

**Ontario Species at Risk Evaluation Report for
Eastern Hog-nosed Snake
Couleuvre à groin de l'Est
(*Heterodon platirhinos*)**

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

Assessed by COSSARO as Threatened

November 2021

Final

Couleuvre à groin de l'Est (*Heterodon platirhinos*)

La couleuvre à groin de l'Est (*Heterodon platirhinos*) est classée dans la catégorie des espèces menacées en Ontario par le CDSEPO.

Les couleuvres à groin de l'Est sont présentes actuellement dans deux régions géographiquement distinctes en Ontario : la région carolinienne, au sud-ouest, et la région du Bouclier, dans la partie centrale de la province, délimitée par la rivière des Français et le lac Nipissing au nord et par la baie Georgienne, à l'est.

En dehors de l'Ontario, l'aire de répartition de la couleuvre à groin de l'Est englobe la majeure partie de l'est des États-Unis, en s'étendant de l'Ontario, vers le sud, jusqu'à la Floride et au golfe du Mexique et de la côte de l'Atlantique, vers l'ouest, jusqu'à certaines parties du Texas, de l'Oklahoma, du Kansas et du Nebraska. Cette espèce se trouve dans 1 province, 34 États et dans le District de Columbia.

La couleuvre à groin de l'Est se nourrit presque exclusivement de crapauds, toxiques pour la majorité des prédateurs. Sa densité est faible et elle est très vagile (mobile), ce qui, au total, augmente sa vulnérabilité à l'urbanisation, à la fragmentation de l'habitat et à la mortalité due à la circulation routière. Ces menaces sont de niveaux différents dans la région carolinienne et dans la région du Bouclier, ces menaces étant supérieures dans la région carolinienne.

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Executive summary

Eastern Hog-nosed Snakes are large, stout-bodied snakes. This species common name is derived from the upturned scale at the tip of its snout, a feature unique to hog-nosed snakes that is used for excavating loose soils. Eastern Hog-nosed Snakes are found from south-central Ontario southward across much of eastern United States. In Ontario, this species occurs in two geographically distinct areas: the Carolinian Region in the southwest and the Great Lakes/St. Lawrence Region in the central part of the province, south of the French River and Lake Nipissing and east of Georgian Bay. Eastern Hog-nosed Snake occurs in low densities, with recorded values in Ontario ranging from 0.004 to 0.04 adults per hectare. In Ontario, Eastern Hog-nosed Snakes are experiencing a continuing decline in abundance, due on ongoing threats that include road traffic mortality, road construction and expansion, urban expansion, agricultural intensification, introduced and abnormally abundant predators, and direct persecution. Based on recent extirpation of five subpopulations, there appear to be significant range contractions in landscapes that have been highly modified by agriculture and urbanization in the south, as well as in more intact landscapes in the northeast, including protected areas. The magnitude of decline is uncertain because this species is more challenging to monitor than other, similarly sized snakes in Ontario; however, Eastern Hog-nosed Snakes are suspected to decline within the province by more than 30% over the next 20 years.

1. Eligibility for Ontario status assessment

1.1. Eligibility conditions

1.1.1. Taxonomic distinctness

Eastern Hog-nosed Snake (*Heterodon platirhinos* Latreille 1801; family Colubridae) is one of five North American Hog-nosed Snakes in the genus *Heterodon* (Crother et al. 2017). Its common name is derived from the upturned, keeled scale on the tip of its snout, which gives the snake its unique “hog-nosed” appearance (Johnson 1989). Some confusion existed historically regarding the correct spelling of the Latin binomial for this species however, this was clarified by Platt (1985). No subspecies of Eastern Hog-nosed Snake are currently recognized (Crother et al. 2017).

1.1.2. Designatable units

The distribution of Eastern Hog-nosed Snake in Ontario comprises two ecologically distinct regions located in separate Terrestrial Amphibians and Reptiles Faunal Provinces (Carolinian and Hurontario). While disjoint distributions across these two faunal provinces is not uncommon in reptile species in Ontario, the distribution of Eastern Hog-nosed Snake is less disjunct than other Ontario reptile species, particularly when historical records are considered.

Genetic data from 12 microsatellite DNA markers support distinction of the Hurontario (Shield) region but also contain evidence for three additional genetically distinct clusters in Ontario (Wasaga Beach, Long Point/Norfolk county, and Pinery and Rondeau Provincial Parks) (Xuereb et al. 2015). These genetic clusters provide evidence of population fragmentation and discreteness but do not provide sufficient evidence of evolutionary significance between the two regions.

Separation of the Ontario Eastern Hog-nosed Snake population into more than one designatable unit is not supported by the available information. Historic records do not demonstrate a disjunct distribution in the province, and microsatellite DNA data do not identify designatable units based on eco-geographic regions nor do they provide sufficient evidence for evolutionary significance among distinct clusters. Based on this, Eastern Hog-nosed Snake should continue to be addressed in Ontario as a single Designatable Unit.

1.1.3. Native status

Eastern Hog-nosed Snake is Native to Ontario (COSEWIC 2021).

1.1.4. Occurrence

Eastern Hog-nosed Snakes are currently found in two geographically distinct areas in Ontario: the Carolinian Region in the southwest and the Shield region in the central

portion of the province bound by the French River and Lake Nipissing to the north, and east of Georgian Bay (Figure 1).

1.2. Eligibility results

Eastern Hog-nosed Snake (*Heterodon platirhinos*) is eligible for status assessment in Ontario.

2. Background information

2.1. Current designations

- GRANK: G5 (NatureServe 2016)
- IUCN: Least Concern (March 2007)
- NRANK Canada: N3
- COSEWIC: Threatened (April 2021)
- SARA: Threatened (Schedule 1)
- ESA 2007: Threatened (2007)
- SRANK: S3 (ranked in 2015)

2.2. Distribution in Ontario

Eastern Hog-nosed Snake are currently restricted to two geographically distinct areas in Ontario: the Carolinian Region and the Shield region of central Ontario south of the French River and Lake Nipissing and east of Georgian Bay. This species is absent from the St. Lawrence and eastern portions of the province with only a few records as far east as Peterborough and Bancroft. Historic records of this species extend almost as far east as Ottawa.

The northern limit of Eastern Hog-nosed Snakes corresponds to portions of the province that experience 120-day frost-free period or to areas with greater than 2100 Annual Crop Heat Units (COSEWIC 2021). The species extends farther north into slightly cooler areas where there are sandy, exposed, south-facing slopes with warmer soil conditions for incubation; availability of suitable thermal conditions is likely responsible for northern range limits (Brooks et al. 2003).

Records for Eastern Hog-nosed Snake indicate several areas where the species has not been documented within the past 20 years. There are no current records (i.e., since 1998) in the Golden Horseshoe region around the west end of Lake Ontario, or in extensive areas of southwestern Ontario including Point Pelee National Park. Despite multiple historical records, there is only a single current (2001) record of a road-killed Eastern Hog-nosed Snake on Pelee Island. This species is likely extirpated from Algonquin Provincial Park as it has not been documented there since the early 1980s. Occurrence records for this species also indicate areas where Eastern Hog-nosed Snake was either not found historically or was infrequently recorded. There are multiple current records in the Goderich area, where this species was first reported in 2011. Increases in the number of occurrences of Eastern Hog-nosed Snake records likely

reflects increased search effort for this species rather than an expanding range in Ontario.

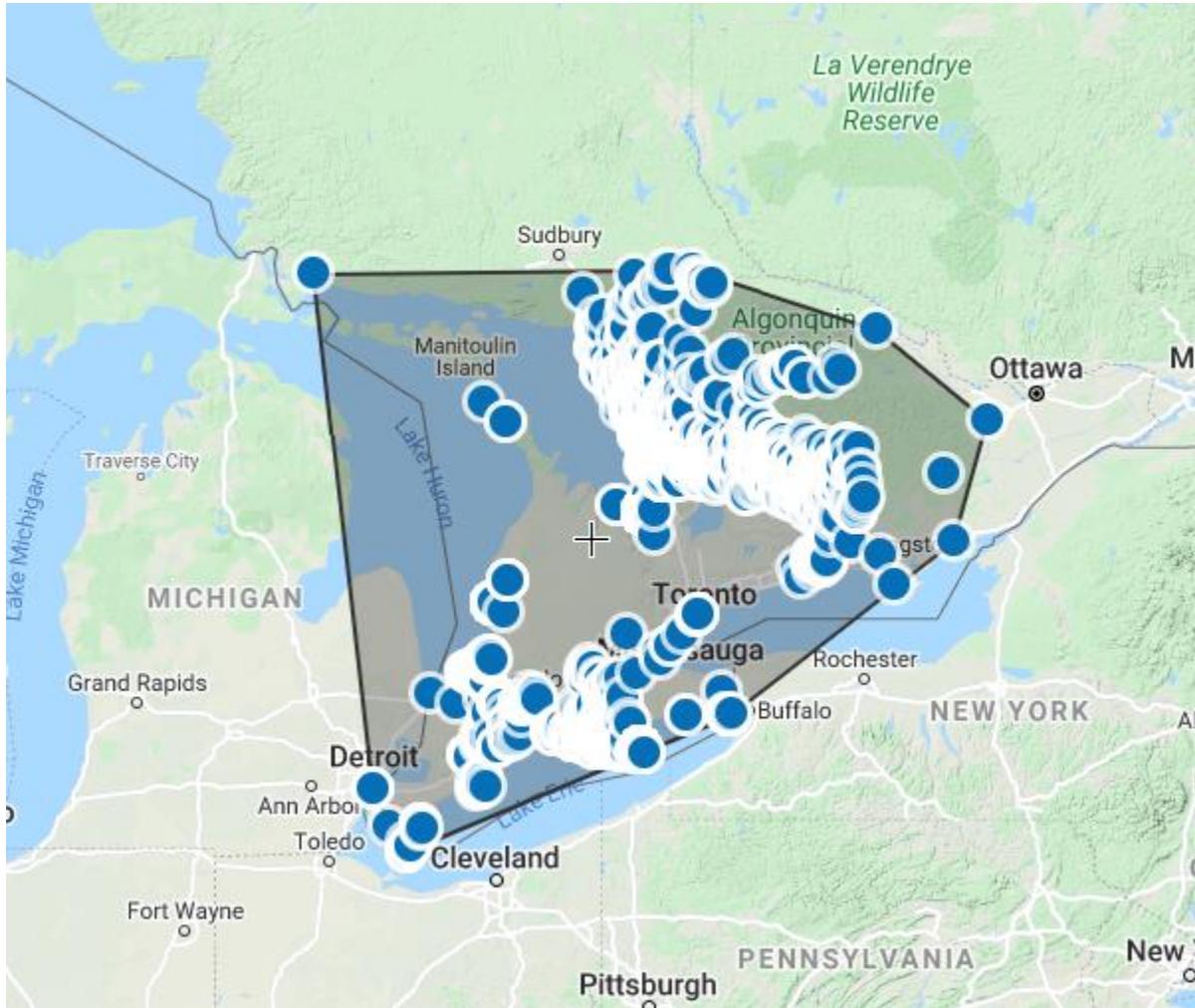


Figure 1. All Ontario Eastern Hog-nosed Snake (*Heterodon platirhinos*) records from Natural Heritage Information Centre. Created for this report using [GeoCAT](#) [website accessed November 4, 2021].

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

Eastern Hog-nosed Snake is found in Ontario and throughout much of the eastern United States with a range that extends from Ontario south to Florida and the Gulf of Mexico, and from the Atlantic Coast west to parts of Texas, Oklahoma, Kansas, and Nebraska. Eastern Hog-nosed Snakes are found in one province, 34 states, and the District of Columbia.

Outside of Ontario, Eastern Hog-nosed Snake is listed at some level of risk in 14 of the 36 states where it is found (NatureServe 2021); this species does not occur in Canada outside

of Ontario. According to NatureServe (2021), the status for Eastern Hog-nosed Snake was up-listed (i.e., risk of becoming endangered has increased) in 8 states since the last COSSARO assessment 2007; it is listed as Possibly Extirpated (SH) in the District of Columbia, Critically Imperiled (S1) in New Hampshire and listed as Imperiled (S2) in an additional five states (NatureServe 2021). Eastern Hog-nosed Snake was down-listed (i.e., risk of becoming endangered has decreased) in one state since 2007; in Ohio it was previously listed as Vulnerable (S3) and is now listed as Apparently Secure (S4).

It should be noted that Eastern Hog-nosed Snakes are not known to be present along much of the southern shorelines of the Great Lakes (Figure 2).



Figure 2. Global distribution of Eastern Hog-nosed Snake (*Heterodon platirhinos*) (NatureServe and IUCN 2007) [website accessed November 4, 2021].

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	--		
Manitoba	--		
Michigan	Yes	S3	NatureServe (2021)
Minnesota	No	S4	NatureServe (2021)
Nunavut	--		

Adjacent Jurisdictions	Biologically Relevant to Ontario (n/a, yes, no)*	Condition	Notes & Sources
New York	No	S3	NatureServe (2021)
Ohio	Yes	S4	NatureServe (2021)
Pennsylvania	No	S3	NatureServe (2021)
Wisconsin	No	S4	NatureServe (2021)
<i>Other Relevant Jurisdiction</i>			

*See additional discussion regarding inclusion of adjacent jurisdictions in the Broader Biologically Relevant Range in Section 3.1.8 of this report.

2.4. Ontario conservation responsibility

Less than 10% of the global range of Eastern Hog-nosed Snake is in Ontario.

2.5. Direct threats

Habitat loss from intensive agriculture and residential development, increase in road networks and subsequent road mortality and habitat fragmentation are major threats to this species' survival. Other threats include human-caused persecution, nest predation by subsidized predators, and other anthropogenic threats. Eastern Hog-nosed Snake occurs in low densities and is highly vagile (mobile), which when considered together increases its susceptibility to urbanization, habitat fragmentation, and road mortality. The Carolinian and Shield regions of Ontario experience different levels of these threats with the Carolinian region typically having a higher threat level. Direct threats to Eastern Hog-nosed Snakes are further outlined below.

Roads constitute a medium-impact threat that is pervasive. The threat to this species from roads comes in the form of accidental mortality and habitat destruction from newly built roads, and ongoing mortality from traffic on existing roads. Road density has been found to be significantly higher in areas where Eastern Hog-nosed Snake has been extirpated compared to areas where the species persists (Crowley 2006), suggesting that roads and associated impacts are a driver of local extirpation. Motor vehicles on paved roads, unpaved roads, and trails may be second only to habitat loss as a cause of declines and losses of reptile populations (Wright 2007), and vagility and high dispersal capability have been previously implicated in increasing road mortality of herpetofauna (Gibbs 1998; Bonnet et al. 1999; Carr and Fahrig 2001).

Although specific data on population-level effects of road mortality are not available for Eastern Hog-nosed Snakes, population models for several other Canadian snake species with similar life-histories have demonstrated that even small increases in annual adult mortality can result in significant declines and increases in local extinction risk (Middleton and Chu 2004; Row et al. 2007; COSEWIC 2013, 2018).

Of the 945 IAO grids with current records of Eastern Hog-nosed Snake, 747 have roads for a total length of 3447 km (COSEWIC 2021). The Carolinian region has a high density of roads (Taylor et al. 2001), whereas in the Shield region, road densities are lower; however, the expansion of Highway 69 and the related upgrades of surrounding roads may have resulted in an increase of mortality from more vehicles and higher speed traffic. Radiotracking data show that Eastern Hog-nosed Snakes in some cases avoid crossing paved, but not unpaved roads (Robson and Blouin-Demers 2013), although in other cases that avoidance appears to be dependent on traffic rather than substrate (Rouse et al. 2011). These studies suggest that roads in general are a source of mortality for this species.

For a vagile snake, roads represent linear barriers; snakes may attempt to cross and be killed or avoid crossing (Cunnington 2006; Hawbaker et al. 2006; Rouse 2006; Robson and Blouin-Demers 2013). Reluctance to cross roads might seem beneficial to survival; in reality it exacerbates the fragmentation of suitable habitat as road networks expand, producing small isolated pockets of Eastern Hog-nosed Snakes that are unable to disperse and may suffer from inbreeding. For example, radio-tracked snakes have been found moving along the edges of roads in Wasaga Beach Provincial Park without crossing (Cunnington unpub. data), and one of the snakes tracked in Goderich in 2018 was killed by a roadside mower (COSEWIC 2021). Species that move longer distances may be at greater risk of decline in fragmented landscapes due to increased energetic costs and mortality rates (Roe et al. 2004, 2006). This contrasts with the widely held belief that species that are more vagile may be most resistant to habitat fragmentation.

Roadkill has been documented across the species' Ontario range. In Rondeau Provincial Park over 23 days of irregular sampling in Sept-Oct 2001, 241 snakes, including two Eastern Hog-nosed Snakes, were found dead on a part of one road (Gillingwater and Brooks 2002). An additional Eastern Hog-nosed Snake was found dead on the park road in June 2001. In Pinery Provincial Park, Eastern Hog-nosed Snake was the snake species most commonly encountered as roadkill (COSEWIC 2007); since 2003 its abundance seems to have declined markedly, and the species is now rarely encountered (COSEWIC 2007).

Xuereb et al. (2014) developed microsatellite markers for Eastern Hog-nosed Snake to assess genetic diversity and quantify spatial structuring of the species in Ontario. Distinct genetic clusters were found in Wasaga Beach, Georgian Bay/Shield, and Long Point/Norfolk County, with a fourth cluster comprising individuals from Pinery and Rondeau Provincial Parks (Xuereb et al. 2015). Snakes distributed over a large area of relatively continuous habitat in the Shield region east of Georgian Bay were genetically similar (Xuereb et al. 2015). Genetic data from each of these four Ontario subpopulations revealed evidence of inbreeding and population declines over time. In addition, using an Approximate Bayesian Computation approach, it was estimated that a bottleneck occurred in the Wasaga Beach subpopulation approximately 117 years ago (95% CI 32.5-162.6 years) (Xuereb et al. 2015).

Housing and urban area development constitute a threat for Eastern Hog-nosed Snakes through direct mortality during development, loss of habitat, and habitat fragmentation.

Cottage and seasonal home development is continuing on the Shield. The town of Wasaga Beach witnessed 13% growth between 2015 and 2019 (McSweeney & Associates 2020).

Agriculture poses a threat to Eastern Hog-nosed Snakes as more land is being intensively farmed, particularly in southwestern Ontario in the Carolinian region, than occurred historically. This includes new clearing of woodland habitat not previously farmed, and conversion of small farms to larger farms and the removal of hedgerows. Agricultural impacts are limited on the Shield, as there is agriculture is not a dominant land use in that region.

Invasive and other problematic species pose a low-impact threat, restricted in scope (11-30% of population exposed) but slight in severity (1-10% population decline within the scope). Predation on reptiles by feral and domestic animals, particularly cats, is well documented (Loss et al. 2013). Nest predation by subsidized predators such as Raccoon (*Procyon lotor*) has not been quantified but is potentially a significant threat. Range expansion of Wild Turkey (*Meleagris gallopavo*) also increases predation risk.

Natural system modifications pose a threat to Eastern Hog-nosed Snakes. Fire suppression may decrease suitable habitat for this species due to loss of open canopy habitat, which is important for thermoregulation. Expansion of the invasive Common Reed (*Phragmites australis*) presents a low-impact threat, as it overtakes wetlands and adjacent habitat in the Carolinian region, where it will likely impact breeding, foraging, and thermoregulation habitat of Eastern Hog-nosed Snake; this is currently not an issue on the Shield.

Eastern Hog-nosed Snake is protected; however, human persecution is still a low-impact threat because of the species' exaggerated and intimidating, although harmless, defensive display and the fact that these displays make it resemble venomous snakes such as "cobras" and "puff adders". During the threats calculator meeting, experts noted that they continue to receive calls about people killing snakes. Collection is also part of the threat of persecution, as there is demand for these snakes in the pet trade (COSEWIC 2021).

Logging and wood harvesting may also pose a threat, primarily from accidental mortality during logging activities and from habitat degradation. Currently, Ontario Canadian Forestry Standards Association (stand and site guide) requires little consideration of Eastern Hog-nosed Snake or its habitat during forestry operations (COSEWIC 2021). Although hibernacula and nesting sites are protected under this legislation, these are difficult to identify on the landscape and as such little to no protections are applied to forestry activities. Forestry operations and crown forest activities extensively overlap with Eastern Hog-nosed Snake distribution in the Shield region. Severity of this threat is considered 'unknown' due to the limited data.

Recreational activities pose a threat to Eastern Hog-nosed Snakes where pedestrian and off-road vehicle use of beach or dune habitat results in the disturbance or destruction of nests due to erosion, soil compaction, or direct crushing. As well, off-road vehicle use can result in direct mortality on juvenile and adult snakes throughout their

range. As previously noted, threats from human activity occur even in protected areas (Cunnington, unpub. data); this is a particular concern for Eastern Hog-nosed Snake in the Carolinian region where many of the parks and conservation reserves with snake occurrences are small and intensively used by people and vehicles (Kerr and Cihlar 2004; Crowley 2006). Additionally, the defense behavior exhibited by this species often elicits negative reactions by humans leading to intentional killing of individuals. Finally, interactions with pets, both on and off leash, often result in the death of individual snakes (Cunnington, unpub. data).

Discarded waste in natural settings may pose a threat to Eastern Hog-nosed Snakes. Human garbage for example can pose a threat; there have even been two reported cases of Eastern Hog-nosed Snake getting stuck in discarded pop cans (COSEWIC 2021). Plastic mesh netting may also pose a threat; this material is used for gardening, erosion control, and vegetation establishment (COSEWIC 2021). Other snake species, including Eastern Foxsnake, have become lethally entangled in this material. Eastern Hog-nosed Snake may also be threatened by herbicide and pesticide runoff from agricultural crops in the Carolinian region (COSEWIC 2021).

Limiting factors for this species include availability of suitable habitat, especially sandy soils for oviposition (in some areas) and hibernation sites, availability of prey, and climate. Concentration of nests and high nest site fidelity have been noted in several locations and lend support to the argument that nesting sites are limiting. Eastern Hog-nosed Snake is a prey specialist and in Ontario has been observed to feed almost exclusively on toads, so any decline in numbers of American Toad or Fowler's Toad could limit the Eastern Hog-nosed Snake population. Such coincident declines have recently occurred at Pinery Provincial Park (COSEWIC 2007), as well as Point Pelee National Park (Markle et al. 2018) and other sites along Lake Erie in Ontario where Fowler's Toads were once abundant (Schueler 1997). Climate limits the northern range of the population and likely impacts nest success, reproductive capacity (e.g., number of clutches each year, or overall hatch success) and suitable hibernation habitat, especially in the northern portion of its distribution.

2.6. Specialized life history or habitat use characteristics

Eastern Hog-nosed Snake feeds almost exclusively on toads, which are toxic to most predators. This feeding strategy thus provides an excellent opportunity to study metabolism and digestion. The snake's elaborate defense displays, including death feigning, also provide a rare opportunity to study evolution of anti-predator behaviour and make the species of educational value to the public. The elaborate defense displays also increase the potential for harm to individual snakes when interacting with humans.

Age at maturity for Eastern Hog-nosed Snake is 2-3 years of age in the United States, and snakes can live to 11 years in captivity (Harding 1997). In the northern portion of this species' range, age at maturity for snakes may be as high as 4-5 years (Seburn 2009). Adult survival in Arkansas has been estimated at ~50% (Plummer and Mills

2000). Generation time (GT) can be estimated as $GT = \text{age 50\% maturity} + 1/M$ where $M = \text{natural mortality rate}$. Thus, $GT = 4.5 + 1/0.50 = 6.5$ years (COSWEIC 2021).

Eastern Hog-nosed Snake is oviparous; oviposition can occur anytime during a 2-3 week period beginning in late June-early July, with young snakes emerging from nests in August-September (Cunnington and Cebek 2005; Buchanan 2012; COSWEIC 2021). In one study (Cunnington and Cebek 2005) incubation periods varied from 49 to 63 days, with highly variable temperatures within some individual nests.

Clutch size in the wild in Ontario averages around 27 eggs per nest, ranging between 7 and 40 eggs (Cunnington and Cebek 2005; Peet-Paré and Blouin-Demers 2012; COSWEIC 2021). In Ontario, the only study published to date reported hatching success of 33.3%, 57.1%, and 74.1% in three nests in the wild (Cunnington and Cebek 2005). Average number of days to hatching of nests in the wild is 58 ($n=3$); hatching occurs in late August and early September (Cunnington and Cebek 2005). No data are available on post-hatching and juvenile survival, but limited data on adult survival suggest an annualized rate of ~50% (Plummer and Mills 2000).

At the northern range limit, access to microsites with sufficient heat for thermoregulation and incubation is critical. Anatomical and physiological features, including large gape and enlarged adrenal glands, likely reflect the degree to which Eastern Hog-nosed Snake has become relatively specialized and reliant on toads as prey (Spaur and Smith 1971). This specialization may limit its adaptability to environmental changes that impact either it or its prey, particularly at the edge of the species range.

Eastern Hog-nosed Snake is highly vagile and moves relatively long distances, albeit slowly, when compared to other large snakes. Average daily distance moved by adult Eastern Hog-nosed Snake was estimated at 30 m/day in Massachusetts (Buchanan *et al.* 2017), 51 m/day in New Hampshire (Lagory *et al.* 2009), and daily movements of 100 m are known to occur (Cunnington 2004). The maximum straight-line distance moved over an active season approaches 5 km (Rouse 2006). Adult males have been found to be more vagile than adult females during the mating season (Rouse *et al.* 2011). However, reproductive females make substantial movements as they seek appropriate conditions for nesting and make large movements (as large as 250 m) immediately following oviposition (Cunnington and Cebek 2005; Robson 2011; Buchanan *et al.* 2017). Adult Eastern Hog-nosed Snake has home ranges of approximately 35 ha in Massachusetts (Buchanan *et al.* 2017), 39 ha in the Long Point area in southern Ontario (Robson 2011), 50 ha in New Hampshire (Lagory *et al.* 2009) and can exceed 100 ha in Wasaga Beach Provincial Park in Ontario (Cunnington 2004). Home ranges were significantly larger when they included some closed-canopy forested habitat than when they contained only managed early successional habitat (Akresh *et al.* 2017); this supports the theory that habitat quality may affect home range size. In the northern part of their Canadian range, the average range length (the two points furthest apart within the home range) for Eastern Hog-nosed Snake was 2180 m (range of 116-4971 m; Rouse 2006). Most of the above studies are not explicit about including or excluding movements to hibernacula in range estimates; differences in such movements among studies may increase heterogeneity among those estimates.

Across the species' range, Eastern Hog-nosed Snake appears to hunt mainly by olfaction, and feeds primarily on toads, frogs, and lizards (Platt 1969). Insects, other amphibians, molluscs, birds, crustaceans, turtles, earthworms, and spiders have also been recorded as part of the diet, as documented in the United States (Hamilton and Pollack 1956; Mills and Yeomans 1993). In Ontario, wild adult snakes have only been documented feeding on American and Fowler's toads (COSEWIC 2021).

2.7. Existing Conservation and Recovery Actions

During summer 2005, a dedicated survey near the Trent-Severn Waterway was conducted by Parks Canada using 4-5 people experienced with searching for Eastern Hog-nosed Snakes; they visited a total of 32 previously identified sites (element occurrences) from the NHIC database. No Eastern Hog-nosed Snakes were found but seven of the 32 element occurrences were described as good habitat. The remaining were in habitat deemed poor to fair (COSEWIC 2021).

Annual surveys during the May long weekend have been conducted on Beausoleil Island in Georgian Bay Islands National Park since 2009 (COSEWIC 2021). The species appears to be widely distributed and relatively abundant across the northern half of Beausoleil Island where surveys have occurred.

Occurrence of Eastern Hog-nosed Snake north of Goderich was first reported in 2011. In 2017, researchers surveyed local residents in Goderich and collected 50 new observations of this species, and in 2018 a radio-telemetry tracking study tracked 10 individuals (Maddalena 2019), with tracking continuing in this area in 2019 (COSEWIC 2021).

Over the past two decades, Eastern Hog-nosed Snakes have occasionally been observed during surveys for turtles and snakes on islands and on the mainland in the area of Twelve Mile Bay, south of MacTier (COSEWIC 2007).

Many areas in Norfolk County are also sporadically, but usually annually, searched by naturalists and herpetologists for species at risk, including Eastern Hog-nosed Snake.

Areas that have been checked for Eastern Hog-nosed Snakes (in some cases on an annual basis) include Long Point Provincial Park and National Wildlife Area, an area 30 km south of Parry Sound bisected by the Hwy 400 extension, Rondeau Provincial Park, St. Williams Conservation Reserve, Trent-Severn Waterway, Wasaga Beach Provincial Park, Beausoleil Island and Georgian Bay Islands National Park, the Upper Thames River Watershed including Komoka Provincial Park, and an area north of Goderich.

Two multi-year mark-recapture studies have occurred in Wasaga Beach Provincial Park, in 2001-2005 and in 2015-2017 (COSEWIC 2021), enabling an estimate of subpopulation size in Wasaga Beach Provincial Park.

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

Meets criterial for Threatened (A2cde, A3cde, A4cde).

A suspected >30% decline in number of mature individuals over the past (A2), within the next (A3), and over three generations (20 years) spanning the past and future (A4), based on a decline in index of area of occupancy, extent of occurrence, and quality of habitat (subcriterion c), exploitation (subcriterion d), and the effects of introduced and subsidized predators (subcriterion e).

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

Not applicable. This species EOO and IAO both exceed the thresholds for this criteria.

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

Not applicable. Number of mature individuals is over 10,000, exceeding the threshold for this criteria.

3.1.4. Criterion D – Very small or restricted total population

Not applicable. The population is neither very small nor restricted.

3.1.5. Criterion E – Quantitative analysis

Not applicable. Analysis not conducted.

3.1.6. Application of Special Concern in Ontario

Not applicable as species meets criteria for Threatened.

3.1.7. Ontario's conservation responsibility

As less than 10% of the global range of Eastern Hog-nosed Snake is in Ontario, the province's conservation responsibility is low.

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

Eastern Hog-nosed Snakes are found in both the Carolinian and Shield Regions of the province. While this species is absent from the St. Lawrence Drainage, which includes much of eastern Ontario and most of New York State (COSEWIC 2021). Eastern Hog-nosed Snake is found throughout many of the states immediately to the south of Ontario; however, records in these states are generally located towards the southern portions of these states and not directly adjacent to the Great Lakes (Figure 2). The Broader Biologically Relevant Geographic Range for Eastern Hog-nosed Snakes would

therefore not include states for which the species range is not contiguous with Ontario. Based on this, the Broader Biologically Relevant Range (BBRR) for Ontario Eastern Hog-nosed Snakes only includes the state of Michigan and the northern portion of Ohio (Figure 2).

The threats to Eastern Hog-nosed Snake within the Broader Biologically Relevant Range are similar to those within Ontario (e.g., habitat loss, habitat damage, direct and indirect mortality, climate change, etc.) and these threats do not appear to be ongoing as is evident from the recent change in listing status indicating the species is at increased risk of becoming endangered within the species range. While it should be noted that the status of Eastern Hog-nosed Snake within Ohio is S4, this area only accounts for a very small portion of the BBRR. Given the similar listing status in Michigan, which accounts for the majority of the BBRR, and Ontario, no modification based on the Broader Biologically Relevant Range is recommended at this time.

3.1.9. Rescue Effect

Although Eastern Hog-nosed Snake occurs in the United States directly south and west of Ontario, the southern part of its Ontario range is separated from the American population by the Great Lakes and large rivers. Given that Eastern Hog-nosed Snake has only rarely been reported to swim (Tynning 1990, Cunningham unpub. data), there is little evidence that it would cross large water bodies, and any rescue is unlikely. Additionally, in areas bordered by rivers, habitat is generally unsuitable due to extensive agriculture, urban development, and a high density of road networks.

3.2. Other status categories

3.2.1. Data deficient

Not applicable.

3.2.2. Extinct or extirpated

Not applicable.

3.2.3. Not at risk

Not applicable.

4. Summary of Ontario status

Eastern Hog-nosed Snake (*Heterodon platirhinos*) is classified as Threatened in Ontario based on meeting criterion A2cde, A3cde, and A4cde.

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

5. Information sources

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Appendix 1: Technical summary for Ontario

Species: Eastern Hog-nosed Snake (*Heterodon platirhinos*)

Demographic information

Demographic attribute	Value
<p>Generation time. Based on average age of breeding adult: age at first breeding = X year; average life span = Y years.</p>	~6-7 years
Is there an observed, inferred, or projected continuing decline in number of mature individuals?	Yes based on inferred and projected continuing decline based on ongoing threats (primarily road mortality) and going habitat loss.
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.	Suspected reduction of > 30% due to road mortality, habitat loss, and other threats.
Projected or suspected percent reduction or increase in total number of mature individuals over the next 10 years or 3 generations.	Suspected reduction of >30% due to road mortality, habitat loss and other threats. Threats Calculator projects a 10-70% decline.
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 >30% due to ongoing road mortality, habitat loss and other threats. Threats Calculator projects a 10-70% decline.
Are the causes of the decline (a) clearly reversible, and (b) understood, and (c) ceased?	a. No b. Yes c. No
Are there extreme fluctuations in number of mature individuals?	No

Extent and occupancy information in Ontario

Extent and occupancy attributes	Value
<p>Estimated extent of occurrence (EOO). <i>If value in COSEWIC status report is not applicable, then use geocat.kew.org. State source of estimate.</i></p>	209,580 km ²
<p>Index of area of occupancy (IAO). <i>If value in COSEWIC status report is not applicable, then use geocat.kew.org. State source of estimate.</i></p>	4,164 km ²
<p>Is the total population severely fragmented? i.e., is >50% of its total area of occupancy is 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?</p>	<p>a. No b. Unlikely; however, the landscape is highly fragmented by roads.</p>
<p>Number of locations. <i>See Definitions and Abbreviations on COSEWIC and IUCN websites for more information on the term "location". Use plausible range to reflect uncertainty if appropriate.</i></p>	<p>Unknown but presumed to be large (>10). Road mortality and habitat loss from human developments are probably the greatest threats, but these vary in scope and intensity throughout the range.</p>
<p>Number of NHIC Element Occurrences <i>Request data from MNRF.</i></p>	>7,500
<p>Is there an observed, inferred, or projected continuing decline in extent of occurrence?</p>	<p>Yes (observed), decline based on comparisons of current and historical records.</p>
<p>Is there an observed, inferred, or projected continuing decline in index of area of occupancy?</p>	<p>Yes (observed), decline based on comparisons of current and historical records.</p>
<p>Is there an observed, inferred, or projected continuing decline in number of sub-populations or EOs?</p>	<p>Yes, (observed) decline based on extirpation of 5 NHIC element occurrences (=subpopulations); timing of extirpation is uncertain.</p>
<p>Is there an observed, inferred, or projected continuing decline in number of locations?</p>	<p>Unknown</p>
<p>Is there an observed, inferred, or projected continuing decline in [area, extent and/or quality] of habitat?</p>	<p>Yes (observed and inferred) decline in area</p>

Extent and occupancy attributes	Value
	and quality of habitat due to urban and residential expansion including new roads, expansion of existing roads, increases in traffic volumes, and agricultural expansion in some areas.
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)

Sub-population (or total population)	Number of mature individuals
Total	Number of adults is unknown, but rough estimates put the total number of mature individuals at less than 15,000

Quantitative analysis (population viability analysis conducted)

Probability of extinction in the wild is unknown, as no Population Viability Analysis has been completed for this species.

Threats

Threats were calculated for this species on January 7, 2020.

Key threats were identified as:

- i. Transportation and Service Corridors (4.1 – roads and railroads) – Medium threat impact
- ii. Residential and commercial development (1.1 – housing and urban areas) – Low threat impact
- iii. Agriculture and aquaculture (2.1 – annual and perennial non-timber crops; 2.2 – wood and pulp plantations) - Low threat impact
- iv. Biological resource use (5.1 – hunting and collecting terrestrial animals) - Low threat impact
- v. Human intrusions and disturbances (6.1 – recreational activities) - Low threat impact
- vi. Natural system modifications (7.1 – fire and fire suppression; 7.3 – other ecosystem modifications) - Low threat impact

- vii. Invasive and other problematic species and genes (8.1 – invasive non-native/alien species) – Low threat impact
- viii. Climate change and severe weather (11.3 – storms and flooding) – Low threat impact

Additional relevant limiting factors:

This is a prey specialist (toads) with particular reliance on sandy soils for prey availability, hibernation, and oviposition. Low reproductive potential limits its ability to rebound from perturbations.

Rescue effect

Rescue effect attribute	Value
Does the broader biologically relevant geographic range for this species extend beyond Ontario?	Probably
Status of outside population(s) most likely to provide immigrants to Ontario	Vulnerable (S3) in Michigan
Is immigration of individuals and/or propagules between Ontario and outside populations known or possible?	Unknown, but unlikely due to separation of Canadian range from American range by the Great Lakes and large areas of unsuitable habitat.
Would immigrants be adapted to survive in Ontario?	Probably
Is there sufficient suitable habitat for immigrants in Ontario?	Unknown
Are conditions deteriorating in Ontario?	Yes
Is the species of conservation concern in bordering jurisdictions?	Yes
Is the Ontario population considered to be a sink?	No
Is rescue from outside populations likely?	No, rescue is unlikely due to separation of Canadian range from American range by the Great Lakes.

Sensitive species

Yes, this species is known to be targeted for collection by hobbyists (including illegal wildlife trade) and for intentional killing. Specific location information, including hibernacula, should not be shared. Eastern Hog-nosed Snakes are data-restricted in Ontario.

Acronyms

COSEWIC: Committee on the Status of Endangered Wildlife in Canada

COSSARO: Committee on the Status of Species at Risk in Ontario

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