

Ontario Species at Risk Evaluation Report for
Mudpuppy
Necture tacheté
(*Necturus maculosus*)

Committee on the Status of Species at Risk in Ontario
(COSSARO)

Assessed by COSSARO as Special Concern

April 2024

Final

Executive summary

Mudpuppy is the largest salamander in Canada, with adults ranging from 20 to 49 cm total length. Mudpuppy is a permanently aquatic salamander, with prominent reddish, external gills which are retained throughout its life. Adult coloration ranges from a cream or rusty brown to grey or black, with scattered, darker blotches or spots.

Mudpuppy occurs throughout much of eastern North America. The distribution of Mudpuppy includes most of the east-central United States, from the Appalachian Mountains west to the Great Plains and from Louisiana in the south into the southern portions of Manitoba, Ontario and Quebec.

Mudpuppy is widely distributed in the southern portions of Ontario, particularly along the edge of the Great Lakes and associated drainages, the St. Lawrence River and in the Ottawa River basin. Current and historic records indicate that this species is found as far north as Thunder Bay in the west and Blanche River in the east.

A threats calculation for this species assigned the overall threat impact as High. Pollution, Natural System Modification, Residential and Commercial Development, Biological Resource Use and Invasive and other problematic species are considered to be the primary threats to this species.

Mudpuppy (*Necturus maculosus*) is classified as Special Concern in Ontario. Mudpuppy does not currently meet criteria to be considered Endangered or Threatened, however inferred declines in number of mature individuals and locations, as well as ongoing threats to the species, may result in this Mudpuppy becoming Threatened if threats are not reversed or managed. This species was not previously listed in Ontario under the *Endangered Species Act, 2007*.

1. Eligibility for Ontario status assessment

1.1. Eligibility conditions

1.1.1. Taxonomic distinctness

Mudpuppy (*Necturus maculosus*) is recognized as a distinct taxon. Mudpuppy is the most widely distributed member of the family Proteidae and is the only taxon of this family occurring in Canada (Petranka 2010).

1.1.2. Designatable units

The occurrences of Mudpuppy in Ontario are considered to be a single designatable unit and part of the Great Lakes-St. Lawrence DU.

1.1.3. Native status

Mudpuppy (*Necturus maculosus*) is native to Ontario.

1.1.4. Occurrence

Mudpuppy occurs throughout much of eastern North America. The distribution of Mudpuppy includes most of the east-central United States, from the Appalachian Mountains west to the Great Plains and from Louisiana in the south into the southern portions of Manitoba, Ontario and Quebec (COSEWIC 2023). In Canada, Mudpuppy is known to occur in Ontario, Manitoba and Quebec (COSEWIC 2023).

1.2. Eligibility results

Mudpuppy (*Necturus maculosus*) is eligible for assessment in Ontario.

2. Background information

2.1. Current designations

- GRANK: G5 (NatureServe 2015)
- IUCN: Least Concern (2021)
- NRANK Canada: N4N5 (NatureServe 2015)
- COSEWIC: Special Concern (2023)
- SARA: Not Listed
- ESA 2007: Not at risk
- SRANK: S4 (ranked in 2015)

2.2. Distribution in Ontario

Mudpuppy is widely distributed in the southern portions of Ontario, particularly along the edge of the Great Lakes and associated drainages, the St. Lawrence River and in the

Ottawa River basin (Gendron 1999; Ontario Nature 2023). Current and historic records indicate that this species is found as far north as Thunder Bay in the west and Blanche River in the east (Ontario Nature 2023). Mudpuppy appears to be absent from Lake Nipigon and from upstream of the Petawawa River, as well as from the Algonquin Dome (COSEWIC 2023).

2.3. Distribution, status and the broader biologically relevant geographic range outside Ontario

The distribution of Mudpuppy includes most of the east-central United States, from the Appalachian Mountains west to the Great Plains and from Louisiana in the south into the southern portions of Manitoba, Ontario and Quebec (COSEWIC 2023). Mudpuppy is ranked S4 in Manitoba and the Manitoba population was assessed as Threatened by COSEWIC in 2023. This species is also ranked as S3 in Quebec, New York, Pennsylvania, Michigan, Minnesota, and Indiana. Mudpuppy is also ranked S4 in Ohio and S1 in Illinois.

For the purposes of this assessment, the broader biologically relevant geographic range (BBRGR) for Mudpuppy is considered to include Quebec, Manitoba and states bordering the Great Lakes basin. Although rescue effect from subpopulations in these jurisdictions is unlikely, individuals of this taxon are likely to be capable of surviving and reproducing in Ontario.

Table 1. Condition of the Species in Adjacent Jurisdictions and Broader Biologically Relevant Geographic Range.

Adjacent Jurisdictions	Biologically Relevant to Ontario (n/a, yes, no)	Condition	Notes & Sources
Quebec	Yes	S3	NatureServe 2024
Manitoba	Yes	S4 Threatened	NatureServe 2024 COSEWIC 2023
New York	Yes	S3	NatureServe 2024
Pennsylvania	Yes	S3	NatureServe 2024
Ohio	Yes	S4	NatureServe 2024
Michigan	Yes	S3	NatureServe 2024
Minnesota	Yes	S3	NatureServe 2024
Wisconsin	Yes	S3	NatureServe 2024
Illinois	Yes	S1	NatureServe 2024
Indiana	Yes	S3	NatureServe 2024

2.4. Ontario conservation responsibility

Ontario’s conservation responsibility is considered to be low. A small proportion of the North American range and population of Mudpuppy occurs in Ontario.

2.5. Direct threats

A threats assessment was conducted by COSEWIC (2023), which assigned an overall threat impact for Mudpuppy as High. Known and suspected threats are listed below.

Pollution (High-Medium threat impact)

Chemical water pollution and siltation have reduced habitat suitability for Mudpuppy in several regions and have contributed to declines in the size of Mudpuppy populations in the U.S. (COSEWIC 2023). Mudpuppy subpopulations in the Great Lakes, the St. Lawrence River, and their tributaries, are exposed to high levels of contaminants (COSEWIC 2023).

Agricultural and Forestry Effluents (High-Medium threat impact)

Potential threats related to agricultural and forestry effluents include elevated loads of phosphorus, nitrogen, and suspended solids. Siltation in watercourses has been documented to reduce access to benthic shelters that are used for nesting and as refuges by Mudpuppy (Gendron 1999). Alteration of rivers and streambeds can also reduce the availability of food resources for Mudpuppy (COSEWIC 2023). Mudpuppy were noted to be absent from several St. Lawrence River tributaries and Southwestern Ontario watersheds that are heavily degraded by siltation over most of their length (COSEWIC 2023).

Household sewage and urban wastewater (Medium-Low threat impact)

Although effluent from municipal wastewater facilities has generally improved, non-persistent compounds such as organophosphate flame retardants, plasticizers, and pharmaceuticals continue to pose a toxicity risk to aquatic organisms (COSEWIC 2023). Increasing chloride levels related to road salt use also has the potential to negatively affect amphibians (COSEWIC 2023). This is an existing threat and is expected to continue in future (COSEWIC 2023). The potential threat impact related to household sewage and urban wastewater is considered to be medium-low, as there is substantial uncertainty about the subpopulation effects and average impact across the range of this species (COSEWIC 2023).

Industrial and Military Effluents (Low threat impact)

Industrial contaminants such as Polychlorinated biphenyls (PCBs) and other organochlorine compounds, as well as Mercury and heavy metals, are considered to be a potential threat to Mudpuppy. High levels of PCBs can result in limb deformities and PCBs and organochlorine pesticides were also reported to cause hormonal disturbances in Mudpuppy in the St. Lawrence River and the Ottawa River (Gendron et al. 1997).

Mercury was detectable in Mudpuppy tissues sampled from the St. Lawrence and Ottawa Rivers in the 1990's (COSEWIC 2023). Although there is an absence of research on the direct impacts of mercury contamination on Mudpuppy (COSEWIC

2023), mercury is broadly recognized as a toxin to vertebrates and is suspected to have resulted in some amphibian declines (COSEWIC 2023).

Lampricides (Unknown threat impact)

Mudpuppy mortalities have been reported historically following lampricide applications (COSEWIC 2023). Sensitivity to lampricides is suspected to increase during stressful times of the year (mating and spawning) and juveniles may be more sensitive than adults (COSEWIC 2023). The overall threat posed by applications of lampricides is unknown.

Natural Systems Modification (Medium-Low threat impact)

Dams and water management/use (Medium-Low threat impact)

Mudpuppy is vulnerable to sudden changes in water levels. Numerous carcasses have been observed along shorelines on several occasions after major storms or severe flooding (COSEWIC 2023). Individuals were washed onto banks or beaches and died after not being able to reenter water. In areas near hydroelectric power stations, abrupt changes in water levels related to facility operation have the potential to strand Mudpuppy in small pools (COSEWIC 2023).

Human activities that modify flooding regimes (e.g., dams) and that affect connectivity of watersheds (e.g., roads and infrastructure) also have an impact on habitat connectivity and viability of metapopulations of aquatic salamanders (Schalk and Luhring 2010). The scope of this threat is restricted to parts of the population affected by water management activities, and while the severity of this threat can be locally high, the frequency and extent of such rapid water change events is not known (COSEWIC 2023).

Other ecosystem modifications (Medium-Low threat impact)

Erosion from housing, shoreline development and land uses such as agriculture and forestry can degrade Mudpuppy habitat. Siltation results in the loss of crevices and refuges in bottom substrates, reducing habitat quality (COSEWIC 2023). The scope and severity for this threat is variable and considered to be a medium-low threat impact.

Residential and commercial development (Low threat impact)

Residential and commercial development in the Great Lakes region has resulted in an increasing human population density and the associated human-generated threats have contributed to deterioration of coastal ecosystems and their watersheds (COSEWIC 2023). Potential impacts related to residential and commercial developments are considered to be a low impact threat to Mudpuppy.

Biological Resource Use (Low threat impact)

Fishing & harvesting aquatic resources (Low threat impact)

Mudpuppy was historically commercially harvested in Lake Erie and Lake Ontario, however the current status of harvest is largely unknown (COSEWIC 2023). Mudpuppy may also be harvested for personal use with a small game license in Ontario and are often caught incidentally during ice fishing and angling. Collection and sale of Mudpuppy in Asian food markets have also been reported, and collections may occur for use in the pet trade and as fishing bait (COSEWIC 2023).

Invasive and other problematic species and genes (Unknown threat impact)

Mass mortality events related to type E botulism infection may be a leading cause of mortality for some subpopulations and is suspected to be associated with the death of 7,015 to 23,015 individuals in Lake Erie from 2000 to 2010 (COSEWIC 2023). With type E botulism, Mudpuppy is suspected to be affected through the food chain, by eating dead and contaminated fish (including gobies) that concentrate the toxins by consuming Zebra Mussel or Quagga mussel (COSEWIC 2023).

Invasive species introduced into the Great Lakes, such as Zebra Mussel, Quagga Mussel, and Eurasian Watermilfoil, can indirectly harm Mudpuppy by altering the composition of the habitat and the food chain (COSEWIC 2023). Round Goby may also pose a threat to Mudpuppy by consuming or attacking young-of-the-year (COSEWIC 2023). Rusty Crayfish and hybrids may also pose a threat to Mudpuppy, however further research is required (COSEWIC 2023).

2.6. Specialized life history or habitat use characteristics

Mudpuppy occupies permanent aquatic habitats, including both clear and turbid water in lakes, reservoirs, canals, ditches, and streams (Petranka 2010). This species is absent from ephemeral water bodies and from small ponds that dry or freeze. The species uses a variety of substrates (including rock, gravel, sand, and mud), but appears to be intolerant of heavy siltation (COSEWIC 2023). Habitats with an abundance of refuges and retreats appear to be preferred (Matson 2005) and a lack of shelters may limit habitat use (Sutherland et al. 2020). Mudpuppy are reported to be sedentary and limited information suggests that home ranges may be approximately 100 m² in size.

Mudpuppy does not hibernate, however spring migrations have been observed from deep water toward shorelines. Adult Mudpuppy prefer well-aerated waters downstream from or adjacent to riffles, and areas of high flow are avoided. Mudpuppy has also been reportedly captured at depths to 27 meters in Lake Michigan (COSEWIC 2023) and 17 meters in Lake Erie (COSEWIC 2023).

Breeding takes place in shallow water. Eggs are deposited on the roof of a small cavity dug under rocks, tree trunks, planks, and other debris. Nests typically occur near riffles at a depth of 50 to 200 cm. Larvae and juveniles are rarely observed in association with adults, appearing to prefer deeper water pools with low current (Beattie et al. 2017). In Ontario, young individuals have been found in shallow water among leaves and under flat rocks at the bottom of creeks, streams, and ponds. Later in development, juveniles are found under shelters not occupied by adults or predatory fish in portions of streams free of organic debris (COSEWIC 2023).

As an entirely aquatic salamander, recolonization of suitable habitats that are not hydrologically connected is unlikely (COSEWIC 2023). Dams may create barriers to gene flow, and high flows, opposing currents, insufficient water depth or the temporary drying of water bodies hinder dispersal and has the potential to isolate subpopulations (Mills and Hill 2016). Mudpuppy is widely distributed throughout the connected lakes and river systems in the Great Lakes-St. Lawrence DU and there is currently no evidence for fragmentation (COSEWIC 2023).

2.7. Existing Conservation and Recovery Actions

Mudpuppy is not currently designated as at risk in Ontario and no species-specific recovery actions are underway.

3. Ontario status assessment

3.1. Application of endangered/threatened status in Ontario

3.1.1. Criterion A – Decline in total number of mature individuals

Does not apply. Insufficient data to document change in total number of mature individuals.

3.1.2. Criterion B – Small distribution range and decline or fluctuation

Does not apply. IAO of 2,340 km² is above the threshold for Threatened, the population is not severely fragmented, the number of locations is >10, and extreme fluctuations have not been documented.

3.1.3. Criterion C – Small and declining number of mature individuals

Does not apply. Total number of mature individuals is unknown and insufficient data is available to document a decline.

3.1.4. Criterion D – Very small or restricted total population

Does not apply. Population is not considered to be very small or restricted.

3.1.5. Criterion E – Quantitative analysis

Does not apply. Analysis not conducted.

3.2. Application of Special Concern in Ontario

Applicable. Mudpuppy meets the threshold for Special Concern in Ontario. This species does not currently meet criteria to be considered Endangered or Threatened, however inferred declines in number of mature individuals and locations, as well as ongoing threats to the species, may result in this Mudpuppy becoming Threatened if threats are

not reversed or managed.

3.3. Status category modifiers

3.3.1. Ontario's conservation responsibility

Ontario's conservation responsibility is considered to be low. A small proportion of the North American range and population of Mudpuppy occurs in Ontario.

3.3.2. Status modification based on level of risk in broader biologically relevant geographic range

No status modifiers based on broader biologically relevant geographic range have been considered. Threats and population trends are similar in adjacent jurisdictions.

3.3.3. Rescue Effect

The potential for rescue effect from adjacent jurisdictions is possible but limited. This species is strictly aquatic and has a low dispersal rate. Any potential migration into Ontario would be limited to connected waterbodies.

3.4. Other status categories

3.4.1. Data deficient

Does not apply.

3.4.2. Extinct or extirpated

Does not apply.

3.4.3. Not at risk

Does not apply.

4. Summary of Ontario status

Mudpuppy (*Necturus maculosus*) is classified as Special Concern in Ontario. Mudpuppy does not currently meet criteria to be considered Endangered or Threatened, however inferred declines in number of mature individuals and locations, as well as ongoing threats to the species, may result in this Mudpuppy becoming Threatened if threats are not reversed or managed.

This status of this species is consistent with the definition of status under the *Endangered Species Act, 2007*.

5. Information sources

Beattie, A., M. Whiles, and P. Willink. 2017. Diets, population structure, and seasonal activity patterns of mudpuppies (*Necturus maculosus*) in an urban, Great Lakes coastal habitat. *Journal of Great Lakes Research* 43:132-143.

COSEWIC. 2023. IN PRESS. COSEWIC assessment and status report on the Mudpuppy *Necturus maculosus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 22 pp. (<https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html>).

Gendron, A., C. Bishop, R. Fortin, and A. Hontela. 1997. In vivo testing of the functional integrity of the corticosterone-producing axis in mudpuppy (Amphibia) exposed to chlorinated hydrocarbons in the wild. *Environmental Toxicology and Chemistry* 16:1694-1706.

Gendron, A. D. 1999. Status report on the Mudpuppy, *Necturus maculosus* (Rafinesque), in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, Ontario.

Harding, J. H. 1997. *Amphibians and Reptiles of the Great Lakes Region*. The University of Michigan Press, Ann Arbor, Michigan.

Matson, T. 2005. *Necturus maculosus* (Rafinesque, 1818), Mudpuppy. in M. Lannoo (ed.). *Amphibian Declines: The Conservation Status of United States Species*. University of California Press, Berkeley, California.

Mills, P., and D. Hill, D. 2016. Ancient lake maxima and substrate-dependent riverine migration have defined the range of the mudpuppy (*Necturus maculosus*) in southern Ontario following the Wisconsinan glaciation. *The Canadian Field-Naturalist* 130:158-163.

NatureServe. 2024. NatureServe Network Biodiversity Location Data accessed through NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.105412/Necturus_maculosus. (accessed March 7, 2024).

Ontario Nature. 2023. *The Ontario Reptile and Amphibian Atlas, 2009-2019*. Ontario Nature.

Petranka, J. W. 2010. *Salamanders of the United States and Canada* (2nd ed.). Smithsonian Books, Washington, DC.

Schalk, C., and T. Luhring. 2010. Vagility of aquatic salamanders: implications for wetland connectivity. *Journal of Herpetology* 44:104-109.

Sutherland, J., D. Mifsud, M. Stapleton, S. Spear, and K. Greenwald. 2020. Environmental DNA assessment reveals restoration success for mudpuppies (*Necturus maculosus*). *Herpetologica* 76:366-374.

Wellington, R. 2009. An overview of concerns and issues relating to the Mudpuppy, *Necturus maculosus maculosus*, in Lake Erie / Presque Isle Bay, Erie County, Pennsylvania. *Bulletin of the Chicago Herpetological Society* 44(3):38-41.

Appendix 1: Technical summary for Ontario

Species: Mudpuppy (*Necturus maculosus*)

Demographic information

Demographic attribute	Value
Generation time. Based on average age of breeding adult: age at first breeding = X year; average life span = Y years.	15 years.
Is there an observed, inferred, or projected continuing decline in number of mature individuals?	Yes. Inferred from lack of extant records particularly along northern shores of Lake Erie and Lake Ontario.
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations.	Unknown.
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over the last 10 years or 3 generations.	Unknown.
Projected or suspected percent reduction or increase in total number of mature individuals over the next 10 years or 3 generations.	Suspected reduction based on threats calculator (Overall Impact: High, projected decline of 10–70%).
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over any 10 years, or 3 generations, over a time period including both the past and the future.	Suspected reduction of 10–70% based on lack of extant records particularly along northern shores of Lake Erie and Lake Ontario and ongoing threats (calculator Overall Impact: High).
Are the causes of the decline (a) clearly reversible, and (b) understood, and (c) ceased?	a. Unknown. b. No. c. Unknown.
Are there extreme fluctuations in number of mature individuals?	Unknown. Several localized mass mortality events have been documented, but it is unknown what proportion of mature individuals in a population are affected by these events.

Extent and occupancy information in Ontario

Extent and occupancy attributes	Value
Estimated extent of occurrence (EEO).	447,523 km ²
Index of area of occupancy (IAO).	2,340 km ²
Is the total population severely fragmented? i.e., is >50% of its total area of occupancy in habitat patches that are: (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of locations.	Much greater than 10
Number of NHIC Element Occurrences	1,507 records from Ontario Nature and iNaturalist. Species not previously tracked by NHIC.
Is there an observed, inferred, or projected continuing decline in extent of occurrence?	Yes, inferred decline of up to 7%, based on extant vs. all (historical and extant) records. Assumes Mudpuppy were present but undetected prior to 1997 at all extant sites, due to limited search effort and low dispersal capacity of Mudpuppy.
Is there an observed, inferred, or projected continuing decline in index of area of occupancy?	Yes, inferred decline of ~14%, based on apparent loss (0.86) of historical cells x detection probability (0.16)
Is there an observed, inferred, or projected continuing decline in number of sub-populations or EOs?	Inferred decline due to lack of extant records along most of the northern shores of Lake Erie and Lake Ontario.
Is there an observed, inferred, or projected continuing decline in number of locations?	Inferred decline due to lack of extant records along most of the northern shores of Lake Erie and Lake Ontario
Is there an observed, inferred, or projected continuing decline in [area, extent and/or quality] of habitat?	Inferred decline in extent and quality of habitat.
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of mature individuals in each sub-population or total population (if known)

The number of mature individuals is unknown, but well over 10,000.

Quantitative analysis (population viability analysis conducted)

Probability of extinction in the wild is unknown.

Threats

A threats calculation for this species was conducted by COSEWIC (2023) and assigned the overall threat impact as High.

Pollution (High-Medium) - agricultural and forestry effluents, household sewage and urban, wastewater, and industrial and military, Lampricides

Natural System Modification (Medium-Low) - dams and water management/use, other ecosystem modifications

Residential & Commercial Development (Low) - housing and urban areas expansion

Biological Resource Use (Low) - fishing and harvesting aquatic resources

Invasive & other problematic species & genes (Unknown) - Invasive non-native/alien species

Rescue effect

Rescue effect attribute	Value
Does the broader biologically relevant geographic range for this species extend beyond Ontario?	Yes
Status of outside population(s) most likely to provide immigrants to Ontario	Quebec – S3 Manitoba – S4 (Threatened) New York – S3 Pennsylvania – S3 Ohio – S4 Michigan – S3 Minnesota – S3 Wisconsin – S3 Indiana – S3 Illinois – S1
Is immigration of individuals and/or propagules between Ontario and outside populations known or possible?	Likely possible, especially in shared trans-border waterbodies.
Would immigrants be adapted to survive in Ontario?	Yes
Is there sufficient suitable habitat for immigrants in Ontario?	Unknown
Are conditions deteriorating in Ontario?	Possibly
Is the species of conservation concern in bordering	Yes. Threatened in Manitoba.

Rescue effect attribute	Value
jurisdictions?	
Is the Ontario population considered to be a sink?	No.
Is rescue from outside populations likely?	Unlikely. Species has limited dispersal capability. Also, as Canada and the US share a border through the Great Lakes and St. Lawrence River, it is likely that any dramatic changes to conditions in either country will be felt across these contiguous water bodies.

Sensitive species

Not a data sensitive species.

Acronyms

COSEWIC: Committee on the Status of Endangered Wildlife in Canada
COSSARO: Committee on the Status of Species at Risk in Ontario
DU: Designatable Unit
ESA: Endangered Species Act
EO: Element occurrence (as defined by NHIC)
EOO: extent of occurrence
GRANK: global conservation status assessments
IAO: index of area of occupancy
IUCN: International Union for Conservation of Nature and Natural Resources
MNRF: Ministry of Natural Resources and Forestry
NHIC: Natural Heritage Information Centre
NNR: Unranked
NRANK: National conservation status assessment
SARA: Species at Risk Act
SNR: unranked
SRANK: subnational conservation status assessment
S1: Critically Imperiled
S2: Imperiled
S3: Vulnerable
S4: Apparently Secure
S5: Secure
IUCN: International Union for Conservation of Nature and Natural Resources
CDSEPO: Le Comité de détermination du statut des espèces en péril en Ontario