

Identifying Provincially Rare Species (Species at Risk) Vulnerable to Climate Change in the Lake Simcoe Watershed, Ontario, Canada

Sam Brinker & Colin Jones

Natural Heritage Information Centre
Science and Information Branch
Ministry of Natural Resources
300 Water St. N., Peterborough, ON, Canada, K9J 8M5

SUMMARY

An important precursor to creating adaptation strategies for natural resource management in the face of climate change is to identify the vulnerabilities of the assessment area. We used NatureServe's Climate Change Vulnerability Index (CCVI) on a subset of provincially rare species found within the Lake Simcoe Watershed, in Ontario, Canada, to identify species potentially vulnerable to climate change. We completed vulnerability assessments for 17 high priority species out of a total of 62 provincially rare species currently known from the watershed. Of the 17 species assessed, six were identified as vulnerable. Redside Dace (*Clinostomus elongatus*) scored extremely vulnerable, followed by Schweinitz's Sedge (*Carex schweinitzii*) with a score of highly vulnerable. American Ginseng (*Panax quinquefolius*), Eastern Prairie Fringed-orchid (*Platanthera leucophaea*), Ram's-head Lady's-slipper (*Cypripedium arietinum*) and Jefferson Salamander (*Ambystoma jeffersonianum*) all scored moderately vulnerable. Key vulnerabilities associated with many of these species in the Lake Simcoe Watershed included specialized life history requirements, limited dispersal capabilities coupled with a high degree of barriers to movement, restricted distributions, a high degree of habitat specialization, and specific physiological requirements with regards to temperature and moisture. We propose more systematic and complete baseline data be captured for these species across their range within the study area to form a basis for future quantitative monitoring. We suggest that the vulnerabilities of each species be integrated with other known stressors acting on them currently, and that adaptive measures focus on reducing vulnerabilities that affect multiple species to maximize efficiency.

ACKNOWLEDGEMENTS

Gary Nielsen, Climate Change Project Coordinator, Ministry of Natural Resources, Bruce Young, Director, Species Science, NatureServe

INTRODUCTION

Certain species considered provincially rare in the Lake Simcoe Protection Area Watershed Boundary (LSPA WB), including some listed as Threatened or Endangered under Ontario's *Endangered Species Act* (ESA 2007), may be at risk of extirpation due to adverse effects of

natural and / or anthropogenic stressors. Climate change acting alone or intensifying current stressors may pose an important new threat for many of these species. A number of tools assessing climate change impacts on species are being developed for use by resource managers to categorize the relative vulnerabilities of various species to climate change. We tested the relative utility of the Climate Change Vulnerability Index (CCVI) developed by NatureServe (Young et al 2010) on a subset of provincially rare species occurring in the LSPAWB. This particular vulnerability index was chosen because it is rapid, has gone through an extensive scientific peer review process, works for plants and animals (both terrestrial and aquatic species), has written guidelines to help perform assessments, and is already in use or under experimentation in ten jurisdictions in the United States. The CCVI predicts whether a species will likely suffer range contractions, population reductions, range expansions, or maintain stable populations within an assessment area. By testing the model against a subset of high priority provincially rare species found within the LSPAWB our objectives were to:

- Categorize the relative vulnerability of each species;
- Identify species level indicators vulnerable to climate change; and
- Identify the key factors causing their vulnerability.

METHODS

Species Selection

Possible species level indicators were those considered to be provincially rare, i.e., those having a provincial status rank (Srank) of possibly extirpated/historic (SH), critically imperilled (S1), imperilled (S2) or vulnerable (S3) defined by the Natural Heritage Information Centre (NHIC). While these ranks are not legal designations, many of these species also have official status and protection under the Ontario *Endangered Species Act*. A Geographic Information System (GIS) was used to generate a full list of all known provincially rare species from within the study area using occurrence records contained within the NHIC's provincial database (NHIC 2010). An element occurrence base layer was overlaid on the LSPAWB and clipped to that layer to determine which species have been observed from within the study area. The resulting list contained 62 provincially rare species. In order to determine which species would be chosen as potential climate change indicators, each species was given a rank of high, medium or low based on a number of qualitative criteria (see Appendix 1). Table 1 shows the possible priority score and the associated criteria used to rank each species. An effort was made to ensure that the subset of species spanned a variety of taxonomic groups (birds, fishes, reptiles, amphibians, insects, vascular plants) and habitat preferences (aquatic, semi-aquatic, terrestrial).

Table 1. Criteria used to rank the 62 provincially rare species in the Lake Simcoe Protection Area Watershed Boundary.

Seventeen of the 62 species were identified as high priority species and these were chosen as potential indicators of climate change to run through the CCVI tool. Table 2 highlights the seventeen high priority species, along with their relative conservation status ranks. As illustrated, the vast majority of species are species at risk or are of global conservation concern.

Table 2. List of seventeen high priority species selected as potential indicators to be run through the climate change vulnerability index tool.

Climate Change Vulnerability Index Tool

Once the list of high priority potential indicators was determined, each species was run through the CCVI tool. The NatureServe CCVI contemplates vulnerability to climate change by the year 2050, a typical cut-off date for predictions made in the International Panel on Climate Change reports (e.g. IPCC 2007). The CCVI uses a scoring system that integrates a species' predicted exposure to climate change within the assessment area (in this case the Lake Simcoe Protection Area Watershed Boundary) and three sets of factors associated with climate change sensitivity including: 1) indirect exposure to climate change; 2) species specific factors such as habitat specificity, genetic factors, dispersal ability; and 3) documented response to climate change (if known). Exposure to climate change is measured by examining the magnitude of predicted temperature and moisture change across the range of the species within the assessment area. For the LSPA WB, moisture deficit data and mean annual ranges of temperature and precipitation for 1951-2006 and 2040-2069 were taken from Young et al. (2010) and the Climate Wizard, an on-line tool that provides climate data from 16 Global Climate Models statistically downscaled to 12-km resolution (<http://www.climatewizard.org>). To assess moisture availability, we used the AET:PET Moisture Metric (Hamon 1961), 2040-2069 (medium emissions A1B, 16-model ensemble average) generated by NatureServe. The Hamon AET:PET integrates temperature and precipitation through a ratio of actual evapotranspiration (AET) to potential evapotranspiration (PET), with consideration of total daylight hours and saturated vapour pressure. To calculate a score, direct climate exposure is computed as a climate stress index and is then used as a weighting factor for the appropriate indirect exposure and sensitivity factors to generate an overall score. This score is compared against threshold values to generate a Vulnerability Index Score.

Upon entering the necessary inputs into the CCVI, a calculated Index score and a measure of confidence was generated by the tool. Because a species may be exposed to significant changes in climate but not inherently sensitive, or sensitive to changes in climate but not expected to experience significant exposure, the CCVI tool weights the numerical scores for the sensitivity factors by the magnitude of projected temperature and moisture change across the assessment area. The Index scores (listed below) provide a relative measure of vulnerability to climate change. Because the Index is based on factors that are associated with climate change, it is impossible to calculate numerical probabilities for decline. Nevertheless, the Index does separate species with numerous risk factors and a fast changing climate from those with fewer risk factors or characteristics that may cause them to increase.

Definition of Index Scores

Extremely Vulnerable: Abundance and/or range extent within geographical area assessed extremely likely to substantially decrease or disappear by 2050.

Highly Vulnerable: Abundance and/or range extent within geographical area assessed likely to decrease significantly by 2050.

Moderately Vulnerable: Abundance and/or range extent within geographical area assessed likely to decrease by 2050.

Not Vulnerable/Presumed Stable: Available evidence does not suggest that abundance and/or range extent within the geographical area assessed will change (increase/decrease) substantially by 2050. Actual range boundaries may change.

Not Vulnerable/Increase Likely: Available evidence suggests that abundance and/or range extent within geographical area assessed is likely to increase by 2050.

Insufficient Evidence: Available information about a species' vulnerability is inadequate to calculate an Index score.

RESULTS

The results of the climate change vulnerability index assessment are summarized in Figure 1. A total of six species out of the seventeen were identified as potentially vulnerable to climate change from within the LSPA WB. Of those six, one species was identified as extremely vulnerable, one as highly vulnerable, and four as moderately vulnerable. The remaining eleven species were not considered vulnerable, with ten presumed stable with climate change, and one likely to increase with climate change.

Figure 1. Results of the climate change vulnerability index assessment.

Table 3 outlines the index scores for each vulnerable species. According to the climate change vulnerability assessment, Redside Dace (*Clinostomus elongatus*) is likely the most sensitive, with a score of extremely vulnerable, followed by Schweinitz's Sedge (*Carex schweinitzii*) with a score of highly vulnerable. American Ginseng (*Panax quinquefolius*), Eastern Prairie Fringed-orchid (*Platanthera leucophaea*), Ram's-head Lady's-slipper (*Cypripedium arietinum*) and Jefferson Salamander (*Ambystoma jeffersonianum*) all scored moderately vulnerable to climate change. All species except Ram's-head Lady's-slipper are at their northern range limit (relatively speaking).

Table 3. Six species identified as potentially vulnerable to climate change.

DISCUSSION

A number of vulnerabilities have been identified by the CCVI for each of the 6 indicator species. Typically these vulnerabilities are associated with the specialized life history requirements of the species, the dispersal capabilities of the species and the relative barriers existing in the LSPA WB, the degree of habitat specialization, or the physiological requirements of the species with regards to temperature and moisture. Key vulnerabilities for each species are summarized below.

Redside Dace

Barriers: almost completely surround the current distribution of the species such that distributional shifts are unlikely.

Thermal Niche: requires cold, clear water streams that may warm and increase in turbidity with climate change.

Dietary Versatility: limited - specialized diet and foraging strategy, leaping out of the water to catch terrestrial insects, mostly flies.

Schweinitz's Sedge

Barriers: study area bordered by Lake Simcoe forming a natural barrier.

Thermal Niche: requires cool, stream edges, springheads, seeps.

Hydrological Niche: specialized habitat requirements relating to areas of constant seepage.

Restriction to uncommon geological features: occurs in highly calcareous soils .

American Ginseng

Dispersal: limited ability to shift location through unsuitable habitat.

Disturbance: increased vulnerability to catastrophic / stochastic environmental events such as wind or ice storms.

Eastern Prairie Fringed-orchid

Hydrological Niche: completely dependent on specialized wetland habitat and moisture regime that is highly vulnerable to reduction in quality with climate change.

Pollinator Specificity: dependent on a few species for pollination.

Interspecific Interaction: requires a specialized fungal symbiont for seedling establishment.

Jefferson Salamander

Barriers: natural and anthropogenic barriers border the current distribution such that climate change-caused distributional shifts are likely to be impaired in the assessment area.

Hydrological Niche: requires specific vernal pool habitat for reproduction that may be impacted hydrologically by climate change.

Ram's-head Lady's-slipper

Thermal Niche: almost completely restricted to cool environments that may be significantly reduced or lost with climate change.

Hydrological Niche: somewhat dependant on specific wetland habitat vulnerable to loss with climate change.

Pollinator Specificity: requires specific pollinators.

Interspecific Interaction: requires specialized fungal symbionts required for seedling establishment.

It should be noted that there is a degree of uncertainty associated with the climate change projections and the tool does not quantify this or take it directly into account, thus there are limitations to the applications of the results.

RECOMMENDATIONS

Based on the results of the CCVI tool, certain provincially rare species in the LSPAWB are likely vulnerable to climate change to varying degrees, and require consideration in conservation planning in order to ensure populations are sustained in the long-term. The potential impacts of climate change on these species should be integrated with and weighted against other known stressors and threats from within the LSPAWB. Based on the vulnerabilities of each of the six species identified, options should be developed that will benefit multiple species to maximize efficiency where vulnerabilities overlap.

Currently, none of the six species receive any formal quantitative monitoring such that impacts could be attributable to climate change. If these species were being actively monitored throughout the LSPAWB, we would be in a better position to be able assess overall population status (decline, increase or remaining stable), and to detect the expansion and contraction of each species across the study area. While we possess detailed locational data on occurrences of these species, the data is most often based on incidental observations, versus complete and systematic surveys across the entire study area, limiting our ability to assess their overall status. Therefore, in most cases we cannot be completely confident we have detected all occurrences in the study area. Future adaptive strategies should include inventories and mapping of all known occurrences of each species to provide a quantitative baseline for future monitoring and should consider expanding these surveys to other suitable habitat.

REFERENCES

ESA (Endangered Species Act), 2007. Website accessed December 15, 2010. Available at: http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_07e06_e.htm

Hamon, W.R. 1961. Estimating potential evapotranspiration. Journal of the Hydraulic Division, Proceedings of the American Society of Civil Engineering 87: 107-120.

IPCC (Intergovernmental Panel on Climate Change). 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden and C. E. Hanson, eds., Cambridge University Press, Cambridge, UK. 976pp. Available: <http://www.ipcc.ch/ipccreports/ar4-wg2.htm>.

NHIC (Natural Heritage Information Centre). 2010. Element Occurrence database. Natural Heritage Information Centre, Ontario Ministry of Natural Resources, Peterborough, Ontario. Electronic databases.

Young, B., E. Byers, K. Gravuer, K. Hall, G. Hammerson and A. Redder. 2010. Guidelines for Using the NatureServe Climate Change Vulnerability Index Release 2.01 – Canada. NatureServe, Arlington, VA. 48 pp.

GLOSSARY OF TERMS

COSEWIC (Committee on the Status of Endangered Wildlife in Canada) - A committee of experts that assesses and designates which wildlife species are in some danger of disappearing from Canada.

Element Occurrence - A term used by Conservation Data Centres and NatureServe that refers to an occurrence of an element of biodiversity on the landscape; an area of land and/or water on/in which an element (e.g. species or ecological community) is or was present. An EO has conservation value for the element: it is a location important to the conservation of the species or community. For a species, an EO is generally the habitat occupied by a local population. What constitutes an occurrence varies among species. Breeding colonies, breeding ponds, denning sites and hibernacula are general examples of different types of animal EOs. For an ecological community, an EO may be the area containing a patch of that community type.

END (Endangered) - A native species facing imminent extinction or extirpation in Ontario.

GIS (Geographic Information System) - Computer software that allows spatial data to be viewed, manipulated, and printed.

GRANK (Global Rank) - Global ranks are assigned by a consensus of the network of Conservation Data Centres, scientific experts, and The Nature Conservancy to designate a rarity rank based on the range-wide status of a species, subspecies or variety.

G1 (Extremely rare) - Usually 5 or fewer occurrences in the overall range or very few remaining individuals; or because of some factor(s) making it especially vulnerable to extinction.

G2 (Very rare) - Usually between 5 and 20 occurrences in the overall range or with many individuals in fewer occurrences; or because of some factor(s) making it vulnerable to extinction.

G3 (Rare to uncommon) - Usually between 20 and 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.

Species - The lowest principal unit of biological classification formally recognized as a group of organisms distinct from other groups. In sexually producing organisms, "species" is more narrowly characterized as a group of organisms that in natural conditions freely interbreed with members of the same group but not with members of other groups.

SRANK (Provincial Rank) - Provincial (or Subnational) ranks are used by the Natural Heritage Information Centre (NHIC) to set protection priorities for rare species and natural communities. These ranks are not legal designations. Provincial ranks are assigned in a manner similar to that described for global ranks, but consider only those factors within the political boundaries of Ontario. By comparing the global and provincial ranks, the status, rarity, and the urgency of conservation, needs can be ascertained. The NHIC evaluates provincial ranks on a continual basis and produces updated lists at least annually.

SH [Possibly Extirpated (Historical)] - Species or community occurred historically in the nation or state/province, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or community could become NH or SH without such a 20-40 year delay if the only known occurrences in a nation or state/province were destroyed or if it had been extensively and unsuccessfully looked for. The NH or SH rank is reserved for species or communities for which some effort has been made to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.

S1 (Critically Imperilled) - Critically imperilled in the nation or state/province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province.

S2 (Imperilled) - Imperilled in the nation or state/province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province.

S3 (Vulnerable) - Vulnerable in the nation or state/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.

THR (Threatened) - A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed.

Figure 1. Results of the climate change vulnerability index assessment in the Lake Simcoe Protection Area Watershed Boundary.

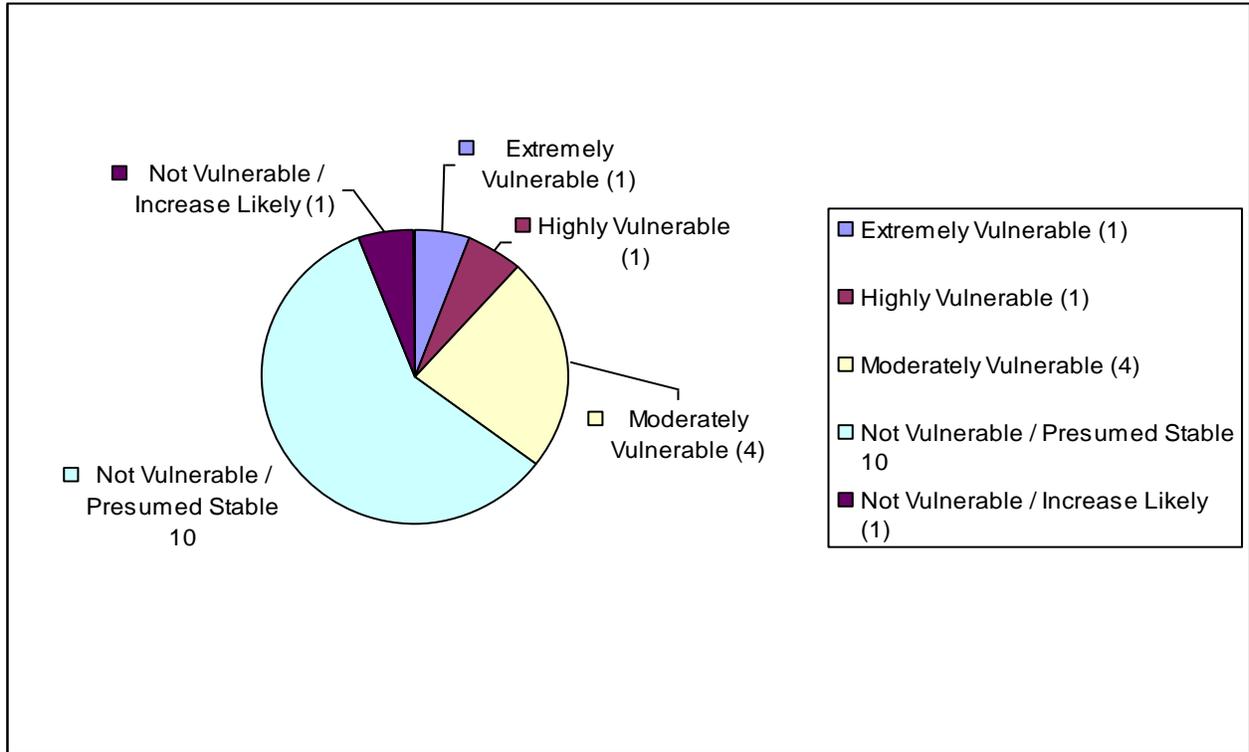


Table 1. Criteria used to rank the 62 provincially rare species in the Lake Simcoe Protection Area Watershed Boundary.

Priority	Criteria
High	Species at Risk
	Globally rare
	At northern or southern range limit
	Specialized habitat or life history requirements
	Good degree of literature available
	Recent, substantiated records from the study area
Medium	Provincially rare and widespread
	Lack information pertaining to Ontario
	Wide ecological amplitude
	Posses other confounding influences affecting their status that may be difficult in the assessment process
Low	Little or no available literature
	Few substantiated records or only old vague records from the study area
	Extirpated from the watershed

Table 2. List of seventeen high priority species selected as potential indicators to be run through the climate change vulnerability index tool.

Common Name	Scientific Name	Grank	Srank	COSEWIC	OMNR
American Ginseng	<i>Panax quinquefolius</i>	G3G4	S2	END	END
Eastern Prairie Fringed-orchid	<i>Platanthera leucophaea</i>	G2	S2	END	END
Purple Twayblade	<i>Liparis liliifolia</i>	G5	S2	END	END
Ram's-head Lady's-slipper	<i>Cypripedium arietinum</i>	G3	S3		
Schweinitz's Sedge	<i>Carex schweinitzii</i>	G3G4	S3		
Lilypad Clubtail	<i>Arigomphus furcifer</i>	G5	S3		
Jefferson Salamander	<i>Ambystoma jeffersonianum</i>	G4	S2	THR	THR
Western Chorus Frog (Great Lakes / St. Lawrence - Canadian Shield Population)	<i>Pseudacris triseriata</i>	G5TNR	S3	THR	
Blanding's Turtle	<i>Emydoidea blandingii</i>	G4	S3	THR	THR
Milksnake	<i>Lampropeltis triangulum</i>	G5	S3	SC	SC
Black Tern	<i>Chlidonias niger</i>	G4	S3B	NAR	SC
Bobolink	<i>Dolichonyx oryzivorus</i>	G5	S4B	THR	THR
Canada Warbler	<i>Wilsonia canadensis</i>	G5	S4B	THR	SC
Chimney Swift	<i>Chaetura pelagica</i>	G5	S4B,S4N	THR	THR
Least Bittern	<i>Ixobrychus exilis</i>	G5	S4B	THR	THR
Yellow Rail	<i>Coturnicops noveboracensis</i>	G4	S4B	SC	SC
Redside Dace	<i>Clinostomus elongatus</i>	G3G4	S2	END	END

Table 3. Six species identified as potentially vulnerable to climate change in the Lake Simcoe Protection Area Watershed Boundary.

Indicator	Conservation Ranks	Range	Index Score
Redside Dace	G3G4 S2 END	Northern edge	Extremely Vulnerable
Schweinitz's Sedge	G3G4 S3	Northern edge	Highly Vulnerable
American Ginseng	G3G4 S2 END	Northern edge	Moderately Vulnerable
Eastern Prairie Fringed-orchid	G2 S2 END	Northern edge	Moderately Vulnerable
Jefferson Salamander	G4 S2 THR	Northern edge	Moderately Vulnerable
Ram's-head Lady's-slipper	G3 S3	Centre	Moderately Vulnerable

APPENDICES

Appendix Table 1: Provincially rare species known to occur within the Lake Simcoe Watershed ranked by their priority (Rank from 1-3) to be assessed using the NatureServe CCVI and the supporting rationale for the ranking. Also included in the table is the Global Conservation Status Rank (Grank), Subnational (in this case Ontario) Conservation Status Rank (Srank), and the relevant status as assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and under *Ontario's Endangered Species Act, 2007* (OMNR).

1	High priority species with MNR / COSEWIC status; globally and/or provincially rare / at northern or southern range limit / likely vulnerable to climate change based on habitat or life history requirements/ good degree of literature available / recent, substantiated records
2	Medium priority species that are provincially rare / widespread / lack information pertaining to Ontario / have wide ecological amplitudes / posses other confounding influences affecting their status that may be difficult in the assessment process
3	Low priority species with little available literature / few substantiated or old vague records / extirpated from the watershed

Rank	Scientific Name	Common Name	Rationale	Grank	Srank	COSEWIC	OMNR
1	<i>Ambystoma jeffersonianum</i>	Jefferson Salamander	SAR; northern range limit; threats related to reduction of the hydro period of breeding ponds; good degree of biological/ecological literature available (including Jefferson X Blue-spotted Salamander occurrences)	G4	S2	THR	THR
1	<i>Arigomphus furcifer</i>	Lilypad Clubtail	Provincially rare; distribution in Ontario largely confined to the southern edge of the Canadian Shield.	G5	S3		
1	<i>Carex schweinitzii</i>	Schweinitz's Sedge	Globally rare to uncommon; narrow ecological amplitude - dependant on calcareous, perennially wet, seepy habitats along spring-fed rivers and brooks, in mixed or coniferous cover; likely susceptible to hydrological and temperature changes	G3G4	S3		
1	<i>Chaetura pelagica</i>	Chimney Swift	Newly added SAR; has declined dramatically in Ontario with some of the greatest declines occurring in the Lake-Simcoe region; good degree of biological/ecological information available.	G5	S4B,S4N	THR	THR
1	<i>Chlidonias niger</i>	Black Tern	SAR; declining; in Ontario, mostly found along the southern edge of the Canadian Shield	G4	S3B	NAR	SC

Lake Simcoe Watershed Climate Change Vulnerability Assessment: Ecosystems

Rank	Scientific Name	Common Name	Rationale	Grank	Srank	COSEWIC	OMNR
1	<i>Clinostomus elongatus</i>	Redside Dace	SAR; globally rare and declining; prefers clear cool streams	G3G4	S2	END	END
1	<i>Coturnicops noveboracensis</i>	Yellow Rail	SAR; most known Ontario populations occur in the Hudson Bay Lowland and Rainy River District and 90% of the species breeding range occurs in Canada. The species is rare and very local in the south but is known to breed in the Lake Simcoe watershed.	G4	S4B	SC	SC
1	<i>Cypripedium arietinum</i>	Ram's-head Lady's-slipper	Globally rare (G3); usually found in areas possessing cool microclimates (populations are often confined to northern exposures or cold air channels); potentially declining; sensitive to moisture / hydrological changes	G3	S3		
1	<i>Dolichonyx oryzivorus</i>	Bobolink	Newly added SAR but still a fairly common breeding species in the Lake Simcoe watershed; good degree of biological/ecological information available.	G5	S4B	THR	THR
1	<i>Emydoidea blandingii</i>	Blanding's Turtle	SAR; high proportion of global range in Ontario; long generation time of the species (exceeding 40 years) limits its ability to adapt genetically to short environmental changes; lots of literature	G4	S3	THR	THR
1	<i>Ixobrychus exilis</i>	Least Bittern	SAR; rare and local breeder; may be decreasing in abundance; in Ontario, mostly found south of the Canadian Shield	G5	S4B	THR	THR
1	<i>Lampropeltis triangulum</i>	Milksnake	SAR; found in anthropogenic landscapes (adaptable?) and susceptible to the effects of human encroachment/habitat loss; persecuted species	G5	S3	SC	SC
1	<i>Liparis liliifolia</i>	Purple Twayblade	SAR; northern range limit but apparently expanding; wide ecological amplitude; adaptable?	G5	S2	END	END
1	<i>Panax quinquefolius</i>	American Ginseng	SAR; declining; fragmented populations likely highly vulnerable to environmental stochasticity; poor dispersal ability; lots of literature; ***consider sensitivity of locational info and mapping	G3G4	S2	END	END

Lake Simcoe Watershed Climate Change Vulnerability Assessment: Ecosystems

Rank	Scientific Name	Common Name	Rationale	Grank	Srank	COSEWIC	OMNR
1	<i>Platanthera leucophaea</i>	Eastern Prairie Fringed-orchid	SAR; globally rare (G2G3); narrow ecological amplitude; northern range limit; sensitive to moisture/hydrological changes; lots of literature	G2G3	S2	END	END
1	<i>Pseudacris triseriata</i>	Western Chorus Frog (Great Lakes / St. Lawrence - Canadian Shield Population)	Federal SAR; low dispersal ability and relatively high site-fidelity; limited ability to cope with habitat fragmentation and reduced habitat quality	G5TNR	S3	THR	
1	<i>Wilsonia canadensis</i>	Canada Warbler	Newly added SAR but still quite common and widespread. 80% of the breeding range occurs in Canada with the greatest concentration in the southern Canadian Shield region. Prefers damp wooded habitat.	G5	S4B	THR	SC
2	<i>Caprimulgus vociferus</i>	Whip-poor-will	Newly added SAR; like many aerial insectivores, this species has declined significantly in Ontario. Declines may be related to natural forest succession, or use of insecticides.	G5	S4B	THR	THR
2	<i>Chelydra serpentina</i>	Snapping Turtle	widespread and still numerous; concerns over declining populations, human exploitation (legal and illegal harvest), road mortality	G5	S3	SC	SC
2	<i>Chordeiles minor</i>	Common Nighthawk	Newly added SAR; like many aerial insectivores, this species has declined significantly in Ontario. Declines may be related to natural forest succession, or use of insecticides.	G5	S4B	THR	SC
2	<i>Dendroica cerulea</i>	Cerulean Warbler	SAR; declining; at the northern edge of its range	G4	S3B	SC	SC
2	<i>Graptemys geographica</i>	Northern Map Turtle	relatively widespread; lower priority SAR	G5	S3	SC	SC
2	<i>Hydroprogne caspia</i>	Caspian Tern	Designated "Not at Risk" by COSSARO and COSEWIC. Mostly nests on islands in the Great Lakes although they do nest on larger inland lakes including Lake Simcoe.	G5	S3B	NAR	NAR
2	<i>Juglans cinerea</i>	Butternut	widespread but declining; maybe hard to factor the effects of climate change given species susceptibility to Butternut Canker and that climate for butternut varies greatly within its range	G4	S3?	END	END

Lake Simcoe Watershed Climate Change Vulnerability Assessment: Ecosystems

Rank	Scientific Name	Common Name	Rationale	Grank	Srank	COSEWIC	OMNR
2	<i>Juncus secundus</i>	One-sided Rush	relatively widespread in S. Ontario; alvars and rock barrens	G5?	S3		
2	<i>Lanius ludovicianus</i>	Loggerhead Shrike	One of Ontario's most endangered species having declined dramatically since 1966. The reasons for the declines are not fully understood but may be related in part to natural succession. Probably not a good candidate for this analysis given the uncertainty for declines.	G4	S2B	END	END
2	<i>Melanerpes erythrocephalus</i>	Red-headed Woodpecker	has declined in Ontario but declines are largely associated with a decrease in available nesting sites (old snags) and the spread of Beech Bark Disease and the resultant decline in American Beech, an important forage species for Red-headed Woodpeckers.	G5	S4B	THR	SC
2	<i>Myotis septentrionalis</i>	Northern Long-eared Bat	Currently not a SAR but with concerns over White Nose Syndrome this species may very likely become a SAR.	G4	S3?		
2	<i>Sporobolus heterolepis</i>	Prairie Dropseed	Widespread; known from NW & S Ontario; prairies, alvars, rocky areas	G5	S3		
2	<i>Thamnophis sauritus</i>	Eastern Ribbonsnake	lack of information pertaining to Ontario populations; shoreline/wetland habitat degraded; may be sensitive to amphibian decline	G5	S3	SC	SC
2	<i>Trichophorum clintonii</i>	Clinton's Clubrush	Widespread but generally locally rare; fairly wide ecological amplitude; limited published literature	G4	S2S3		
3	<i>Aeshna clepsydra</i>	Mottled Darner	lack of biological / ecological information; historical records only	G4	S3		
3	<i>Aeshna verticalis</i>	Green-striped Darner	lack of biological / ecological information; historical records only	G5	S3		
3	<i>Ammodramus henslowii</i>	Henslow's Sparrow	Number's of Henslow's Sparrows in Ontario are extremely low, and its distribution is scattered and somewhat unpredictable. Breeding has not been confirmed within the past 20 years. Declines in Ontario are likely a result of changes in agricultural land use. May not be a good candidate for this analysis.	G4	SHB	END	END

Lake Simcoe Watershed Climate Change Vulnerability Assessment: Ecosystems

Rank	Scientific Name	Common Name	Rationale	Grank	Srank	COSEWIC	OMNR
3	<i>Arigomphus cornutus</i>	Horned Clubtail	very few records in the watershed	G4	S3		
3	<i>Arigomphus villosipes</i>	Unicorn Clubtail	Historic; no recent records in the watershed	G5	S2S3		
3	<i>Asio flammeus</i>	Short-eared Owl	largely a nomadic species therefore effects of climate change will likely be difficult to ascertain	G5	S2N,S4B	SC	SC
3	<i>Asterocampa celtis</i>	Hackberry Emperor	actual location falls outside LSWPA (accuracy buffer just inside LSWPA boundary)	G5	S2		
3	<i>Bartonia virginica</i>	Yellow Bartonia	actual location falls outside LSWPA (accuracy buffer just inside LSWPA boundary)	G5	S2		
3	<i>Brachythecium calcareum</i>	A Moss	lack of biological / ecological information	G3G4	S2		
3	<i>Chenopodium foggii</i>	Fogg's Goosefoot	questionable record; difficulty with identifications	G2G3	S2		
3	<i>Crataegus brainerdii</i>	Brainerd's Hawthorn	vague, historic record; no recent information; lack of biological / ecological information	G5	S2		
3	<i>Cyperus houghtonii</i>	Houghton's Flatsedge	can be weedy; lack of published literature	G4?	S3		
3	<i>Dichanthelium ovale ssp. praecocius</i>	White-haired Panic Grass	lack of biological / ecological information	G5T5?	S3		
3	<i>Enallagma aspersum</i>	Azure Bluet	lack of biological / ecological information	G5	S3		
3	<i>Glyptemys insculpta</i>	Wood Turtle	1 dead on road specimen at the ROM from the study area; 1 other historic record; few substantiated records; data sensitivity issues	G4	S2	THR	END
3	<i>Gomphus graslinellus</i>	Pronghorn Clubtail	only a single historic record	G5	S3		
3	<i>Heterodon platirhinos</i>	Eastern Hog-nosed Snake	vague record falls outside LSWPA (accuracy buffer just inside LSWPA boundary); no recent records from LSWPA	G5	S3	THR	THR
3	<i>Houstonia caerulea</i>	Bluets	Historic; no recent records in Ontario	G5	SH		
3	<i>Icteria virens</i>	Yellow-breasted Chat	no confirmed breeding in the Lake Simcoe watershed - mostly a Carolinian species.	G5	S2B	SC	SC
3	<i>Lestes eurinus</i>	Amber-winged Spreadwing	lack of biological / ecological information	G4	S3		
3	<i>Moxostoma valenciennesi</i>	Greater Redhorse	actual location falls outside LSWPA (accuracy buffer just inside LSWPA boundary)	G4	S3		
3	<i>Poa saltuensis ssp. languida</i>	Weak Blue Grass	vague data; lack of biological / ecological information	G5T3T4Q	S3		
3	<i>Pterospora andromedea</i>	Woodland Pinedrops	actual location falls outside LSWPA (accuracy buffer just inside LSWPA boundary)	G5	S2		

Lake Simcoe Watershed Climate Change Vulnerability Assessment: Ecosystems

Rank	Scientific Name	Common Name	Rationale	Grank	Srank	COSEWIC	OMNR
3	<i>Rallus elegans</i>	King Rail	This species is likely extirpated from the watershed.	G4	S2B	END	END
3	<i>Sistrurus catenatus</i>	Massasauga	vague, historic record; not part of accepted range; no recent sightings	G3G4	S3	THR	THR
3	<i>Somatochlora ensigera</i>	Plains Emerald	only a single historic record	G4	S1		
3	<i>Somatochlora forcipata</i>	Forcipate Emerald	only a single historic record	G5	S3		
3	<i>Somatochlora tenebrosa</i>	Clamp-tipped Emerald	only historic records exist	G5	S2S3		
3	<i>Stylurus spiniceps</i>	Arrow Clubtail	only a single historic record	G5	S2		
3	<i>Vertigo elatior</i>	Tapered Vertigo	lack of biological / ecological information	G5	S2S3		
3	<i>Zizania aquatica</i>	Indian Wild Rice	Some populations in Ontario likely introduced	G5	S3		