MANAGEMENT PLAN FOR THE SNAPPING TURTLE *(Chelydra serpentina)* IN NOVA SCOTIA

A report prepared for the Nova Scotia Department of Natural Resources and Renewables

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Management Plan for the *Snapping Turtle 2026*

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Cover illustration: Adult snapping turtle, Antigonish Landing, Antigonish County. Photo courtesy of John Chiasson, Antigonish.

PREFACE

Sixty-one percent of all global turtle species are threatened or extinct (Lovich et al. 2018). Over the past 25 years the conservation status of Snapping Turtle throughout its Canadian range has been uplisted from relatively low to moderate risk of extirpation due to increased levels of risk, and new understanding of data. National NatureServe conservation status (i.e., risk assessment) ranks assigned in the Wild Species: General Status of Species in Canada reports for Snapping Turtle declined from 'Apparently Secure' (N4) in 2000, 2005, 2010, and 2015, to 'Vulnerable' (N3) in 2020. This change in risk status was a reflection of increased levels of risk in all jurisdictions where the species occurred, and new interpretation of data. At the sub-national level, Nova Scotia rankings mirrored national rankings, with one exception. Nova Scotia's recognition of an increased level of risk to this species was reflected in a S3 designation in 2015. Snapping Turtle was assessed as Special Concern (SC) in 2008 by The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and listed under Schedule 1 of the federal Species at Risk Act (SARA; 2011). There has been no COSEWIC status update since 2008. The International Union for Conservation of Nature (IUCN) lists Snapping Turtle globally as 'Least Concern' (LC) based on a 2010 assessment. In 2013, the Nova Scotia Department of Natural Resources designated Snapping Turtle as 'Vulnerable' under the Nova Scotia Endangered Species Act (NSESA). A federal management plan was drafted in 2016 (Environment and Climate Change Canada 2016) and updated in 2020 (Environment and Climate Change Canada 2020).

Management Plan for the *Snapping Turtle 2026*

Under the *Nova Scotia Endangered Species Act (2007)*, a Management Plan is defined as "…*a statement of needs and actions to be undertaken to keep a vulnerable species from becoming at increased risk.*"

The objectives and actions identified in this Management Plan are based upon the best available information on the species and is subject to modifications and/or revisions as new information becomes available. Management of Vulnerable species at risk is a shared responsibility and the collaborative approach emphasized in this document is reflective of this. Implementation of the actions and approaches identified in this plan are subject to budget constraints, appropriations, and changing priorities.

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Recovery Team Members

- Dr. Tom Herman
- Dr. Julia Riley
- Jeffie McNeil
- Dr. Matthew Smith
- Peter Kydd
- Mark Pulsifer

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EXECUTIVE SUMMARY

The Snapping Turtle (*Chelydra serpentina*) was assessed nationally as Special Concern by COSEWIC in 2008, and under the Species at Risk Act in 2011. In Nova Scotia, this species was listed as Vulnerable under the Nova Scotia Endangered Species Act in 2013. Snapping Turtle is the largest freshwater turtle in Canada and has a distinctly prehistoric look with its large head, strongly hooked upper jaw, and muscular neck, limbs and tail. Snapping Turtle are found in all counties in Nova Scotia; however, occurrence records indicate that the population is likely largest, in central and western regions with an estimated total population size numbering in the few thousands.

The Snapping Turtle is a habitat generalist, occupying a wide variety of freshwater habitats characterized by shallow slow-moving water with soft mud or sandy substrates. Suitable overwintering and nesting sites are critical for sustainability and individuals demonstrate a high level of fidelity to both. Snapping Turtle life-history characteristics such as delayed maturity, low recruitment, and extreme longevity make them vulnerable to anthropogenic threats. The most serious threats to long-term persistence include vehicle mortality, subsidized predation, and human persecution. Emerging threats that may play a more significant role in future include impacts of climate change such as increased flooding, erosion, and temperature, as well as impacts from invasive species.

Management objectives for this species focus on four elements: reduce principal threats, increase demographic knowledge, maintain current levels of occupancy, and maintain abundance over the long-term. This will be achieved using several management actions that focus on habitat management and stewardship, surveys and monitoring, community outreach and education, enhanced enforcement and policy, and research to address gaps in current knowledge. Management activities are prioritized, and categorized into short, medium and long-term timelines, and will be monitored to assess progress.

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Assessment Summary:
Common Name: Snapping Turtle
Scientific Name: *Chelydra serpentina*
Status: Special Concern (COSEWIC 2008)
Reason for Designation: Although the species is widespread and still somewhat abundant, its life history (late maturity, great longevity, low recruitment, lack of density-dependent responses) and its dependence on long, warm summers to complete incubation successfully make it unusually susceptible to anthropogenic threats. When these threats cause even apparently minor increases in the mortality of adults, populations are likely to decline as long as these mortality increases persist. There are several such threats and their impacts are additive. Aboriginal Traditional Knowledge generally supports the declining trend and population figures in the COSEWIC report.
Occurrence: Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba and Saskatchewan
Nova Scotia Occurrence: All counties in Nova Scotia
Status History: Special Concern (COSEWIC 2008)
Special Concern (SARA 2011)
Vulnerable (NSESA 2013)

*The following definitions are applicable in this section and elsewhere: NSSARWG (Nova Scotia Species at Risk Working Group); COSEWIC (Committee on the Status of Endangered Wildlife in Canada); NSESA (Nova Scotia Endangered Species Act); SARA (Species at Risk Act).

2. SPECIES STATUS INFORMATION

Snapping Turtle are still abundant throughout much of its range; however, there are indications that some populations are coming under increased threats. Snapping Turtle exhibit several life history characteristics (i.e., late maturation, long lifespan, low recruitment, absence of density-dependent responses), and a dependence on warm summers for successful incubation that make them vulnerable to anthropogenic threats (ECCC 2020). In Nova Scotia, Snapping Turtle is still a relatively common species in

most watersheds; however, populations continue to come under increasing threats that act synergistically to place populations at risk.

In Nova Scotia, Snapping Turtle comes under the jurisdiction of the Nova Scotia Department of Natural Resources (NSDNR). The species is protected under the Nova Scotia Wildlife Act and classified as Vulnerable (2013) under the NSESA. Species classified as Vulnerable under the NSESA require a management plan.

Definitions of ranks are provided below. Global ranking was last reviewed 8 Dec 2024. (https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.103761/Chelydra_serpentina).*

Table 1. NatureServe Conservation Status Ranks for Snapping Turtle in Canada

Global (G) Rank[a]	National (N) Rank[b]	Subnational (S) Rank[c]
G4 (Apparently Secure)	N4 (Apparently Secure)	S3 - (Vulnerable) NS, NB, MB, SK S4 – ON, QU (Apparently Secure)

[a] G-Rank – Global Conservation Status Rank, G1 = Critically Imperiled; G2 = Imperiled; G3 = Vulnerable; G4 = Apparently Secure; G5 = Secure
[b] N-Rank – Provide ranking for each province the species is found in. National Conservation Status Rank, N1 = Critically Imperiled; N2 = Imperiled; N3 = Vulnerable; N4 = Apparently Secure; N5 = Secure
[c] S-Rank – Sub-national (provincial or territorial) ranks, S1 = Critically Imperiled; S2 = Imperiled; S3 = Vulnerable; S4 = Apparently Secure; and S5 = Secure. B = breeding; and U = Unrankable.
*A full list of definitions can be found in Definitions of NatureServe Conservation Status Rankings at http://help.natureserve.org/biotics/Content/Record_Management/Element_Files/Element_Tracking/ETRACK_Definitions_of_Heritage_Conservation_Status_Ranks.htm

G4, N4, S4 - Apparently Secure — At fairly low risk of extinction or collapse due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.

S3 – Vulnerable - At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.

Snapping Turtle was last formally assessed by COSEWIC as “Special Concern” in 2008 and is currently under review for reassessment. Special concern refers to wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats (https://cosewic.ca/index.php/en/assessment-process/cosewic-assessment-process-categories-and-guidelines/status-categories.html).

Nationally, Snapping Turtle is listed as Special Concern on Schedule 1 of the SARA (2011). The definition of Special Concern for COSEWIC and SARA is the same. Snapping Turtle is an Appendix II species on the Convention on International Trade in

Endangered Species of Wild Fauna and Flora (CITES). Appendix II includes species that may become threatened with extinction in future if their trade is not monitored (https://cites.org/eng/app/index.php).

The International Union for the Conservation of Nature (IUCN) ranked Snapping Turtle as “least concern”(2010), meaning that it has been evaluated against conservation (Red List) criteria and does not meet the standard for critically endangered, endangered, vulnerable, or near threatened (https://www.iucnredlist.org/#:~:text=Least%20Concern%20(LC),qualify%20for%20Endangered%20Near%20Threatened).

3. SPECIES INFORMATION

3.1. Species Description

The Snapping Turtle (*Chelydra serpentina* Linnaeus 1758) is the largest freshwater turtle in Canada. This species has a distinctive “prehistoric” look. Adult carapace lengths typically range from 22 to 35 cm in Nova Scotia (Gilhen 1984). This species has a large head, strongly hooked upper jaw and withsmall barbels on the chin. The neck is long and muscular with tubercles along its length. The carapace varies in colour from tan, olive, brown, green, or black, with dark radiating lines extending from the apex of each scute to their margins. There are three keels on the carapace that extend along its length and the posterior scutes are strongly serrated. Concentric growth rings may be visible on scutes of younger turtles. The unhinged plastron has a cruciform shape and is relatively small compared to other turtles, leaving the heavily muscled limbs and sides unprotected. The muscular tail is nearly as long as the carapace and has a medial row of raised pyramidal tubercles. Amongst adults, the size of the head, and length of neck and tail are unique amongst other freshwater turtles in Canada. Adult male Snapping Turtle are larger than adult females. Hatchlings and immature turtles are scaled-down versions of adults with the same morphological features that make them unique amongst other freshwater turtles (Gilhen 1984; Steyermark *et al.* 2008; ECCC 2020).

3.2. Population and Distribution

3.2.1. Global Distribution

Snapping turtle are a widely distributed endemic North American species found throughout the eastern and central United States, and southern and Maritime Canada This species has the greatest latitudinal extent of all turtles in North America and extends west from the Atlantic coastline to the eastern base of the Rocky Mountains, and south to the Gulf of Mexico (Figure 1).

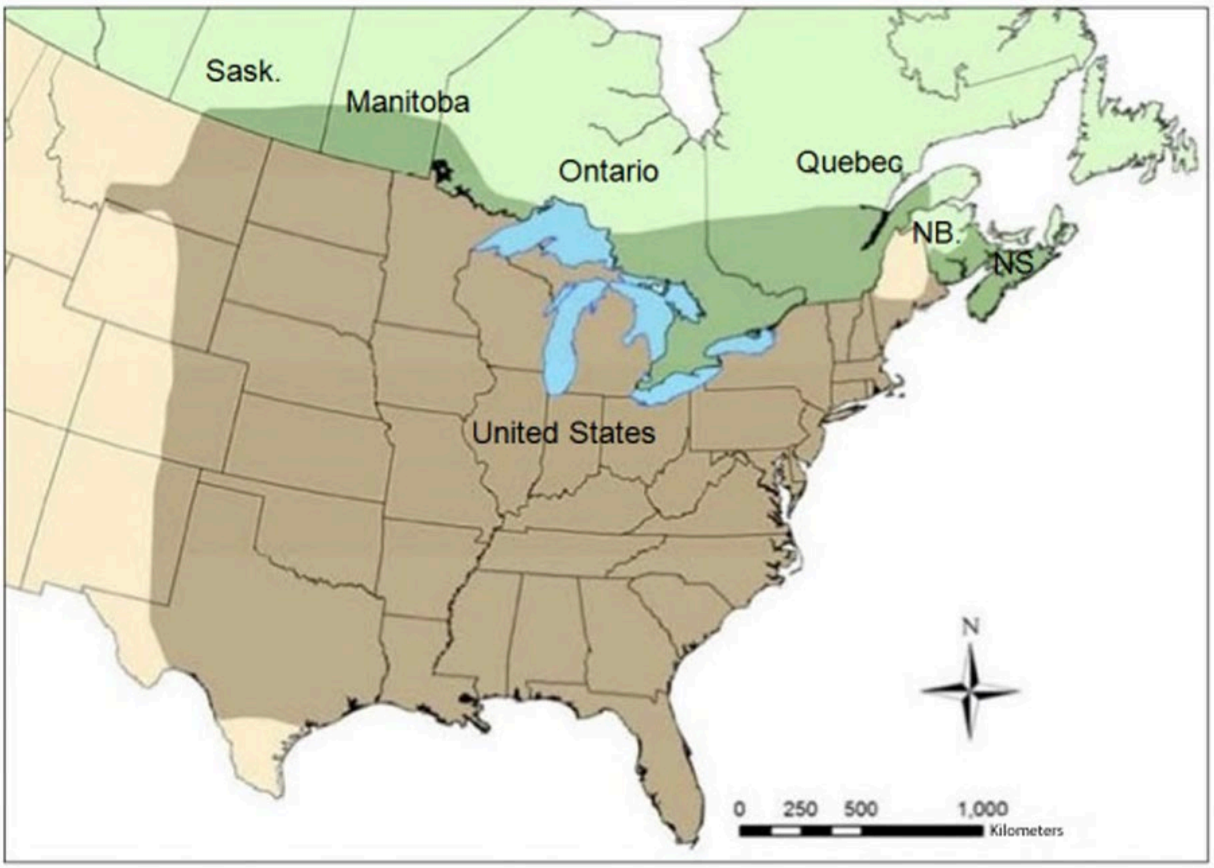

Figure 1. North American distribution of Snapping Turtle. Figure originally from ECCC (2020) Snapping Turtle management plan.

3.2.2. Canadian Range

In Canada, Snapping Turtle are primarily found in southern areas of Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, and all of Nova Scotia. The most northern occurrence is found near the Ontario – Manitoba border at 54°N latitude. The northern limit of this specie's range appears to be dependent on suitable incubation time for eggs, as opposed to physiological constraints of overwintering (Ultsch 2006).

3.2.3. Nova Scotia Range

Snapping Turtle are found in all counties within the province. The extent of occurrence for Snapping Turtle in Nova Scotia is based on several sources. Gilhen (1984) reported that this species was most common in the western part of the province and declined in abundance northeast of Halifax, with only three records for Cape Breton Island. More recently, Gilhen and Power (2018), and Power and Gilhen (2018) have established that Snapping Turtle have likely been present, and breeding in Cape Breton for several decades. A review of 874 provincial Biodiversity Investigation Reports (BIRs) collected

between 1999 and 2024 for this species by the Nova Scotia Department of Natural Resources and Renewables supports these studies (Figure 2). Occurrence distribution is further supported by iNaturalist observations (n=992; 28 Jan 2025) suggesting that while this species is found throughout the province, it is most common in central and western areas (Figure 3).

The relatively low numbers of reported occurrences in eastern and northern Nova Scotia may reflect habitat and environmental conditions, human population numbers and level of opportunity for interaction with turtles, and/or human tendencies to report sightings.

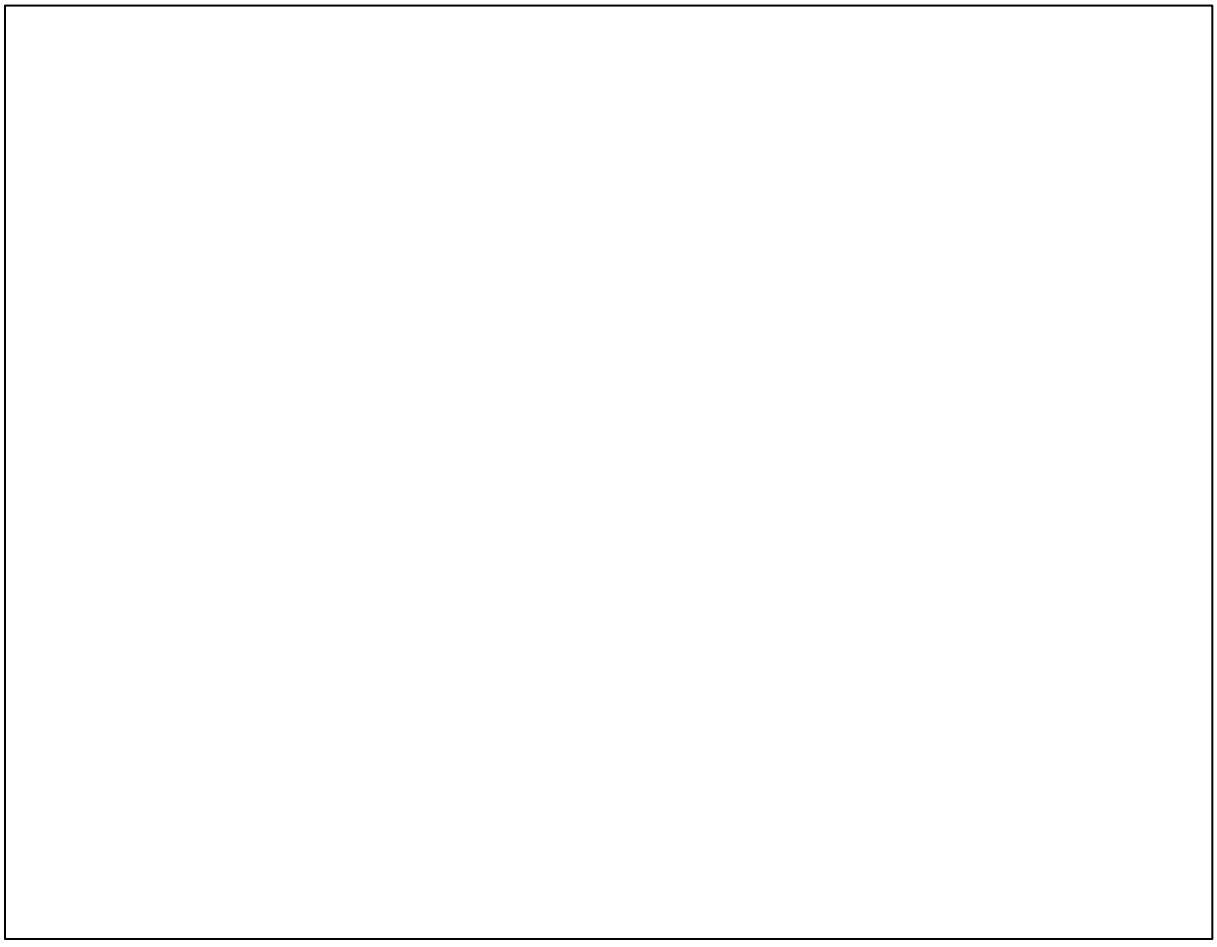

Figure 2. Distribution of NSDNRR BIR occurrences for Snapping Turtle in Nova Scotia. Figure courtesy of the NSDNRR Wildlife Division.

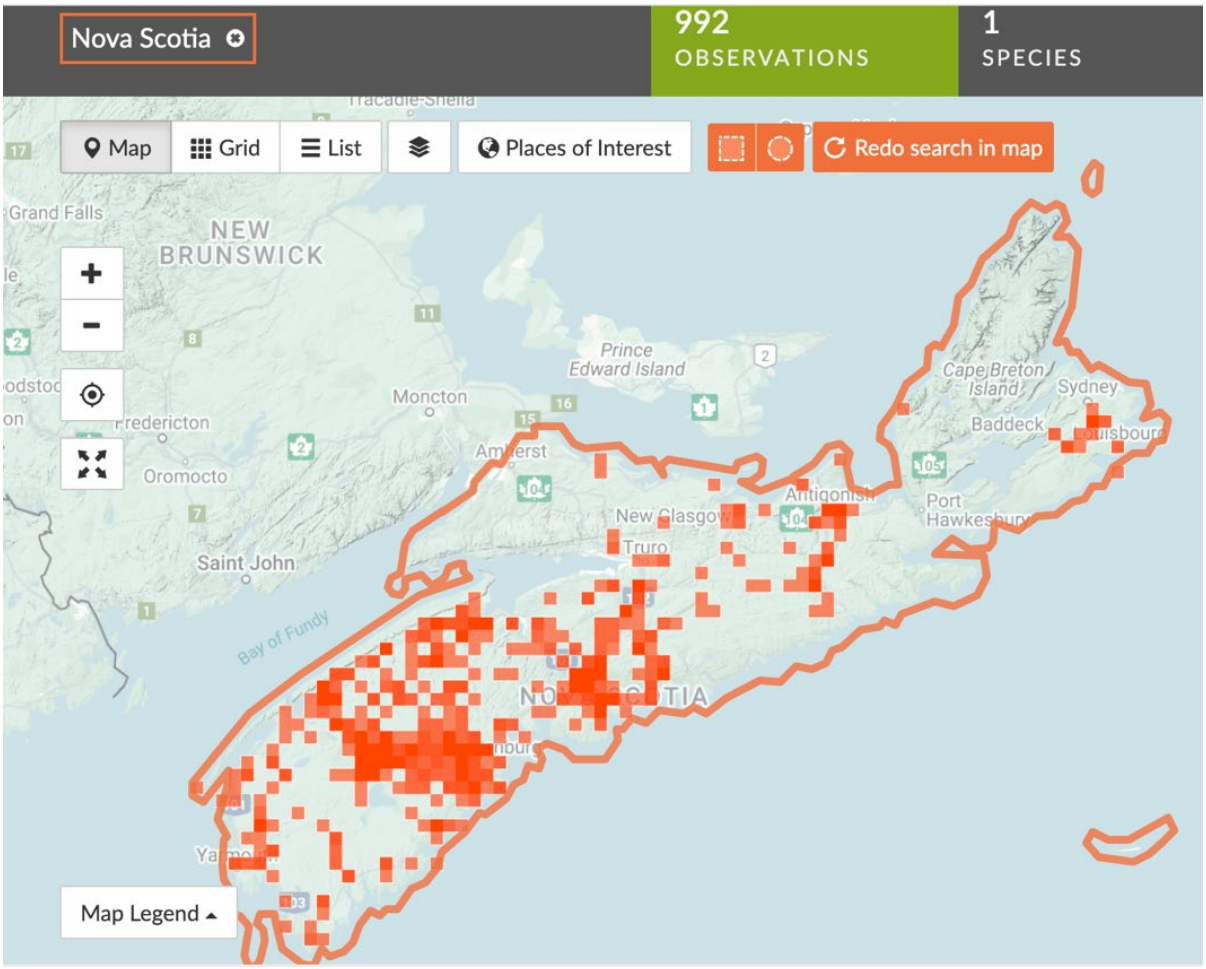

Figure 3. iNaturalist observations for Snapping Turtle in Nova Scotia reported up to January 2025. Image derived from species search on website. Note the similarities with the provincial BIR distribution with the exception of a concentration of iNaturalist observations in the western interior of the province.

3.2.4. Population Size and Trends

The size of the Nova Scotia Snapping Turtle population is unknown; however, the population is thought to be relatively abundant in eastern Canada (ECCC 2020). Provincial distribution records based on BIRs and iNaturalist reports suggests that the population likely numbers in the thousands. Populations of Snapping Turtle in Ontario are trending downward from the combined effects of several threats, particularly, adult mortality from vehicle collisions, and loss of habitat. Changes in turtle population numbers in Nova Scotia are difficult to track due to current levels of knowledge. It is reasonable to assume that most of the more serious threats to Snapping Turtle in other jurisdictions also impact numbers in Nova Scotia at various ecological scales. With low recruitment rates, any threat that results in adult mortality has the potential to impact long-term population numbers.

3.3. Species Needs

3.3.1. General Habitat Needs

The Snapping Turtle is a habitat generalist that can be found in almost all freshwater habitats (Buchanan *et al*. 2017); however, the most stable populations are often found in the vegetated shallows of lakes and watercourses with slow-moving water, soft mud or sandy substrates. Transient individuals can also be found in small wetlands, ponds, ephemeral waterbodies, and drainage ditches. Maintenance of critical habitats such as nesting and overwintering sites are essential for long-term sustainability of populations (Piczak and Chow-Fraser 2019).

Home range size for both sexes combined averaged 3.44 ha, and most animals showed high fidelity with their home ranges (Obbard and Brooks 1981).

Turtles produce young that are essentially miniature versions of adults, and differences in body size can also result in age-related differences in habitat and diet (Congdon *et al.* 1992). Although the habitat preferences of hatchlings and juveniles is relatively unknown, Congdon *et al.* (1992) found that hatchling and juvenile *Chelydra* generally selected shallow aquatic habitats for foraging and predator avoidance, while older and larger individuals exploited deeper and larger bodies of water.

3.3.2. Overwintering

Snapping Turtle require overwintering sites to prevent freezing. In northern latitudes turtles may spend more than half of their lives overwintering (Ultsch 2006). Snapping Turtle are one of the few species that can persist under hypoxic or anoxic conditions for several months (Ultsch and Reese 2006). At the northern limits of the specie’s range, selection of appropriate overwintering sites is critical for survival. Preferred overwintering sites have water that is deep enough not to freeze to the bottom, shallow enough that turtles can reach air if needed, has a mud bottom to bury into, will experience ice-free conditions early in the spring, and is associated with structural features such as stumps, logs, and overhanging banks that provide protection from predators (Meeks and Ultsch 1990; Brooks *et al.* 1991; Brown and Brooks 1994). Snapping Turtle will utilize a variety of aquatic hibernacula in three general locations, stream sites, lakeshore sites, and muddy sites (Brown and Brooks 1994). Individuals or small groups will overwinter in cattail stands (Meeks and Ultsch 1990), buried in mud (Obbard and Brooks 1981), in seeps and springs (Dunson 1986), and under banks (Petit *et al.* 1995). In Nova Scotia, Snapping Turtle will emerge from their winter hibernaculae in May and return to aquatic overwintering sites in autumn (Gilhen 1984). Snapping Turtle young are not able to overwinter in the nest. Hatchlings must emerge before winter and go to water (Ultsch 2006). Snapping Turtle have been shown to demonstrate a high level of fidelity to their overwintering sites, so it is critical that overwintering sites be protected wherever possible (Brown and Brooks 1994).

3.3.3. Reproduction and Nesting

Less than 0.1% of Snapping Turtle eggs hatch and survive to reproductive maturity; therefore, population survival is contingent on suitable nesting habitat that facilitates successful incubation, development, and recruitment (Kolbe and Janzen 2002**;** Marchand and Litvaitis 2004). Females exhibit nest site fidelity and will return to the same site year after year (Obbard and Brooks 1980). Suitable nesting habitat contains well-drained substrate, minimal levels of vegetation and good solar exposure (Dekker 2015; Thompson *et al.* 2017; Kolbe and Janzen 2002). Naturally occurring nest sites include sandy, gravely, or rocky shorelines, abandoned beaver lodges, and muskrat houses (Obbard and Brooks 1980). In disturbed or urbanized landscapes lacking natural habitats Snapping Turtle will attempt to nest in anthropogenically created locations such as road shoulders, agricultural fields, gravel parking lots, gardens, or created gravel mounds. Increased nest and hatchling success in created mounds has been described by Paterson *et al.* (2013). Congdon *et al.* (1987) found that shaded Snapping Turtle nests in Michigan did not provide enough heat to ensure complete development and successful emergence. Gilhen (1984) reported that in Nova Scotia, Snapping Turtle typically lay 19 – 41 eggs in beach sand or gravel above the water's edge, or in nearby wood roads. Less common nest sites include sawdust piles at mill sites, residential gardens, or sand bunkers on golf courses. Eggs hatch between late September and the end of October after 75-100 days in the nest (Obbard and Brooks 1981). Emergent hatchlings use visual, and to lesser extent, olfactory cues to move to the first water they encounter, and depending on environmental conditions may remain there their first winter (Ehrenfeld 1979).

3.3.4. Thermoregulation

Turtles are ectotherms and rely on environmental conditions to regulate their body temperatures and functions such as nesting excursions (Krawchuk and Brooks 1998), egg production (Carrière *et al.* 2008), and digestion (Hammond *et al.* 1988). Snapping Turtle occupy a variety of habitats that vary in their thermal properties; consequently, thermoregulation requires individuals to select atmospheric basking sites and aquatic thermal patches (Dubois *et al.* 2009). Basking behaviours are more positively correlated with daily solar radiation, and the temperature of surrounding substrates rather than ambient temperature (Obbard and Brooks 1979; Dutta *et al.* 2020). Although Snapping Turtle do not aerial bask as much as other freshwater turtles (Ryan *et al.* 2014), they will utilize basking sites such as emergent logs (Obbard and Brooks 1979) and concrete slabs (Elsey 2021).

3.3.5. Foraging

Snapping Turtle are omnivorous apex ambush predators that consume a variety of algae, plants, invertebrates, and vertebrates throughout their broad geographic range (Ernst and Lovich 2009; Alcott *et al.* 2020). Dietary preferences are a function of turtle

size, particularly in hatchling and juvenile turtles who prefer shallow and/or ephemeral aquatic habitats where they can feed on invertebrates, amphibians, and scavenge on carrion (Moldowan *et al.* 2015). Adults prefer to forage on amphibians, snakes, fish, young waterfowl, and small mammals in deeper water.

3.3.6. Movement

Snapping Turtle are commonly found within 5 m of shore in water < 2 m deep (Brown 1992); however, they will use terrestrial habitats for movement. Understanding terrestrial movements of freshwater turtles are important for understanding ecological connectivity, sex and age-related habitat use, population genetics, conservation priorities and land-use planning (Ryan *et al*. 2014; Rowe *et al.* 2020). Snapping Turtle are capable of moving overland several hundreds of meters between watersheds which conveys both a survival advantage during times when ephemeral waterbodies dry up, but also a disadvantage by exposing turtles to increased predator threats when travelling overland (Brown and Brooks 1993; Steyermark *et al.* 2008). Snapping Turtle will use rocky streams to move from one water body to another in spring (Brown and Brooks 1993).

Home range size can vary depending on the sex of the individual and quality of habitat. In Ontario, home ranges varied from a few hectares (Obbard and Brooks 1981; Pettit *et al.* 1995) to a few dozen hectares (Paterson *et al.* 2012). Female home ranges have been reported to be similar in size to male home ranges (Obbard and Brooks 1981), and larger than male home ranges (Pettit *et al.* 1995; Paterson *et al.* 2012).

Females travel farther than males, particularly during the nesting season (Pettit *et al.* 1995). Pre-nesting movements between wetlands can range from <1 km to >11 km (Obbard and Brooks 1980) and take multiple days (Congdon *et al.* 1987). Nesting migrations from wetlands to nesting sites are shorter in distance and only take one day to complete (Steyermark *et al.* 2008). Home range size varies between sexes and time of year. Recent studies have shown that hatchling Snapping Turtle movements are influenced by temperature during embryogenesis and level of satiety (Miller *et al.* 2020). Following emergence from the nest in fall, hatchlings will move to water and conceal themselves by burying under leaf litter and debris (Ernst *et al.* 1994).

4. THREATS

The ECCC 2020 Management Plan for the Snapping Turtle (*Chelydra serpentina*) in Canada identified several threats to Snapping Turtle that would be relevant to Nova Scotia. The conversion of aquatic or riparian habitats for agriculture and urban development, and road networks with vehicle related mortalities are considered high level threats. Medium level threats included fishing bycatch, illegal harvesting, human persecution, invasive exotic species (Common Reed), and human-subsidized predators (e.g., Raccoons, Striped Skunk, Red Fox). Additional threat information specific to Nova Scotia is found in Table 2 under detailed threats.

4.1. Threat Assessment

This threat assessment is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threat classification system (IUCN 2012). Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (in this case, the province of Nova Scotia). Limiting factors are not considered during this assessment process. For purposes of the threat assessment, only present and future threats are considered. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in Section 4.2 Description of Threats. This threat assessment table was prepared with the assistance of biologists from NSDNRR's Regional Services and Renewable Resources branches.

Table 2. Threat Calculator Assessment

Threat #	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed Threats
1	Residential and commercial development	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)	Overall loss of habitat and increased exposure to humans is primary concern. Overall impacts of this threat depend on location and human population density.
1.1	Housing and urban areas	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)	Loss of habitat seen as a pervasive threat that will not diminish over time. Areas with disturbed substrates (e.g., gardens, flower beds, driveways) encourage nesting which may be an ecological trap. Increased encounters with humans and pets in population centers.
1.2	Commercial and industrial areas	Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	Loss of habitat is main threat. Pre-existing commercial and industrial development tends to attract additional development resulting in cumulative negative effects. Pollution and chemical contamination are not thought to be an issue.
1.3	Tourism and recreation areas	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	General feeling that tourists and users of recreational areas (hikers, campers, and canoeists) tend to have established stewardship ethics and do not pose more than a slight threat. Concerns with perceived human safety occasionally results in injuries, or translocation to other water bodies.
2	Agriculture and aquaculture	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Aquaculture is generally not a concern. Loss or conversion of habitats for agriculture, increased risks from subsidized predation, exposure to farm machinery, and watercourse bank stabilization are contributing threats.
2.1	Annual and perennial non-timber crops	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Loss of habitat through conversion of wetlands and floodplains to agriculture is primary concern. Secondary threats include destruction of nests, and injuries/mortalities from farm machinery. Streambank stabilization can act as ecological traps if turtles become trapped between large rocks.
2.2	Wood and pulp plantations	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Plantations are common in some areas of province; however, impacts on turtles are more

Threat #	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed Threats
						likely to occur as the result of roads and landings associated with these areas.
2.3	Livestock farming and ranching	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Nests on riverbanks, or in pastures may occasionally be crushed by livestock.
2.4	Marine and freshwater aquaculture	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	No evidence of these activities impacting Snapping Turtle.
3	Energy production and mining	Low	Restricted – Small (1-30%)	Slight (1-10%)	High (Continuing)	Most potential harm to the species is expected to result from losses of nests and individuals at gravel and sand pits/quarries found throughout the province on all land tenures.
3.1	Oil and gas drilling					Not applicable at this time.
3.2	Mining and quarrying	Low	Restricted – Small (1-30%)	Slight (1-10%)	High (Continuing)	Sand and gravel quarries and pits, including roadside borrow-pits are common throughout the province and attract nesting turtles. These areas act as ecological traps and expose turtles, nests and hatchlings to vehicle related injury and mortality.
3.3	Renewable energy	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Wind energy has the potential to result in either loss or modification of habitat. Majority of wind energy projects are located on higher elevations where turtles are less likely to be impacted; however, some larger wind farms are located in and adjacent to wetland complexes that may contain suitable habitat.
4	Transportation and service corridors	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	Linear transportation corridors present the most serious of all threats to this species in the province. Vehicles account for approximately 60% of all Snapping Turtle injuries and mortalities reported to the provinces two wildlife rehabilitation centers. Soft road shoulders also provide nesting opportunities for turtles that frequently result in nest loss from compaction, or predation by foraging mammals (e.g., raccoon, fox, coyote, skunk).
4.1	Roads and railroads	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	Linear corridors, i.e., roads and trails are pervasive throughout the province and increasing annually. Collisions with vehicles account for the great majority of injuries and mortalities reported to NSDNR and the province's two wildlife rehabilitation centers. Approximately 60% of 235 Snapping Turtle incidents reported to Hope for Wildlife from 2017 - 2022 involved vehicles. Vehicle related incidences are most common in high population centers. Roads and trails are critical infrastructure that contribute to the impact of several other threat categories.
4.2	Utility and service lines	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Electrical transmission lines and rights-of-way provide access to upland habitats. Although the impacts of these areas are unknown, it is likely that they are negligible.
4.3	Shipping lanes					Not applicable.
4.4	Flight paths	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	The impacts of aircraft on turtle behaviour is unknown; however, there are only a handful of locations within the province where aircraft routinely operate, and it is likely that only turtles located within a relatively short distance around these airports may be affected.
5	Biological resource use	Low	Restricted – Small (1-30%)	Slight (1-10%)	High (Continuing)	This species may not be harvested or kept in captivity without a scientific research permit from the province. NSDNR enforcement staff initiated at least 16 investigations involving Snapping Turtle between 2010 and 2024. These investigations involved individuals who were in possession of eggs for incubation, possession of an adult turtle, killing hatchlings and adults, and the sale of an individual turtle. Persecution in general remains a problem. Killing individuals using vehicles, guns, or by bludgeoning is widespread, although the extent is unknown.

Threat #	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed Threats
5.1	Hunting and collecting terrestrial animals	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	No legal harvest of turtles without a permit is allowed in the province. Illegal harvest is recognized as a main threat.
5.2	Gathering terrestrial plants					Not applicable.
5.3	Logging and wood harvesting	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	The primary threat with this activity is the road and trail network that accompanies the forest harvest. Roads and landings attract nesting females, putting the turtle, nests, and hatchlings at risk. This threat is addressed under 4.1. Actual forest harvest activities do not pose a serious threat to turtles unless they are killed or injured by forest harvest equipment.
5.4	Fishing and harvesting aquatic resources	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Recreational fishing by-catch appears to be uncommon and perhaps limited to specific areas in the province. A joint investigation between NSDNR and DFO revealed four dead snapping turtles found in American eel traps set in lakes. Records from Hope for Wildlife Rehabilitation Center showed that since 2022, 4 of 104 Snapping Turtle cases involved fishing tackle. NSDNR enforcement staff also investigated the death of a turtle in a conibear trap set for nuisance beaver, and an incidence of baited hooks being left unattended. Approximately one live turtle every three years found in hoop nets. No turtle mortalities in nets in past 10 years likely due to small entrance diameter, shallow water placement, and internal floatation to provide breathing space (Andrew Lowles pers. comm.). Steen et al. (2014) found that prevalence of ingested fishhooks ranged from 0-33% depending on species, sex, age, and site, with the highest rates (among the species studied) in adult female Snapping Turtles. Steen and Robinson (2017) estimated a probability of an individual turtle ingesting a hook and dying to be 1-11% and sufficient to cause population declines in simulation models. Midwood et al. 2015 found that bycatch mortality in fixed gear fishing equipment can also cause significant population level impacts.
6	Human intrusions and disturbance	Medium - Low	Small (1-10%)	Negligible (<1%)	High (Continuing)	There are some reports of individuals purposefully excavating nests to collect, incubate, and head-start hatchlings which is illegal under most circumstances. General persecution is consistent threat.
6.1	Recreational activities	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Non-fishing or trapping related injuries are thought to be rare and poorly recorded. Records from 235 incidences involving Snapping Turtles obtained from Hope for Wildlife Rehabilitation Center between 2017 and 2023 showed zero cases of boat propeller strikes, or other injuries that could be attributed to recreational activities.
6.2	War, civil unrest, and military exercises					Not applicable.
6.3	Work and other activities	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	There is limited information on this potential threat. Some reports of non-authorized individuals purposefully excavating nests to collect, incubate, and head-start hatchlings under the guise of conservation. Fish research employing fyke nets (if not set partially above water to allow turtles to breathe) can cause turtle mortality. Gill netting by MNR in Ontario to catch eels for translocation occasionally kills snapping turtles. Accidental mortality from non-lethal research on Snapping Turtle, or other research in its habitat is also scored here.
6.4	Persecution	Medium	Pervasive (71-100%)	Moderate	High (Continuing)	Human persecution is a continuing threat throughout the province because of public

Threat #	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed Threats
						misperceptions about human safety, and potential conflict with recreational fishers.
7	Natural system modifications	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	
7.1	Fire and fire suppression					Not applicable.
7.2	Dams and water management/use	Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Changes in controlled water levels at Ducks Unlimited structures, or by removing nuisance beaver dams on private land has the potential to negatively impact turtles by removing habitat or flooding nest sites. There are no data to assess this threat.
7.3	Other ecosystem modifications					Several of the threats already assessed have the potential to modify ecosystems to the detriment of this species. No new ecosystem modifiers have been added here.
8	Invasive and other problematic species, genes and diseases	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
8.1	Invasive non-native/alien species/diseases	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)	Limited evidence of predation by Chain Pickerel (*Esox niger*) and Smallmouth Bass (*Micropterus dolomieu*) on hatchling turtles. Live and dead hatchlings found in the stomach of pickerel and bass in Petite Riviere system in 2015, 2016 and 2018 (Amy Russell, pers. comm.). Red-eared Slider (*Trachemys scripta elegans*) present in several locations in Nova Scotia and may act as a vector for disease. No direct evidence of this yet. Rana virus has been confirmed in Snapping Turtle in Ontario so possibility exists for the disease to eventually come here. *Phragmites* has a limited distribution in the province, but has the potential to impact turtle populations by shading nesting sites, reducing overall habitat quality, and altering behaviors (movements) within dense stands (Hughstin Grimshaw-Surette, pers. comm.).
8.2	Problematic native species	Medium	Large (31-70%)	Moderate (11-30%)	High (Continuing)	Subsidized predation by Raccoons (*Procyon lotor*), Eastern Coyote (*Canis latrans*), Red Fox (*Vulpes vulpes*) and Striped Skunk (*Mephitis mephitis*) is a problem for all freshwater turtle species in the province. Subsidized predators account for a significant number of lost turtle clutches annually. Within the last 10 years coyotes have learned to forage for turtle nests in Guysborough County (M. Pulsifer, pers. comm.)
8.3	Introduced genetic material					Not applicable at this time.
8.4	Problematic species/diseases of unknown origin					Not applicable at this time.
8.5	Viral/prion-induced diseases					Not applicable at this time.
8.6	Diseases of unknown cause					Not applicable at this time.
9	Pollution	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Pollution from urban and industrial effluents, agricultural runoff, industrial waste, and domestic garbage occurs at varied levels across the province, but is highest in population centers, and high production agricultural areas. Because Snapping Turtle are long-lived they can bioaccumulate contaminants such as PCBs within their tissues (Colson et al. 2021).
9.1	Domestic and urban waste water	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Includes road salt, petroleum products, domestic fertilizers, and sewage. Runoff may result in erosion and siltation of watercourses in sensitive areas.
9.2	Industrial and military effluents	Unknown	Restricted (11-30%)	Unknown	High (Continuing)	

Threat #	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed Threats
9.3	Agricultural and forestry effluents	Unknown	Restricted (11-30%)	Unknown	High (Continuing)	High production forestry practices in specific areas will rely on increased use of chemical fertilizers to promote maximum forest yields, and may result in increased probabilities of chemical runoff entering watercourses.
9.4	Garbage and solid waste	Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
9.5	Air-borne pollutants	Negligible (<1%)	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
9.6	Excess energy					Not applicable.
10	Geological events					Not applicable.
10.1	Volcanoes					Not applicable.
10.2	Earthquakes/tsunamis					Not applicable.
10.3	Avalanches/landslides					Not applicable.
11	Climate change and severe weather	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Nova Scotia is predicted to experience significant increases in annual temperatures and average precipitation, with more intense storms and increased erosion by 2100.
11.1	Habitat shifting and alteration	Unknown	Unknown	Unknown		
11.2	Droughts					Not applicable.
11.3	Temperature extremes	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Snapping Turtle is potentially susceptible to changes in sex ratios (at multiple ecological scales) resulting from nest temperature fluctuations or shifts caused by increased temperatures. Shifts from current sex ratios have potential to be positive, negative, or neutral. Impacts will likely be pervasive, but the potential severity of this change is unknown.
11.4	Storms and flooding	Medium - Low	Pervasive (71-100%)	Moderate (11-30%)	High (Continuing)	Increases in the number and intensity of extreme weather events will result in increased localized precipitation and erosion that may lead to lost or inundated nests and egg mortality. It is expected that this will be a widespread phenomenon with unknown effects.
12	Other options					
12.1	Other threat					

[a] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g, if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[b] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted; Small; Negligible).

[c] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate; Slight; Negligible; Neutral or Potential Benefit ≥ 0%).

[d] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2. Description of Threats

This section describes important threats to Snapping Turtle identified in Table 2 above with supporting information. Snapping Turtle are a long-lived, late maturing species that are susceptible to cumulative effects from a variety of threats in the province, and although threats are described individually, it is noteworthy that most threat categories are not truly discrete and independent. For example, roads pose a serious threat by themselves (van der Ree *et al.* 2015); however, roads also contribute to habitat modification, as well as being necessary for logging and wood harvesting, and residential and commercial development. Unfortunately, in Nova Scotia there is limited empirical information on temporal changes to Snapping Turtle populations, or impacts of recognized threats on historical or extant populations.

4.2.1. Transportation and service corridors – Roads and railroads (High)

Road mortalities and injuries present a significant threat to many non-marine turtle species (Beaudry et al. 2010; Carstairs *et al.* 2018; Piczak and Chow-Fraser 2019; Haxton 2000). Slow moving wildlife such as turtles are vulnerable to vehicle traffic because they lack a well-developed flight response to danger (Fahrig and Rytwinski 2009). Vehicle interactions that result in loss of reproduction either through death or injury are particularly harmful at the population level because turtles are long-lived, late to mature, and can potentially lay eggs over many years; therefore, the loss of even one female turtle is magnified (Steen et al. 2006; Rytwinski and Fahrig 2015). Sex-biased turtle road mortality has been studied by several authors with mixed results. Steen *et al.* (2006) reviewed 157 studies of freshwater turtles and found that females represented a consistently larger proportion of turtles found on-roads than off-roads. More recently, Carstairs *et al.* (2018) found no statistical difference between the number of male (n=254) and female (n=249) Snapping Turtle admitted to The Ontario Turtle Conservation Centre between 2013 and 2017.

Negative interactions between Snapping Turtle and vehicles on Nova Scotia roads is the most tangible threat to this species. Biodiversity Investigation Reports (BIR) collected and maintained by the Nova Scotia Department of Natural Resources since 1999 indicate that 55 (6.3%) of 874 Snapping Turtle reports filed up to Jan 2025 documented vehicle related injuries or mortality. An additional 247 incidents were classified as “sick, injured, or distressed” and likely include occurrences where turtles were observed at risk from traffic. These data are further supported by records kept by the province’s two wildlife rehabilitation centers, Hope for Wildlife (HFW), and the Cobequid Wildlife Rehabilitation Centre (CWRC). These centers care for, or rehabilitate orphaned, injured and sick wildlife from the entire province. Between 2017 and October 2023, HFW recorded 138 (59% of all Snapping Turtle incidents) occurrences of vehicle related trauma to Snapping Turtle at their clinic (J. Dunbar pers. comm.). Similarly, CWRC records also indicate that the most common source of injury to Snapping Turtle was vehicles (Brenda Boates, pers. comm.). All sources of data indicate that vehicle related injury and mortality is highest in the central and western part of the province. Reasons for this include higher human population levels with concomitant road

densities and vehicles; in addition to the possibility of increased local awareness and proximity to one of the two rehabilitation clinics.

4.2.2.Invasive and other problematic species, genes and diseases - Problematic native species (Medium)

For many species of turtles, high egg predation is a major contributing factor to low annual recruitment and shifts in population structure (Congdon *et al.* 1987). Egg predation for Snapping Turtle may be higher than other freshwater turtle species because the size of the nest and visible substrate disturbance may make the nest more obvious to predators (Wirsing *et al.* 2012). In many places within the species' Canadian range, Snapping Turtle nest success is negatively impacted by generalist predators such as Raccoon, Red Fox, Eastern Coyote, and Striped Skunk (Riley and Litgus 2014). Predator populations such as these frequently benefit from human – modified landscapes (e.g., agriculture, residential development, proliferation of road networks) that ultimately increase predation pressures on turtle populations (COSEWIC 2008; Riley and Litgus 2014). In Nova Scotia, Raccoons are considered to be the primary nest predator for all freshwater turtle species, and may account for up to 100% egg loss on some nesting beaches (M. Pulsifer pers. comm). It is unlikely that the high rate of egg loss will diminish with time. All of these human-subsidized predators are furbearers whose numbers are controlled by density dependent factors such as disease (e.g., distemper, sarcoptic mange), rather than trapping effort, although focused local trapping effort may provide short-term benefits to turtle subpopulations. NSDNR records indicate that fur harvesting activity in the province has trended downward for the past several decades; therefore, the combination of sustained human-subsidization of predators, and declining anthropogenic predator population checks will likely result in continued high levels of egg predation that may potentially alter Snapping Turtle population structure.

4.2.3. Human Intrusion and Disturbance – Persecution (Medium)

The Snapping Turtle has long been subject to human persecution, largely based on the misperception of perceived threats to humans, and their foraging choices (e.g. fish, waterfowl). Social media portrayals and anecdotal reports contribute to an exaggerated perception of threat from Snapping Turtles, fueling unnecessary defensive actions by humans. In Nova Scotia, surveys by Smith *et al.* (2020) revealed that residents often misinterpret natural defensive behaviors such as head retraction and jaw snapping as signs of unprovoked aggression, often leading to intentional harm. Snapping Turtle are also incidental bycatch of fishing and fur harvesting (Steen and Robinson 2017). This form of persecution is a significant threat and potentially contributes significantly to population declines. Snapping Turtles have frequently been killed on sight because of misunderstandings about the species behavior and ecological role. Ashley *et al.* (2007) found that 1.8% of drivers intentionally swerve to hit turtles. Adult females looking for nesting sites are particularly vulnerable to this type of persecution, with long term

population impacts. Snapping Turtle are frequently targeted by hunters and fisherman who perceive them to be competition for fish and waterfowl, despite these foods making up a small portion of turtles' diet (Brown and Brooks 1994; Steen *et al.* 2014). In Nova Scotia, admissions records from HFW wildlife rehabilitation centre indicate that Snapping Turtle ingest baited hooks intended for fish, or are foul-hooked by fisherman. NSDNRR enforcement records have also reported incidents of multiple turtle deaths in lobster traps intended to act as water control structures in a watercourse, and in a nuisance wildlife situation that resulted in turtles being caught in submerged conibear traps intended for beaver. Additional enforcement investigation records show incidences of deliberate shooting and bludgeoning, having turtles in captivity, possession of eggs, and sale of turtles. Although Snapping Turtle cannot be legally harvested for food in Nova Scotia, it is possible that this still occurs.

4.2.4. Climate change and severe weather – Storms and flooding (Medium – Low)

During this century Nova Scotia is predicted to experience a 4.5° C increase in average annual temperature, 10% more precipitation, and more intense storms that will result in more frequent flooding and increased risk of erosion (https://climatechange.novascotia.ca/changing-climate). These changing environmental conditions may have the greatest impact on nesting turtles (Carter and Janzen 2021; Hedrick *et al.* 2021; Lakhnaravam *et al.* 2024). Inundation of freshwater turtle nests has been identified as a threat to recruitment and long-term viability of at-risk species (Espinoza et al. 2022). Snapping Turtle nests are frequently located in open areas above the high-water mark within 20 m of water (Congdon *et al.* 1999) in well-drained soils with minimal vegetation (Congdon *et al.* 1987).

The close proximity of nests to freshwater features increases their vulnerability to the effects of erosion (i.e., scouring) and flooding. Inundated nests from flooding expose developing embryos to potentially lethal hypoxic conditions.

4.2.5. Residential and commercial development – Housing and urban areas (Low)

In areas of Canada where human populations are most concentrated, Snapping Turtle habitat has diminished in quality and extent from land use practices that promote residential and commercial development (COSEWIC 2020). These developments have resulted in the conversion of freshwater and adjacent habitats (e.g., wetlands, watercourses, waterbodies, riparian zones, floodplains) into partly or wholly unusable habitats for some or all life-stages of Snapping Turtle. Infilling wetlands, hardening of streambanks, and building developments obstruct turtle movements and foraging, potentially resulting in permanent losses of critical nesting habitats. Furthermore, turtles in these areas are more likely to experience other threats such as vehicles, pets, and ecological traps associated with nesting in gardens, flowerbeds, and along roadsides.

In Nova Scotia, housing developments continue to exert pressure on wetlands, particularly in areas where human population density is highest (e.g., Halifax Regional Municipality). Nova Scotia has had a Wetland Conservation Policy since 2011 that outlines a framework to achieve no net loss; however, the policy does allow for wetland alteration where reasonable alternatives for development do not exist. Despite these pressures in restricted areas, the overall impact on the provincial Snapping Turtle population is low.

4.2.6. Agriculture and aquaculture - Annual and perennial non-timber crops (Low)

Historically, agricultural practices have been responsible for significant losses of aquatic and wetland habitats that are important for Snapping Turtle (COSEWIC 2020). Biologically productive wetlands and riparian floodplains were drained, infilled, cleared, and tilled to create nutrient rich agricultural lands to support crops and livestock. In Nova Scotia, approximately 810,000 ha of “improved” agricultural land was under production in 1891 (MacKinnon 1991). These improved lands would have contained an unknown area of freshwater habitats that were converted from biologically important ecosystems to farm land. In addition to habitat conversion, agricultural practices contribute to human-subsidized predation of eggs, and shifts in nesting habitat use away from natural areas to open and sunny farm fields. The latter has also contributed to an increased proportion of male offspring due to nest shading and maternally-derived mercury levels in nesting females (Thompson *et al.* 2018).

4.2.7. Energy production and mining – Mining and quarrying (Low)

Although this threat has been ranked as low, activities associated with resource extraction can pose several different risks to Snapping Turtle in Nova Scotia. Mining and quarrying frequently involve vegetation clearing, and wetland drainage which can alter critical Snapping Turtle habitats, including nesting, overwintering, and foraging areas. Habitat fragmentation can also isolate populations, reducing genetic diversity and impeding movement between essential habitats (Bodie 2001). Mining operations can introduce toxins, acidic runoff, and other pollutants into water bodies, negatively impacting water quality. These types of operations can modify water flow patterns, lower groundwater tables, and lead to wetland degradation. Snapping Turtle rely on wetlands, slow-moving rivers, and ponds for feeding, nesting, and overwintering. The loss or alteration of these water bodies can reduce habitat availability and impact food sources (Mitchell and Klemens, 2000). Road construction associated with mining and quarrying increases the risks of road mortality in general, and particularly for nesting females searching for suitable nesting sites (Steen and Gibbs 2004). Nests along roads may be lost due to compaction of the road surface. Stockpiling of aggregate can potentially impact Snapping Turtle. Stock piles of aggregates such as sand and gravel are attractive to nesting females looking for suitable nesting substrates because they tend to be open, sun-exposed areas with little vegetation. These temporary and artificial nesting areas become ecological traps for turtles looking to deposit eggs.

4.2.8. Hunting and collecting terrestrial animals (Low)

Under the Nova Scotia Wildlife Act, anyone is prohibited from destroying, taking, possessing, buying, or selling a turtle, or a turtle egg, or disturbing a turtle nest without a permit. Hunting and collecting Snapping Turtle is not permitted in Nova Scotia. All life stages are vulnerable to collection for food, pets, medicines, and trinkets (COSEWIC 2008; Mali *et al.* 2014). Adults are collected mainly for food. Harvesting of adults and sub-adults can have a significant impact on population structure leading to long-term declines (Van Dijk 2012). NSDNR enforcement records, and records from HFW indicate several instances where various aged Snapping Turtle were confined and detained by members of the public.

4.2.9. Biological resource use - Logging and wood harvesting (Low)

Snapping turtles often seek open, sandy, or gravelly areas for nesting, which are frequently associated with logging roads, and landing areas. The exposed, sunlit surfaces of road edges and landings can provide the warm incubation temperatures needed for egg development, making them attractive nesting sites (Steen et al., 2012). However, nests in these areas face higher destruction rates due to vehicle traffic and road maintenance activities. Logging roads fragment habitat making it more dangerous for turtles to access resources. Roads in general increase the likelihood of turtles being struck by vehicles, and nesting females are particularly vulnerable when moving to, or looking for suitable nesting sites (Garrah *et al.* 2015).

4.2.10. Biological resource use - Fishing and harvesting aquatic resources (Low)

Snapping Turtles may inadvertently ingest fishing hooks or become entangled in fishing gear, leading to injuries or mortality (Browne *et al.* 2020). The ingestion of hooks can cause internal damage, while entanglement can restrict movement, impair feeding, or result in drowning. The 2020 Management Plan for the Snapping Turtle in Canada identifies recreational fishing as a source of mortality due to such accidental captures (ECCC 2020). Records from Hope for Wildlife indicate that four Snapping Turtle were admitted between May 2022 and August 2024 for ingestion of fishing hooks, or for having fishing hooks or fishing line embedded in their flesh. Improper disposal or loss of fishing gear may also result in ingestion and entanglement hazards that could lead to injury and death. NSDNR enforcement records show one record of an investigation into a Snapping Turtle caught on a set fishing line left unattended. Other activities associated with recreational fishing such as habitat disturbance (i.e., boat traffic, shoreline vegetation modification) can impact Snapping Turtle. Popular fishing areas may experience high levels of human-turtle interactions that may result in injured or dead turtles. Generally speaking, of all the freshwater turtles in Nova Scotia, Snapping Turtle experience the highest levels of persecution because of the misperception that this species is dangerous is humans.

Provincial enforcement records also indicate that Snapping Turtle are at risk of mortality from activities associated with nuisance beaver preventative measures. A turtle was killed when it was accidentally captured in a submerged conibear trap, and in another instance, “several” dead Snapping Turtle were found in lobster traps placed in a brook to prevent beaver from damming the brook.

4.2.11. Invasive and other problematic species, genes and diseases - Invasive non-native/alien species/diseases (Low)

Snapping turtles in Nova Scotia face potential threats from invasive species that can disrupt their habitats and food sources, or cause disease (Linzey and Clifford 2002). Invasive competitors such as Chain Pickerel and Smallmouth Bass consume a wide range of food items, potentially impacting Snapping Turtle prey availability. These predators may also directly impact Snapping Turtle by preying on hatchling and young turtles. Chain Pickerel with live hatchling Snapping Turtle in their stomachs have been documented in the Petite Riviere system in Lunenburg County in 2015 (Andrew Lowles, pers. comm.). Smallmouth Bass also prey on hatchling turtles. Snapping Turtle young were found in Smallmouth Bass in 2016 and 2018 as part of the Atlantic Whitefish Recovery Project (Amy Russell, pers. comm.).

Ranavirus is an emerging invasive pathogen known to infect amphibians and reptiles, including Snapping Turtle. While there are no documented cases of Ranavirus infections in Snapping Turtle specifically within Nova Scotia, understanding the potential threat is crucial, especially given confirmed reports from nearby areas such as Ontario in 2017 and 2018 (Hughstin Grimshaw-Surette, pers. comm.). Ranavirus infection was fatal in all cases. Stressors such as pollution, habitat alteration, and climate change may increase susceptibility to infection.

Red-eared Slider is becoming increasingly more common in the province. This popular pet species competes with native turtle species for basking spots, food, and other resources when released into the wild. They may also potentially harbor respiratory diseases that can impact Snapping Turtle (NS Invasive Species Council 2021).

Common Reed (*Phragmites australis* ssp. *australis*) is an emerging invasive species that forms dense stands of grass along waterways. This plant has potential to reduce habitat quality and availability by shading nesting and basking sites, and making navigation through dense stands energetically costly for Snapping Turtle (Hughstin Grimshaw-Surette, pers. comm.).

4.2.12. Pollution - Domestic and urban waste water (Low)

Domestic and urban wastewater can negatively impact Snapping Turtle in Nova Scotia through several pathways. Wastewater often contains pollutants such as heavy metals, pesticides, pharmaceuticals, and per- and polyfluoroalkyl substances (PFAS) (deSolla

et al. 2008; Taylor *et al.* 2022). These contaminants can accumulate in aquatic ecosystems, leading to bioaccumulation in long-lived organisms such as Snapping Turtle. Nutrient-rich wastewater can lead to eutrophication, causing excessive algal blooms that deplete oxygen levels in aquatic habitats. This degradation can reduce the availability of suitable habitats for snapping turtles, affecting their foraging and nesting areas. Untreated or inadequately treated wastewater can introduce pathogens into aquatic environments, potentially leading to diseases in snapping turtle populations.

5. MANAGEMENT OBJECTIVE(S)

Management Objective(s)

The following are management objectives for Snapping Turtle in Nova Scotia

1. Reduce the principal threats to the species (Short-term)
2. Increase demographic knowledge of the species (Short-term)
3. Maintain the current area of occupancy (Long-term)
4. Maintain Snapping Turtle abundance (Long-term)

These objectives will be met by adopting broad-based strategies similar to those proposed in the Management Plan for the Snapping Turtle (Chelydra serpentina) in Canada (ECCC 2020). These strategies include:

- Adopt legal and policy measures to conserve the Nova Scotia Snapping Turtle population and its habitat;
- Minimize threats to Snapping Turtles by reducing mortality, injuries, and harvesting;
- Steward habitats essential for the Snapping Turtle across its Nova Scotian range;
- Build relationships through outreach efforts and partnerships to support conservation goals for the species;
- Develop and implement survey and monitoring programs to assess Snapping Turtle populations and their habitats
- Promote research and collect critical life-history data to support the effective management of Snapping Turtles and their habitats, including an assessment of potential threats.

Rationale

Implementing comprehensive conservation and management objectives for Snapping Turtle is essential to ensure the species' long-term viability. Studies have shown that

even small-scale declines in numbers can cause substantial population decreases over time (Piczak and Chow-Fraser 2019). Sustaining stable population levels is vital for the ecological well-being and genetic diversity of this species. Addressing key threats such as road mortality, habitat loss, and persecution is imperative for the conservation of this species. For instance, road mortality has been identified as a significant factor contributing to population declines, with studies documenting severe reductions in turtle numbers due to vehicular collisions (Piczak and Chow-Fraser 2019). Preserving the habitats occupied by Snapping Turtle is crucial, as habitat loss and degradation are primary threats to their populations. Ensuring the availability of suitable aquatic and terrestrial environments supports essential activities such as foraging, nesting, and hibernation. Conservation measures should focus on protecting wetlands and adjacent upland areas from development and environmental contaminants to maintain the species' distribution and ecological functions. Enhancing our understanding of Snapping Turtle life history traits, such as age at maturity, reproductive rates, and survival rates, is essential for informed management decisions. Long-term demographic studies provide insights into population dynamics and the effectiveness of conservation strategies. Research has emphasized the importance of demographic data in developing sustainable management practices for long-lived species like Snapping Turtle. The importance of these data will be especially important with the uncertainties of climate change. Furthermore, concerted efforts to reduce levels of persecution through effective public education are critical. Effective conservation efforts will only be successful with improved public understanding and attitudes toward this species.

6. GENERAL APPROACHES TO MANAGEMENT

6.1. Actions Completed or Underway

6.1.1. Federal Government

- ECCC Snapping Turtle management plan (2020) identifies threats and suggested management actions necessary for the long-term sustainability of Snapping Turtle for Canada. Although many of the threats are similar for Nova Scotia, several threat rankings within the province are generally lower.

- Mockford *et al.* in the mid 1990's investigated Snapping Turtle at Grafton Lake in Queen's County prior to the dam being removed using mark-recapture and radio-telemetry. A final report resides at Kejimkujik National Park. Findings from this report provided new information on Snapping Turtle movements, and use of habitat features.

- Dr. Mike Brylinsky completed a report for Kejimkujik National Park entitled, "Grafton Watershed Ecological Restoration Monitoring Project Kejimkujik National Park Phase 1 Final Report". Publication No. 19, Acadia Centre for Wildlife and Conservation Biology. 125 pp. This report included a short section

on radio-tagged Snapping Turtle that documented habitat use, and seasonal turtle movements.

6.1.2. Provincial Government

- The Minister of Natural Resources has appointed a provincial Reptile and Amphibian Recovery Team whose mandate is to work towards species recovery and provide advice on species at risk.

- Terry Power and John Gilhen published two papers on Snapping Turtle in Nova Scotia. Gilhen and Power (2018) confirmed Snapping Turtle as belonging to the native herpetofauna of Cape Breton Island. This work was followed by Power and Gilhen (2018) which provided additional information on the distribution and nesting ecology of Snapping Turtle on Cape Breton Island.

- Nova Scotia Department of Natural Resources - Wildlife Division has maintained a database of Biodiversity Investigation Reports (BIR) since 1999. There have been 874 recorded BIRs for Snapping Turtle up to early 2025. These records include reports of injured, dead, and perceived nuisance or threatening turtles and address a variety of threat types.

- Nova Scotia Department of Natural Resources - Enforcement Division maintains an enforcement database that includes investigations of wrongful activities concerning wildlife. Sixteen investigations involving Snapping Turtle have occurred since 2010 throughout the province. These records identify several different threats to Snapping Turtle.

6.1.3. University Research

- Denise Whynot completed an Honours thesis in 1996 while at Acadia University, “Spatial dynamics and morphology of the Common Snapping Turtle*, C. serpentina*, in Grafton Lake, Kejimkujik National Park, Nova Scotia”. This thesis documented the movements of several radio-tagged Snapping Turtle before and after the dam was removed at Grafton Lake as part of the ecological restoration for that area. Results indicated that males appeared to have abandoned the lake with decreased water levels, and that prior to the dam being removed turtles created and maintained steep-sided pits in shallow water, presumably to act as summer refugia and winter hibernacula (Dr. Tom Herman, pers. comm.).

- Jan Trojanowski completed an Honours thesis at Acadia University in 1999 on “Assessment of genetic variation in Snapping Turtle (*Chelydra serpentina*) populations using RAPD analysis”. This research was supervised by Dr. Tom Herman and Dr. Marty Snyder.

- Julia Dunbar completed an Honours thesis at Lakehead University in 2004 on "The impacts of road development on Common Snapping Turtles and Eastern Painted Turtles in Nova Scotia". This work validates the significant negative impacts that roads and vehicles have on Snapping Turtle and implications for long-term population viability.

- Dr. Amy Mui (Dalhousie University) has recently begun preliminary investigations into the formulation of decoy chemical attractants to change predator search behaviors around turtle nests.

6.1.4. Non-government Organizations

- Coastal Action initiated a Snapping Turtle monitoring program in 2020 in the Petite Rivière watershed that continued through 2024. Analysis of environmental contaminants (i.e., mercury) within eggshells from depredated nests was conducted by partner and Saint Mary's University affiliate, Dynamic Ecology and Environmental Health Research (DEEHR). Road crossing and nesting areas, mortality sites, and high frequency observation areas have been mapped. Public engagement and stewardship activities to increase awareness of reptiles and critical habitats has been ongoing.

- Wildlife rehabilitation centres such as Hope for Wildlife and Cobequid Wildlife Rehabilitation Centre admit and treat injured turtles with the goal of releasing them back where they were found. Every surviving adult is important for long-term population sustainability.

- Mersey Tobeatic Research Institute (MTRI) has been recording Snapping Turtle captures in Blanding's Turtle traps for 25 years. Trap effort, and number of Snapping Turtle caught daily was recorded. Numbers of Snapping Turtle observed at nesting sites, and road locations is also available.

- Annual Herp Week seminars (2022 – 2026). For the past five years MTRI has organized a week of seminars on at-risk herpetofauna, including Snapping Turtle to bring biologists, managers, consultants, and herp enthusiasts together to discuss threats, on-going and proposed research, and threat mitigation activities.

6.1.5. Citizen Science

- The current Nova Scotia Herp Atlas project has been coordinated by MTRI since 2021. Besides engaging non-scientists in conservation activities involving herptiles, this project provides information on the spatial distribution of amphibians and reptiles over time. A precursor, also known as The Nova Scotia Herpetofaunal Atlas Project was administered through a group comprised of the Acadia University Biology Department, Nova Scotia Museum of Natural History,

Nova Scotia Department of Natural Resources Wildlife Division, and the Blomidon Naturalists Society, from 1999 to 2003.

- iNaturalist provides a digital platform for scientists and non-scientists to record observations of all species, including amphibians and reptiles. Records for Snapping Turtle in Nova Scotia provide insights into the distribution of the species and further support species distribution records provided through provincial BIR records.

6.2. Recommended Management Actions

Table 3 provides the recommended conservation measures for achieving management objectives for the species, and the timeframe for completing these actions. Conservation measures are organized according to the following categories: Habitat protection, monitoring and stewardship; surveys and monitoring; communication, outreach, and education; law, policy, and enforcement; and research to address knowledge gaps.

Conserving the Snapping Turtle population in Nova Scotia requires a strategic and multifaceted approach to address both immediate threats and long-term sustainability. In the short term, efforts should focus on understanding population demographics and key threats, while the overarching long-term goal remains maintaining the species' current range and abundance. Key management actions include habitat protection, mitigation of human-induced threats, long-term monitoring, public engagement, and policy enforcement.

One of the primary concerns for Snapping Turtle is the loss and degradation of critical habitats, including nesting sites, overwintering areas, and movement corridors. Conducting comprehensive surveys to map these areas will allow for targeted conservation efforts, such as the development and application of SMPs. If, in future, Snapping Turtle is uplisted from “vulnerable” in Nova Scotia, other land-based conservation options such as land acquisition, or private land conservation easements may be appropriate. Protecting habitats ensures the species can complete their life histories with minimal human disturbance. Road mortality is a particularly significant threat, as roads often intersect key habitat areas. Partnering with NSPW to install wildlife crossings and exclusion fencing will help reduce turtle deaths and improve connectivity between critical habitats.

Implementing a standardized, long-term monitoring program is essential for assessing population health, distribution, and trends over time. Established survey techniques such as capture-mark-recapture studies, baited hoop trapping, and visual encounter surveys will provide valuable data. Additionally, emerging methodologies like environmental DNA (eDNA) sampling can enhance species detection, particularly in areas where traditional surveys are challenging. Research on threats such as nest predation, disease prevalence, and the impact of invasive species will help inform targeted mitigation strategies. Engaging Mi’kmaq communities in sharing traditional

ecological knowledge (TEK) can provide historical insights into population trends and habitat use, strengthening conservation efforts through co-management approaches.

Public education and stakeholder engagement play a crucial role in conservation success. Raising awareness about the ecological importance of Snapping Turtle through outreach programs, citizen science initiatives, and educational materials can foster a sense of stewardship and reduce levels of persecution. Schools, conservation organizations, and local communities can be engaged through workshops and curriculum integration, ensuring that conservation messaging reaches a broad audience. Additionally, working with landowners, recreational groups, and industries to adopt best management practices will help minimize habitat disturbances, particularly during critical periods like nesting season.

Legislative protections and enforcement mechanisms must also be maintained to ensure compliance with conservation goals. Snapping Turtle in Nova Scotia are currently protected by the provincial Wildlife Act, NSESA, and SARA. Advocating for the placement of Snapping Turtles in a higher risk category such as “threatened” under Nova Scotia’s Endangered Species Act would provide facilitate the development of a recovery plan. Increased training and resources for wildlife enforcement officers will improve monitoring and reduce activities such as poaching, habitat alteration, and persecution in general. Municipal governments can also play a key role in conservation efforts by integrating Snapping Turtle habitat considerations into land-use planning and ensuring critical habitats are safeguarded from development, or developments are assessed with species at risk in mind.

Addressing knowledge gaps through focused research will further refine conservation strategies. Long-term studies on nesting, foraging, overwintering, and dispersal patterns will inform habitat management and land-use planning. Investigating the effects of climate change, pollution, and emerging diseases will allow for adaptive management strategies that can respond to new and evolving threats. Additionally, studying genetic diversity among populations will provide insights into connectivity and potential risks of inbreeding.

Ensuring that conservation strategies are adaptable and based on the best available science will be key to achieving both short-term and long-term management objectives. Successful implementation of management actions to achieve desired goals and objectives is dependent on collaborations with academic institutions, government departments and non-government organizations.

Table 3. Management Actions and Implementation Schedule in Support of Objectives

Management Actions	Threat(s) Addressed*	Priority**	Timeline
Habitat Protection, Monitoring, and Stewardship			
(i) Conduct comprehensive surveys to map critical habitats such as nesting sites, overwintering areas, and movement corridors. Explore options for land	1.1, 1.2, 2.1, 2.2, 2.3, 3.2, 8.1, 8.2, 9.1,	High	2026-2031

protection/acquisition, conservation easements, landowner agreements, or designation as protected areas.	9.3, 11.1, 11.4		
(ii) Work with NS Department of Public Works to plan for and install wildlife crossings and exclusion fencing in areas where roads intersect critical habitats to reduce vehicle-related turtle mortality. Road mortality has been identified as a significant threat to snapping turtle populations.	1.1, 1.2, 4.1	High	2026-2031
(iii) Implement standardized, long-term monitoring to track population trends, health, and habitat use. These data are vital for assessing the effectiveness of conservation measures and making informed management decisions.	1, 2, 3, 4, 5, 6, 8, 9, 11	High	2026-2028
(iv) Develop educational materials and outreach programs to inform the public about the ecological role of snapping turtles, the threats they face, and actions individuals can take to support their conservation.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	High	2026-2028
(v) Provide Best Management Practices for industries and land developers to minimize habitat disruption, especially during critical periods like nesting season.	1, 2, 3, 4, 5, 9	High	2026-2031
(vi) Engage Mi'kmaq communities in sharing traditional ecological knowledge (TEK), which can provide insights into historical population trends and habitat use. Develop partnerships for co-management practices, ensuring that conservation strategies are culturally appropriate and mutually beneficial.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	High	2026-2028
(vi) Investigate specific threats, including predation rates on nests, impacts of invasive species, and disease prevalence, to develop targeted mitigation strategies.	2.1, 4.1, 5.1, 5.3, 5.4, 6.4, 8.1, 8.2, 8.4	Medium	2026-2031
(vii) Collaborate with local stakeholders, including landowners, recreational groups, and schools, to promote stewardship practices that protect turtle habitats and reduce human-induced threats.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	Medium	2026-2028

(viii) Enhance degraded wetland areas to improve nesting and foraging opportunities for long-term benefit. Similar to a Ducks Unlimited model.	1, 2, 3, 4, 5.3	Low	2026-2035
Surveys and Monitoring			
(i**)** Engage with conservation organizations, and government agencies to establish standardized methods for data collection, and monitoring protocols to ensure consistency and reliability across studies.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	High	2026-2028
(ii) Adopt established methodologies, such as capture-mark-recapture, baited hoop trapping, and visual encounter surveys, to accurately assess population size, distribution, and demographics.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	High	2026-2031
(iii) Establish long-term monitoring programs to conduct periodic surveys to detect trends in population dynamics, reproductive success, and survival rates.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	High	2026-2031
(iii) Develop platforms, such as online databases or mobile applications, where public can report snapping turtle sightings.	4.1, 5.1, 5.4, 6.1, 6.4, 8, 9	High	2026-2028
(iv) Utilizing eDNA sampling involves detecting genetic material shed by snapping turtles into their aquatic environments. This non-invasive method can confirm species presence in various habitats, including those where traditional survey methods are challenging. While promising, eDNA techniques require further validation for snapping turtles in Nova Scotia's specific environmental conditions.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	Medium	2026-2031
(v) Developing habitat suitability models helps identify potential snapping turtle habitats by analyzing environmental variables such as water depth, vegetation cover, and prey availability. These models can guide targeted surveys and inform habitat protection strategies. However, they necessitate comprehensive environmental data and expertise in spatial analysis.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	Medium	2026-2031
(vi) Attaching radio or GPS transmitters to individual snapping turtles provides detailed information on movement patterns, habitat use, and behavior. While	1, 2.1, 2.3, 3.2, 4.1, 5.1, 5.3, 5.4, 6.1,	Low	2026-2036

telemetry offers valuable insights, it is resource-intensive and may not be practical for large-scale monitoring efforts.	6.3, 6.4, 7.2, 8.1, 8.2, 9.1, 9.2, 9.3, 11		
Communication, Outreach, and Education			
(i) Engage local communities through workshops, citizen science projects, and volunteer opportunities to foster a sense of stewardship.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	High	2026-2028
(ii) Develop comprehensive educational materials and outreach programs to inform the public about the ecological significance of snapping turtles, the threats they face, and conservation actions.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	High	2026-2028
(iii) Integrate snapping turtle conservation topics into school curricula to educate students about local biodiversity and conservation efforts. Collaborations with educational institutions can facilitate these programs.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	Medium	2026-2031
(iv) Work with landowners, recreational groups, and industries to promote practices that protect snapping turtle habitats. Providing guidelines and resources can encourage stakeholders to participate in conservation efforts.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	Medium	2026-2031
(v) Utilize traditional and social media platforms to share information, success stories, and upcoming events related to snapping turtle conservation. While this can reach a broad audience, it may have limited engagement compared to direct community involvement.	5.4, 6.1, 6.3, 6.4, 8.1, 8.2	Low	2026-2031
(vi) Install informative signs in areas frequented by the public, such as parks and nature reserves, to raise awareness about snapping turtles and encourage protective behaviors. This action, while beneficial, may have a localized impact.	5.1, 5.4, 6.1, 6.4, 8.1, 8.2	Low	2026-2031
Law, Policy, and Enforcement			

(i) Reassess Snapping Turtle under Nova Scotia's Endangered Species Act to determine if recovery measures are required to sustain the species in Nova Scotia	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	High	2026-2028
(ii) Increase resources and training for wildlife enforcement officers to ensure compliance with existing regulations that protect snapping turtles from illegal activities such as persecution, poaching and habitat destruction. This includes regular patrols of known critical habitats and prompt responses to reported violations.	5.1, 5.3, 5.4, 6.1, 6.4, 9.3	High	2026-2028
(iii) Collaborate with municipal governments to integrate snapping turtle conservation into land-use planning. This includes implementing buffer zones around wetlands and regulating development activities that could negatively impact turtle habitats.	1, 2.1, 2.2, 3.2, 3.3, 4.1	Medium	2026-2028
(v) Assess current wildlife laws to identify gaps in the protection of Snapping Turtles.	5.1, 5.3, 5.4, 6.4, 7.2, 9.3	Low	2026-2028
Research to Address Knowledge Gaps			
(i) Long-term mark-recapture studies and genetic assessments to estimate population size, age distribution, and demographic trends.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	High	2026-2031
(ii) Research on nesting, foraging, overwintering, and dispersal patterns to inform habitat protection and land-use planning.	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	High	2026-2031
(iii) Studies assessing the impact of roads on turtle populations and evaluating the effectiveness of mitigation measures (e.g., fencing, underpasses).	4.1	High	2026-2031

(iv) Investigating how temperature and precipitation shifts affect nest survival, hatchling sex ratios, and recruitment rates.	7, 11	High	2026-2036
(v) Studies examining the effects of pollutants, including agricultural runoff, heavy metals, and wastewater discharge, on snapping turtle health and reproduction.	3.2, 4, 9	Medium	2026-2036
(vi) Research on nest predation rates, key predators, and potential management strategies (e.g., predator exclusion methods).	8.2	Medium	2026-2031
(vii) Understanding gene flow among snapping turtle populations in different watersheds to assess isolation and inbreeding risks.	4.1	Medium	2026-2031
(viii) Investigating the presence and impact of emerging diseases and parasites (e.g., Ranavirus, Shell-rot) on local snapping turtle populations.	8	Medium	2026-2031
(ix) Social science research on public attitudes, conflicts, and engagement in snapping turtle conservation.	5.4, 6.4	Low	2026-2031
(x) Examining potential competition with or predation by invasive species (e.g., non-native fish or plants affecting turtle food sources).	8.1	Low	2026-2031

+++*Threat or Limitation should refer to the IUCN Threat Classification Table Rankings. Either the first level or second level threat ranking can be used depending on how the Broad Strategy affects the threat. Multiple threats can be addressed under a single Recovery Measure.
**Priority should be classified as High(H), Medium(M), or Low(L). “Priority” is a qualitative measure of the relative degree to which an approach will have a positive impact on the recovery objective. High priority conservation approaches are considered those most likely to have an immediate and/or direct influence on reaching the management objective for the species. Medium priority conservation approaches may have a less immediate or less direct influence on reaching the management objective but are still considered important measures to implement. Low priority conservation approaches will likely have an indirect or gradual influence on reaching the management objective and are more tied to increasing knowledge or public perception/education.

6.3. Narrative to Support the Management Actions Table

6.3.1. Habitat Protection, Management and Stewardship

Snapping turtles are a species of conservation concern in Nova Scotia due to habitat loss, road mortality, climate change, and human disturbances (COSEWIC, 2008). A

strategic, science-based management approach is necessary to ensure population abundance and their long-term survival. Comprehensive habitat surveys and protection measures will ensure that critical habitats such as nesting sites, overwintering areas, and movement corridors remain intact (Paterson et al. 2019). Habitat fragmentation and wetland degradation pose significant risks, making land acquisition strategies such as, conservation easements, and legal protection viable tools for conservation.

Threat mitigation strategies are embedded across multiple actions. Understanding and mitigating specific threats is crucial for targeted conservation actions. Road mortality is a major cause of adult Snapping Turtle deaths, particularly among nesting females crossing roads to reach suitable nesting sites (Steen *et al*. 2006). Partnering with the Nova Scotia Department of Public Works to install wildlife crossings, such as underpasses and culverts at high-risk crossing locations can significantly reduce road-related mortality. Additionally, exclusion fencing can help guide turtles toward safe crossing points, preventing individuals from accessing high-risk roadways (Gunson *et al*. 2012). Given their late-maturing life history, preventing adult fatalities is essential for population stability. Nest predation by Raccoons and Striped Skunks can significantly reduce hatchling success (Spencer *et al*. 2017). Invasive species such as Common Reed (*Phragmites australis*) alter wetland hydrology, reducing suitable nesting areas (Bolton and Brooks, 2010). Additionally, disease surveillance is essential, as emerging pathogens like *Ranavirus* and *Herpesvirus* have been linked to mass mortality events in turtles (Allender *et al.* 2011).

Public education and outreach will reduce human-induced threats such as persecution and illegal collection by increasing awareness of snapping turtles' ecological role. Community stewardship programs will further reinforce conservation ethics and protective behaviors. Engaging stakeholders in habitat restoration projects, citizen science programs, and stewardship agreements fosters long-term conservation efforts (Mitchell et al. 2020). Encouraging responsible land-use practices, such as protecting nesting sites from ATV damage, can enhance local conservation outcomes. Habitat degradation is a significant driver of snapping turtle population declines. Restoring degraded wetlands by improving water quality, reconnecting fragmented habitats, and enhancing nesting substrate availability can benefit both snapping turtles and broader wetland biodiversity (Keith *et al.* 2025). Development of Best Management Practices (BMPs) for industry and land developers will minimize habitat degradation and contribute to the conservation of critical habitats.

A long-term monitoring framework using standardized methodologies such as capture-mark-recapture, genetic studies, and telemetry will provide crucial demographic insights. This includes population structure and trends, recruitment rates, and survival probabilities. Additionally, collaborating with Mi’kmaq communities will integrate Traditional Ecological Knowledge (TEK), enhancing historical and ecological understanding of population dynamics. Research into nest predation, invasive species, and disease will provide data-driven strategies to mitigate emerging threats, ensuring that conservation measures remain adaptive and responsive. Local landowners,

recreational groups, and conservation organizations play a key role in snapping turtle conservation.

6.3.2. Surveys and Monitoring

Implementing effective surveys and monitoring programs is critical for maintaining the area of occupancy and population abundance of Snapping Turtles in Nova Scotia, mitigating key threats, and expanding demographic knowledge. Effective survey and monitoring frameworks are needed to assess population trends, habitat use, and emerging threats. Given the species' long lifespan, delayed sexual maturity, and susceptibility to human-induced threats, long-term monitoring is essential to recognize subtle population changes and guide adaptive management strategies (Congdon et al. 1994).

Standardized data collection and monitoring protocols developed in collaboration with conservation organizations, government agencies, and academic institutions will ensure consistency and reliability in population and habitat assessments. These efforts will identify critical areas such as nesting, overwintering, and foraging sites, allowing for habitat protection initiatives. Consistency in data collection is critical for comparing results across different study sites and time periods. The development of habitat suitability models will further refine conservation planning by analyzing environmental variables (e.g., water depth, substrate, vegetation, prey availability) to pinpoint suitable and at-risk habitats. Additionally, eDNA sampling will enhance habitat monitoring, detecting Snapping Turtle presence in areas difficult to survey through traditional means (Rees *et al.* 2009; Goldberg et al. 2011; Davy et al. 2015).

Regular population assessments using capture-mark-recapture, baited traps, visual encounter surveys, radio-telemetry and eDNA will provide reliable estimates of population size and demographics that are critical for effective conservation measures (Congdon *et al.* 1994; Rees *et al.* 2009; Eskew et al. 2010). Long-term monitoring programs will track population trends, reproductive success, and survival rates, informing adaptive management strategies. Integrating public engagement through citizen science initiatives (e.g., online databases, mobile applications) will expand data collection efforts, identifying important habitats and high-risk areas where conservation actions are most needed.

Monitoring programs also help identify key threats, such as road mortality, habitat degradation, and predation. Radio and GPS telemetry will provide insight into habitat selection, seasonal movement patterns, road-crossing behaviors, and habitat preferences, guiding mitigation measures like wildlife underpasses and exclusion fencing (Brown and Brooks 1993; Paterson *et al.* 2019). Given Snapping Turtles' long lifespan and delayed reproductive maturity, short-term studies may fail to detect significant population declines (Gibbs and Shriver, 2002). Long-term monitoring programs should include periodic surveys to assess trends in population demographics, reproductive success, and survival rates. Data collected over extended periods can

inform conservation actions, such as targeted habitat protection or mitigation measures for road mortality. Finally, habitat suitability modeling will highlight areas vulnerable to urbanization, climate change, and other environmental stressors, potentially allowing for mitigative protection efforts. eDNA sampling can also detect the presence of invasive species that may compete with or prey on snapping turtles.

Citizen science initiatives can enhance data collection by encouraging public reports of Snapping Turtle sightings. Developing online platforms or mobile applications where users can submit georeferenced observations, photographs, and behavioral notes can expand data coverage across Nova Scotia. Platforms such as iNaturalist and the Nova Scotia Herp Atlas have demonstrated the value of public involvement in reptile conservation.

Each of these monitoring actions contributes to a more robust understanding of Snapping Turtle population dynamics. Capture-mark-recapture studies will assess age structures, growth rates, and survival probabilities, while telemetry will provide fine-scale data on habitat use and seasonal movement. Long-term monitoring will enable researchers to evaluate the impact of environmental changes on reproductive success. Additionally, public sighting reports via online databases will help track population distribution over time.

6.3.3. Communication, Outreach and Education

Public engagement is a critical component of snapping turtle conservation, as human activities such as habitat destruction, road mortality, and persecution due to misconceptions pose significant threats to populations (Gibbs and Shriver, 2002; Steen and Gibbs, 2004; Beaudry et al. 2008). Effective communication, education, and outreach initiatives can foster stewardship, increase awareness, and promote conservation-friendly behaviors among diverse stakeholders. This is essential for maintaining the area of occupancy and population abundance of Snapping Turtle in Nova Scotia, reducing key threats, and expanding demographic knowledge. Public engagement fosters stewardship and facilitates conservation efforts across multiple stakeholder groups. Engaging local communities through citizen science initiatives can significantly enhance data collection efforts (Sterrett et al. 2019). Training volunteers to report sightings, nesting activities, and road mortalities increases the spatial and temporal coverage of monitoring programs. Such involvement also fosters public awareness and support for conservation efforts. Research has shown that targeted outreach programs (e.g., anglers, landowners) can significantly improve public attitudes toward reptiles and mitigate negative perceptions (Shine and Koenig, 2001).

Public involvement in citizen science projects, workshops, and volunteer programs increases the likelihood of identifying critical snapping turtle habitats, including nesting sites and overwintering areas (Steen et al. 2012). Initiatives such as the Nova Scotia Herp Atlas, and iNaturalist enable local communities to contribute observational data, which potentially informs habitat protection measures. Educational materials and

outreach programs, developed in collaboration with conservation organizations enhance public understanding of Snapping Turtle ecology and the importance of preserving important habitats (Browne and Hecnar 2007). These initiatives help ensure that key habitats remain undisturbed, preventing habitat loss and fragmentation.

Integrating snapping turtle conservation topics into school curricula fosters early environmental awareness and instills conservation ethics in students, encouraging long-term engagement in conservation efforts (Ballantyne and Packer 2005; Ballantyne *et al*. 2011). This action can lead to future generations adopting protective behaviors, reducing human-induced mortality. Working with landowners, recreational groups, and industries ensures that best management practices (BMPs) are implemented to safeguard critical habitats for nesting, overwintering, foraging and travel. Providing guidelines on habitat protection, reducing vehicle strikes, and minimizing pollution helps maintain stable population numbers by reducing anthropogenic threats.

Social and traditional media outreach increases public awareness of threats faced by Snapping Turtle by disseminating conservation success stories, warning about high-risk areas, and encouraging community involvement. Research indicates that targeted outreach campaigns can influence behaviors that reduce wildlife mortality, such as responsible driving near known highway crossing areas (Ashley et al. 2007). Private landowners, recreational users, and industries can play a significant role in turtle habitat conservation. Providing guidelines and best management practices (BMPs) for forestry, agriculture, aggregate mining, and land development can minimize habitat disruption, particularly during the nesting season (Baldwin *et al*. 2004; Gillingwater 2013). Studies have shown that although well-placed signage can reduce road mortality for turtles and other wildlife by increasing driver awareness, especially in critical habitat areas, there is a localized effect (Aresco 2005). In these situations, signage should be combined with other conservation measures, such as wildlife crossings and community outreach.

Citizen science initiatives and public sighting reports through social media contribute valuable demographic data, improving knowledge of snapping turtle distribution, movement patterns, and population trends. Landowners and industry stakeholders can report observations and identify habitat changes, helping researchers track population dynamics over time. Educational outreach and school programs also encourage young scientists to pursue research, fostering long-term engagement in Snapping Turtle conservation. The Mi’kmaq have long-standing knowledge of Snapping Turtle habitats and behaviors. Incorporating Traditional Ecological Knowledge (TEK) into conservation planning can provide valuable historical insights on population trends, habitat changes, and ecological relationships (Berkes 2012). Co-management initiatives between Mi’kmaq communities and conservation agencies ensure culturally appropriate conservation strategies.

6.3.4. Law, Policy and Enforcement

Effective legal frameworks and enforcement measures are essential for maintaining the current area of occupancy and population abundance of Snapping Turtle in Nova Scotia. Strengthening policy mechanisms can mitigate key threats such as habitat destruction, and road mortality while increasing demographic knowledge to inform long-term conservation planning.

Advocating for the placement of Snapping Turtles in a higher risk category (i.e., threatened) under the *Nova Scotia Endangered Species Act* (*NSESA*) would provide additional provincial-level considerations, facilitating increased awareness for habitat preservation and conservation planning (COSEWIC, 2020). This would provide enhanced legal recognition of their vulnerability and mandate the creation of a recovery plan. A higher risk listing would strengthen local conservation efforts, including habitat protection, research funding, and enforcement priorities. Core habitat designation under provincial law would further secure key nesting, foraging, and overwintering sites by restricting potentially harmful activities such as wetland drainage, development, and pollution (Browne and Hecnar 2007). By legally protecting these habitats, turtles can continue to occupy their historical range with reduced human disturbance.

Wildlife conservation laws are only as effective as their enforcement. Wildlife enforcement training in reptile identification and habitat requirements would help ensure that regulations protecting Snapping Turtle from illegal collection, confinement, and habitat destruction are implemented. Regular monitoring and patrolling of critical habitats improve compliance, reducing human-induced mortality (Mali *et al*. 2014). Municipal government collaboration in land-use planning can also limit habitat fragmentation by integrating conservation principles into zoning laws and infrastructure projects (e.g., green spaces, proper waste water disposal) (Steen and Gibbs 2004). These measures collectively support stable and resilient turtle populations.

Snapping turtles face multiple threats, including habitat loss, road mortality, and exploitation. Assessing wildlife laws for gaps in protection is necessary to ensure that current regulations adequately address emerging threats such as climate change and invasive species. For example, habitat fragmentation due to expanding road networks requires legal or policy frameworks that provide mitigation measures, such as exclusion fencing and wildlife corridors (Garrah et al. 2015). Advocating for stricter penalties for offenses can act as a deterrent against habitat destruction and poaching, reinforcing compliance through substantial fines or legal consequences (Gibbs and Shriver 2002). Stronger enforcement of protective laws directly reduces population declines caused by human activities.

Effective conservation policy requires accurate data on population size, movement patterns, and survival rates. Strengthened legal protections facilitate long-term research and monitoring programs that track demographic trends. Wildlife officers can assist researchers by reporting illegal turtle captures and habitat disturbances, providing valuable insights into conservation challenges (Bulté et al. 2010). Additionally, land-use

policies that mandate environmental impact assessments can contribute to demographic studies, ensuring conservation actions are data-driven.

6.3.5. Research to Address Knowledge Gaps

Despite being a long-lived species with ecological significance, many aspects of Snapping Turtle biology and conservation remain poorly understood in Nova Scotia. Effective conservation of Snapping Turtle will require targeted research to fill knowledge gaps. Ecological information is incomplete or inadequate in several key areas. Comprehensive data on population size, age structure, and distribution across Nova Scotia are lacking. Understanding these parameters is vital for assessing conservation status and implementing effective management strategies. Detailed information on habitat selection, including nesting, foraging, and hibernation sites, is insufficient. Identifying and characterizing these critical habitats will aid in habitat protection and restoration efforts. Power and Gilhen (2018) have provided insights into the nesting ecology of Snapping Turtle on Cape Breton Island, but comprehensive habitat assessments remain incomplete. Further investigations for mainland Nova Scotia into clutch size, nesting success rates and factors influencing hatchling survival will inform strategies to enhance recruitment and population stability. The extent of threats like road mortality, habitat destruction, pollution, and bycatch on Snapping Turtle populations is not well-quantified. Evaluating these impacts is crucial for developing targeted mitigation measures. While road mortality and habitat loss are recognized threats, their specific effects require further investigation. There is a paucity of information regarding the genetic diversity within and between Snapping Turtle populations in Nova Scotia. Understanding genetic variability and connectivity is essential for understanding turtle movements and impacts of land use development projects.

Closing these knowledge gaps is crucial for developing effective management strategies, mitigating threats, and ensuring the long-term persistence of populations. Long-term mark-recapture studies are vital for estimating population size, age distribution, and survival rates (Browne and Hecnar 2007). These studies provide critical demographic data that inform conservation status assessments and habitat protection measures (Lovich et al. 2018). Genetic assessments can further reveal population connectivity, gene flow, and potential inbreeding risks, ensuring that conservation strategies maintain genetic diversity (Shoemaker and Gibbs 2013; Pérez-Santigosa *et al.* 2017).

Given the longevity and late-maturing nature of Snapping Turtles, multi-decade studies are necessary to detect population trends accurately. Understanding the habitat use of snapping turtles across life stages is fundamental to their conservation. Research on nesting site selection, overwintering behaviors, and movement patterns will allow for targeted habitat protection and land-use planning (Steen *et al*. 2012).

Road mortality is likely the leading cause of adult turtle deaths, particularly adult females searching for nesting sites (Steen and Gibbs 2004; Beaudry *et al.* 2008). Research assessing roadkill hotspots and the effectiveness of mitigation measures—such as underpasses, exclusion fencing, and turtle crossing signs—will help reduce mortality rates (Garrah *et al.* 2015). Studies have demonstrated that properly designed wildlife crossings significantly reduce turtle road mortality (Rytwinski and Fahrig 2015).

Temperature-dependent sex determination (TSD) makes snapping turtles highly vulnerable to climate change (Thompson *et al.* 2018; Roberts *et al.* 2023). Rising temperatures can skew sex ratios toward females, leading to long-term population imbalances (Janzen and Paukstis 1991; Janzen 1994). Changes in precipitation patterns may also affect nest success by altering soil moisture levels and hatchling emergence timing. Local research on how Nova Scotia's climate trends influence snapping turtle reproduction is needed to inform adaptive management strategies.

Pollution from agricultural runoff, heavy metals, and wastewater discharge can have detrimental effects on snapping turtle populations. Bioaccumulation of contaminants such as mercury and polychlorinated biphenyls (PCBs) has been linked to reduced reproductive success and immune function in turtles (de Solla *et al*. 2008; Taylor *et al*. 2022). Research assessing contamination levels in Nova Scotia's snapping turtles will provide insights into potential sublethal effects and inform habitat remediation efforts.

High nest predation rates can severely impact Snapping Turtle recruitment. In some areas, increased populations of subsidized mesopredators (e.g., Raccoons, Striped Skunks) have led to unsustainable levels of nest loss (Spencer and Thompson 2003). Studies identifying key predators, seasonal predation patterns, and the effectiveness of management strategies (e.g., nest cages, predator deterrents) are needed to enhance hatchling survival rates.

Isolation of turtle populations due to habitat fragmentation can lead to inbreeding depression and reduced genetic diversity. Research examining gene flow among snapping turtle populations in different watersheds will help assess connectivity and potential barriers to movement (Kolbe and Janzen 2002; Davy and Murphy 2014). This information can guide conservation corridor design and habitat restoration efforts.

Emerging infectious diseases, such as Ranavirus, Shell-rot, and fungal infections pose potential threats to snapping turtles. Ranavirus outbreaks have been linked to mass mortality events in amphibians and reptiles (Gray *et al*. 2009; Allender *et al*. 2013). Monitoring for disease prevalence and assessing its impact on local populations will help wildlife managers develop response strategies.

Conservation success often depends on public attitudes and behaviors. Research on human perceptions of Snapping Turtle, conflicts with human activities (e.g., fishing, road crossings), and public willingness to engage in conservation initiatives will help tailor outreach programs (St. John *et al.* 2010; McKeown and Webb 2013).

Invasive species may impact Snapping Turtle through competition for food resources, predation on hatchlings, or habitat degradation. Non-native fish species, (e.g., Chain Pickerel and Smallmouth Bass) can alter aquatic ecosystems and reduce turtle foraging success (Jackson *et al*. 2010). Research assessing how invasive species influence snapping turtle populations will guide mitigation strategies, such as targeted invasive species removal and habitat restoration.

7. MEASURING PROGRESS

7.1. Performance Indicators

The performance indicators identified below are a means by which progress towards management goals and objectives can be measured within a five-year time frame. High level indicators would include:

- No net loss of index of area of occupancy of Snapping Turtle in Nova Scotia;
- Based on available demographic information, there has been no decrease in index Snapping Turtle populations;
- Threats to Snapping Turtle have been reduced or mitigated;
- Demonstrative progress towards filling knowledge gaps has been met.

Progress towards achieving high-level indicators may be aided by the following:

- Maintain (no net loss) currently occupied wetland and aquatic habitats by 2031;
- Design and implement targeted Snapping Turtle surveys within three years to confirm occupancy and population trends;
- Identify at least 25 new critical habitats (e.g., nesting sites, overwintering areas) within five years**;**
- Achieve a stable or increasing population trend based on mark-recapture (or other suitable) studies over a 10-year period;
- Implement road mortality reduction measures in at least five high-risk areas, leading to a 25% decrease in road mortality of adult females by 2031;
- Reduce reported road mortality incidents by 50% in high-risk areas through mitigation measures (e.g., public awareness, fencing, underpasses) by 2029;
- Implement nest protection programs (e.g., predator exclusion measures) at 10 priority nesting sites by year 3, leading to an increase in hatchling survival rates**;**
- Reduce illegal harvesting and disturbance incidents by at least 30% by 2028 through enhanced enforcement and public awareness campaigns;
- Initiate at least three long-term mark-recapture studies across Nova Scotia to estimate population size, survival rates, and recruitment trends by 2028;
- Conduct eDNA monitoring in at least 10 key water bodies to assess habitat occupancy and population connectivity by 2028;

- Increase public reporting of snapping turtle sightings by 50% through citizen science initiatives (e.g., mobile apps, community engagement) by 2028;
- Publish a species status assessment for Snapping Turtles in Nova Scotia by 2031.

7.2. Monitoring

The following table categorizes monitoring into four main areas: demographics (population and distribution), threats, habitat assessment, and community engagement and policy making. Each category includes specific monitoring methods, measurable benchmarks, and implementation considerations. This combination of scientific research, public engagement, and policy initiatives informs adaptive conservation efforts that can be regularly evaluated and modified to meet conservation objectives.

Table 4. Monitoring framework

Demographic Monitoring (Population and Distribution)		
Objective	**Monitoring Measures and Protocols**	**Benchmark(s)**
Track population size, structure, health, and movement to assess conservation effectiveness.	(i) Capture-Mark-Recapture (CMR) and Baited Hoop Trapping. Use PIT tags and shell notching to estimate population size and survival (NEPARC 2020).	• 75% recapture rate over five years to track long-term trends.
	(ii) Visual Encounter Surveys (VES) and Citizen Science Reports. Conduct annual surveys in known habitats. Encourage public reporting via mobile apps and online databases.	• 30% increase in reported sightings over five years.
	(iii) eDNA sampling for species presence in remote or low-density areas.	• Validate eDNA as a reliable monitoring tool within three years.

	(iv) Radio/GPS telemetry for movement and habitat use. Track home ranges, nesting sites, and overwintering locations.	• Identify at least five critical movement corridors within five years.
	(v) Long-term population trends (mark-recapture and genetic studies). Assess genetic diversity and connectivity among populations.	• Tracking population trends in at least one population per region. • Low inbreeding risk detected through genetic studies.
Threat Monitoring		
Identify, mitigate, and track threats to snapping turtle populations.	(i) Road mortality surveys and mitigation effectiveness. Conduct biweekly surveys in high-risk areas. Evaluate effectiveness of wildlife crossings and exclusion fencing.	• 50% reduction in roadkill within five years.
	(ii) Nest predation and protection strategies. Use camera traps to identify predators and test nest exclosures for effectiveness.	• 70% hatching success in protected nesting areas.
	(iii) Impact of invasive species and pollutants Collaborate with NSECC to monitor water quality in high-risk habitats (pesticides, heavy metals) and with NS Inland Fisheries and NGOs to track food web changes due to invasive species such as Chain Pickerel and Smallmouth Bass.	• Identify three high-risk areas within five years.

	(iv) Disease surveillance (Ranavirus, Shell Rot, parasites). Screen as many turtles possible annually for emerging diseases.	• Develop a rapid screening protocol within 3 years. • Establish a province-wide disease monitoring database.
	(v) Research on climate change impacts. Study nest temperature and hatchling sex ratios. Track subset of known nesting areas for erosion loss and flooding.	• Develop adaptation strategies for climate impacts. • No net loss of nesting beaches.
Habitat Assessment		
Identify, protect, and restore key snapping turtle habitats.	(i) Mapping and protection of critical habitats. Use GIS and field surveys to map nesting, overwintering, and movement corridors.	• Protect 90% of identified critical habitats within 10 years using "core habitat" designation.
	(ii) Habitat Suitability Models for conservation planning. Engage with universities on research to analyze environmental factors affecting distribution with the intent of creating a habitat suitability model.	• Develop predictive models within five years.
Community Engagement and Policy Monitoring		
Increase public awareness, stewardship, and policy protection for snapping turtles.	(i) Public Education and Outreach. Implement school programs, citizen science projects, and workshops.	• Increase public participation by 40% in five years.
	(ii) Policy and Legislative Monitoring. Advocate for provincial listing of snapping turtles as threatened.	• Uplisting to higher risk category under Nova Scotia's

		Endangered Species Act within 10 years.
	(iii) Best Management Practices (BMPs) for industry and landowners. Develop and distribute BMP guidelines.	• Completion of BMPs and 50% adoption of BMPs in key development projects.
	(iv) Stakeholder collaboration and co-management with Mi'kmaq communities. Integrate Traditional Ecological Knowledge (TEK) in conservation planning.	• Establish at least two Indigenous-led conservation initiatives within five years.

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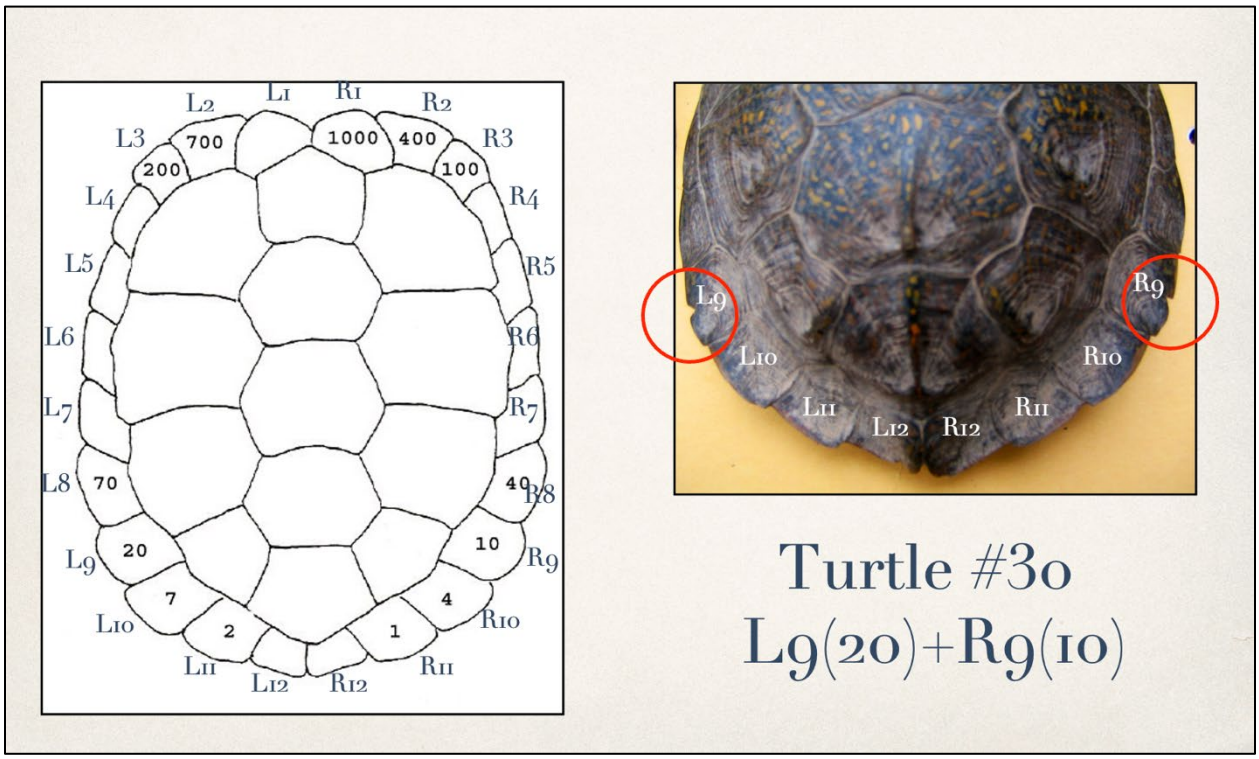
10. APPENDICES

10.1. Turtle notching code currently used in Nova Scotia modified from Cagle (1939)



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