Hammerson 2016)

Threats and Limitations
Habitat loss and degradation resulting from human activities and successional changes may threaten some populations of this species. Road mortality is a threat, especially in southern areas of Canada where road density is high. Subsidized predation by feral and free-ranging pet cats is a concern (CHS, Hammerson 2016).

In situ Conservation Actions
In 2016, after ~15 years of no confirmed records in PEI, the provincial government requested submissions of documented sightings from the public through the PEI Nature Tracker app, which resulted in several confirmed observations, verifying presence and persistence. Further information on abundance and distribution is needed. This species occurs in several parks and preserves (Hammerson 2016).

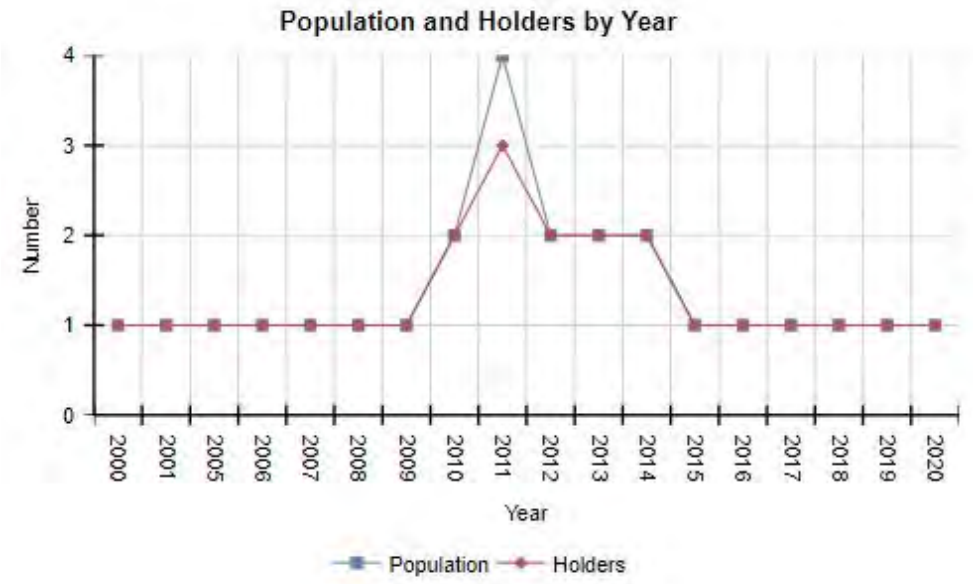
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

Education and snake appreciation programs through zoos in Canada. In Illinois, The Chicago Academy of Sciences and Peggy Notebaert Nature Museum are collaborating with the nature preserve district and a wildlife centre to **supplement** existing populations by **incubating eggs** artificially, **headstarting** neonates, and **reintroducing** new populations with experimental approaches at historical locations.

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *O. vernalis*	4 (0.4.0)	0	1 (0.0.1)	5 (0.4.1)
Number of institutions	1	0	1	2
Breeding status	Breeding recorded in captivity in Canada (in 2016)			
Living wild-born	4 (0.3.1) confirmed (in Canada and other region)			
Generation time (yr)	est. 3			
Potential surrogates(s)	Rough Greensnake (*O. aestivus*)			
Husbandry notes	Oviparous, avg. 7 eggs, insectivorous, requires well balanced captive diet, diurnal, arboreal			
Historical holdings (2000-2020) * *O. vernalis*				

Resources

Canadian Herpetological Society. Species Information. http://canadianherpetology.ca/species/index.html [accessed 2021].
Hammerson, G.A. 2016. Opheodrys vernalis. The IUCN Red List of Threatened Species 2016: e.T63842A90083304. https://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T63842A90083304.en. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.103123/Opheodrys_vernalis. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

The following *ex situ* conservation roles were not discussed for Smooth Greensnake: ark, insurance, demographic manipulation, reintroduction, reinforcement, ecological replacement, assisted colonization.

Rescue was considered to be locally important (e.g., risk from snake fungal disease) but was not recommended at this time.

Greensnakes are a beautiful display species, however there are difficulties with keeping them in captivity. Recommended research on maintaining health in captivity (including long-term maintenance, nutrition/diet, breeding), and on snake fungal disease and natural history. Difficulties with obtaining permits or acquiring correct species from the US impact feasibility.

Specific needs for training and education were not identified for the species but it can be used for snakes in general. Graphics may be helpful if too difficult to maintain in captivity,

Recommended Actions

First steps:

- Identify what knowledge needs to be documented to improve husbandry practices.
- Collect a small number of Smooth Greensnakes from a healthy population (e.g., from the Shield) to establish a captive research population.

Table 21. *Ex Situ* Conservation Assessment and Recommendations for Smooth Greensnake (*Opheodrys vernalis*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Rescue	Low	Low, can be improved	Not assessed	Not recommended at this time
Research	Moderate-Low	Low, can be improved	Not assessed	**Recommended with restrictions** (Healthy source)
Training	Low	Low, can be improved	Not assessed	**Recommended with restrictions** (Opportunistic)
Education	Moderate-Low	Low, can be improved	Not assessed	**Recommended with restrictions** (Opportunistic)

Species-Specific Status and Recommendations

Colubridae

Natricinae

Photo: Common Gartersnake (*Thamnophis sirtalis*), Stephanie Winton

QUEENSNAKE
Regina septemvittata (Natricinae)

SPECIES STATUS

Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2007)
Canada: **Imperiled** (NatureServe 2016), **Endangered** (COSEWIC/SARA 2010)
Provincial: **Imperiled** (ON; NatureServe 2016)

Canadian Distribution and Population Trend:
Sporadically distributed in watersheds of southwestern Ontario west of the Niagara Escarpment (5% of global range); Declining (COSEWIC/SARA 2010)

Evolutionary Distinctiveness†:
Global: 11.696, Canada: 23.073

Wild Population

Low density, isolated populations with minimal opportunity for migration and genetic exchange between populations. Documented loss of historic populations and evidence of declining habitat quality and prey. Indicator species due to reliance on specialized aquatic prey and habitat (COSEWIC 2010).

Threats and Limitations

Loss, fragmentation, and degradation of habitat and decline in prey abundance due to urbanization and agricultural activities in riparian habitat are the most significant threats. Other threats include snake fungal disease, persecution, and effects of invasive Zebra Mussels and European Common Reed. Limited by extremely specialized diet (freshly moulted juvenile crayfish) and specialized habitat needs (proximity to water) and vulnerable to effects of isolation and small population size (CWHC 2017, COSEWIC 2010, Hammerson 2007).

In situ Conservation Actions

Queensnakes are known to occur in some protected areas, with variable degrees of protection. Recovery activities include a large-scale collaborative effort to gather information about the Queensnake across Ontario using standardized methods as well as soliciting public observations, identifying important habitat, restoring degraded habitat, and acquiring properties for habitat conservation, multi-year ecological, habitat, and threat studies (including several mark-recapture population studies), and stewardship outreach and guidelines. Bruce Peninsula National Park conducts monitoring, aquatic invasive management, and visitor engagement and communication (ECCC 2016, Parks Canada 2016, MNDMNRF 2016).

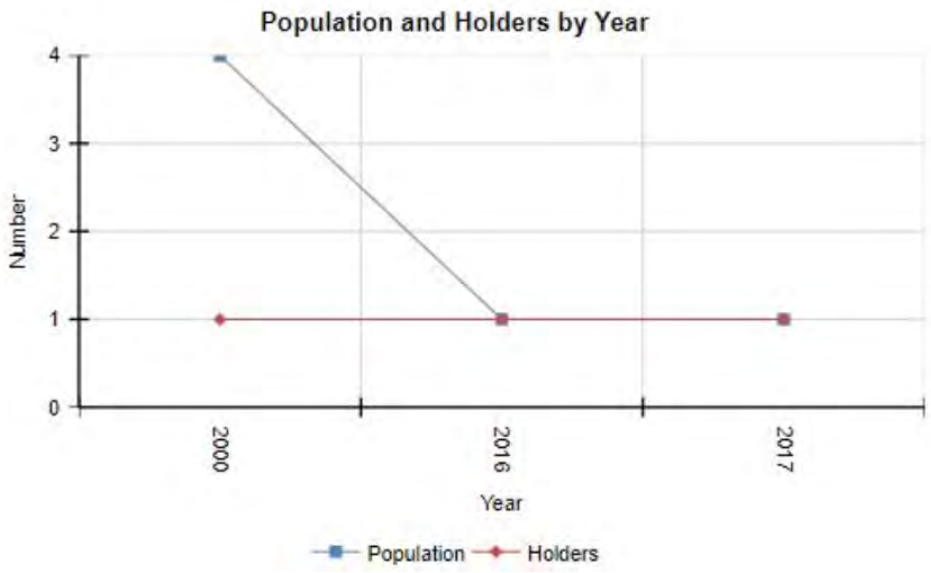
Prior Recommended *Ex situ* Conservation Actions

Investigate the feasibility of **population supplementation** or **reintroduction** of Queensnake to parts of its current and historic range: investigate closely related sub-populations using genetic data and potential for relocation of closely related animals (from other populations in Canada or US); evaluate potential reintroduction sites (including assessment of habitat and threats); evaluate the feasibility of restoring Queensnake to its historic range (e.g., individuals from other populations available to use); and develop and implement a reintroduction program if restoration is deemed feasible (ECCC 2016).

Existing *Ex situ* Conservation Actions

Initial steps toward investigating the feasibility of reintroducing populations at historic locations have been completed through the development of habitat suitability models and standardized habitat surveys to identify the species' habitat requirements (MNDMNRF 2016).

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *R. septemvittata*	0	0	0	0
Number of institutions	0	0	0	0
Breeding status	None documented in captivity			
Living wild-born	0			
Generation time (yr)	9 (COSEWIC 2010)			
Potential surrogates(s)	None known			
Husbandry notes	Semi-aquatic, viviparous, 8–14 neonates, primarily diurnal, highly restricted diet (feed exclusively on crayfish that have recently moulted), sensitive to heat stress, vulnerable to dehydration			
Historical holdings in North America (2000-2017) * *R. septemvittata*				

Resources

Canadian Wildlife Health Cooperative. 2017. Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp. **COSEWIC. 2010**. COSEWIC assessment and status report on the Queensnake Regina septemvittata in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii+34pp. **Environment and Climate Change Canada. 2016.** Recovery Strategy for the Queensnake (Regina septemvittata) in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. 3 parts, 28 pp.+vi+34 pp.+5 pp. **Hammerson, G.A. 2007**. Regina septemvittata. The IUCN Red List of Threatened Species 2007: e.T63887A12717768. **Huron Stewardship Council. 2013.** A Stewardship Guide for Queensnake. http://hsc.huronstewardship.ca/wp-content/uploads/sites/2/2014/01/final-queensnake-stewardship-guide.pdf **Ministry of Northern Development, Mines, Natural Resources & Forestry. 2016**. Five-year review of progress towards the protection and recovery of Ontario's species at risk - 2016: Queensnake. Government of Ontario. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.102448/Regina_septemvittata. (Accessed: Oct 14, 2020). **Parks Canada Agency. 2016**. Multi-species Action Plan for Bruce Peninsula National Park and Fathom Five National Marine Park of Canada. Species at Risk Act Action Plan Series. Parks Canada Agency, Ottawa. v+22 pp.

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

Several small, disjunct populations of Queensnake remain in Ontario that are likely genetically distinct (i.e., within separate river systems). Population and genetic research show that populations are likely declining rapidly, and genetic diversity is low. Thus, the value of most *ex situ* conservation roles is moderate to high, however, contingent on the need to address threats in wild and husbandry challenges.

The Queensnake's diet of freshly molted crayfish presents a significant husbandry challenge and there is low feasibility/high risk of establishing a captive population currently. Other risks include high handling stress for capture and movement of individuals (e.g., delicate, low heat tolerance, etc.) and potential harm to declining wild populations.

Research is priority for this species and there was agreement that, despite difficulties, it might be worth conducting research on the non-endangered Ontario populations or animals from the US. Research needs include:

- Husbandry:
  - can Queensnakes be transitioned to alternative food sources in captivity and back to proper food source in the wild
  - feasibility of treatment and release for snake fungal disease
- Genetics:
  - compare genetics within Ontario and to US (e.g., bio samples)

If husbandry feasibility is improved, it is critical to rescue (through short-term holding and release) highly infected populations, very small populations with low viability, or populations with imminent threats (e.g., bridge/dam construction, chemical spill, invasive species control).

Again, if research is successful at improving feasibility of maintaining a captive population, can consider establishing an insurance population(s) and reintroduction/reinforcement (if habitat/prey available and *in situ* threat reduction undertaken). Given purported genetic diversity, it would be valuable to obtain a few individuals from many populations.

Recommended Actions

Next step: organize a meeting at Queensnake Symposium scheduled for March 2022 to plan *ex situ* conservation research projects and methods to garner support.

Table 22. *Ex Situ* Conservation Assessment and Recommendations for Queensnake (*Regina septemvittata*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Moderate	Low, can be improved	Moderate	Not recommended at this time
Rescue	High-Mod	Mod-Low	High	**Recommended** (case by case)
Demographic Manipulation	Mod-Low	Low, can be improved	Moderate	Not recommended at this time
Reintroduction	Moderate	Low, can be improved	Moderate	Not recommended at this time
Reinforcement	Moderate	Low, can be improved	Low	Not recommended at this time
Research	High	Mod-Low	Moderate	**Recommended**
Training	Moderate	Low, can be improved	Mod-Low	Not recommended at this time
Education	Mod-Low	Low, can be improved	Mod-Low	Not recommended at this time

BUTLER'S GARTERSNAKE
Thamnophis butleri (Natricinae)

SPECIES STATUS
Global: Apparently Secure (NatureServe 2016), Least Concern (IUCN Red List 2007)
Canada: **Imperiled** (NatureServe 2016), **Endangered** (COSEWIC/SARA 2010)
Provincial: **Imperiled** (ON; NatureServe 2016)

Canadian Distribution and Population Trend:
Confined to small areas within two disjunct regions in southwestern Ontario (16% of global range); Declining (COSEWIC/SARA 2010)

Evolutionary Distinctiveness†:
Global: 3.205, Canada: 15.388

Wild Population

One of the most restricted global distributions of any snake in North America. The current disjunct distribution suggests a much wider historical range. Although apparently locally abundant and still present at several small, fragmented locations, an overall decline in the number of localities is presumed (recent loss of 32% of locations in one region) and extirpations are presumed in several regions outside current range. Four to five genetically distinct populations likely in Ontario (Luther Marsh population distinct from the Windsor-Sarnia populations). Unique morphological variants of this species observed in Ontario (COSEWIC 2010).

Threats and Limitations

The major threats are ongoing habitat loss (i.e., wetlands), degradation, and fragmentation, due to urban, industrial and road development as well as expansion of intensive agriculture. Potential threats of unknown impact include roadkill, illegal collection, subsidized predation (e.g., feral and free-ranging pet cats), and snake fungal disease. Small, isolated subpopulations with limited dispersal capacity subjected to higher extinction risks due to potential inbreeding depression and demographic stochasticity (ECCC 2018, CWHC 2017, COSEWIC 2010).

In situ Conservation Actions

Recovery actions include extensive surveys across the range, public outreach and education, habitat restoration, land acquisition, several mark-recapture and radio-telemetry studies, and road mortality monitoring. The Luther Marsh population is located within a managed protected area and occurrences exist in several protected areas within the Windsor-Sarnia region. Snake exclusion, salvage, and relocation as well as mitigation and habitat creation/restoration were undertaken for a major highway development and ongoing monitoring is being conducted through a mark-recapture study (ECCC 2018).

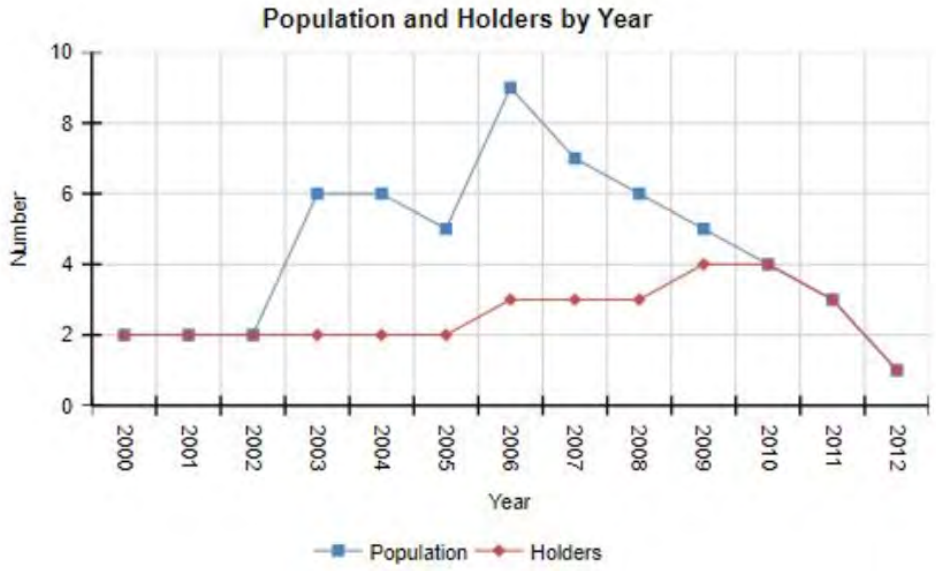
Prior Recommended *Ex situ* Conservation Actions

Recovery objective to increase **the distribution and abundance** of extant subpopulations, where biologically and technically feasible, but further research is needed (MECP 2019, ECCC 2018).

Existing *Ex situ* Conservation Actions

None known

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *T. butleri*	0	0	0	0
Number of institutions	0	0	0	0
Breeding status	None documented in captivity			
Living wild-born	0			
Generation time (yr)	4 (COSEWIC 2010)			
Potential surrogates(s)	*Thamnophis* spp.			
Husbandry notes	Viviparous, 8–12 neonates, feed primarily on earthworms			
Historical holdings in North America (2000-2012) * *T. butleri*				

Resources

Canadian Wildlife Health Cooperative. 2017. Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp. **COSEWIC. 2010**. COSEWIC assessment and status report on the Butler's Gartersnake Thamnophis butler in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Xi + 51 pp. **Environment and Climate Change Canada. 2018**. Recovery Strategy for the Butler's Gartersnake (Thamnophis butleri) in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. Viii + 51 pp. **Ministry of the Environment, Conservation and Parks. 2019.** Recovery Strategy for the Butler's Gartersnake (Thamnophis butleri) in Ontario. Ontario Recovery Strategy Series. Prepared by the Ministry of the Environment, Conservation and Parks, Peterborough, Ontario. Iv + 6 pp. + Appendix. Adoption of the Recovery Strategy for the Butler's Gartersnake (Thamnophis butleri) in Canada (Environment Canada 2018). **Ministry of the Environment, Conservation and Parks. 2020.** Butler's Gartersnake Ontario Government Response Statement. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.103286/Thamnophis_butleri. (Accessed: Oct 14, 2020). **Noble, D., J. D. Choquette, J. S. Placyk Jr. and R. J. Brooks. 2013.** Population genetic structure of the endangered Butler's Gartersnake (Thamnophis butleri): does the Short-headed Gartersnake (Thamnophis brachystoma) exist in Canada? Canadian Journal of Zoology, 91(11): 810-819.

† Kominek A, Cornies O, M©Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada – Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries – Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

The following *ex situ* conservation roles were not discussed for Butler's Gartersnake: ark, demographic manipulation, ecological replacement, assisted colonization.

Butler's Gartersnakes exhibit key genetic differences across their range, which is not large in Canada and is being lost. There is some conservation value in roles such as insurance and reintroduction/reinforcement due to declining populations, but wild populations are still relatively large with high genetic diversity and there are many unknowns which reduce feasibility and increase risk, so establishing an *ex situ* population for these roles was not recommended at this time. Further, it was thought that establishing a genetically managed long term breeding population would take space and resources that could be used for species of greater conservation concern. Butler's Gartersnakes are small snakes that are relatively easy to keep and breed in captivity (maintaining an earthworm colony overwinter recommended as commercial source is unreliable and has disease concerns.)

In addition to the biological risks associated with breeding and releasing Butler's Gartersnakes, there are political risks (e.g., the province of Ontario has generally not been supportive of snake reintroduction projects to date), and potential failures could impact future options. The feasibility of reintroduction could be improved through research. Knowledge gaps around releasing animals through reintroduction include survival rates at new locations (i.e., risk is lowered if returned to same site and critical features like hibernacula still present), habitat suitability, restoration techniques (e.g., creating overwintering habitat), release techniques (e.g., hard vs forced hibernation). There have been previous successful emergency salvage-reintroduction projects, but little information has been published or made accessible, therefore there is a need to share information.

In the final summary session rescue was recommended on a case-by-case basis (i.e., short-term holding *ex situ* for release). Rescued snakes should be returned to the same habitat, if possible, and if not, used for reinforcement, and then reintroduction (i.e., essentially wild-to-wild translocation to areas where previously extirpated). It was also agreed to keep a few individuals from rescue to create a small *ex situ* population for research, training, education, if the opportunity arises (e.g., neonates, non-releasable individuals). The possibility of using these animals to develop an insurance population and/or use for reintroduction was discussed but not recommended. Currently, there are many emergency salvages occurring where snakes are moved to suitable habitat a short distance away from disturbance footprint of planned developments and there were concerns expressed that developers may misinterpret a recommendation as permission to destroy habitat.

Recommended Actions

Establish a small *ex situ* population if the opportunity arises (e.g., neonates, non-releasable individuals) for training and education, and research focusing on improving success and minimizing risk of reintroduction.

Table 23. *Ex Situ* Conservation Assessment and Recommendations for Butler's Gartersnake (*Thamnophis butleri*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Moderate	Moderate	Low	Not recommended at this time
Rescue	Critical-High	High-Mod	Divergent	**Recommended** (case by case)
Reintroduction	Moderate	Low, can be improved	High-Mod	Not recommended at this time
Reinforcement	Low	Not assessed	Not assessed	Not recommended at this time

Research	Moderate	Moderate	Low	**Recommended** (case by case)
Training	Low	Mod-Low	Low	**Recommended** (case by case)
Education	Moderate	Moderate	Low-None	**Recommended** (case by case)

EASTERN RIBBONSNAKE (Atlantic)
Thamnophis sauritus (Natricinae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2007)
Canada: **Imperiled** (NatureServe 2016), **Threatened** (COSEWIC/SARA 2012)
Provincial: **Imperiled** (NS; NatureServe 2016)

Evolutionary Distinctiveness†:
Global: 7.079, Canada: 20.902

Canadian Distribution and Population Trend:
Restricted to southwest Nova Scotia (5% of global range); Declining (COSEWIC/SARA 2012)

Wild Population

Small, isolated population susceptible to demographic and environmental fluctuations and threatened by shoreline development. Quantitative data lacking on population size and trends, but continuing decline in overall numbers of mature individuals suspected; surveys suggest that abundance may vary considerably and may not regularly occur at the high densities reported elsewhere. Likely a relict population; geographically distinct and isolated from main range (including Great Lakes population in Canada) with possible genetic differentiation. May display local adaptations and constitute an important evolutionary unit (COSEWIC 2012).

Threats and Limitations

Significant threat of fragmentation, degradation, and loss of wetland and shoreline habitat (including alteration of water level and flow) due to increasing development and other human activities. Susceptible to road mortality, amphibian declines, snake fungal disease, small population effects, and secondary effects of human activities such as predation by pets (e.g., feral and free-ranging pet cats), introduction of exotic predatory fish, persecution, and pollution (CWHC 2017, COSEWIC 2012, Parks Canada 2012, Hammerson 2007).

In situ Conservation Actions

Recovery Team formed in 2003 and several recent studies have been undertaken on seasonal movement patterns, habitat use, microhabitat selection, location of hibernacula, morphology, and behaviour as well as long-term mark-recapture studies at two sites and ongoing outreach and stewardship initiatives. Several occurrences within protected areas, but only a small percentage of overall range. Kejimkujik National Park protects critical habitat and has installed road mitigation, conducts population monitoring and research to address knowledge gaps, and runs projects to prevent the introduction of exotic predatory fish (Parks Canada 2012 & 2017, COSEWIC 2012).

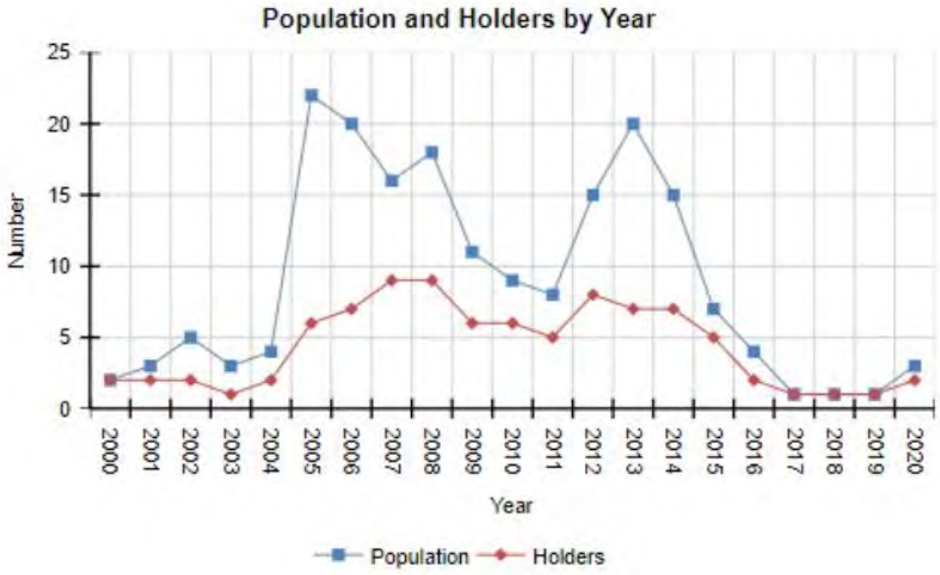
Prior Recommended *Ex situ* Conservation Actions

Recovery objectives include achieving a **self-sustaining population** with 95% probability of persistence across its current range and maintaining or **expanding the current distribution** of occupied wetlands, but better understanding of population dynamics and habitat use is needed and challenges in conducting research on small, cryptic species must be addressed such as **exploring and improving survey, capture, marking, and tracking techniques** (Parks Canada 2012).

Existing *Ex situ* Conservation Actions

None known

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *T. sauritus and T. s. septentrionalis*	19 (4.3.12)	1 (0.1.0)	5 (0.0.5)	25 (4.4.17)
Number of institutions	3	1	1	5
Breeding status	Breeding recorded in captivity (between 2005-2014) including in Canada.			
Living wild-born	2 (0.2.0) confirmed (in Canada and US)			
Generation time (yr)	4-6 (COSEWIC 2012)			
Potential surrogates(s)	*Thamnophis* spp.			
Husbandry notes	Live fish and amphibian feeders, cannot be fed frozen/thawed prey, require Vitamin B1 supplements, viviparous, commonly 9–12 neonates, mainly aquatic			
Historical holdings (2000-2020) * *T. sauritus*				

Resources

Canadian Wildlife Health Cooperative. 2017. Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp**. COSEWIC. 2012.** COSEWIC assessment and status report on the Eastern Ribbonsnake Thamnophis sauritus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 39 pp. **Hammerson, G.A. 2007**. Thamnophis sauritus. The IUCN Red List of Threatened Species 2007: e.T63991A12727431. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63991A12727431.en. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.79.732599/Thamnophis_saurita_pop_3. (Accessed: Oct 14, 2020). **Parks Canada Agency, 2012**. Recovery Strategy for the Eastern Ribbonsnake (Thamnophis sauritus), Atlantic Population in Canada. Species at Risk Act Recovery Strategy Series. Parks Canada Agency, Ottawa. x + 46 pp. **Parks Canada Agency. 2017**. Multi-species Action Plan for Kejimkujik National Park and National Historic Site of Canada. Species at Risk Act Action Plan Series. Parks Canada Agency, Ottawa. v + 28 p

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

The two DUs for Eastern Ribbonsnake were assessed separately and the following *ex situ* conservation roles were not discussed for the Atlantic DU: ark, demographic manipulation, reintroduction, reinforcement, ecological replacement, assisted colonization.

There are few Eastern Ribbonsnakes in captivity, and no Atlantic specimens in the *ex situ* population, so the feasibility of establishing an insurance population is low and the risk of impacting the wild population by bringing animals into captivity is unknown but potentially high given the small size of wild populations. Therefore, an insurance population was not recommended at this time, however, the idea of using gametes or skin biopsies for a biobank were considered as technology is developed and as captive animals are available.

Ribbonsnakes were identified as a good model for researching durable non-invasive marking techniques that are effective on small, slender snakes. They may also be used to train in identification and handling where animals exist in captivity. Community science and stewardship on private, working land is important for this species to increase knowledge of abundance and targeted messaging should be used in training and education. Having a small population of locally sourced stock (e.g., at Nova Scotia Wildlife Park) would be preferred to using Ontario specimens for regional education and training. The cultural value of Elapaqtekjijk (Ribbonsnake) to Mi'kmaq language reclamation and community engagement was noted.

In the final summary session rescue was recommended on a case-by-case basis, as most subpopulations are in protected areas or of substantial size, but some small local populations could be at risk, especially on lakes with heavy cottage development that pose a significant risk to the entire local population.

Recommended Actions

Establish a small *ex situ* population of Eastern Ribbonsnakes from the Atlantic DU for research, training, and education needs.

Table 24. *Ex Situ* Conservation Assessment and Recommendations for Eastern Ribbonsnake (*Thamnophis sauritus*) – Atlantic DU

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Low	Mod-Low	High-Mod	Not recommended at this time
Rescue	Not assessed	Not assessed	Not assessed	**Recommended** (case by case)
Research	Mod-Low	High	Low	**Recommended**
Training	Moderate	High	Low	**Recommended**
Education	High-Mod	High	Low	**Recommended**

EASTERN RIBBONSNAKE (Great Lakes) *Thamnophis sauritus* (Natricinae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2007)
Canada: **Vulnerable** (NatureServe 2016), **Special Concern** (COSEWIC/SARA 2012)
Provincial: Apparently Secure (ON; NatureServe 2016), **Imperiled** (QC; NatureServe 2016)

Evolutionary Distinctiveness†:
Global: 7.079, Canada: 20.902

Canadian Distribution and Population Trend:
Southern Ontario and extreme southern Quebec (5% of global range); Declining (COSEWIC/SARA 2012)

Wild Population

Patchily distributed, but relatively widespread and appear locally abundant at several known wetland sites, contiguous with the US range. Quantitative data lacking on population size and trends, but unless habitat losses are reversed the species is at risk of becoming Threatened (COSEWIC 2012).

Threats and Limitations

Significant threat of fragmentation, degradation, and loss of wetland and shoreline habitat due to increasing development. Susceptible to road mortality, amphibian declines, snake fungal disease and secondary effects of human activities such as predation by pets (e.g., feral and free-ranging pet cats), introduction of exotic predatory fish, persecution, and pollution (CWHC 2017, COSEWIC 2012, Hammerson 2007).

In situ Conservation Actions

Several occurrences within protected areas, but only a small percentage of overall range. Several surveys have occurred mainly within protected areas, several road mortality assessment and mitigation projects have been undertaken, and wetland conservation and education programs are ongoing (Parks Canada 2016, ECCC 2015, COSEWIC 2012)

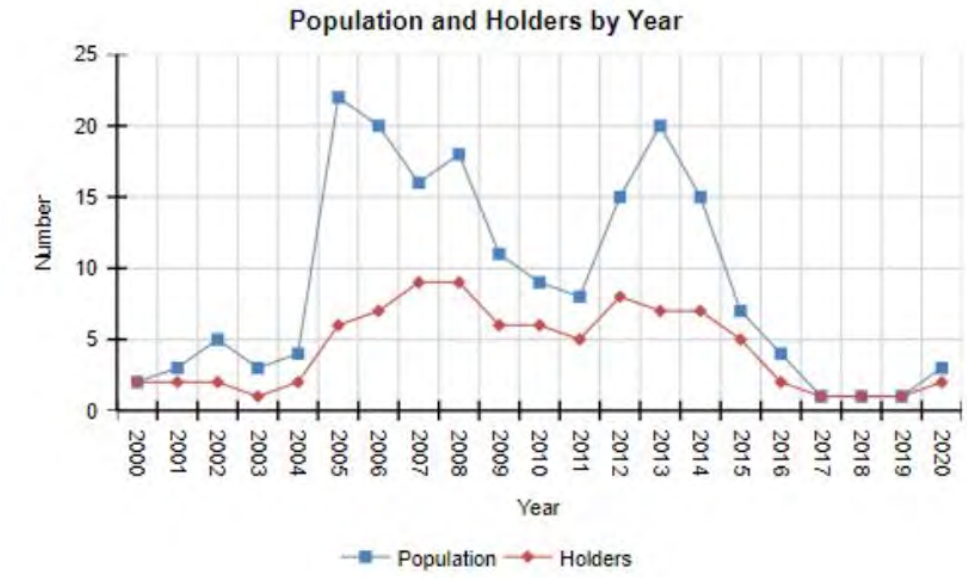
Prior Recommended *Ex situ* Conservation Actions

None known for Great Lakes population

Existing *Ex situ* Conservation Actions

None known

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *T. sauritus and T. s. septentrionalis*	19 (4.3.12)	1 (0.1.0)	5 (0.0.5)	25 (4.4.17)
Number of institutions	3	1	1	5
Breeding status	Breeding recorded in captivity (between 2005-2014) including in Canada.			
Living wild-born	2 (0.2.0) confirmed (in Canada and US)			
Generation time (yr)	4-6 (COSEWIC 2012)			
Potential surrogates(s)	*Thamnophis* spp.			
Husbandry notes	Live fish and amphibian feeders, cannot be fed frozen/thawed prey, require Vitamin B1 supplements, viviparous, commonly 9–12 neonates, mainly aquatic			
Historical holdings (2000-2020) * *T. sauritus*				

Resources

Canadian Wildlife Health Cooperative. 2017. Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp**. COSEWIC. 2012**. COSEWIC assessment and status report on the Eastern Ribbonsnake Thamnophis sauritus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 39 pp. **Environment Canada. 2015**. Management Plan for the Eastern Ribbonsnake (Thamnophis sauritus), Great Lakes population, in Canada. Species at Risk Act Management Plan Series. Environment Canada, Ottawa. iv + 23 pp. **Hammerson, G.A. 2007.** Thamnophis sauritus. The IUCN Red List of Threatened Species 2007: e.T63991A12727431. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63991A12727431.en. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.103516/Thamnophis_saurita. (Accessed: Oct 14, 2020). **Parks Canada Agency. 2016**. Multi-species Action Plan for Bruce Peninsula National Park and Fathom Five National Marine Park of Canada. Species at Risk Act Action Plan Series. Parks Canada Agency, Ottawa. v + 22 pp.

† Kominek A, Cornies O, M°Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

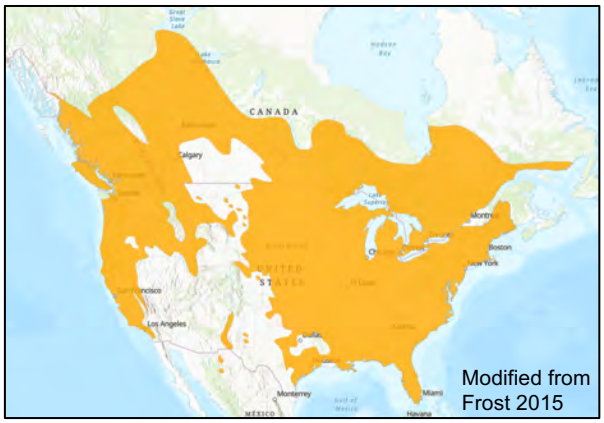
Ex Situ Conservation Assessment
Summary of Discussion
The Great Lakes DU of Eastern Ribbonsnake was not assessed in detail. It was decided that since the DU is widespread and generally stable, the comments and decisions for other not-at-risk Gartersnake species applied. Gartersnakes were noted as being a good model species for general snake training and education.
Recommended Actions
No specific actions recommended.

Table 25. *Ex Situ* Conservation Assessment and Recommendations for Eastern Ribbonsnake (*Thamnophis sauritus*) – GL DU

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Rescue	Not assessed	Not assessed	Not assessed	Not recommended at this time
Research	Not assessed	Not assessed	Not assessed	Not recommended at this time
Training	Not assessed	Not assessed	Not assessed	**Recommended as model**
Education	Not assessed	Not assessed	Not assessed	**Recommended as model**

COMMON GARTERSNAKE
Thamnophis sirtalis (Natricinae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2015)
Canada: Secure (NatureServe 2016), Not Assessed, low priority candidate for assessment (COSEWIC)



Canadian Distribution and Global Population Trend:
The Common Gartersnake is found throughout much of southern Canada and occurs in all provinces and territories except for Newfoundland and Labrador, Yukon and Nunavut territories; Stable (IUCN Red List 2015)

Evolutionary Distinctiveness†:
Global: 9.558, Canada: 20.902

Subspecies

		Distribution	**Provincial Status** (NatureServe 2016)
Valley Gartersnake	*T. s. fitchi*	Central BC	Secure (BC)
Maritime Gartersnake	*T. s. pallidulus*	NB, NS, PEI, QC	Secure (NB, NS, PEI), Unranked (QC)
Red-sided Gartersnake	*T. s. parietalis*	Eastern BC to northwestern ON and southern NWT	Secure (BC, SK), Apparently Secure (AB, MB), **Imperiled** (NWT), Unranked (ON)
Puget Sound Gartersnake	*T. s. pickeringii*	Vancouver Island and southwestern BC	Secure (BC)
Eastern Gartersnake	*T. s. sirtalis*	Eastern MB to western QC	**Vulnerable** (MB), Secure (ON), Unranked (QC)

Wild Population

Most abundant snake in Canada. Large number of occurrences with good viability across North America and no major threats have been identified. Extent of occurrence, area of occupancy, number of subpopulations, and population size probably are relatively stable or declining at a low rate. There are some anecdotal reports of declines in local populations (Frost 2015, BCCDC 2011)

Threats and Limitations

A significant threat to all subspecies is road mortality, especially in parts of southern Canada with high road density and traffic volume. Wetland loss also impacts all subspecies as wetlands can be an important habitat for gartersnakes in general. Capable of persisting in areas with low to moderate human disturbance, however, human persecution and subsidized predation (e.g., feral and free-ranging pet cats) may threaten populations. Snake fungal disease has been reported in Gartersnake species and is a concern, especially in eastern Canada. The Red-sided Gartersnake subspecies may be susceptible to mass mortality events due to flooding or freezing of communal hibernation sites (CHS 2021, CWHC 2017).

In situ Conservation Actions

Recovery actions and research on snake species that occupy similar areas likely benefit Common Gartersnakes. Several studies use the Eastern Gartersnake as a surrogate species to assess intentional hibernation at artificial hibernacula, in preparation for Eastern Massasauga reintroductions. Many occurrences of this species are in areas that afford adequate protection. The Narcisse Wildlife Management Area is an Important Amphibian and Reptile Area that contains a large proportion of Manitoba's Red-sided Gartersnake population and protects hibernacula used by 50 000 snakes and important breeding and foraging habitat. Public viewing of the hibernacula provides opportunities for interpretive and educational programs, but also results in disturbance to snakes. The installation of fences and tunnels along the highway in the WMA reduced snake mortality by ~75% from 2000-2009, although more recently (2017) high amounts of road mortality have been observed likely due to disrepair of the fences (H. McCurdy-Adams, pers. comm. 2021). A Red-sided Gartersnake relocation project was completed in central Alberta. Snakes were relocated to an occupied hibernacula nearby and 30% of the relocated snakes return to the new hibernacula in following years showing that snakes can be relocated to other occupied hibernacula with some success. The project included extensive public education through presentations and fieldtrips. (Frost 2015, Prouten and Rutherford 2010, Takats 2002).

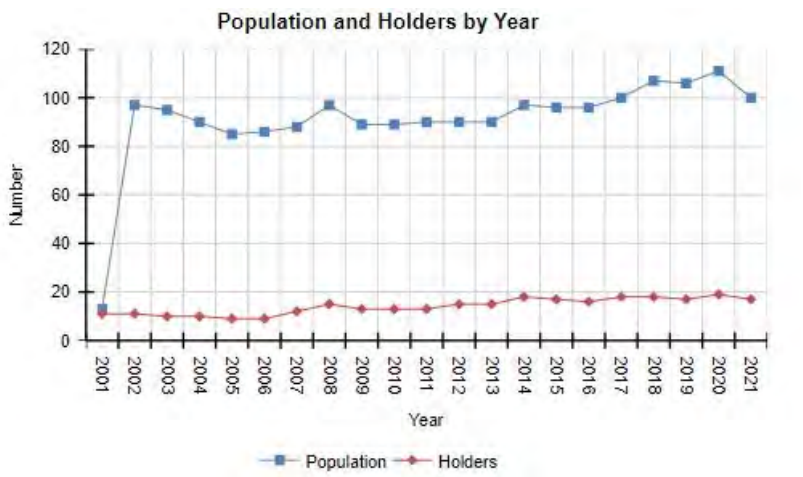
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

None known

Existing *Ex situ* Population

	Species/subspecies	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) **	*T. sirtalis*	25 (9.15.1)	90 (3.3.84)	12 (1.0.11)	127 (13.18.96)
	T. s. fitchi	0	1 (0.0.1)	0	1 (0.0.1)
	T. s. pallidulus	0	0	0	0
	T. s. parietalis	30 (3.4.23)	0	0	30 (3.4.23)
	T. s. pickeringii	0	0	0	0
	T. s. sirtalis	30 (4.6.20)	3 (1.2.0)	0	33 (5.8.0)
Number of institutions	*T. sirtalis*	6	11	4	21
	T. s. fitchi	0	1	0	1
	T. s. pallidulus	0	0	0	0
	T. s. parietalis	4	0	0	4
	T. s. pickeringii	0	0	0	0
	T. s. sirtalis	4	2	0	6
Breeding status	Breeding recorded in captivity (since 2002), including in Canada				
Living wild-born	18 (4.5.9) *T. sirtalis* and *T. sirtalis* ssp. confirmed in captivity in Canada and US, including 2 *T. s. sirtalis* from Windsor				
Generation time	No estimate				
Potential surrogates(s)	*Thamnophis* spp., and other *T. sirtalis* ssp. including San Francisco Gartersnake (*T.s. tetrataenia*)				
Husbandry notes	Viviparous, range of 5-40 neonates, multiple paternity possible, diurnal, varied diet, neonates need to be fed often, long-lived				
Historical global holdings (2001-2021) * *T. sirtalis*					

Ex Situ Conservation Assessment

Summary of Discussion

All not-at-risk gartersnake species (Common, Terrestrial, Plains, and Northwestern) were grouped and assessed together but conservation roles were not assessed in detail.

While no direct *ex situ* conservation roles for gartersnakes were recommended, it was agreed that gartersnakes are good models for conservation education and general training for other snake species as they are ubiquitous in Canada. Training and education were recommended for all gartersnake species but with no specific need or method, and questions were raised about how the public responds to education for common species.

Most captive gartersnakes are in one facility in Canada, so there is a need to have populations elsewhere. It was noted that there would be value for individual organizations to have local species (i.e., area relevant representation), so small local captive populations were recommended that will vary depending on species, opportunity, and messaging. Educational messaging should focus on "keeping common species common" or be targeted to local conservation issues (e.g., road mortality). Gartersnakes should be used as surrogates for at-risk species in both education and training, where they are of more value *ex situ* compared to other species.

Potential research topics that gartersnakes could be useful in examining include design and use of artificial hibernacula (naturally colonize, rescue/relocation, sinks/sources), local adaptation (especially Terrestrial Gartersnakes) and as a model species for hibernation techniques (e.g., Eastern Gartersnake model for Massasauga). The need to publish existing research on these topics was noted.

Recommended Actions

No specific actions recommended. Establishing small, local *ex situ* populations could benefit conservation education depending on opportunity (e.g., availability of non-releasable animals) and need.

Table 26. *Ex Situ* Conservation Assessment and Recommendations for Common Gartersnake (*Thamnophis sirtalis*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Rescue	Not assessed	Not assessed	Not assessed	Not recommended at this time
Research	Not assessed	Not assessed	Not assessed	**Recommended as model**
Training	Not assessed	Not assessed	Not assessed	**Recommended as model**
Education	Not assessed	Not assessed	Not assessed	**Recommended as model**

Resources

B.C. Conservation Data Centre. 2011. Conservation Status Report: Thamnophis sirtalis. B.C. Minist. of Environment. Available: https://a100.gov.bc.ca/pub/eswp/ **Canadian Herpetological Society. 2021**. Species Information. http://canadianherpetology.ca/species/index.html **Canadian Wildlife Health Cooperative. 2017**. Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp. **Frost, D.R., Hammerson, G.A. & Santos-Barrera, G. 2015**. Thamnophis sirtalis. The IUCN Red List of Threatened Species 2015: e.T62240A68308267. https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T62240A68308267.en. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.101158/Thamnophis_sirtalis. (Accessed: Oct 14, 2020). **Prouten B and Rutherford P. 2010**. Important Amphibian and Reptile Area - Narcisse Wildlife Management Area (NWMA). http://canadianherpetology.ca/conservation/doc/narcisse.pdf **Takats L. 2002**. Red-sided Gartersnake relocation and education project final report. Alberta species at risk report No. 30, Alberta Sustainable Resource Development, Edmonton, Alberta. 17pp.

† Kominek A, Cornies O, M©Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

TERRESTRIAL GARTERSNAKE
Thamnophis elegans (Natricinae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2007)
Canada: Secure (NatureServe 2016), Not Assessed, **low priority candidate for assessment** (COSEWIC)
Provincial: Secure (BC; NatureServe 2016), Apparently Secure (SK, AB; NatureServe 2016)

Canadian Distribution and Global Population Trend:
Southern BC and Alberta, southwestern Saskatchewan; Stable (IUCN Red List 2007)

Evolutionary Distinctiveness†:
Global: 5.030, Canada: 16.769

Wild Population

Extent of occurrence, area of occupancy, number of subpopulations, and population size are probably relatively stable. In BC, some anecdotal reports of population fluctuations, however, no temporal trends have been documented in one long term monitoring site in Okanagan Falls but declines were noted at another site in the Chilcotin (BCCDC 2011, Frost 2007).

Threats and Limitations

Road mortality can be a significant threat to populations located near busy roads and road construction can destroy hibernacula. Capable of persisting in areas with low to moderate human disturbance, however, habitat loss (e.g., wetlands), human persecution, and subsidized predation (e.g., feral and free-ranging pet cats) may threaten populations in high density urban areas. Snake fungal disease has been reported in gartersnake species and is a concern (CHS 2021, CWHC 2017, FLNRORD 2014).

In situ Conservation Actions

In 2016, 150 Terrestrial and Common Gartersnakes were salvaged from a hibernaculum destroyed during highway expansion near Williams Lake, BC. An artificial hibernaculum was constructed and fencing was installed to direct snakes away from the road. A few snakes were observed emerging from the artificial hibernacula the following spring; however, ongoing highway construction adjacent to the site has prevented follow-up monitoring (MOE 2020). The Alberta Snake Hibernaculum Inventory asks for voluntary information on the location of snake hibernacula as well as general reptile sightings, including road mortality.

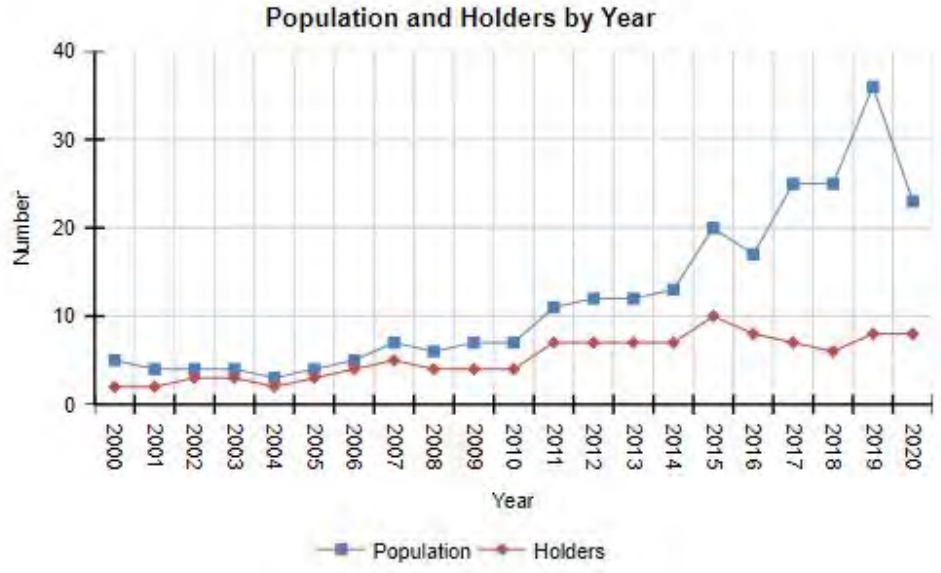
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

None known

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *T. elegans and T. e. vagrans*	3 (0.3.0)	18 (3.1.14)	0	21 (3.4.14)
Number of institutions	3	5	0	8
Breeding status	Breeding recorded in captivity (in 2017)			
Living wild-born	9 (0.1.8) *T. elegans* confirmed in captivity (in Canada and US)			
Generation time (yr)	No estimate			
Potential surrogates(s)	*T. e. elegans, T. e. terrestris*			
Husbandry notes	Viviparous, 4–19 neonates, varied diet, long-lived, diurnal, semi-aquatic			
Historical holdings in North America (2000-2020) * *T. elegans*				

Resources

B.C. Conservation Data Centre. 2011. Conservation Status Report: Thamnophis elegans. B.C. Minist. of Environment. Available: https://a100.gov.bc.ca/pub/eswp/ **Canadian Herpetological Society. 2021**. Species Information. http://canadianherpetology.ca/species/index.html **Canadian Wildlife Health Cooperative. 2017**. Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp. **Frost, D.R., Hammerson, G.A. & Hollingsworth, B. 2007.** Thamnophis elegans. The IUCN Red List of Threatened Species 2007: e.T63976A12732762. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63976A12732762.en. **Government of BC**. Natural Resource Best Management Practices. https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/best-management-practices. **Ministry of Environment and Climate Change Strategy, 2020**. Guidelines for Amphibian and Reptile Conservation during Road Building and Maintenance Activities in British Columbia. Version 1.0. March 30, 2020. **Ministry of Forests, Lands, Natural Resource Operations, and Rural Development, 2014.** Guidelines for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia. 2014 edition. Companion document to Develop with Care. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.102240/Thamnophis_elegans. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

All not-at-risk gartersnake species (Common, Terrestrial, Plains, and Northwestern) were grouped and assessed together but conservation roles were not assessed in detail. See Summary of Discussion for Common Gartersnake.

It was noted that Terrestrial Gartersnakes are not good for handling (prone to biting; potential reactions to mild venom), so other gartersnake species are better as models for education/training. *Ex situ* populations of Terrestrial Gartersnakes (if available) should be used for research on local adaptations as they exhibit a higher degree of local adaptation than other gartersnake species. Some research looking at local adaptation is best done in captivity but *in situ* information is needed before research questions can be identified.

Recommended Actions

No specific actions recommended.

Table 27. *Ex Situ* Conservation Assessment and Recommendations for Terrestrial Gartersnake (*Thamnophis elegans*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Rescue	Not assessed	Not assessed	Not assessed	Not recommended at this time
Research	Not assessed	Not assessed	Not assessed	**Recommended with restrictions**
Training	Not assessed	Not assessed	Not assessed	Not recommended at this time
Education	Not assessed	Not assessed	Not assessed	Not recommended at this time

PLAINS GARTERSNAKE
Thamnophis radix (Natricinae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2007)
Canada: Secure (NatureServe 2016), Not Assessed, **mid priority candidate for assessment** (COSEWIC)
Provincial: Secure (SK; NatureServe 2016), Apparently Secure (AB, MB; NatureServe 2016)

Canadian Distribution and Global Population Trend:
Southern Alberta, Saskatchewan, and Manitoba; Stable (IUCN Red List 2007)

Evolutionary Distinctiveness†:
Global: 3.207, Canada: 15.388

Wild Population

Common but localized. Public perception of long-term declines. Public education combined with protection of key habitats (hibernacula) will benefit this species (Government of Alberta 2017).

Threats and Limitations

Threatened by road mortality, and habitat loss and fragmentation due to increased human development and oil and gas activity. Capable of persisting in areas with low to moderate human disturbance, however, habitat loss (e.g., wetlands), human persecution, and subsidized predation (e.g., feral and free-ranging pet cats) may threaten populations in high density urban areas. Snake fungal disease has been reported in gartersnake species and is a concern, especially in eastern populations (CHS 2021, CWHC 2017, Government of Alberta 2017).

In situ Conservation Actions

The Alberta Snake Hibernaculum Inventory asks for voluntary information on the location of snake hibernacula as well as general reptile sightings, including road mortality. Alberta and Saskatchewan have implemented habitat inventory guidelines, setback distances, and snake protection plan requirements for oil and gas activities.

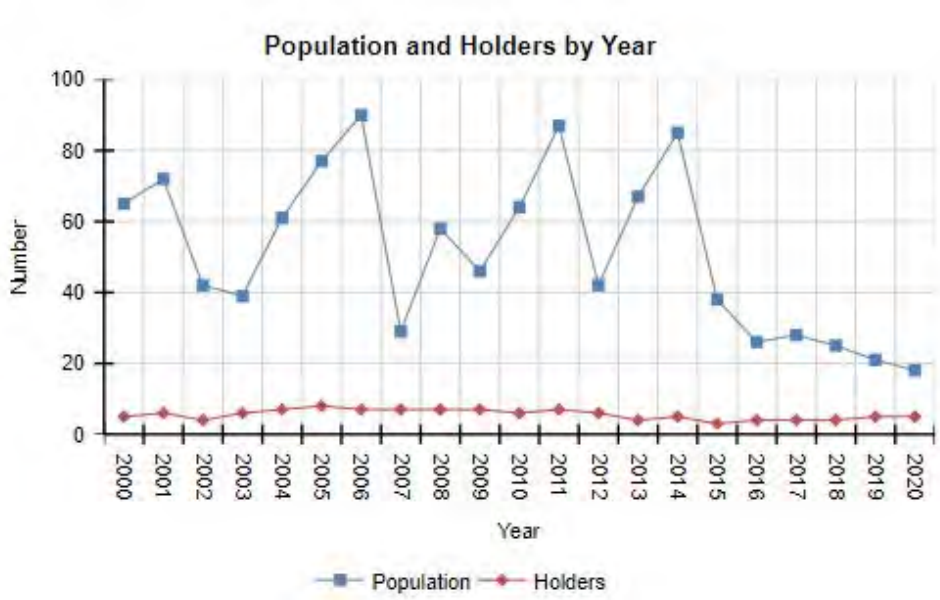
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

In 2015, ~300 Plains Gartersnakes were removed from a farm house near Regina, SK and held over winter at a wildlife rehabilitation centre and Saskatchewan Polytechnic. The college induced hibernation in 99 snakes and monitored them using artifical hibernation chambers in a walk-in fridge. The snakes were released in a nature refuge the following spring.

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *T. radix and T. r. radix*	1 (0.0.1)	16 (7.8.1)	1 (0.1.0)	18 (7.9.2)
Number of institutions	1	3	1	5
Breeding status	Breeding recorded in captivity (since 2000)			
Living wild-born	11 (5.5.1) confirmed in captivity globally			
Generation time (yr)	No estimate			
Potential surrogates(s)	*Thamnophis* spp.			
Husbandry notes	Viviparous, 5-40 neonates, varied diet including minnows and earthworms, semi-aquatic			
Historical holdings in North America (2000-2020) * *T. radix*				

Resources

Canadian Herpetological Society. 2021. Species Information. http://canadianherpetology.ca/species/index.html. **Canadian Wildlife Health Cooperative. 2017.** Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp. **Government of Alberta. 2017**. Alberta Wild Species General Status Listing – 2015. https://open.alberta.ca/publications/alberta-wild-species-general-status-listing-2015. **Government of Alberta, 2020**. Snake protection plan : requirements for all disposition purposes and activities. https://open.alberta.ca/publications/snake-protection-plan-requirements-disposition-purposes-activities. **Hammerson, G.A. 2007.** Thamnophis radix. The IUCN Red List of Threatened Species 2007: e.T63988A12726792. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63988A12726792.en. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.104972/Thamnophis_radix. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, M^{c}Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

All not-at-risk gartersnake species (Common, Terrestrial, Plains, and Northwestern) were grouped and assessed together but conservation roles were not assessed in detail. See Summary of Discussion for Common Gartersnake.

Recommended Actions

No specific actions recommended.

Table 28. *Ex Situ* Conservation Assessment and Recommendations for Plains Gartersnake (*Thamnophis radix*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Rescue	Not assessed	Not assessed	Not assessed	Not recommended at this time
Research	Not assessed	Not assessed	Not assessed	Not recommended at this time
Training	Not assessed	Not assessed	Not assessed	**Recommended as model**
Education	Not assessed	Not assessed	Not assessed	**Recommended as model**

NORTHWESTERN GARTERSNAKE
Thamnophis ordinoides (Natricinae)

SPECIES STATUS

Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2007)
Canada: Apparently Secure (NatureServe 2016), Not at Risk (COSEWIC 2003**; low priority candidate for reassessment**)
Provincial: Apparently Secure (BC; NatureServe 2016)

Evolutionary Distinctiveness†:
Global: 4.498, Canada: 17.911

Canadian Distribution and Population Trend:
Southwestern coast of BC, Vancouver Island, and many Gulf Islands; Stable (COSEWIC 2003)

Wild Population

Limited distribution in Canada and susceptible to several threats but appears to be very common within range and to have suffered declines only in areas of intense urban development (COSEWIC 2003).

Threats and Limitations

Road mortality can be a significant threat to populations located near busy roads. Loss of important wetland habitat can also impact gartersnakes in general. Capable of persisting in areas with low to moderate human disturbance, however, human persecution and subsidized predation (e.g., feral and free-ranging pet cats) may threaten populations. Snake fungal disease has been reported in gartersnake species and is a concern (CHS 2021, CWHC 2017).

In situ Conservation Actions

A series of best management practices in BC provide guidelines for conservation of reptiles during urban and rural development, road building and management activities, and salvages. Some occurrences are likely protected in parks (BCCDC 2011).

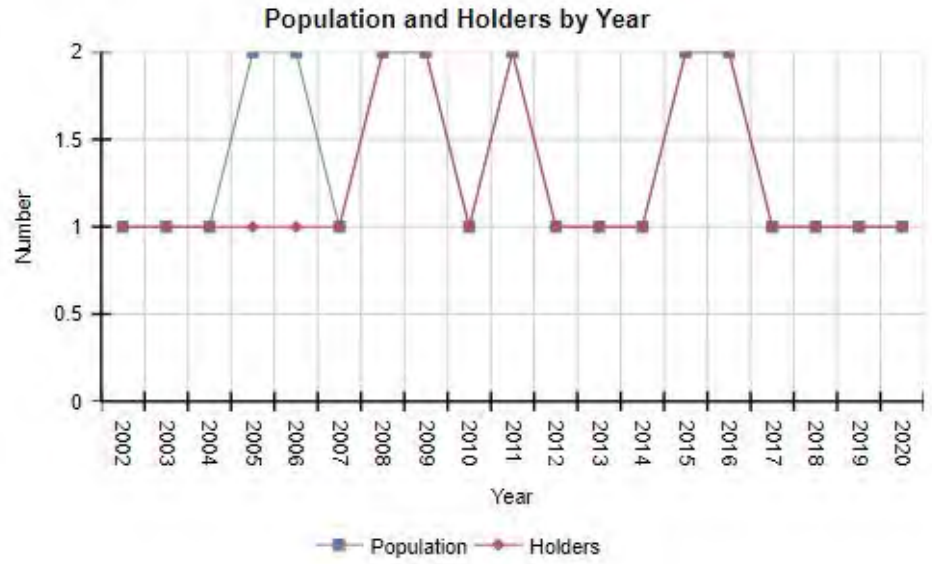
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

None known

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *T. ordinoides*	0	1 (0.0.1)	0	1 (0.0.1)
Number of institutions	0	1	0	1
Breeding status	Breeding recorded in captivity (in 2008).			
Living wild-born	1 (0.0.1) confirmed (in US)			
Generation time (yr)	No estimate			
Potential surrogates(s)	*Thamnophis* spp.			
Husbandry notes	Viviparous, 3–20 neonates, primarily eats slugs and earthworms, long-lived, diurnal			
Historical holdings in North America (2002-2020) * *T. ordinoides*				

Resources

B.C. Conservation Data Centre. 2011. Conservation Status Report: Thamnophis ordinoides. B.C. Minist. of Environment. Available: https://a100.gov.bc.ca/pub/eswp/ **Canadian Herpetological Society. 2021.** Species Information. http://canadianherpetology.ca/species/index.html **Canadian Wildlife Health Cooperative. 2017**. Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp. **Government of BC.** Natural Resource Best Management Practices. https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/best-management-practices **Hammerson, G.A. 2007**. *Thamnophis ordinoides*. The IUCN Red List of Threatened Species 2007: e.T63985A12726329. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63985A12726329.en. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.106394/Thamnophis_ordinoides. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, McCurdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

All not-at-risk gartersnake species (Common, Terrestrial, Plains, and Northwestern) were grouped and assessed together but conservation roles were not assessed in detail. See Summary of Discussion for Common Gartersnake.

Recommended Actions

No specific actions recommended.

Table 29. *Ex Situ* Conservation Assessment and Recommendations for Northwestern Gartersnake (*Thamnophis ordinoides*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Rescue	Not assessed	Not assessed	Not assessed	Not recommended at this time
Research	Not assessed	Not assessed	Not assessed	Not recommended at this time
Training	Not assessed	Not assessed	Not assessed	**Recommended as model**
Education	Not assessed	Not assessed	Not assessed	**Recommended as model**

NORTHERN WATERSNAKE
Nerodia sipedon sipedon (Natricinae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (*Nerodia sipedon*; IUCN Red List 2007)
Canada: Secure (NatureServe 2016), Not at Risk (COSEWIC 2002; **low priority candidate for reassessment**)
Provincial: Secure (ON; NatureServe 2016), **Vulnerable** (QC; NatureServe 2016)

Canadian Distribution and Population Trend:
Widespread in Ontario; extreme southern Quebec; Stable (COSEWIC 2002)

Evolutionary Distinctiveness†:
Global: 5.685, Canada: 23.073

Wild Population
Widespread distribution in Ontario, dense populations, and protected status in several parks and reserves make status relatively secure in Canada, despite declines because of loss of wetland habitat (COSEWIC 2002).

Threats and Limitations
Habitat loss, road mortality, and human persecution are the most significant threats, but the northern watersnake can tolerate a good deal of habitat alteration. Industrial and residential construction and development along waterfronts, as well as water pollution from pesticides and heavy metals, affect both habitat and food sources. Snake fungal disease is also a possible threat for watersnakes (CHS 2021, CWHC 2017, Hammerson 2007, MFFP 2001).

In situ Conservation Actions
The presence of the water snake is being monitored in Quebec (MFFP 2001).

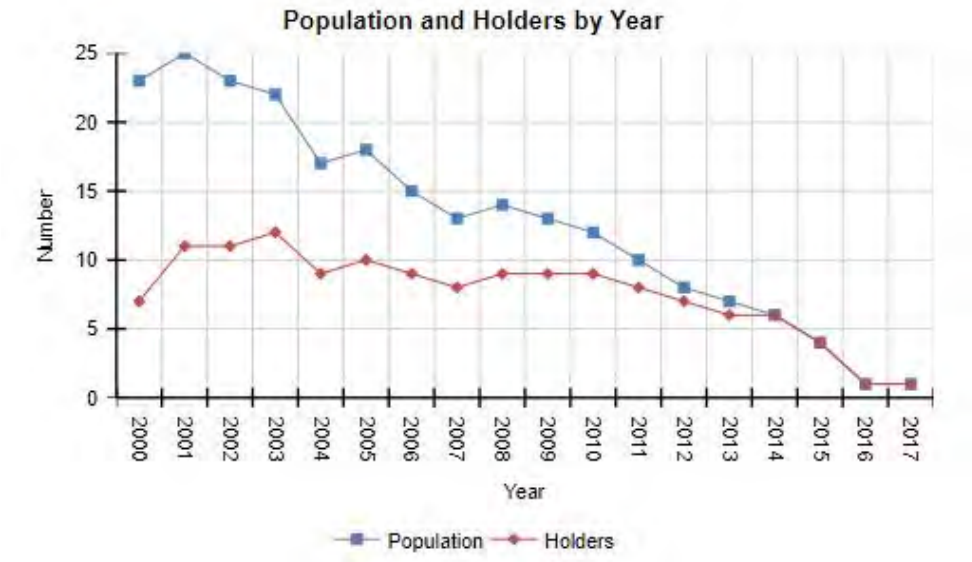
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

Education and snake appreciation programs through zoos and other *ex situ* facilities. Has been used as model for eastern massasaugas in snake hook training programs.

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *N. sipedon and N. s. sipedon*	40 (16.16.8)	34 (1.2.31)	0	74 (17.18.39)
Number of institutions	4	8	0	12
Breeding status	Breeding recorded in captivity in Canada (in 2020)			
Living wild-born	1 (0.1.0) confirmed (in Canada)			
Generation time (yr)	est. 5			
Potential surrogates(s)	Lake Erie Watersnake (*N. s. insularum*), Midland Northern Watersnake (*N. s. pleuralis*)			
Husbandry notes	Viviparous, 13–46 (avg. 27) neonates, semi-aquatic, live fish and amphibian feeders, cannot be fed frozen/thawed prey, require Vitamin B1 supplements, anticoagulant in saliva			
Historical holdings in North America (2000-2017) * *N. s. sipedon*				

Resources

Canadian Wildlife Health Cooperative. 2017. Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp. **Canadian Herpetological Society**. Species Information. http://canadianherpetology.ca/species/index.html [accessed 2021]. **Hammerson, G.A. 2007**. Nerodia sipedon. The IUCN Red List of Threatened Species 2007: e.T62239A12583567. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T62239A12583567.en. **Ministère des Forêts, de la Faune et des Parcs. 2001. Liste** des espèces fauniques menacées ou vulnérables au Québec: Couleuvre d'eau. Gouvernement du Québec. https://mffp.gouv.qc.ca/la-faune/especes/especes-menacees-vulnerables/ **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.102045/Nerodia_sipedon_sipedon. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, McCurdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

The two subspecies of watersnake were discussed together and the conservation roles of research, training, and education were evaluated but not assessed in detail.

Conservation education using animals in current collections was identified as the *ex situ* role with highest conservation value for Northern Watersnake (research and training lower priority), given the critical need to reduce persecution for both subspecies of watersnake. Northern Watersnake was also identified as a good model/surrogate for Lake Erie Watersnake as there are more Northern Watersnakes in captivity, the subspecies is not-at-risk, and the two species are visually identical. No specific research needs were identified for the two subspecies as they have been highly studied in the US.

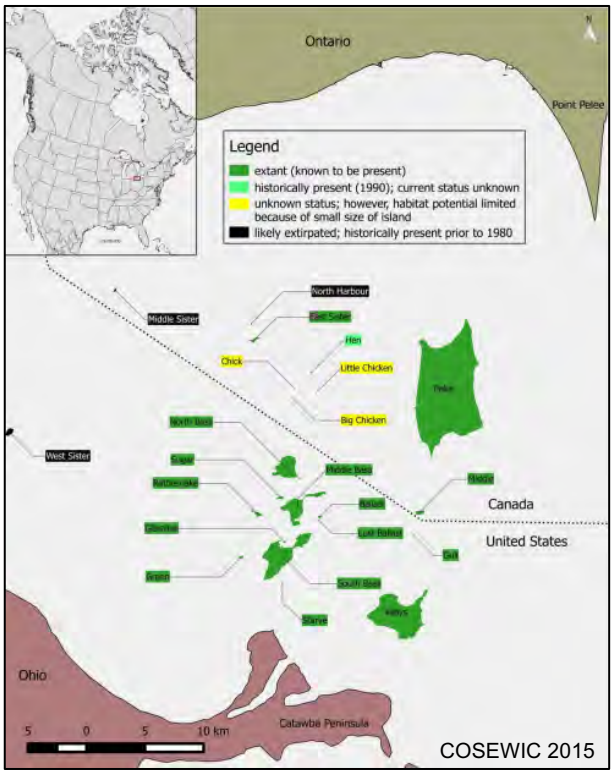
Recommended Actions

No specific actions recommended.

Table 30. *Ex Situ* Conservation Assessment and Recommendations for Northern Watersnake (*Nerodia sipedon sipedon*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Research	Not assessed	Not assessed	Not assessed	**Recommended**
Training	Not assessed	Not assessed	Not assessed	**Recommended**
Education	Not assessed	Not assessed	Not assessed	**Recommended**

LAKE ERIE WATERSNAKE
Nerodia sipedon insularum
(Natricinae)



SPECIES STATUS
Global: **Imperiled** (NatureServe 2016), Least Concern (*Nerodia sipedon*; IUCN Red List 2007)
Canada: **Special Concern** (SARA 2019; COSEWIC 2015), **Imperiled** (NatureServe 2016)
Provincial: **Imperiled** (ON; NatureServe 2016)

Evolutionary Distinctiveness†:
Global: 5.685, Canada: 23.073

Canadian Distribution and Population Trend:
Confined to four small islands in Lake Erie: Pelee, Hen, East Sister, and Middle (38% of global range); Declining (SARA 2019, COSEWIC 2015)

Wild Population

Significant portion of species' global distribution within Canada. Estimate of ~3300 mature individuals on Pelee Island based on habitat suitability assessments and density estimates from US islands. Estimates of <200 individuals on East Sister and Middle islands. Historically present on Hen Island and although the status is unknown it seems likely that the species is still present unless a localized extinction event occurred. Likely extirpated on Middle Sister and North Harbour Islands. Populations decreased in the latter half of the 20th century, but on US islands, subpopulations are increasing (~6%/yr) because of an increased fish prey base (introduced Round Goby) and efforts to reduce persecution. Sufficient data have not been collected to determine whether a similar recovery has occurred in Canadian subpopulations, but the persistence of several threats suggests that populations may still be in decline, particularly on Pelee Island. Populations on the islands of western Lake Erie are separated by water from mainland populations in the US and Canada, however gene flow occurs among islands and between islands and the mainland and there is slight evidence to suggest integration of Northern Watersnakes & Lake Erie Watersnakes (COSEWIC 2015).

Threats and Limitations

The most significant threats to the largest subpopulation on Pelee Island are human-induced mortality on roads or through persecution and the reduction of habitat quantity and quality through shoreline development and invasive species. Additional threats include environmental contamination and elevated levels of predation. The small subpopulations on the three other islands are vulnerable to demographic stochasticity and have increased susceptibility to perturbations. Snake fungal disease is also a possible threat for watersnakes. Therefore, it is possible that the Canadian population is still declining, despite the potential positive influence of an increased food source (ECCC 2020, CWHC 2017, COSEWIC 2015).

In situ Conservation Actions

Middle & East Sister islands are protected parks. Mark-recapture population surveys have been conducted on East Sister & Middle Islands and to a limited degree on Pelee Island. Efforts in the last 10 years have been limited to incidental observations during other monitoring programs by Parks Canada or MNDMNRF on Middle Island, East Sister Island Provincial Nature Reserve and Lighthouse Point & Fish Point Provincial Nature Reserves on Pelee Island. Point Pelee National Park provides education & outreach to promote stewardship, protection, and conservation. Reduced speed limits, invasive species management efforts and habitat creation are occurring on Pelee Island. Private landowners may enter into conservation easements or may be eligible for tax incentives (ECCC 2020, Parks Canada 2016, COSEWIC 2015).

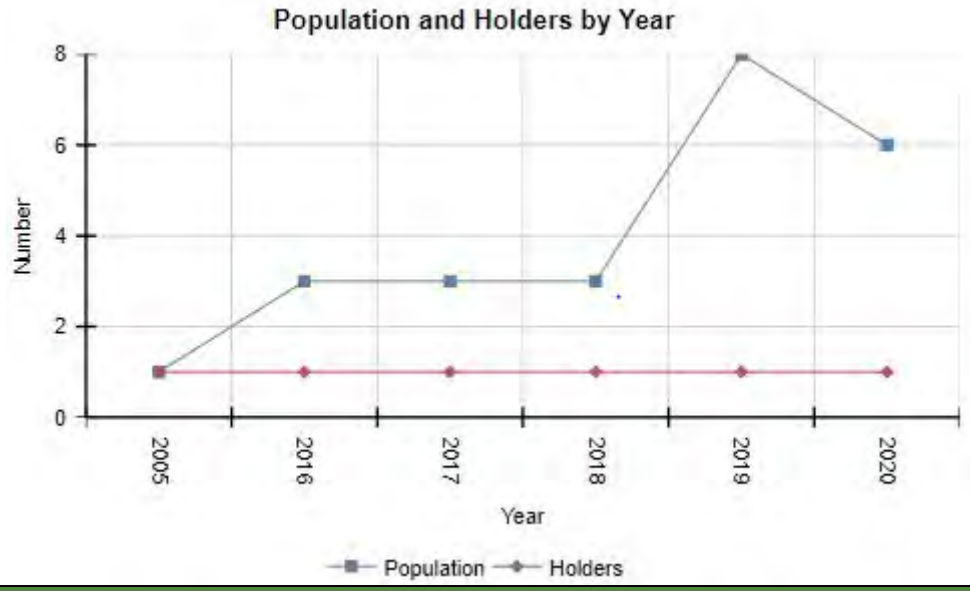
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

None known

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *N. s. insularum*	0	6 (0.1.5)	0	6 (0.1.5)
Number of institutions	0	1	0	1
Breeding status	Breeding recorded in captivity (in 2019).			
Living wild-born	1 (0.1.0) confirmed (in US)			
Generation time (yr)	6 (COSEWIC 2015)			
Potential surrogates(s)	Northern Watersnake (*N. sipedon*), Midland Northern Watersnake (*N. s. pleuralis*)			
Husbandry notes	Viviparous, 13–46 (avg. 27) neonates, semi-aquatic, piscivorous, anticoagulant in saliva			
Historical holdings in North America (2005-2020) * *N. s. insularum*				

Resources

Canadian Wildlife Health Cooperative. 2017. Snake Fungal Disease in Canada Rapid Threat Assessment. Prepared for Environment and Climate Change Canada. 45pp. **COSEWIC. 2015.** COSEWIC assessment and status report on the Lake Erie Watersnake Nerodia sipedon insularum in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 37 pp. **Environment and Climate Change Canada. 2020**. Management Plan for the Lake Erie Watersnake (Nerodia sipedon insularum) in Canada. Species at Risk Act Management Plan Series. Environment and Climate Change Canada, Ottawa. 2 parts, 28 pp. + 20 pp. **Ministry of Northern Development, Mines, Natural Resources & Forestry. 2016**. Best Management Practices for Mitigating the Effects of Roads on Amphibians and Reptile Species at Risk in Ontario. Queen's Printer for Ontario. 112 pp. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.105775/Nerodia_sipedon_insularum. (Accessed: Oct 14, 2020). **Parks Canada Agency. 2016.** Multi-species Action Plan for Point Pelee National Park of Canada and Niagara National Historic Sites of Canada. Species at Risk Act Action Plan Series. Parks Canada Agency, Ottawa. iv + 39 pp

† Kominek A, Cornies O, M©Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

The two subspecies of watersnake were discussed together and the conservation roles of research, training, and education were evaluated but not assessed in detail. See Summary of Discussion for Northern Watersnake.

The Lake Erie Watersnake is considered at risk due to limited distribution but is generally stable and there are few in captivity. Education is important for this species as they are highly persecuted. Northern Watersnakes can serve as an educational model for both subspecies to provide conservation messaging to try and mitigate this threat.

In the final summary session, rescue was briefly discussed but not recommended for the Lake Erie Watersnake as there is minimal threat from development across the species range (primarily Pelee Island).

Recommended Actions

No specific actions recommended.

Table 31. *Ex Situ* Conservation Assessment and Recommendations for Lake Erie Watersnake (*Nerodia sipedon insularum*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Research	Not assessed	Not assessed	Not assessed	Not recommended at this time
Training	Not assessed	Not assessed	Not assessed	Not recommended at this time
Education	Not assessed	Not assessed	Not assessed	Not recommended at this time

DeKay's Brownsnake
Storeria dekayi (Natricinae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2012)
Canada: Secure (NatureServe 2016), Not at Risk, **low priority candidate for assessment** (COSEWIC 2002)
Provincial: **Imperiled** (QC; NatureServe 2016), Secure (ON: NatureServe 2016)

Canadian Distribution and Global Population Trend:
Southern Ontario and greater Montreal area in Quebec; Stable (IUCN Red List 2012)

Evolutionary Distinctiveness†:
Global: 9.806, Canada: 22.838

Wild Population

Relatively common and widespread within its Canadian range, although little information on its abundance is available. Limited research has been conducted on the biology of this species in Canada due to difficulties in studying this small, secretive, and fossorial snake. It is also difficult to get accurate estimates of population sizes and fluctuations. Despite these problems, and even though habitat has been lost due to expanding urban areas, this species is not believed to be at risk in Canada. The Quebec population, however, is located in an area of extremely high urban density and many historically occupied sites have disappeared. The distribution in Quebec is restricted and discontinuous and known populations are almost all isolated from each other with low densities (Pouliot 2008, COSEWIC 2002, CHS).

Threats and Limitations

This species is fairly tolerant of human disturbances to the landscape and is often found in urban areas. Because of this, however, the species is particularly susceptible to habitat loss and fragmentation due to increasing urban sprawl, especially in high density areas. In Quebec, there are documented cases of habitat modification and destruction, including of known hibernacula. Subsidized predation (e.g., racoons, feral and free-ranging pet cats), road mortality, collection, pesticides, and snake fungal disease are potentially detrimental to the species. Limited by low mobility, prey availability, abundance of cover and presence of suitable hibernacula. The species is susceptible to high over winter mortality and shows high hibernation site fidelity. Small, isolated populations increase vulnerability to disturbance (Pouliot 2008, CHS).

In situ Conservation Actions

In some cases, in Quebec, individuals from sites with potential urbanization have been relocated to protected sites. As part of Québec's Brown Snake Conservation Plan developed by Zoo Ecomusem, seven protected areas were designated between 2016 and 2018 to conserve habitat. Zoo Ecomusem monitors the sites annually, and has enhanced and created habitat, and petitions local governments to include habitat protection in urban development and management plans. Snake fungal disease surveillance program around Montreal established by Zoo Ecomuseum, ECCC, and University of Illinois.

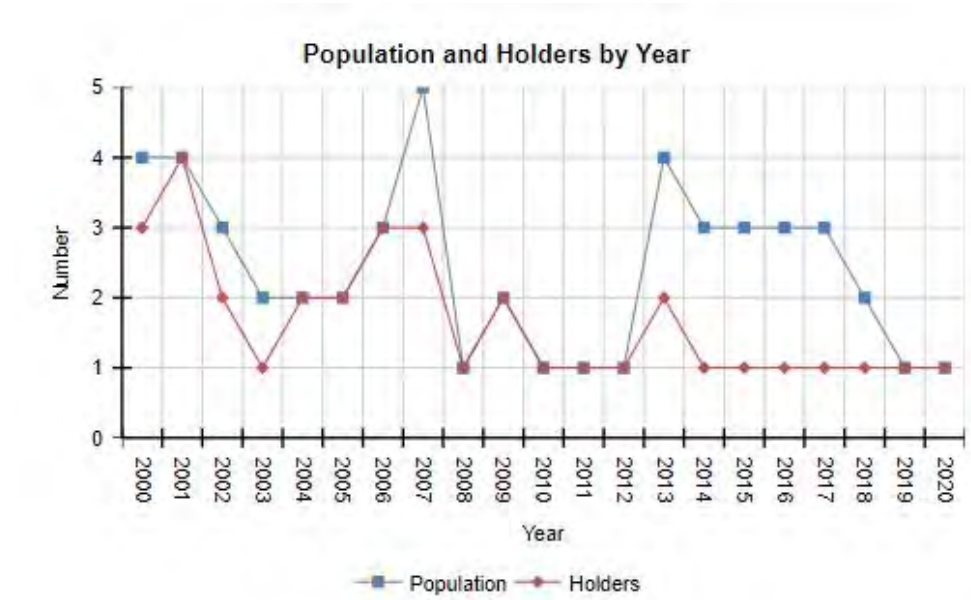
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

Education and snake appreciation programs through zoos and other *ex situ* facilities

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *S. dekayi and S. d. dekayi*	1 (1.0.0)	1 (0.0.1)	0	2 (1.0.1)
Number of institutions	1	1	0	2
Breeding status	Breeding recorded in captivity (in 2007 & 2009). None documented in Canada.			
Living wild-born	1 (0.0.1) confirmed (in US)			
Generation time (yr)	est. 5			
Potential surrogates(s)	None known			
Husbandry notes	Viviparous, 3-31 neonates, primarily nocturnal, requires well balanced captive diet			
Historical holdings in North America (2000-2020) * *S. dekayi*				

Resources

Canadian Herpetological Society. Species Information. http://canadianherpetology.ca/species/index.html [accessed 2021]. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.893278/Storeria_dekayi. (Accessed: Oct 14, 2020). **Pouliot, D. 2008.** Rapport sur la situation de la couleuvre brune (Storeria dekayi) au Québec. Ministère des Ressources naturelles et de la Faune du Québec, Faune Québec, 26 p. **Zoo Ecomuseum**. https://zooecomuseum.ca/en/protecting-the-brown-snake/

† Kominek A, Cornies O, McCurdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

The DeKay's Brownsnake and Red-bellied Snake were discussed together but not assessed in detail as neither is at risk and there are none or very few in captivity. Initially a blanket statement was made that there were no *ex situ* roles recommended for either species; however, it was later decided that there may be some value in having a few animals for local education and training as the snakes are appealing (model for all snakes), especially in urban areas where they are one of the only snake species that occur. No formal recommendation was made to develop education and training programs, but if animals were brought into captivity for other reasons (e.g., rehabilitated animals) there would be value for those roles.

Recommended Actions

No specific actions recommended.

Table 32. *Ex Situ* Conservation Assessment and Recommendations for DeKay's Brownsnake (*Storeria dekayi*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Training	Not assessed	Not assessed	Not assessed	**Recommended with restrictions**
Education	Not assessed	Not assessed	Not assessed	**Recommended with restrictions**

RED-BELLIED SNAKE
Storeria occipitomaculata (Natricinae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2007)
Canada: Secure (NatureServe 2016), Not Assessed, **low priority candidate for assessment** (COSEWIC)
Provincial: Secure (ON, NB, NS, QC), Apparently Secure (PEI), **Vulnerable** (SK, MB) (NatureServe 2016)

Canadian Distribution and Global Population Trend:
Southeastern Saskatchewan, southern Manitoba, break in range north of Lake Superior, southern Ontario, southern Quebec, New Brunswick, Nova Scotia, PEI; Stable (IUCN Red List 2007)

Evolutionary Distinctiveness†:
Global: 8.742, Canada: 22.838

Wild Population
Locally common in many parts of widespread range, although secretive and sometimes hard to detect. The extent of occurrence, area of occupancy, number of subpopulations, and population size are probably relatively stable or declining at a low rate (Hammerson 2007).

Threats and Limitations
No major threats identified. Threats include predation by larger snakes, raccoons and pets (e.g., feral and free-ranging pet cats), habitat loss, and road mortality. Fairly tolerant of some disturbance and alteration to habitat (Hammerson 2007, CHS)

In situ Conservation Actions
None specific to Red-bellied Snake known.

Prior Recommended *Ex situ* Conservation Actions
None known

Existing *Ex situ* Conservation Actions
None known

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *S. occipitomaculata*	0	0	0	0
Number of institutions	0	0	0	0
Breeding status	None documented in captivity			
Living wild-born	0			
Generation time (yr)	No estimate			
Potential surrogates(s)	None known			
Husbandry notes	Viviparous, 4–14 neonates, nocturnal, eat invertebrates			
Historical holdings *	None known for *S. occipitomaculata*			

Ex Situ Conservation Assessment

Summary of Discussion

The Red-bellied Snake and DeKay's Brownsnake were discussed together but not assessed in detail as neither is at risk and there are none or very few in captivity. Initially a blanket statement was made that there were no *ex situ* roles recommended for either species; however, it was later decided that there may be some value in having a few animals for local education and training as the snakes are appealing (model for all snakes), especially in urban areas where they are one of the only snake species that occur. No formal recommendation was made to develop education and training programs, but if animals were brought into captivity for other reasons (e.g., rehabilitated animals) there would be value for those roles.

Recommended Actions

No specific actions recommended.

Table 33. *Ex Situ* Conservation Assessment and Recommendations for Red-bellied Snake (*Storeria occipitomaculata*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Training	Not assessed	Not assessed	Not assessed	**Recommended with restrictions**
Education	Not assessed	Not assessed	Not assessed	**Recommended with restrictions**

Resources

Canadian Herpetological Society. Species Information. http://canadianherpetology.ca/species/index.html [accessed 2021]. **Hammerson, G.A. 2007.** Storeria occipitomaculata. The IUCN Red List of Threatened Species 2007: e.T63930A12729296. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63930A12729296.en. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.102128/Storeria_occipitomaculata. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, McCurdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Species-Specific Status and Recommendations

Colubridae

Dipsadinae

Photo: Eastern Hog-nosed Snake (*Heterodon platirhinos*), Nick Cairns

SHARP-TAILED SNAKE
Contia tenuis (Dipsadinae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2016)
Canada: **Critically Imperiled** (NatureServe 2016), **Endangered** (COSEWIC/SARA 2009)
Provincial: **Critically Imperiled** (BC; NatureServe 2016)

Next COSEWIC status assessment:
November 2021 (proposed split into 2 Designatable Units: Coast Mountains and Pacific Coast)

Canadian Distribution and Population Trend:
Extreme southeastern Vancouver Island and four southern Gulf Islands of British Columbia (Pacific Coast) and coast/interior transition zone on mainland BC (Coast Mountains) (5-10% of global range); Declining (COSEWIC/SARA 2009)

Evolutionary Distinctiveness†:
Global: 13.758, Canada: 36.922

Wild Population

Confined to 17 small, isolated populations (13 to 80 individuals) most of which are threatened by development and may not be viable (at least 3 populations are considered historical). Although recent efforts have detected previously unknown populations, overall population is likely declining. Contributes significantly to the biodiversity of coastal British Columbia, as one of only four species of native snake in the region and a member of a ditypic genus (ECCC 2020, COSEWIC 2009).

Threats and Limitations

High overall threat level in BC with the main threats consisting of habitat loss, degradation, and fragmentation due to expanding rural or urban development, and associated roads. Snakes within developed areas are vulnerable to habitat fragmentation, road mortality, and loss of key habitat features, including thermoregulation and egg-laying sites which are likely already limited on the landscape. Other threats include predation or competition with introduced wildlife and pets, invasive plants, pesticides, mortality from landscaping, off-trail recreation, logging, and stochastic effects on small populations. Limited by specific habitat requirements and isolation due to natural barriers and anthropogenic habitat fragmentation that prevents dispersal between populations. Knowledge gaps include habitat requirements, demographic trends and population ecology, life history, genetic population structure and relatedness, and threat clarification (ECCC 2020, COSEWIC 2009).

In situ Conservation Actions

Many occurrences within species' range are in protected areas (Hammerson 2019), however, in BC most of the range is on private land. Existing intensive outreach and stewardship program targets landowners and residents. Development permit areas, conservation covenants, and stewardship agreements applied, when possible, on private land. Invasive plant control and habitat restoration at several sites. Habitat assessments and surveys of known locations and suitable habitat ongoing since 1996, intensive monitoring of populations through capture-recapture methods has been carried out at three sites, and ongoing research to address knowledge gaps being conducted (ECCC 2020, COSEWIC 2009).

Prior Recommended *Ex situ* Conservation Actions

None known. The recovery goal is to ensure that populations are stable or increasing in abundance and are well distributed across the species' natural range in British Columbia predominantly through protection and enhancement of habitat and connectivity (ECCC 2020).

Existing *Ex situ* Conservation Actions

None known

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *C. tenuis*	0	0	0	0
Number of institutions	0	0	0	0
Breeding status	None documented in captivity			
Living wild-born	0			
Generation time (yr)	16-21 (COSEWIC 2009)			
Potential surrogates(s)	None known			
Husbandry notes	Semi-fossorial, require cover objects, associated with cool, moist conditions, oviparous, 3-5 eggs, primarily eat slugs			
Historical holdings in North America*	None known for *C. tenuis*			

Resources

COSEWIC. 2009. COSEWIC assessment and status report on the Sharp-tailed Snake Contia tenuis in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 38 pp. **B.C. Ministry of Environment. 2015.** Recovery plan for the Sharp-tailed Snake (Contia tenuis) in British Columbia. Prepared for the B.C. Ministry of Environment, Victoria, BC. 42 pp. **Environment and Climate Change Canada. 2020**. Recovery Strategy for the Sharp-tailed Snake (Contia tenuis) in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. 2 parts, 17 pp. + 42 pp. **Hammerson, G.A. 2019**. Contia tenuis. The IUCN Red List of Threatened Species 2019: e.T90066866A90067130. https://dx.doi.org/10.2305/IUCN.UK.2019-.RLTS.T90066866A90067130.en. Downloaded on 03 February 2021. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.843987/Contia_tenuis. (Accessed: Oct 14, 2020). **Parks Canada Agency. 2018.** Multi-species Action Plan for Gulf Islands National Park Reserve of Canada. Species at Risk Act Action Plan Series. Parks Canada Agency, Ottawa. v + 27 pp.

† Kominek A, Cornies O, McCurdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

Upcoming COSEWIC review proposes to separate the species into two DUs: Pacific Coast (Vancouver Island and Gulf Islands) and Coast Mountains (Pemberton). Sharp-tailed Snake was evaluated as one DU in the workshop per the current COSEWIC designation, but it was noted in discussion that there is higher potential for *ex situ* conservation roles for the Coast Mountains DU. Limited abundance and fragmented *in situ* populations of Sharp-tailed Snakes coupled with their cryptic nature and husbandry difficulties (e.g., specialist diet) created feasibility and risk concerns for any *ex situ* management. No *ex situ* conservation roles were recommended for the species at this time.

Knowledge gaps include husbandry (how to keep in captivity, possible alternative food sources), life history, and wild population distribution and abundance. It was acknowledged that a first step to any *ex situ* work would be a trial experiment to test possible alternative food sources (e.g., shelled snails, worms) with a few individuals at a local facility (i.e., in B.C.), if there is opportunity and provided an appropriate source of food can be accessed. The risk of collection to the wild population was raised. It was recommended that animals collected in salvage operations should be used for wild-to-wild translocations for reintroductions or reinforcement (e.g., move from development areas on private land to suitable habitat on public lands) versus taking into captivity. While there is enough available habitat and rescue was not recommended at this time, most of the known populations on the mainland (Coast Mountains DU) are on private lands which poses a potentially serious difficulty for protection and access given the rate of development in the Pemberton area (e.g., a number of hibernacula have already been destroyed). As such, there is some value in conservation education; however, as there are currently no snakes in captivity the existing conservation program that uses pictures and other educational tools is the best option at this time.

Recommended Actions

None recommended at this time.

Table 34. *Ex Situ* Conservation Assessment and Recommendations for Sharp-tailed Snake (*Contia tenuis*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Mod-Low	Low, difficult to improve	High	Not recommended at this time
Rescue	Mod-Low	Low, can be improved	High-Mod	Not recommended at this time
Demographic Manipulation	Low	Low, can be improved	High	Not recommended at this time
Reintroduction	Low	Low, can be improved	High	Not recommended at this time
Reinforcement	Low	Low, can be improved	High	Not recommended at this time
Research	Moderate	Low, can be improved	High-Mod	Not recommended at this time
Training	Low	Low, difficult to improve	Low	Not recommended at this time
Education	Mod-Low	Low, can be improved	Low	Not recommended at this time

DESERT NIGHTSNAKE
Hypsiglena chlorophaea
(Dipsadinae)


S Winton

ECCC 2019

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (*Hypsiglena chlorophaea*; IUCN Red List 2016)
Canada: **Imperilled** (NatureServe 2016), **Endangered** (COSEWIC/SARA 2011)
Provincial: **Imperiled** (BC; NatureServe 2016)

Canadian Distribution and Population Trend:
South Okanagan and Lower Similkameen Valleys in British Columbia (<1% of global range); Declining (COSEWIC 2011)

Evolutionary Distinctiveness†:
Global: 6.716, Canada: 43.151

Wild Population
Patchily distributed and occurs at low density with only ~70 records in BC from 1980-2015, suggesting total population is very small. Occurrences are severely fragmented with natural and human barriers to dispersal. Viability of subpopulations unknown, but probably declining based on extensive habitat loss and degradation. Scattered distribution pattern, small population size, and no possibility of rescue contribute to the vulnerability of the species in Canada and place it at imminent risk of extirpation (ECCC 2019, COSEWIC 2011).

Threats and Limitations
Habitat loss and degradation due to expanding urban and agricultural (e.g. vineyards) development in valley bottoms as well as road mortality are primary threats. Other threats include non-native species, talus quarries, and fire supression. Limited by relatively low dispersal ability, low reproductive rate, and specific habitat requirements (ECCC 2019, COSEWIC 2011).

In situ Conservation Actions
Several targeted surveys conducted in last 15 years and opportunistic inventory ongoing. Increases in habitat protection and management efforts have occurred recently, however, more than half of known sites and potentially suitable habitat remain unprotected. The South Okanagan-Similkameen biodiversity conservation strategy and specific guidelines for amphibians and reptiles during road building and urban and rural development in BC promote development away from potential hibernation/denning sites and south-facing rock outcrops. Ongoing outreach and communication to reduce mortalities and obtain sightings (Southern Interior Snake Recovery Team 2020, ECCC 2019, COSEWIC 2011)

Prior Recommended *Ex situ* Conservation Actions

The recovery goal is to maintain or **increase abundance** but more information about population sizes, trends, and threat mitigation opportunities is needed to quantify an appropriate long-term recovery goal.

Existing *Ex situ* Conservation Actions

None known in Canada

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *H. torquata*	0	8 (3.2.3)	0	8 (3.2.3)
Number of institutions	0	2	0	2
Breeding status	None documented in captivity			
Living wild-born	None confirmed			
Generation time (yr)	Unknown; possibly about 5 years (COSEWIC 2011)			
Potential surrogates(s)	None known			
Husbandry notes	Oviparous, avg. 4 eggs, triennial reproductive cycle, nocturnal, require diurnal cover, mildy venemous (not harmful to humans), mainly eat lizards and lizard eggs, and occasionally frogs, other snakes, and insects			
Historical holdings *	None known for *H. t. deserticola*			

Resources

COSEWIC. 2011. COSEWIC status appraisal summary on the Desert Nightsnake Hypsiglena chlorophaea in Canada. Committee on the status of endangered wildlife in Canada. Ottawa. xii pp. **Environment and Climate Change Canada. 2019**. Recovery Strategy for the Western Rattlesnake (Crotalus oreganus), the Great Basin Gophersnake (Pituophis catenifer deserticola) and the Desert Nightsnake (Hypsiglena chlorophaea) in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. Part 1, 28 pp., Part 2, A. 37 pp., B. 36 pp., C. 28 pp. **Ministry of Environment and Climate Change Strategy, 2020.** Guidelines for Amphibian and Reptile Conservation during Road Building and Maintenance Activities in British Columbia. Version 1.0., March 30, 2020. **Ministry of Forests, Lands, Natural Resource Operations, and Rural Development, 2014.** Guidelines for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia. 2014 edition. Companion document to Develop with Care. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.817007/Hypsiglena_chlorophaea. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, M[c]Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

Limited abundance, low density, and fragmentation of *in situ* populations of Desert Nightsnakes coupled with their cryptic nature and unknowns around population demographics and husbandry created feasibility and risk concerns for any *ex situ* management. No *ex situ* conservation roles requiring population management were considered of high conservation value and only research, training, and conservation education were recommended for the species at this time. Assisted colonization was discussed and evaluated for this species given the potential for increased habitat and range in Canada based on climate change projections.

The risk of collection to the wild population was raised and it was noted that there is a limited number of snakes in captivity with the US being the only captive source (e.g., Arizona). However, there is potentially high genetic similarity to the US population and a potential pilot research program to determine the feasibility of establishing a future *ex situ* population in Canada was suggested as a first step using animals obtained from the US. Opportunistic and local training and education (e.g., to promote community science, and address persecution by teaching differences from Western Rattlesnakes) were recommended to increase observations and knowledge of snakes in the wild.

Recommended Actions

Pilot program in interior BC, using animals sourced from the US, to develop husbandry methods and meet program needs for training and education.

Table 35. *Ex Situ* Conservation Assessment and Recommendations for Desert Nightsnake (*Hypsiglena chlorophaea*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Low	Mod-Low	Moderate	Not recommended at this time
Rescue	Low	Moderate	Moderate	Not recommended at this time
Demographic Manipulation	Low	Moderate	Moderate	Not recommended at this time
Reintroduction	Low	Moderate	Moderate	Not recommended at this time
Reinforcement	Low	Moderate	Moderate	Not recommended at this time
Assisted Colonization	Low	Low, can be improved	High	Not recommended at this time
Research	Moderate	Low, can be improved	Moderate	**Recommended with restrictions**
Training	Mod-Low	Mod-Low	Low	**Recommended with restrictions**
Education	Moderate	Mod-Low	Low	**Recommended with restrictions**

EASTERN HOG-NOSED SNAKE
Heterodon platirhinos (Dipsadinae)

SPECIES STATUS
Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2007)
Canada: **Vulnerable** (NatureServe 2016), **Threatened** (COSEWIC/SARA 2007)
Provincial: **Vulnerable** (ON; NatureServe 2016)

Next COSEWIC status assessment:
April 2021 (report in revision)

Canadian Distribution and Population Trend:
Southern and south-central Ontario: Carolinian and Great Lakes/St. Lawrence regions (<10% of global range); Declining (COSEWIC/SARA 2007)

Evolutionary Distinctiveness†:
Global: 12.576, Canada: 30.028

Wild Population

Available data indicates a decline in population based on decreases in available habitat and disappearance or drastic decline of populations in several areas (43% of occurrences ranked as extirpated or historical). The continuing decline in available habitat, increase in roads and traffic, and ongoing human persecution will result in a continuing decline. Estimated ~7500 mature individuals. Found in low densities and although highly vagile, many populations in Ontario are spatially isolated and small, and separated from US populations by the Great Lakes (COSEWIC 2007).

Threats and Limitations

Primary threats are increased mortality and severe habitat fragmentation caused by expanding road network and increased traffic, and extensive habitat loss from farming, urban sprawl, and beach/water-related recreation. Additional threats include persecution by humans, collection for the pet trade, and contaminants. Limiting factors include availability of suitable habitat, especially well-drained, sandy soils necessary for oviposition and hibernacula, and the availability of prey (toad specialists). The high mobility of this species increases its susceptibility to road mortality and effects of habitat fragmentation (COSEWIC 2007).

In situ Conservation Actions

Some known populations are in protected areas (<5% of distribution), however, are still susceptible to mortality from roads or human persecution in these areas. Surveys and population monitoring have been conducted at several sites. A long-term mark-recapture study is ongoing at one site and a radio telemetry study was conducted to assess the effects of highway construction on movement patterns. Georgian Bay Biosphere Reserve developed a best management practice, conducted road mortality surveys and installed signage, and conducted outreach and awareness workshops. Wasaga Beach Eastern Hog-nosed Snake Research Program conducts research on demographics, movements and habitat use and undertakes education and awareness programs. Other outreach and awareness projects are undertaken by parks, conservation organizations, and zoos, and creating and monitoring Carolinian reptile habitat is occurring. Best Management Practices for mitigating effects of roads on reptiles have been created (MNDMNRF 2016 & 2017, Seburn 2009, COSEWIC 2007).

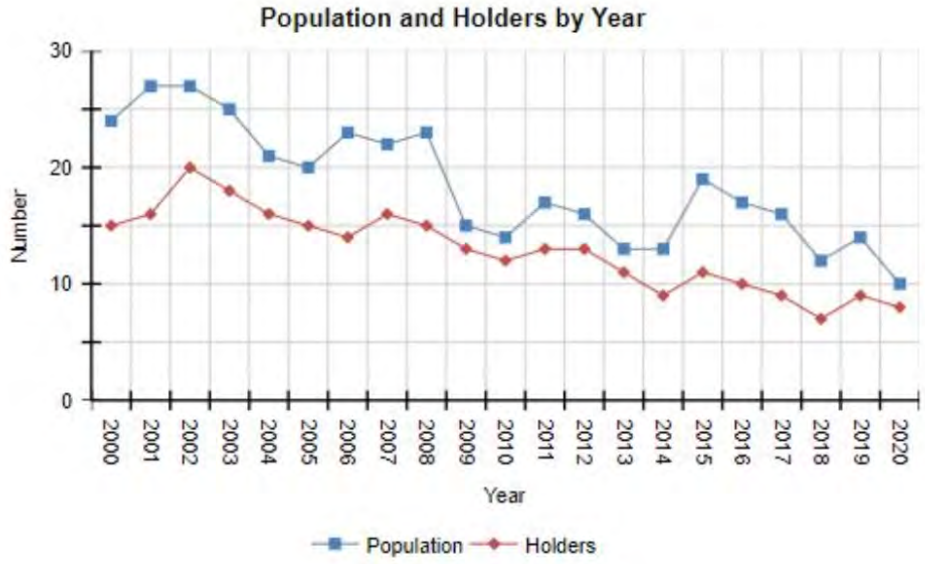
Prior Recommended *Ex situ* Conservation Actions

The recovery goal for the Eastern Hog-nosed Snake in Ontario is to ensure population persistence and retain and expand, where possible, the current range of occupancy and connectivity of extant populations. It is not likely that the distribution of the species can be significantly increased, given the extensive habitat loss. Approaches to meet recovery goals include research on contaminant toxicology, food preference, and genetics as well as strengthening education and outreach including training workshops and materials for wildlife officers and landowners (MNDMNRF 2012, Seburn 2009).

Existing *Ex situ* Conservation Actions

Numerous stewardship initiatives have conducted significant outreach and education work including providing information materials and public presentations (MNDMNRF 2017).

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *H. platirhinos*	5 (2.3.0)	10 (4.2.4)	0	15 (6.5.4)
Number of institutions	1	8	0	9
Breeding status	Breeding recorded in captivity including in Canada.			
Living wild-born	1 (0.0.1) confirmed (in US)			
Generation time (yr)	6-7 (COSEWIC 2007)			
Potential surrogates(s)	Western Hognose Snake (*H. nasicus*)			
Husbandry notes	Hard to get neonates started eating (amphibian diet), oviparous, 7–40 eggs, long-lived, rear fanged venomous (not dangerous to humans)			
Historical holdings in North America (2000-2020) * *H. platirhinos*				

Resources

COSEWIC. 2007. COSEWIC assessment and update status report on the Eastern Hog-nosed Snake Heterodon platirhinos in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 36 pp. **Hammerson, G.A. 2007.** *Heterodon platirhinos. The IUCN Red List of Threatened Species* 2007: e.T63820A12718733. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63820A12718733.en. **Ministry of Northern Development, Mines, Natural Resources & Forestry. 2012.** Eastern Hog-nosed Snake Government Response Statement. Government of Ontario. **Ministry of Northern Development, Mines, Natural Resources & Forestry. 2017.** Five-year review of progress towards the protection and recovery of Ontario's species at risk - 2017: Eastern Hog-nosed Snake. Government of Ontario**. Ministry of Northern Development, Mines, Natural Resources & Forestry. 2016.** Best Management Practices for Mitigating the Effects of Roads on Amphibians and Reptile Species at Risk in Ontario. Queen's Printer for Ontario. 112pp. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.106140/Heterodon_platirhinos. (Accessed: Oct 14, 2020).**Seburn, D. 2009.** Recovery Strategy for the Eastern Hog-nosed Snake (Heterodon platirhinos) in Canada. Species at Risk Act Recovery Strategy Series. Parks Canada Agency, Ottawa. vi+24pp.

† Kominek A, Cornies O, M©Curdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

Most wild populations of Eastern Hog-nosed Snakes are large and intact. The snakes are difficult to find in the wild, and difficult to keep/breed in captivity. Many knowledge gaps exist that reduce feasibility and restrict use for *ex situ* roles. Captive management and roles involving releases were not recommended at this time.

Knowledge gaps that need to be addressed to increase feasibility and reduce risks of *ex situ* management include proper husbandry (breeding, rearing neonates), release techniques, and habitat use. Research and training were recommended but should be targeted and limited to handling animals where they exist in captivity already. A conservation education role was not recommended at this time, and it was noted that the Plains Hog-nosed Snake can be used as a model although there are differences in appearance.

Rescue was revisited in the final summary session, and it was noted that there are a few small populations in the Carolinian region of Ontario that may need rescue on a case-by-case basis. However, the need is rare (one or two sites), and those populations can likely be managed *in situ* at this time, so rescue was not recommended for the population overall.

Indirect conservation roles: improve knowledge about species and life history knowledge gaps; funds/funding and education through *ex situ* ambassador animals

Recommended Actions

Recommendation to train dogs for scent tracking or explore other methods to increase knowledge of species in the wild.

Table 36. *Ex Situ* Conservation Assessment and Recommendations for Eastern Hog-nosed Snake (*Heterodon platirhinos*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Low	Low, can be improved	Moderate	Not recommended at this time
Rescue	Mod-Low	Mod-Low	Low	Not recommended at this time
Demographic Manipulation	Low	Moderate	Mod-Low	Not recommended at this time
Reintroduction	Mod-Low	Low, can be improved	Moderate	Not recommended at this time
Reinforcement	Moderate	Low, can be improved	Moderate	Not recommended at this time
Research	Mod-Low	Moderate	Low	**Recommended with restrictions**
Training	Moderate	Moderate	Low	**Recommended with restrictions**
Education	High-Mod	Moderate	Low	Not recommended at this time

PLAINS HOG-NOSED SNAKE
Heterodon nasicus (Dipsadinae)

SPECIES STATUS
Global: Secure (NatureServe 2015), Least Concern (IUCN Red List 2007)
Canada: **Special Concern** (COSEWIC 2019), Not Listed, **under consideration for addition** (SARA 2019), **Vulnerable** (NatureServe 2015)
Provincial: **Imperiled** (AB), **Vulnerable** (SK), **Critically Imperiled** (MB) (NatureServe 2015)

Evolutionary Distinctiveness†:
Global: 9.761, Canada: 30.028

Canadian Distribution and Population Trend:
Southern Alberta, Saskatchewan, and Manitoba (5-10% of global range); Declining (COSEWIC 2019)

Wild Population

Widespread but discontinuous distribution in Canada at lower densities compared to US populations. Clusters of records indicate several potentially isolated subpopulations. Insufficient data to estimate population size or trends, but continuing population decline is suspected due to ongoing conversion of grasslands to more intensive agricultural uses and other threats such as road mortality. If threats are not effectively managed, declines could continue, and the species could become Threatened (COSEWIC 2019).

Threats and Limitations

Habitat loss is mostly historical due to conversion of native grasslands to agriculture, but habitat continues to be degraded and fragmented through high intensity croplands, overgrazing, energy production, fire suppression, invasive plants, urbanization, and high-density road networks throughout range. Subpopulations in Alberta experience the most significant impact from road mortality, urbanization, and oil and gas exploration. Sites in Saskatchewan and Manitoba are mostly impacted by agriculture. Vulnerable to any factors that increase adult mortality due to slow life history traits (COSEWIC 2019, Hammerson 2007).

In situ Conservation Actions

The species is protected under Wildlife Acts in all three provinces and approximately 13% of all occurrences are in protected areas. In Alberta, occurrences are reported through environmental impact assessments and intensive inventories at Suffield National Wildlife Area. In Saskatchewan, several studies of snake species assemblages have been conducted at Grasslands National Park. In Manitoba, a historical 3-year mark-recapture study was conducted, recent surveys and studies on mixed-grass prairie reptiles have been conducted, and occurrences are documented by the Manitoba Herps Atlas (COSEWIC 2019).

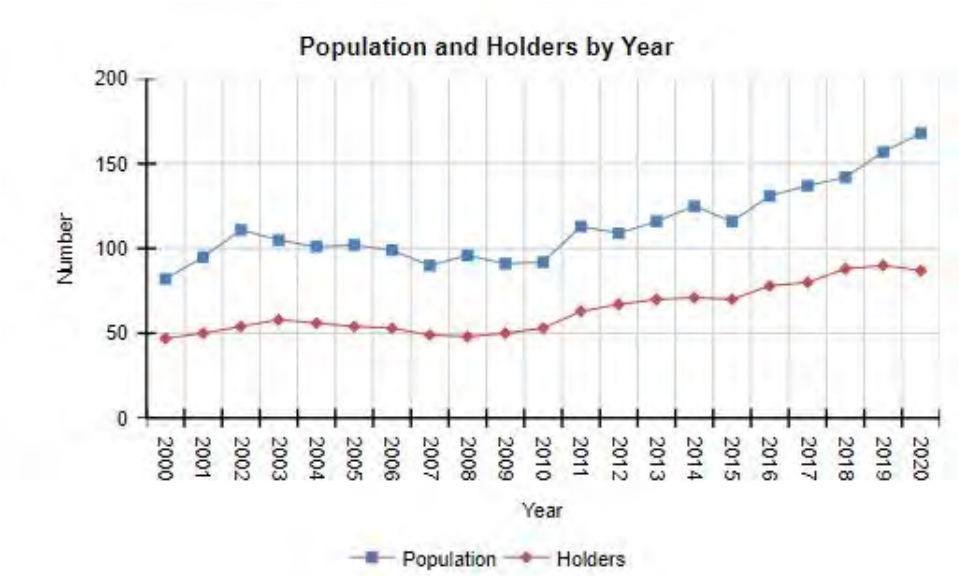
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

None known

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *H. nasicus and H. n. nasicus*	30 (11.8.11)	74 (33.24.17)	80 (17.17.46)	184 (61.49.74)
Number of institutions	10	53	24	87
Breeding status	Breeding recorded in captivity (since 2001) including in Canada (in 2020).			
Living wild-born	9 (6.0.3) confirmed in captivity globally			
Generation time (yr)	5-8 (COSEWIC 2019)			
Potential surrogates(s)	Dusty hognose snake (*H. n. gloydi*), Mexican hognose snake (*H. n. kennerlyi*)			
Husbandry notes	Oviparous, 2–23 eggs, can reproduce annually, long-lived, diurnal, semi-fossorial but sand should not be used as substrate, varied diet, rear fanged, mildly venomous saliva (not dangerous to humans), wild-caught individuals not overly adaptable to captivity, light and temperature important for breeding cues and success			
Historical global holdings (2000-2020) * *H. nasicus*				

Resources

Clayton J. 2013. Western Hognose Snake Care Sheet. https://www.reptilesmagazine.com/western-hognose-snake-care-sheet/ **COSEWIC. 2019.** COSEWIC assessment and status report on the Plains Hog-nosed Snake Heterodon nasicus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 38 pp. **Hammerson, G.A. 2007**. Heterodon nasicus. The IUCN Red List of Threatened Species 2007: e.T63819A12718545. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63819A12718545.en. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.105538/Heterodon_nasicus. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, McCurdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

Training and education were the only *ex situ* roles recommended for Plains Hog-nosed Snakes with the restriction that existing *ex situ* sources be used (i.e., no wild collection). Both roles are important for mitigating the risk of human persecution (learning differences from prairie rattlesnakes) and ensure accuracy of reported sightings. The Plains Hog-nosed Snake was also recommended as a model for the Eastern Hog-nosed Snake despite differences in appearance as there are more Plains in captivity at this time, they are easier to keep in captivity, and have a lower threat status in the wild. All other *ex situ* roles were considered to have low conservation value and were not recommended at this time.

Recommended Actions

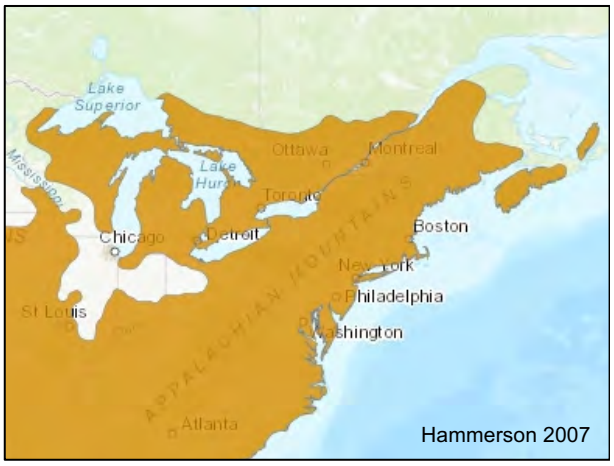
No specific actions were recommended.

Table 37. *Ex Situ* Conservation Assessment and Recommendations for Plains Hog-nosed Snake (*Heterodon nasicus*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Low	Moderate	Low	Not recommended at this time
Rescue	Low	Moderate	Low	Not recommended at this time
Demographic Manipulation	Low	Moderate	Low	Not recommended at this time
Reintroduction	Low	Mod-Low	Low	Not recommended at this time
Reinforcement	Low	Mod-Low	Low	Not recommended at this time
Research	Low	Moderate	Low	Not recommended at this time
Training	Mod-Low	High-Mod	Low	**Recommended with restrictions**
Education	Moderate	High-Mod	Low	**Recommended with restrictions**

RING-NECKED SNAKE
Diadophis punctatus edwardsii
(Dipsadinae)

SPECIES STATUS
Global: Secure (*Diadophis punctatus*; NatureServe 2016), Least Concern (*Diadophis punctatus*; IUCN Red List 2007)
Canada: Secure (NatureServe 2016), Not Assessed, **mid priority candidate for assessment** (COSEWIC)
Provincial: **Vulnerable** (Quebec), Apparently Secure (ON, NB), Secure (NS) (NatureServe 2016)



Canadian Distribution and Global Population Trend:
East of Lake Superior in Ontario, southern Quebec, New Brunswick, and Nova Scotia; Stable (IUCN Red List 2007)

Evolutionary Distinctiveness†:
Global: 22.946, Canada: 36.922

Wild Population
Relatively abundant where it occurs in Canada and most populations are thought to be secure. Local populations throughout range have been lost or reduced due to habitat destruction, but these are a small proportion of the total distribution. Extent of occurrence, area of occupancy, number of subpopulations, and population size are very large and probably relatively stable (CHS, Hammerson 2007).

Threats and Limitations
Threats include habitat loss, subsidized predation (e.g., feral and free-ranging pet cats), and road mortality. Continual collection of wild individuals for the pet trade may also be a concern (CHS).

In situ Conservation Actions
Inventories and monitoring using provincial standardized protocols conducted by Granby Zoo every 2-3 years in municipal parks in Granby and Farnham, Quebec (P. Pare, Granby Zoo, pers. comm. 2021).

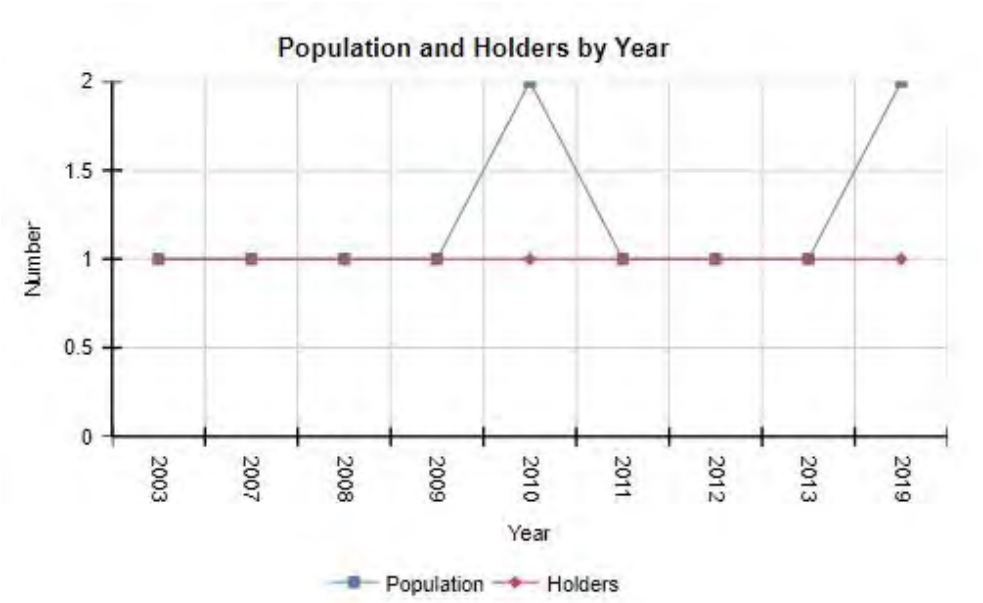
Prior Recommended *Ex situ* Conservation Actions

Create short training videos of capture and handling techniques and equipment (P. Pare, Granby Zoo, pers. comm. 2021)

Existing *Ex situ* Conservation Actions

None known

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *D. punctatus and D. p. edwardsii*	0	0	0	0
Number of institutions	0	0	0	0
Breeding status	None documented in captivity			
Living wild-born	0			
Generation time (yr)	est. 5			
Potential surrogates(s)	None known			
Husbandry notes	Delicate, difficult to keep and breed in captivity, oviparous, up to 10 eggs, mildly venomous (harmless to humans), nocturnal, fossorial, require cover objects, eat amphibians (particularly salamanders) and invertebrates, may eat other snakes			
Historical holdings (2003-2019) * *D. punctatus*				

Resources

Canadian Herpetological Society. Species Information. http://canadianherpetology.ca/species/index.html [accessed 2021]. **Hammerson, G.A. & Frost, D.R. 2007**. Diadophis punctatus. The IUCN Red List of Threatened Species 2007: e.T63769A12714288. https://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63769A12714288.en. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.102372/Diadophis_punctatus_edwardsii. (Accessed: Oct 14, 2020).

† Kominek A, Cornies O, McCurdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

Ring-necked Snake was not assessed in detail, but there was group consensus that conservation value, feasibility, and risk were similar to DeKay's Brownsnake and Red-bellied Snakes, as Ring-necked Snakes are also not at risk and there are none in captivity. Training and conservation education were recommended with the restriction to only use snakes that were brought into captivity for other reasons such as rehabilitation, i.e., no collection from wild populations for these roles.

Recommended Actions

No specific actions recommended.

Table 38. *Ex Situ* Conservation Assessment and Recommendations for Ringed-necked Snake (*Diadophis punctatus edwardsii*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Training	Not assessed	Not assessed	Not assessed	**Recommended with restrictions**
Education	Not assessed	Not assessed	Not assessed	**Recommended with restrictions**

Species-Specific Status and Recommendations
Boidae

Photo: Northern Rubber Boa (*Charina bottae*), Stephanie Winton

NORTHERN RUBBER BOA
Charina bottae (Boidae)


S. Winton

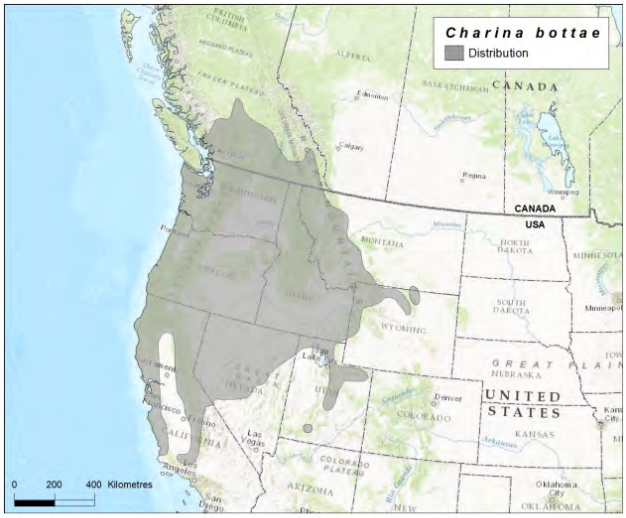


Figure 2. Global distribution of the Northern Rubber Boa in Canada and the United States. Map prepared by Jenny Wu (COSEWIC Secretariat).

COSEWIC 2016

SPECIES STATUS

Global: Secure (NatureServe 2016), Least Concern (IUCN Red List 2016)
Canada: **Special Concern** (COSEWIC/SARA 2016), Apparently Secure (NatureServe 2016)
Provincial: Apparently Secure (BC; NatureServe 2016)

Canadian Distribution and Population Trend:
Widespread but variable in Southern British Columbia (<25% of global range); Declining (COSEWIC 2016)

Evolutionary Distinctiveness†:
Global: 19.593, Canada: 89.903

Wild Population

Inferred declines in Canadian population based on continuing habitat loss and disturbance. Species could become Threatened if threats to local populations are not sufficiently managed and mitigated (COSEWIC 2016).

Threats and Limitations

Overall threat impact low, but habitat loss (particularly of suitable hibernacula or thermoregulatory habitat) and fragmentation due to residential and commercial development, roads and transport corridors, agriculture (e.g., vineyards) and recreational activities could result in a decrease in local subpopulations. Sensitive to human disturbance due to low reproductive rates and specific habitat requirements (COSEWIC 2016, ECCC 2017).

In situ Conservation Actions

Habitat protection in national and provincial/state parks and other protected areas, and through private land stewardship (Hammerson 2019, ECCC 2017).

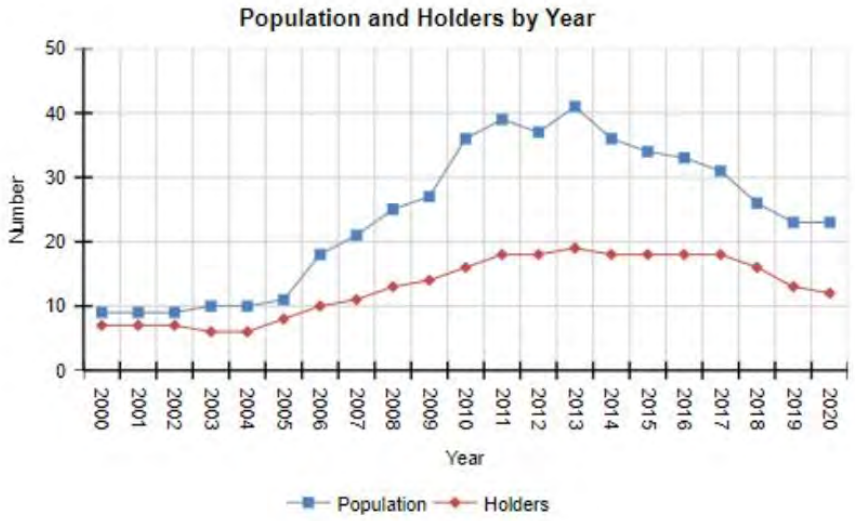
Prior Recommended *Ex situ* Conservation Actions

None known

Existing *Ex situ* Conservation Actions

Education and awareness through zoos and other conservation and stewardship organizations in BC.

Existing *Ex situ* Population

	Canada*	US*	Other Countries*	Global*
Population size (M.F.U) ** *C. bottae* and *C. b. bottae*	1 (0.1.0)	25 (12.8.5)	0	26 (12.9.5)
Number of institutions	1	14	0	15
Breeding status	Breeding recorded in captivity (in 2010)			
Living wild-born	5 (3.2.0) confirmed (in US)			
Generation time (yr)	10-15 (COSEWIC 2016)			
Potential surrogates(s)	Southern rubber boa (*C. b. utahensis*), Rosy boa (*Lichanura*)			
Husbandry notes	Small temperate boa, nocturnal, fossorial, viviparous, 2-8 neonates, low reproductive rate, delayed maturity, and long lifespan. Subject to rapid dehydration due to permeable skin, and do not tolerate high temperatures (max 85F). May not eat for several months (e.g., neonates or during gestation). Brumation cycle is necessary in preparation for breeding, females capable of breeding around 130-150g (Hoyer & Hoyer 2017).			
Historical holdings in North America (2000-2020) * *C. bottae*				

Resources

COSEWIC. 2016. COSEWIC assessment and status report on the Northern Rubber Boa Charina bottae in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiii + 38 pp. **Environment and Climate Change Canada. 2017**. Management Plan for the Northern Rubber Boa (Charina bottae) in Canada. Species at Risk Act Management Plan Series. Environment and Climate Change Canada, Ottawa. 2 parts, 3 pp. + 24 pp. **Hammerson, G.A. 2019.** Charina bottae. The IUCN Red List of Threatened Species 2019: e.T91863316A18978274. https://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T91863316A18978274.en. Downloaded on 28 January 2021. **Hoyer & Hoyer. 2017**. Rubber Boa Care Tips. https://www.reptilesmagazine.com/rubber-boa-care-tips/ **Ministry of Environment and Climate Change Strategy, 2020**. Guidelines for Amphibian and Reptile Conservation during Road Building and Maintenance Activities in British Columbia. Version 1.0., March 30, 2020. **Ministry of Forests, Lands, Natural Resource Operations, and Rural Development, 2014.** Guidelines for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia. 2014 edition. Companion document to Develop with Care. **NatureServe. 2016**. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.828493/Charina_bottae. (Accessed: Oct 14, 2020).
† Kominek A, Cornies O, McCurdy-Adams H, Mooers AO. In review. ***Data Source:** Canada - Species360 [accessed Nov 2, 2020] & pers. comm. , US & other countries - Species360 [accessed Nov 2, 2020]; ****M.F.U** = # males.females.unknown sex

Ex Situ Conservation Assessment

Summary of Discussion

Training and education were the only *ex situ* roles recommended for Northern Rubber Boa with the restriction that it be targeted, local, and use existing *ex situ* sources (i.e., no wild collection). Only a limited number of snakes is required for these activities. The species is highly unique to Canada and very docile and easy to handle; however, messaging needs to address that they are not appropriate pets so as not to inadvertently encourage collection. Risk and feasibility concerns were raised for roles requiring *ex situ* population management. It is unknown how to breed the species in captivity making long-term population maintenance difficult at this time. Collection could negatively impact wild populations and import from the US is difficult as the species is listed in CITES Appendix 2.

Research needs include developing husbandry techniques, and filling knowledge gaps on population demographics. However, *ex situ* conservation research is not recommended at this time.

Recommended Actions

No specific actions recommended.

Table 39. *Ex Situ* Conservation Assessment and Recommendations for Northern Rubber Boa (*Charina Bottae*)

Conservation Role (Direct)	Conservation Value	Feasibility	Risk	Decision
Insurance	Low	Mod-Low	High-Mod	Not recommended at this time
Rescue	Mod-Low	Moderate	Low	Not recommended at this time
Demographic Manipulation	Low	Low, can be improved	High-Mod	Not recommended at this time
Reintroduction	Low	Low, can be improved	High-Mod	Not recommended at this time
Reinforcement	Low	Low, can be improved	High-Mod	Not recommended at this time
Research	Moderate	Low, can be improved	Moderate	Not recommended at this time
Training	Mod-Low	Mod-Low	Low	**Recommended, with restrictions**
Conservation Education	High-Mod	High-Mod	Low	**Recommended, with restrictions**

Literature Cited and Additional Sources

COSEWIC. 2020. Canadian Wildlife Species at Risk. Committee on the Status of Endangered Wildlife in Canada. https://www.canada.ca/en/environmentclimate-change/services/species-risk-public-registry/cosewic-list-species-assessed.html [accessed 9 Dec 2020].

IUCN/SSC. 2014. Guidelines on the Use of Ex Situ Management for Species Conservation. Version 2.0. Gland, Switzerland: IUCN Species Survival Commission. http://www.cpsg.org/sites/cbsg.org/files/documents/IUCN_SSC_ex_situ_guidelines_FINAL.pdf

McGowan, P.J.K., K. Traylor-Holzer, and K. Leus. 2017. IUCN Guidelines for Determining When and How Ex Situ Management Should Be Used in Species Conservation. Conservation Letters 10(3): 361-366. https://doi.org/10.1111/conl.12285

Randall, L., N. Lloyd, and A. Moehrenschlager. 2018. Guidelines for Mitigation Translocations of Amphibians: Applications for Canada's Prairie Provinces. Version 1.0. Centre for Conservation Research, Calgary Zoological Society. Calgary, Alberta, Canada. 94 pp.

Traylor-Holzer, K., K. Leus, and O. Byers. 2018. Integrating Ex Situ Management Options as Part of a One Plan Approach to Species Conservation. In: The Ark and Beyond: The Evolution of Zoo and Aquarium Conservation (ed. Minteer BA, Maienschein J, Collins JP) pp. 129-141. Chicago: University of Chicago Press.

Traylor-Holzer, K., K. Leus, and K. Bauman. 2019. Integrated Collection Assessment and Planning (ICAP) workshop: Helping zoos move toward the One Plan Approach. Zoo Biology. 38: 95–105. https://doi.org/10.1002/zoo.21478.

Taxon-specific references can be found in the *Resources* section for each taxon. General sources include:

COSEWIC status reports and SARA recovery strategies and management plans: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

BC recovery strategies, management plans, and conservation status reports: https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/recovery-planning/recovery-planning-documents/recovery-planning-documents and https://a100.gov.bc.ca/pub/eswp/

Alberta recovery strategies and management plans: https://open.alberta.ca/dataset?tags=species+at+risk

Ontario recovery strategies, management plans, government response statements, and 5-year reviews: https://www.ontario.ca/page/species-risk-ontario

Canadian Herpetological Society resources: http://canadianherpetology.ca/conservation/resources.html

Canadian Wildlife Health Cooperative (CWHC) snake fungal disease resources:
http://www.cwhc-rcsf.ca/snake_fungal_disease.php
http://www.cwhc-rcsf.ca/report_and_submit.php
http://www.cwhc-rcsf.ca/docs/HHWG%20Decontamination%20Protocol%202017-05-30.pdf

NatureServe Explorer: https://explorer.natureserve.org/

IUCN Red List assessments: https://www.iucnredlist.org/

Appendix I: Workshop Participants

Name	Organization
Participants	
John Adamski	Seneca Park Zoo
Theodore Albert	Chippewas of the Thames First Nation
Brian Aucone	Denver Zoo
Dan Boehm	Lincoln Park Zoo
Nick Cairns	Parks Canada
Isabelle Ceillier	Canadian Wildlife Service
Jonathan Choquette	Wildlife Preservation Canada
Gordon Court	Alberta Environment and Parks
Joe Crowley	Ontario Ministry of Environment, Conservation, and Parks
Tarra Degazio	Parks Canada
Andrew Didiuk	Canadian Wildlife Service
Yohann Dubois	Ministère des Forêt, de la Faune et des Parcs du Quebec
Courtney Dunn	Reptilia Zoo
Ariana Emami	Reptilia Zoo
Lisa Faust	Lincoln Park Zoo
Heather Fotherby	Natural Resource Solutions Inc.
Laura Gardiner	Parks Canada
Donnell Gasbarrini	Toronto Zoo
Scott Gillingwater	Upper Thames Conservation Authority
Eric Gross	Canadian Wildlife Service
Jeff Hathaway	Scales Nature Park
Tom Herman	Acadia University
Eric Hileman	Mississippi State University
Matt Huntley	Environment and Climate Change Canada
Leigh Anne Isaac	BC Ministry of Environment and Climate Change Strategy
Jeff Jundt	Detroit Zoo
Randy Junge	Columbus Zoo
Steven Kell	Shawanaga First Nation
Kris Kendell	Alberta Conservation Association
Kevin Kerr	Toronto Zoo
Jillian Kusch	Saskatchewan Conservation Data Centre
Philippe Lamarre	Ministère des Forêts, de la Faune et des Parcs du Québec
Karl Larsen	Thompson Rivers University
Jolene Laverty	Nova Scotia Department of Lands and Forestry
Melanie Lefaive	Parks Canada
Jared Maida	Canadian Wildlife Service
Kristen Mancuso	Okanagan Nation Alliance

Name	Organization
Jennifer McCarter	Natural Resource Solutions Inc.
Stephen Mockford	Acadia University
Lee Parker	Little Ray's Nature Center
Jenny Pearce	Sciensational Sssnakes!!
Menita Prasad	Greater Vancouver Zoo
Patricia Presseau	Zoo Ecomuseum
Tanya Pulfer	Environment and Climate Change Canada
Tracy Reynolds	BC Wildlife Park
Sandi Robertson	Alberta Environment and Parks
Tricia Robins	Parks Canada
Njal Rollinson	University of Toronto
Jeremy Rouse	Ontario Ministry of Northern Development, Mines, Natural Resources & Forestry
Jesús Sigala Rodríguez	IUCN SSC Viper Specialist Group and Universidad Autonoma de Aguascalientes
Alanna Smolarz	Magnetawan First Nation
Sarah Jane Stanger-Guy	Scales Nature Park
Amanda Steen	Little Rays Nature Center
Charlotte Stringam	Nk'Mip Desert Cultural Centre
Nathalie Tessier	Ministère des Forêts, de la Faune et des Parcs du Québec
John Urquhart	Blazing Star Environmental
Marc-Antoine Vien	Zoo Ecomuseum
Rick Vos	Toronto Zoo
Rachel White	Shared Value Solutions
Robert Willson	Ecophylla
Emiko Wong	Biodome Montreal
Lance Woolaver	Wildlife Preservation Canada
Anne Yagi	8Trees Inc
Organizers	
Amy Chabot	Canadian Species Initiative; African Lion Safari
Hannah M^{c}Curdy-Adams	Wildlife Preservation Canada
Jessica Steiner	Canadian Species Initiative; Wildlife Preservation Canada
Kathy Traylor-Holzer	IUCN SSC Conservation Planning Specialist Group
Stephanie Winton	Canadian Species Initiative; Wildlife Preservation Canada

Appendix II: Workshop Agenda

Canadian Snake Integrated Collection Assessment and Planning (ICAP) Workshop
MARCH 8-10, 2021 (virtual - on Zoom)

Draft Agenda

Each session will be ~ 2 to 2.5 hours, with ~45-minute breaks between sessions

All participants are requested to attend the three PLENARY sessions (Sessions 1, 2, and 9)

	Monday, MARCH 8	
0900-1115 CST	***SESSION 1: (PLENARY)**	Welcome; Workshop overview (purpose, scope, format) Short overview of IUCN *ex situ* guidelines decision process Discussion of potential *ex situ* conservation roles and activities Workshop process overview and practice
		BREAK
1200-1415 CST	***SESSION 2: (PLENARY)**	Assessment of Eastern Massasauga (2 taxa) as a detailed case study to enable participants to learn and apply the ICAP process
		BREAK
1500-1730 CST	**SESSION 3:**	Remaining Viperidae (rattlesnakes - 3 taxa): Assessment and draft recommendations

	Tuesday, MARCH 9	
0900-1115 CST	**SESSION 4:**	Natricinae – Thamnophis (gartersnakes – 9 taxa; possibly also ribbonsnakes – 2 taxa): Assessment and draft recommendations
		BREAK
1200-1415 CST	**SESSION 5:**	Remaining Natricinae (5-7 taxa): Assessment and draft recommendations
		BREAK
1500-1730 CST	**SESSION 6:**	Dipsadinae & Boidae (6 taxa): Assessment and draft recommendations

	Wednesday, MARCH 10	
0900-1115 CST	**SESSION 7:**	Colubrinae (racers, milksnakes, greensnakes – 5 taxa; possibly bullsnakes – 1 taxa): Assessment and draft recommendations
		BREAK
1200-1415 CST	**SESSION 8:**	Remaining Colubrinae (Pantherophis & Pituophis – 6-7 taxa): Assessment and draft recommendations
		BREAK
1500-1730 CST	***SESSION 9: (PLENARY)**	Review of draft recommendations across all taxa and revisions, if needed Identification of next steps, as appropriate

For each species assessment, we will quickly:

1. Review *in situ* status and threats.
2. Review *ex situ* status and expertise.
3. Identify potential *ex situ* roles.
4. For each potential role, discuss (and rate, where appropriate):
   a. Program characteristics required to meet role;
   b. Relative conservation benefit if achieved;
   c. Relative feasibility; and
   d. Risks (biological, political, financial, etc.)
5. Determine which potential *ex situ* roles, if any, are recommended for that species.
6. Identify specific actions for the next steps, as time allows

CPSG CANADIAN SNAKE INTEGRATED COLLECTION ASSESSMENT AND PLANNING WORKSHOP

March 8-10, 2021

Photo: Stephanie Winton

WORKSHOP COMPANION GUIDE

This Guide provides a companion resource for participants of the Canadian Snake Integrated Collection Assessment and Planning workshop. Here you will find useful reference information to support workshop discussions, such as descriptions of ex situ conservation roles and questions to consider during identification of potential roles, their feasibility and risks.

IUCN SSC Species Survival Commission

CONSERVATION PLANNING SPECIALIST GROUP
Changing the Future for Wildlife

CANADIAN SPECIES INITIATIVE

ONE PLAN APPROACH

The 'One Plan' approach (OPA) to species conservation promotes the joint development of management strategies and conservation actions that considers all populations of a species and involves all responsible parties, both in situ and ex situ, to produce one comprehensive conservation plan for the species, with the ultimate goal of supporting its conservation in the wild (Byers et al. 2013)[1].

Decision Process from the IUCN SSC *Guidelines on the Use of Ex Situ Management for Species Conservation*[2]

Five-step decision-making process to decide if and how *ex situ* management is an appropriate conservation tool within the overall conservation strategy for a taxon:

STEP 1. Compile a status review of the species, including a threat analysis, to understand its conservation needs.

STEP 2. Identify the potential role(s) that *ex situ* management might play in the overall conservation of the species and its relative conservation value.

STEP 3. Determine the characteristics of the *ex situ* population and program needed to fulfil each potential conservation role.

STEP 4. Define the resources and expertise needed for the *ex situ* program to meet each potential role and appraise the feasibility and risks.

STEP 5. Make a decision that is informed (i.e. uses the information gathered above) and transparent (i.e. demonstrates how and why the decision was taken) regarding *ex situ* roles and activities, if any, to support conservation of the taxon.

ICAP Process

The ICAP process is a rapid application of these five steps to a group of related taxa to identify priorities for *ex situ* conservation activities and programs and help inform *ex situ* collection planning.

In addition to assessing conservation roles for *ex situ* individuals (Direct Conservation Roles), an ICAP may identify other ways in which the *ex situ* community can support species conservation (Indirect Conservation Roles), such as providing equipment or expertise. An ICAP also may record other important *ex situ* roles for the taxon (Non-Conservation Roles), such as high exhibition value. The primary focus of the discussions, however, center around Direct Conservation Roles of *ex situ* management. For more information, see Traylor-Holzer *et al*. 2019[3].

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[1] Byers, O., C. Lees, J. Wilcken, and C. Schwitzer. 2013. The "One Plan Approach": The philosophy and implementation of CBSG's approach to integrated species conservation planning. *WAZA Magazine* 14: 2-5.

[2] IUCN SSC. 2014. Guidelines on the Use of Ex Situ Management for Species Conservation. Version 2.0. Gland, Switzerland: IUCN Species Survival Commission.

[3] Traylor-Holzer, K., Leus, K. and K. Bauman. 2019. Integrated Collection Assessment and Planning (ICAP) workshop: Helping zoos move toward the One Plan Approach. *Zoo Biology* 38: 95-105.

QUESTIONS TO CONSIDER regarding Potential *Ex Situ* Roles

FOR THREATENED SPECIES (defined here as those assessed as Endangered, Threatened, or Special Concern by the Committee on the Status of Endangered Wildlife in Canada)

DIRECT CONSERVATION (i.e. the individuals in the *ex situ* population play a conservation role – see page 4)

1. **Is there an existing conservation strategy/action plan for this species that calls for some form of *ex situ* management in support of conservation?**

2. **Do you feel (and/or does an existing strategy/plan state) that *ex situ* management with one or more direct conservation roles would be beneficial for this species – and if so, which roles? *(One* ex situ *program may serve several conservation roles – either simultaneously or consecutively)***
    a. **If yes, do you feel that the zoo community should help with:**
        - Implementing an *ex situ* program located elsewhere than on zoo grounds (e.g. in a government facility or other non-zoo environment)
    b. **And/or:**
        - Implementing an *ex situ* program in professionally managed zoos (this can range from one, to a few zoos, to a large cooperative program regionally or globally)

Consider the conservation benefit of any direct conservation roles identified: Critical/High/Moderate/Low

INDIRECT CONSERVATION (i.e. ways in which the expertise, knowledge, materials, staff, fundraising, etc. present in the zoo community can contribute to *in situ* conservation activities – see page 5). Please note that a threatened species may benefit from indirect conservation support from the zoo community even if it is not held by zoos.

3. **Do you see a specific need for expertise, knowledge, materials, staff or other support from the zoo community to help implement *in situ* conservation action, or address a particular *in situ* problem?**

4. **Is there a high priority *in situ* project for which small scale funding from the zoo community could make a lot of difference for the conservation of the species?**

5. **Are there particular messages that you feel would be good for zoos to include in conservation educational activities for the zoo visitors?**

NON-CONSERVATION ROLES

6. **Do you see any important non-conservation roles for this species** (see page 5)

FOR NON-THREATENED SPECIES

7. **Do you have reason to believe that this taxon, which is currently not listed as either EN, TH or SC, might recently have run into significant trouble, such that its current threat status might be more severe than is evident from its current COSEWIC Assessment Status?** If yes, consider questions 1-5 above

8. **Do you feel there is a need or value for this non-threatened species to function as a model, through *ex situ* activities, for a threatened species, for example to gain husbandry experience, for conservation-targeted research, conservation-targeted education, or as an "ecological replacement" for an extirpated species?**

9. **Do you see any important non-conservation roles for this species in zoos or other *ex situ* facilities?** (see page 5)

COMMON DIRECT CONSERVATION *EX SITU* ROLES

Based on a combination of the role descriptions in the IUCN SSC Guidelines on the Use of Ex situ Management for Species Conservation, IUCN SSC Guidelines for Reintroduction and Other Conservation Translocations, and Appendix I of the Amphibian Ark Conservation Needs Assessment Process

In essence, *ex situ* management can support species conservation and prevent extinction by:

1) addressing primary threats and/or their causes;
2) counteracting the impacts of primary or stochastic threats on the population (such as reduced survival, poor reproduction and genetic isolation);
3) using *ex situ* populations for population restoration or conservation introduction; and/or
4) preventing extinction by gaining time in situations where threats are not under control or mitigation is not successful (enough).

This list of 11 potential conservation roles for *ex situ* (or other population management) activities are the most common roles that address these four functions.

Ark population

Maintain a long-term *ex situ* population after extinction of all known wild populations and as a preparation for reintroduction or assisted colonization if and when feasible.

Insurance population

Maintain a long-term viable *ex situ* population of the species to prevent predicted local, regional or global species extinction and preserve options for future conservation strategies. These are typically species that are threatened and/or declining and for which it is unsure whether *in situ* threat mitigation will have the sufficient effect in a sufficient timeframe to prevent the extinction of the species or to prevent a dramatic decline in the numbers, populations and/or genetic diversity of the species. An *ex situ* population may be desired as an insurance population from which individuals can be taken for genetic and/or demographic supplementation or other conservation translocations as required, but these are not yet actively planned for the foreseeable future.

Rescue population (temporary or long term)

Establish an *ex situ* population for a species that is in imminent danger of extinction (locally or globally) and requires *ex situ* management, as part of an integrated program, to ensure its survival. The species may be in imminent danger because the threats cannot/will not be reversed in time to prevent likely species extinction, or the threats have no current remedy. The rescue may need to be long term or temporary (for example, to protect from catastrophes or predicted imminent threats that are limited in time, e.g. extreme weather, disease, oil spill).

Demographic manipulation

Improve a demographic rate (survival or reproduction) or status (e.g. skewed sex ratio) in the wild, often of a particular age, sex, or life stage. An example is a head-start program that reduces high mortality during a specific life stage by removing individuals from the wild to be reared under *ex situ* conditions and subsequently returns them to the wild.

Population restoration: Reintroduction

Serve as a source of individuals for population restoration to re-establish the species to part of its former range from which it has been extirpated.

Population restoration: Reinforcement

Serve as a source of individuals for population restoration to supplement an existing population (e.g. for demographic, behavioral or genetic purposes).

Conservation introduction: Ecological replacement

Introduce the species outside of its indigenous range to re-establish a lost ecological function and/or modify habitats. This may involve species that are not themselves threatened but that contribute to the conservation of other taxa through their ecological role.

Conservation introduction: Assisted colonization

Introduce the species outside of its indigenous range to avoid extinction of populations of the species.

Conservation-based research

Use an *ex situ* population for research that will directly benefit conservation of the species, or a similar species, in the wild (e.g. develop monitoring methods such as telemetry transmitters and genetic sampling; address data gaps in disease transmission or treatment). The research must address specific questions essential for success of the overall conservation strategy for the species. This can include non-threatened species serving as a model for threatened species, or establishing *ex situ* populations of a threatened species to gain important species-specific husbandry and breeding expertise that is likely to be needed in the future to conserve the species.

Conservation-based training

Use an *ex situ* population for training that will directly benefit conservation of the species, or a similar species, in the wild (e.g. train field biologists or wildlife managers in restraint, handling and/or health assessment). Training must address expertise essential for success of the overall conservation strategy for the species. This can include non-threatened species serving as a model for threatened species.

Conservation education

Forms the basis for an education and awareness program that addresses specific threats or constraints to the conservation of the species or its habitat. Education should address specific human behavioral changes that are essential for the success, and an integral part of, the overall conservation strategy for the species. This primarily involves *ex situ* locations visited by the intended human audience.

INDIRECT CONSERVATION *EX SITU* ROLES

These are situations in which the zoo (or other *ex situ*) community can contribute to conservation by:

- making available its expertise, knowledge, materials, staff, fundraising or other resources to help implement *in situ* conservation actions, and/or:
- conducting general awareness and conservation education activities aimed at zoo visitors

Indirect conservation contributions can be made for a species regardless of whether or not it is held in captivity.

Examples of indirect conservation *ex situ* roles include:

Expertise: Providing knowledge, experience or training to transfer skills and build capacity, e.g. for veterinary care or handling of animals in the field (e.g. radio collar application, transport, health assessment) or education /behavior change expertise to teams developing awareness programs for local communities.

Knowledge: Act as a source of expert knowledge on species biology/behavior; veterinary knowledge on disease causes, diagnosis and treatment options, etc.

Resources (equipment, materials, staff): Provide existing zoo education materials or veterinary supplies for sample collection; allocate staff time to *in situ* activities; etc.

Education: Conduct education and awareness about the status of and threats to the species. Increase interest in the species and its habitat/ecosystem.

Networking and lobbying: Influence opinions or legislation processes, promote collaboration, etc.

Funds/Fundraising: Small scale fundraising to contribute to high priority *in situ* projects or IUCN SSC Specialist Group activities.

NON-CONSERVATION *EX SITU* ROLES

In some cases, a species may have particular *ex situ* value for non-conservation purposes. Questions that can be asked to investigate non-conservation roles for *ex situ* management in *ex situ* facilities:

- Is this species required/well suited to let holders gain experience in snake husbandry before taking on more difficult species? Specify which type of experience.
- Is the species important for research that is not conservation related (basic and applied research)? Specify the research fields.
- Is the species particularly valuable for non-conservation education? Specify the education topics.
- Does the species have an above average evolutionary distinctiveness score (see species sheets)?
- Is the species colorful/distinctive/diurnal/active and particularly attractive as a zoo exhibit?
- Does the taxon have a special human cultural value (e.g. as a national or regional symbol, in a historic context, featuring in traditional stories, etc.) or economic value (e.g. traditional medicine, tourism, hunting) within its natural range or in a wider global context, and does this give the species a particular value for education or exhibit?

QUESTIONS TO CONSIDER regarding *Ex Situ* Program Structure and Management Needed to Fulfil Identified Potential Role(s)

1. **General characteristics**
   - Does the program likely need to be long, medium or short term?
   - Is a release phase already planned for the foreseeable future?
   - Is proximity to the natural habitat crucial or beneficial?
   - Do the *ex situ* activities involve whole living organisms and/or live bio-samples?
   - What level of human proximity or interaction is desirable?

2. **Founders and population size**
   - Is the founder base of the current *ex situ* population likely already sufficient or are more founders required?
   - Can additional founders or unrelated individuals be (legally and logistically) obtained? From the wild? Other zoo regions? Other *ex situ* collections?
   - Can the population be kept at, or grown to, the required population size?

3. **Genetic and demographic management**
   - Is the taxonomy clear *in situ* and *ex situ*? What is the taxonomic scope of the *ex situ* program?
   - Will reproduction be required in the *ex situ* program?
   - Is retention of a high proportion of gene diversity of high, medium or low importance?
   - Is control over the population size/growth and age/sex structure of high, medium or low importance?
   - Is the species best managed at individual or group level?
   - Will breeding and transfer recommendations be necessary? If yes, how important is it that these are mandatory?
   - How likely are ownership and access issues likely to impede success of the program?

4. **Location and scale**
   - Geographic location and scale? Range province(s) involvement?
   - Do (some) non-zoo association members or non-zoo institutions play a role? If yes, what level of commitment is required from them?
   - If work is required across regions, is there a need for a formal framework for this or is more informal collaboration sufficient?

5. **Catastrophes**
   - Biosecurity needs?
   - Specific requirements to reduce impact of other potential catastrophes?

6. **Research** or **Training** setup/equipment needed?

7. Particular **welfare** issues to be addressed?

<u>Feasibility</u>:
High / Moderate/
Low, but can be improved /
Low, difficult to improve
(existing ex situ population, husbandry challenges, technical or logistical challenges, availability of skilled staff, availability of sufficient financial and other resources, etc.)

<u>Risks</u>:
High / Moderate / Low /None
(sensitivity to catastrophes, consequences for wild population, occupying ex situ space for other species in urgent need, human health and safety risks, political risks, risks for social or public conflicts, etc.)

SELECTING FINAL ROLES AND RECOMMENDATIONS

The ICAP workshop facilitators will aim to reach consensus and produce recommendations for each taxon regarding whether or not *ex situ* activities are recommended as part of the conservation plan for that taxon and, if so, the recommended roles and structure of those activities.

In developing these recommendations, the group will consider the following:

- Relative conservation value of *ex situ* activities for the taxon
- Relative conservation impact (risk) of not establishing these *ex situ* activities
- Likelihood of success
- Relative costs and risks

Potential factors that can influence the relative weighting of these include:

- Severity of threats/risk to the wild population
- Value of the species (ecological, cultural, sociological, economic, evolutionary distinctiveness, potential as flagship species, etc.)
- Legal and political mandates
- Other taxon- or situation-specific considerations

The resulting recommendations will be documented in the Canadian Snake ICAP final report to inform relevant *ex situ* and *in situ* stakeholders and guide management decisions.

CANADIAN SNAKE DESIGNATABLE UNITS (DUs)
categorized by threat category and number held in zoos

Viperidae (5 DUs)		In situ population status (Canada)			
		Endangered or Extirpated	Threatened	Special Concern	Not at risk/not assessed
Ex situ population size (Canada & US)	None in captivity				
	<25 individuals		• Western Rattlesnake (10)	• Prairie Rattlesnake (17)	
	25-55 individuals				
	>70 individuals	• Eastern Massasauga, Carolinian (98) • Timber Rattlesnake - extirpated (129)	• Eastern Massasauga, Great Lakes/St. Lawrence (98)		

Colubrinae (12 DUs)		In situ population status (Canada)			
		Endangered or Extirpated	Threatened	Special Concern	Not at risk/not assessed
Ex situ population size (Canada & US)	None in captivity		• Western Yellow-bellied Racer (0)		
	<25 individuals	• Pacific Gophersnake - extirpated (9) • Blue Racer (18)	• Eastern Yellow-bellied Racer (1) • Great Basin Gophersnake (20)		• Smooth Greensnake (4)
	25-55 individuals	• Eastern Foxsnake (53)		• Eastern Milksnake (27) • Bullsnake (47)	
	>70 individuals	• Gray Ratsnake, Carolinian (79)	• Gray Ratsnake, Great Lakes/St. Lawrence (79)		

Natricinae (16 DUs)		In situ population status (Canada)			
		Endangered or Extirpated	Threatened	Special Concern	Not at risk/not assessed
Ex situ population size (Canada & US)	None in captivity	• Queensnake (0) • Butler's Gartersnake (0)			• Red-bellied Snake (0) • Maritime Gartersnake (0) • Puget Sound Gartersnake (0)
	<25 individuals		• Eastern Ribbonsnake, Atlantic (20)	• Lake Erie Watersnake (6) • Eastern Ribbonsnake, Great Lakes (20)	• Northwestern Gartersnake (1) • Valley Gartersnake (1) • Dekay's Brownsnake (2) • Plains Gartersnake (17) • Terrestrial Gartersnake (21)
	25-55 individuals				• Red-sided Gartersnake (30) • Eastern Gartersnake (33)
	>70 individuals				• Northern Watersnake (72) • Common Gartersnake (109)

Dipsadinae and Boidae (6 DUs)		In situ population status (Canada)			
		Endangered or Extirpated	Threatened	Special Concern	Not at risk/not assessed
Ex situ population size (Canada & US)	None in captivity	• Sharp-tailed Snake (0)			• Ring-necked Snake (0)
	<25 individuals	• Desert Nightsnake (8)	• Eastern Hog-nosed Snake (15)		
	25-55 individuals			• Northern Rubber Boa (26)	
	>70 individuals			• Plains Hog-nosed Snake (103)	

Canadian Snakes

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IUCN SSC Species Survival Commission

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