RECOVERY PLAN FOR THE CANADA LYNX (*LYNX CANADENSIS*) IN NOVA SCOTIA

Nova Scotia Department of Natural Resources

2025

Recommended Citation:

Nova Scotia Department of Natural Resources. 2025. Recovery Plan for the Canada Lynx (*Lynx canadensis*) in Nova Scotia. *Nova Scotia Endangered Species Act Recovery Plan Series.* 46 pp.

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PREFACE

This Recovery Plan has been prepared by the responsible jurisdiction, the Nova Scotia Department of Natural Resources, in cooperation with the Nova Scotia Mammals Recovery Team. The Recovery Plan outlines the recovery goals, objectives, and actions that are deemed necessary to protect, conserve, and recover Canada Lynx in Nova Scotia.

Recovery plans are not designed to provide a comprehensive summary of the biology and status of Species at Risk in Nova Scotia. For more information regarding Canada Lynx, consult the Nova Scotia Provincial Status Report (Nova Scotia Department of Natural Resources and Renewables 2001). Under the *Endangered Species Act (1998)*, a Recovery Plan must be developed for species listed as Endangered or Threatened under the Act and include the following:

- Identification of the needs and threats to recovery of the species;
- The viable status needed for recovery;
- The options for recovery and the costs and benefits of these options;
- The recommended course of action or combination of actions to achieve recovery of the species;
- A schedule for implementation of the recovery plan including a prioritized listing of recommended actions;
- Identification of habitat, and;
- Identification of areas to be designated as core habitat for the species.

The goals, objectives, and actions identified in this Recovery Plan are based upon the best available information on the species and are subject to modifications and/or revisions as new information becomes available. Recovery of 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.

ACKNOWLEDGEMENTS

The province contracted NovaSila Wildlife Consulting Inc. to develop the draft Recovery Plan in consultation with members of the Nova Scotia Mammals Recovery Team and the Nova Scotia Department of Natural Resources.

The Department would like to thank those individuals and/or organizations who have contributed to the Recovery Plan for Canada Lynx in Nova Scotia. In particular, the following members of the Nova Scotia Mammals Recovery Team are recognized for their significant contributions to the development of this Recovery Plan:

- Graham Forbes
- Andrew Hebda
- Michael O'Brien
- Terrance Power
- Don Stewart
- Soren Bondrup-Nielsen
- Lori Phinney
- Maureen Cameron-MacMillon

EXECUTIVE SUMMARY

The Canada Lynx (*Lynx canadensis*) occurs in forested regions throughout Canada and Alaska, south through the Rocky Mountains, Great Lakes region, and northern New England. Canada Lynx are present in all Canadian provinces and territories except Prince Edward Island, where they were extirpated. The current distribution of resident Canada Lynx in Nova Scotia is believed to be limited to Cape Breton Island, with most reported occurrences in the highlands of Victoria and Inverness Counties. Canada Lynx observed on the mainland are considered vagrants or dispersers. The major threats faced by Canada Lynx today include habitat loss and fragmentation due to forest harvesting practices, and the effects of climate change which may alter dominant forest cover or decrease snowfall. Road networks, wildfire, and possible future renewable energy development, surface mining and exploration or other large scale industrial activity may also pose risks to the species' habitat. With such a small, isolated population, minimizing human-caused mortality (particularly during population lows), competition, disease, and the potential for hybridization with bobcats is critical to ensuring the long-term viability of Canada Lynx on Cape Breton Island. Since Canada Lynx populations fluctuate substantially over time in response to abundance of snowshoe hare, long-term monitoring will be required to maintain full understanding of current population trends and factors which may be affecting normal fluctuations within the limited range of the species on Cape Breton Island.

Due to the likely impacts of climate change, the long-term recovery goal (>20 years) for Canada Lynx is to maintain as much of the lynx population in Cape Breton for as long as is feasible to do so. The short-term goal is to gain a better understanding of Canada Lynx habitat use in Cape Breton. This will facilitate better population monitoring and more effective habitat protection.

Population monitoring is essential to improved understanding of habitat use and to evaluate success in species recovery. In turn, this improved understanding will both inform landscape level planning and provide a feedback loop for adaptive landscape management to further recovery goals. A formal report on progress towards the recovery of Canada Lynx in Nova Scotia will be produced every five years. This Recovery Strategy and Action plan will be formally assessed and rewritten at ten-year intervals.

RECOVERY FEASIBILITY SUMMARY

Recovery of Canada Lynx population to levels that would permit the de-listing is not considered feasible, given that climate change will likely negatively impact the species whose extant population is at the species' extreme southern range, and is already restricted to a small, higher altitude region of Cape Breton. However, the maintenance, or increase of the existing Canada Lynx population in Cape Breton, Nova Scotia is considered technically and biologically feasible for the short term (i.e., <50 years) if the following four criteria can be met:

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Annual snow track surveys show that the Canada Lynx population in Cape Breton has remained relatively stable for the last 15 years, allowing for natural fluctuations in response to snowshoe hare cycles. Based on these surveys, the Canada Lynx density has remained near 10.3 (95% CI: 8.0, 13.6) Canada Lynx/ 100 km^2 in the 4,627 km^2 special management area. This would equate to between 370 and 629 Canada Lynx in Cape Breton (DNR, unpublished data)

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Relatively little work has been done to assess the quality or quantity of available habitat for Canada Lynx in Cape Breton. Canada Lynx species distribution models covering northeastern North America identified 4,538 km^2 of suitable habitat in Cape Breton (Hoving et al., 2005). This result is very similar to what Parker et al. (1983; 2001) suggested for this region, 4,627 km^2. However, recent species distribution modelling based on Nova Scotia alone show that there are parts of this area that have as low as a 12.5% chance of supporting Canada Lynx (NS Department of Natural Resources, unpublished data). There is currently no estimate of Minimum Viable Population size to use in determining whether Cape Breton can continue to support a Canada Lynx population.

3. The primary threats to the species or its habitat can be avoided or mitigated.

The primary threats to Canada Lynx in Nova Scotia are logging and wood harvesting that unfavorably alter the forest matrix, combined with the potential for habitat shifting and alteration resulting from climate change (particularly the risk of decreasing snow depth which may threaten the competitive advantage over bobcat). Road networks that increase access for human activities, coyotes, and bobcats also present a risk to Canada Lynx in the Cape Breton Highlands, along with any future renewable energy development, mineral exploration and mining activities, and disease, which may have increased impacts in small populations. The effects of these threats may be somewhat mitigated with ongoing research, monitoring, and adaptive management of Canada

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

Many recovery actions for the Canada Lynx are underway in Nova Scotia. Ongoing and novel approaches to monitoring and assessing population trends and habitat availability can be expected within the lifetime of this plan (ten years) and will facilitate directed conservation efforts for the species moving forward.

The Recovery Team concludes that the overall short-term objective for Canada Lynx in Nova Scotia is to maintain the population, and therefore, Canada Lynx is not anticipated to be delisted. Due to the impacts of climate change on the species, the long-term objective is to maintain the Canada Lynx population as long as feasible.

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Assessment Summary: 2020

Common Name: Canada Lynx

Scientific Name: *Lynx canadensis*

Status: Endangered

Reason for Designation: Small isolated population with limited distribution, resulting from a lack of suitable habitat and restricted gene flow. Climate change, forest harvesting practices, disease, and interspecific interactions are also believed to negatively influence the species in Nova Scotia.

Nova Scotia Occurrence: Cape Breton County, Richmond County, Inverness County, Victoria County

Status History: Canada Lynx were listed as Endangered, under the Nova Scotia Endangered Species Act, in 2002. Canada Lynx were assessed as nationally Not at Risk by COSEWIC in April 1989 and May 2001.

* 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

Canada Lynx (*Lynx canadensis*) in Nova Scotia was listed as Endangered under the Nova Scotia Endangered Species Act in 2002. It has a NatureServe status of S2 (imperiled). Canada Lynx are classified as furbearers under the Nova Scotia Wildlife Act, and it has been illegal to trap or kill Canada Lynx in the province since 1980. Globally, Canada Lynx have a status rank of G5, globally secure, and are listed as Least Concern on the IUCN Red List of Threatened Species. Canada Lynx are not listed under the federal Species at Risk Act, which assessed the Canadian population as a single designatable unit in 2001(IUCN, 2012).

Table 1. NatureServe conservation status ranks for the Canada Lynx in Canada (NatureServe 2022)*.

Global (G) Rank[a]	National (N) Rank[b]	Subnational (S) Rank[c]
G5	N5	S4 – Alberta S5 – British Columbia S3S4 – Newfoundland S4 - Labrador S5 – Manitoba S4 – New Brunswick S5 – Northwest Territories S2 Nova Scotia S4 - Nunavut S5 – Ontario SX – Prince Edward Island S5 – Québec S4 – Saskatchewan S5 – Yukon

[a] G-Rank – Global Conservation Status Rank, G1 = Critically Imperiled; G2 = Imperiled; G3 = Vulnerable; G4 = Apparently Secure; G5 = Secure
[b] N-Rank –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. X = Presumed Extirpated
*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

3. SPECIES INFORMATION

3.1 Species Description

Canada Lynx are a medium-sized felid characterized by prominent, black-tipped ear tufts, elongated legs with large, fur-covered paws adapted for traveling on snow, and a short tail ending in a solid black tip. Their back legs are longer than their front legs, giving their bodies a sloped appearance. Their coat is reddish to grey brown with mottled streaks on the back and side. On the underside, the coat is a buff to white colour. In winter, the fur is long, dense, and appears lighter, while in the summer after the guard hairs have moulted, it is reddish-brown.

Adult males are approximately 80–90 cm long and weigh 9–14 kg. Females are slightly smaller, averaging 76–84 cm long and weighing 8–11 kg (Poole, 2003). Size varies across their range, with Canada Lynx in Cape Breton typically being smaller than those in mainland Canada (Khidas et al., 2013).

3.2 Population and Distribution

3.2.1 Global Range

The Canada Lynx occurs in forested regions throughout Canada and Alaska, south through the Rocky Mountains, Great Lakes region, and northern New England (Nature Serve, 2018; Poole, 2003). In the contiguous United States, it historically occurred in 16 states, although resident populations currently exist in only four of these (Nature Serve, 2018).

Globally, Canada Lynx occupies approximately 60% of its historical range (Laliberte and Ripple, 2004). Most of the range contraction has occurred at the southern end of their range, particularly in the northern contiguous United States, where remaining populations are often small and fragmented. The northern boundaries of their range are largely defined by the treeline (Poole 2003).

3.2.2 Canadian Range

Within Canada, the current Canada Lynx range encompasses approximately 5,500,000 km^2 and represents approximately 95% of their historical range (Poole 2003). Canada Lynx is present in all Canadian provinces and territories except Prince Edward Island, where it was extirpated in the early 19th century.

3.2.3 Nova Scotian Range

Canada Lynx were historically present throughout the province of Nova Scotia, though their exact historical range is unknown. Their distribution on mainland Nova Scotia has not been fully explored; however, they occupied the mainland as recently as the early 1900s (Parker 2001). Parker (2001) suggested that Canada Lynx may have historically occurred along elevated regions of Mainland Nova Scotia that likely would have included the Cobequid Mountain, Pictou Upland, and Musquodoboit Hills Districts within the Loucks' Maritime Uplands Ecoregion (Loucks, 1962; Parker, 2001).

The current distribution of the resident breeding Canada Lynx population in Nova Scotia is believed to be limited to Cape Breton Island (Parker, 2001). Canada Lynx are most common in the western highlands of Victoria and Inverness Counties, though sightings have been reported over much of the island and occasionally on the mainland. These main areas include Eco-districts 100, 210, 310, and portions of 510 (NS Department of Natural Resources and Renewables 2023, T. Power Per. Comm. 2021).

Canada Lynx seen in other areas are assumed to be dispersers (either from Cape Breton or more westerly areas of the range in eastern North American range). Evidence is lacking to confirm this and the role of the mainland in Canada Lynx dispersal is poorly understood. At whatever rate they travel between the Cape Breton Highlands and the contiguous mainland population, these individuals may still serve a role in maintaining genetic connectedness between the populations.

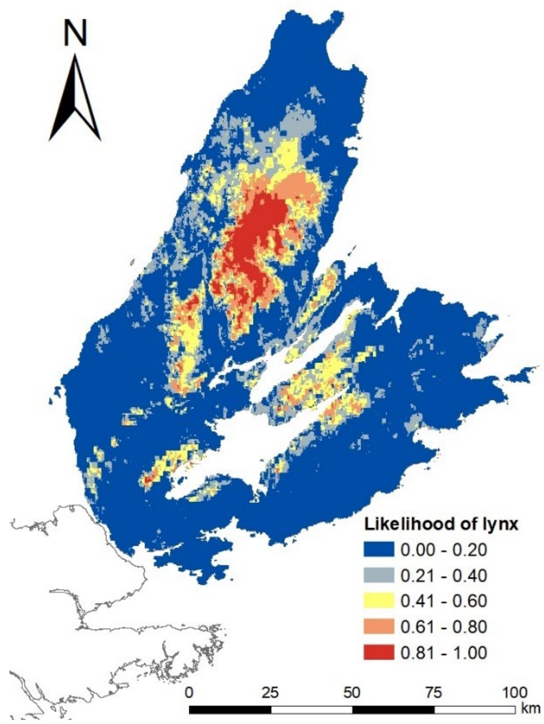

Figure 1. Cape Breton Canada Lynx distribution based on maximum entropy modelling of sighting data (n = 1418) collected from 2000 to 2020.

3.2.5 Nationally Significant Populations

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed the Canadian population of Canada Lynx as Not at Risk in 2001 because they are abundant throughout most of their range. Similarly, the General Status of Species in Canada 2020 classifies Canada Lynx as secure in Canada.

3.2.6 Population Size and Trends

Canada Lynx survival, reproductive success, and dispersal movements are closely tied to the snowshoe hare population cycle. Canada Lynx typically reach peak numbers the year following the peak abundance of snowshoe hare (Mowat *et al.*, 1999). In Nova Scotia, estimates of Canada Lynx annual survival rates are not available, but Parker *et al.* (1983) found the population age structure changed over a three-year period, coinciding with a decline in snowshoe hare abundance.

Limited data are available regarding historical or current population sizes and trends. The population is assumed to have been larger in the past than it is today, as Canada Lynx were once abundant on the mainland and throughout Cape Breton Island. Canada Lynx were already rare on the mainland by the time the provincial harvest records began in 1932 (Parker 2001). Available harvest records do show considerable fluctuation over time and would likely reflect, at least in part, population fluctuations in response to prey cycles (Figure 2).

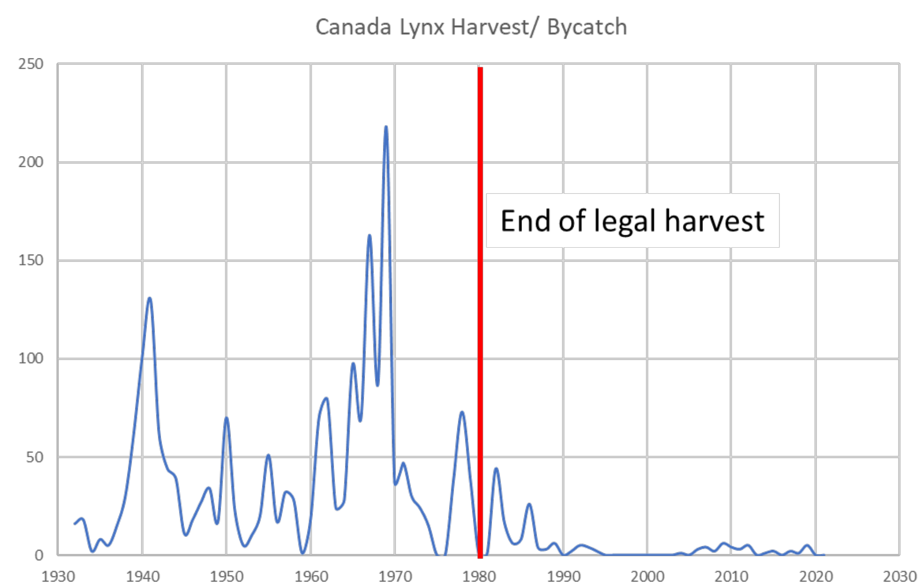

Figure 2. Nova Scotia Canada Lynx harvest from 1932 to 2022. Since 1980 it has been illegal to harvest Canada Lynx with the province seizing all bycaught animals. From 2023 and 2024 accidental Canada Lynx harvest was 1 and 0, respectively.

Most knowledge of Canada Lynx population size and trends in Nova Scotia comes from Parker's three-year study from winter 1977–78 to winter 1979–80 (Parker, 1981; Parker et al., 1983). Using a conservative estimate of 11 Canada Lynx/100 km^2 in times of high abundance, Parker (1983) estimated a population size between 475 and 525 Canada Lynx during peak densities and 95–140 Canada Lynx during times of low densities (20–30 Canada Lynx/100 km^2). However, in the southern Rockies, Canada Lynx densities averaged 2-3 Canada Lynx/100 km^2 (Koehler 1990; Aubry et al. 2000). Snow track surveys completed in Cape Breton from 2005 to 2024 found an average Canada Lynx density of 9.6 (95% CI: 4.0, 19.2) Canada Lynx/100 km^2. This population estimate, based on snow track surveys, suggests that Canada Lynx are at low densities compared to this population in the early 1980s, but are at higher densities than most southern populations.

Snow track surveys are known to produce inaccurate population estimates but are a reliable method for tracking population trends (O'Donoghue et al., 2022). Provincial snow survey data show that the Canada Lynx population in Cape Breton has remained stable over the last 20 years. Canada Lynx densities were calculated using Formozov–Malyshev–Pereleshin formula (outlined in Stephens et al., 2006). This process involves dividing the number of lynx tracks observed by two times the length of the transect surveyed multiplied by the average daily lynx movement rate. The movement rate was assumed to be 7.6 km/day based on Cape Breton work (Parker et al. 1983). Additionally, there was a relationship between the 2-year lagged abundance of snowshoe hare pellets per km and annual Canada Lynx track counts per km in Cape Breton over this same period (Figure 3; R^2 = 0.64).

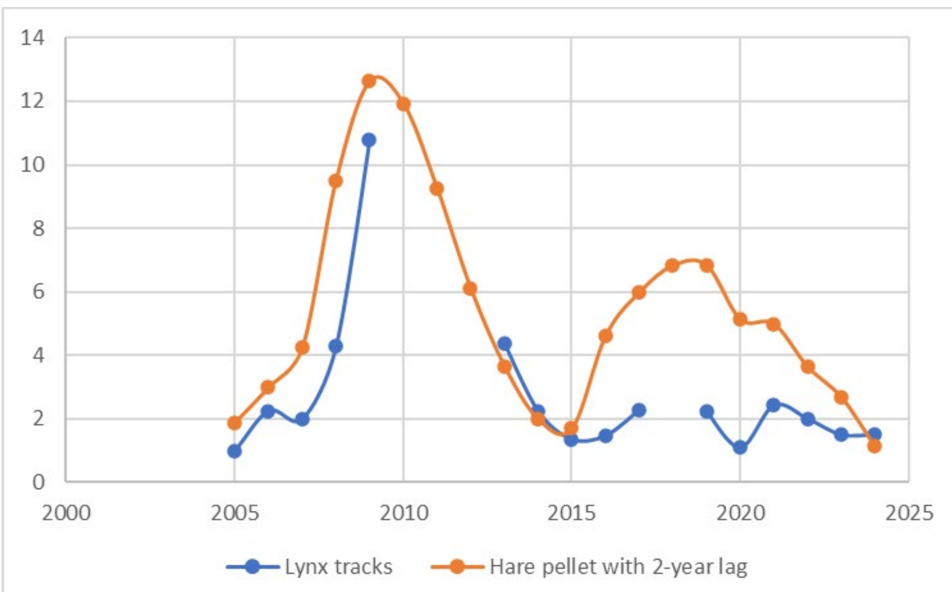

Figure 3. Number of Canada Lynx tracks and snowshoe hare pellet counts with a two-year lag from annual surveys done in Cape Breton collected between 2005 and 2024.

3.3.2 Biology of the Species

Canada Lynx preys primarily on snowshoe hare (*Lepus americanus*), and its abundance is closely tied to snowshoe hare population cycles (Fig. 2), particularly in the northern extent of its range (Roth et al., 2007; Szumski et al. 2023). During a three-year study in the Cape Breton Highlands, diet was examined through analysis of stomach contents from collected carcasses and scats obtained along winter snow-tracking trails and summer roads and trails (Parker et al., 1983), which coincided with a peak and beginning of a decline in snowshoe hare abundance. This study found that snowshoe hares were the most common Canada Lynx prey item. Snowshoe hare was found in 97% of the Canada Lynx stomachs, 93% of the winter scat, and 70% of the summer scat tested. Stable isotope work has shown that while snowshoe hare is the main food source for all Canada Lynx populations. However, Canada Lynx populations farther south increasingly use alternative food sources (Roth et al., 2007; Szumski et al. 2023). In New Brunswick, based on stable isotope data from animal muscle tissue snowshoe hare made up 79 ± 3 % of Canada Lynx diet in areas where bobcat also lived, but only 68 ± 4% of their diet when there were no bobcat present (Nakamoto et al. 2024). Hare abundance also affects how much they make up of a Canada Lynx's diet. In northern population lynx shift to alternative food sources when snowshoe hare becomes scarce. However, in more southern populations, this shift is smaller and, in some cases, non-significant (Szumski et al. 2023).

Canada Lynx are capable of dispersing long distances, with movements >100 km being considered routine in northern populations (Mowat *et al.*, 1999). Dispersal may help counterbalance genetic drift during times of low populations (Row et al., 2012). In Nova Scotia, relatively little is known about Canada Lynx dispersal. Genetic analysis of archival bone samples (from the 1970s and 1980s) indicated that the Cape Breton population of Canada Lynx is genetically distinct from populations in Eastern Canada and has low levels of genetic variation (Prentice *et al.*, 2017). These findings suggest that substantial dispersal between the island and the mainland (or vice versa) is unlikely, which may put the Cape Breton population at a higher risk of extirpation than mainland continental populations (Prentice *et al.*, 2017).

3.3.1 Habitat

The following section is not an extensive review of Canada Lynx habitat use but identifies the most important components of habitat for Canada Lynx in Cape Breton. This information forms the basis of core habitat identified in section 8.

<u>Forest Structure</u>

Canada Lynx inhabits mainly boreal forests, sub-alpine, western montane, and eastern boreal/hardwood forests (McCord and Cardoza 1982; Quinn and Parker 1987). Their densities tend to be highest in conifer and mixed-wood forests dominated by spruce, pine, and balsam fir (Legendre *et al.* 1978, Quinn and Thompson 1987, Hatler 1988,

Dwyer *et al.,* 1989; Mowat *et al.,* 2000). Canada Lynx often occur in a mosaic of mature forests, interspersed with regenerating stands from natural disturbances or forest harvesting (Bull *et al.* 2001). Fuller (*et al.,* 2007) found that Canada Lynx selected for tall regenerating clear-cuts and partially harvested stands (11–26 years) while selecting against stands harvested in the last 10 years and mature second-growth stands (>40 years). Snowshoe hare availability has been suggested as the best predictor of Canada Lynx habitat selection (Vashon et al., 2008; Fuller and Harrison 2010). Hares favor 10- to 40-year-old regenerating conifer and mixed wood forests over select cut or mature forests (Mallett, 2014; Olsen, 2015).

The scale used to assess Canada Lynx habitat use must also be considered. Fuller and Harrison (2010) argued that conservation efforts for Canada Lynx should not focus on specific site conditions but should instead focus on habitat characteristics at the home range or landscape scale. They argue that Canada Lynx are a wide-ranging carnivore that is unlikely to benefit from efforts that focus on a single area's conditions (Fuller and Harrison 2010).

In Nova Scotia, Canada Lynx are found primarily in the Cape Breton Highlands, a plateau around 300 m above sea level, which supports mainly balsam fir, black spruce, and white birch/heart-leaf birch. The central portion of the plateau (area of highest elevation) supports dense stands of short spruce and fir interspersed with heath-shrub barrens and peat bogs. Snow tracking studies from 1977 to 1980 identified preferred winter habitats to be early and advanced successional forests, followed by open mature conifer forests, and open spruce-dominated bogs (Parker, 1981). They frequently used open spruce-dominated bogs for resting, socializing, and also followed road edges and trails, which differs from findings of Canada Lynx habitat use in other portions of their range (Parker, 1981; Fuller *et al.* 2007).

The selection of forest structure likely reflects the high abundance of snowshoe hare. Hares in the northeast are generally associated with forests that have a well-developed understory that provides protection from predation and supplies them with food. This type of forest structure is common in younger (regenerating) forest, but may also occur in coniferous forests with mature but relatively open overstories or in eastern deciduous forests (Orr and Dodds, 1982; Hodges, 2000). Hoving *et al.* (2005) concluded that Canada Lynx avoided areas dominated by deciduous trees. The avoidance of hardwood areas may reflect lower density of snowshoe hare in areas with more deciduous trees (Hodges, 2000). Therefore, certain forest stands are best considered as a proxy for high prey abundance.

Mature forests provide coarse woody debris for denning sites and support alternative prey species such as red squirrels, voles, and other small mammals (Squires and Laurion 2000). Canada Lynx select den-sites at the sub-stand scale. An analysis of den-site selection in Maine by Organ et al. (2008) indicated that tip-up mounds of blown-down trees and visual obscurity at 5 m were the predictor variables with the strongest relationship to den-site selection (Organ et al., 2008).

Snow Conditions

Canada Lynx occur in areas with deep winter snow cover, where their low foot-load provides an advantage over sympatric competitors such as bobcat and coyote (Krohn, 1990; Murray and Boutin,1991; Morin et al., 2020). In Cape Breton, Canada Lynx are normally found at higher elevations where snow is deep, and bobcats tend to occur at low elevations where snow is shallow (Parker et al., 1983). This same pattern was seen in other locations in the northeast (Hoving et al., 2005; Morin 2020). Advances in snowmobile technology and increased track grooming may reduce the competitive advantage that Canada Lynx have in deep snow areas (Buskirk et al., 2000). In the western intermountain region, increased snowmobile access is thought to have facilitated coyote expansion into deep-snow habitats, contributing to lynx declines. As a result, limiting snowmobile activity in lynx habitat has been recommended (Buskirk et al., 2000; Bunnell et al., 2006).

A model of Canada Lynx occurrence across eastern North America found that snowfall and deciduous forests were the most significant predictors for Canada Lynx occurrence (Hoving *et al.*, 2005). Canada Lynx rarely occurred in areas with <270 cm of snowfall per year (Hoving *et al.*, 2005). Hoving *et al.*'s 2005 model included observations from Nova Scotia and identified that some of the Canada Lynx occurrences in the lowlands of Cape Breton are in areas predicted to be poor quality habitat.

Intraspecific Competition

There is evidence that Canada Lynx and coyote living in sympatry will both prey extensively on snowshoe hare when hare is plentiful, but coyote will switch to alternative prey when hare is scarce (O'Donoghue, 1997; O'Donoghue et al., 2001). Canada Lynx are also capable of switching to alternative prey species (Roth et al., 2007). Parker (2001) argued that the presence of bobcats in the lowlands of Cape Breton likely limited Canada Lynx. However, in New Brunswick Canada Lynx and bobcat live sympatrically in the mid-latitudes of the province (Nakamoto et al. 2024). This may be possible due to Canada Lynx and bobcat having large allopatric populations in the north and south of the province, respectively. Stable isotope data from New Brunswick shows that Canada Lynx and bobcat living in the allopatric areas have similar dietary patterns, but in sympatric areas, bobcat had broader diets and Canada Lynx slightly narrower (Nakamoto et al. 2024). Bobcat also used a broader range of habitats when they were found in areas with Canada Lynx based on species distribution data from across North America (Peers et al., 2013). These coyote and bobcat results suggest that niche partitioning between these species can allow them to live in sympatry.

Estimates of Canada Lynx Habitat in Nova Scotia

We estimate that Canada Lynx core habitat in Nova Scotia covers 2179 km^2 (Figure 4). This is based on 1418 sighting reports collected between 2000 and 2020 that were modeled using maximum entropy modelling. Based on this we were able to predict the likelihood Canada Lynx would be found in different areas of the province (Figure 1). We then delineated core habitat from this as any areas that had a greater than 33% chance of supporting Canada lynx (Figure 4).

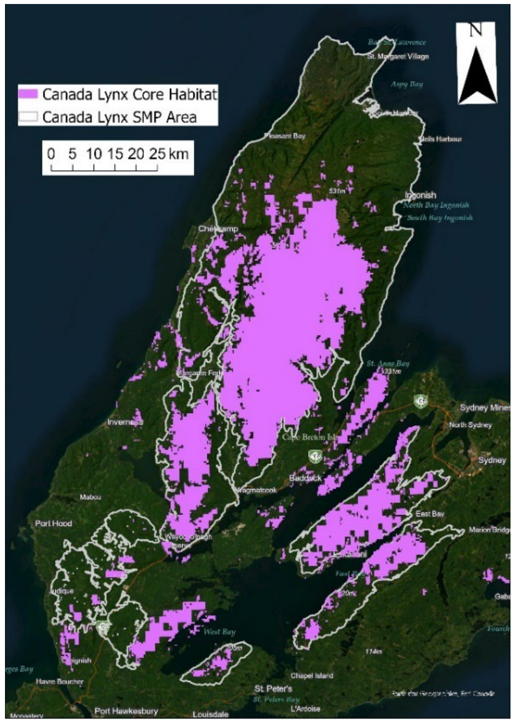

Figure 4: Nova Scotia Canada Lynx core habitat and special management area (SMP area).

The Canada Lynx habitat estimate based on the species distribution model was similar to the estimate based on the Special Management Practice (SMP; Figure 4). The SMP estimated that lynx habitat covered 4,924 km^2 of Cape Breton. The SMP was first mapped in the 1980s and was based on female Canada Lynx with offspring sightings as well as professional knowledge from provincial biologists. These sightings were mapped, and the areas around them were then selected from various eco-districts including the Cape Breton Highlands, the Cape Breton Taiga, the Victoria Lowlands, and portions of Cape Breton Hills (P. Austin Smith, pers comm). These sightings came from a variety of sources, including the public, trappers, and wildlife biologists.

One limitation of both the species distribution model and SMP habitat estimates is that both partially rely on public sightings meaning that they are both likely biased towards areas with more human activity rather than areas that are most preferred by Canada Lynx. However, these habitat estimates are close to regional estimates generated by models covering the Canada Lynx range across eastern North America (Hoving et al., 2005; Manerikar 2018). Manerikar (2018) estimated that there was 4,627 km^2 of available Canada Lynx habitat in Cape Breton. This work was a re-evaluation of

Hoving's 2005 Canada Lynx habitat model of Eastern North America which found that 4,538 km^2 was suitable for Canada Lynx (Hoving et al. 2005).

Habitat Trends

Most of the identified Canada Lynx range falls in protected areas or on Crown land that is managed by large-scale forestry operators. Within protected areas, habitat is impacted by spruce budworm and fire. Climate change is expected to have a significant impact on the forests of Cape Breton and the availability of Canada Lynx habitat (Buskirk et al., 2000, Manerikar 2018, Steenberg *et al.*, 2013).

Climate change is causing milder winters which is reducing winter snow cover. This in turn reduces the areas where Canada Lynx have a competitive advantage over other meso-predators (Hoving et al., 2005; Manerikar 2018, Morin et al., 2020). Climate change also impacts forest composition and disturbance regime (Steenburg et al. 2013). As temperatures increase in the boreal forest the likelihood of fire increases, which will decrease the amount of mature forest available. These higher temperatures will also favor non-boreal plant species (Steenburg et al. 2013).

Much of the Canada Lynx habitat on Cape Breton Island is still showing the effects of a wide-ranging, severe spruce budworm infestation from 1974 to 1981. As a result of the outbreak, large-scale forest harvest salvage operations were undertaken in the 1970s and 1980s (Parker, 2001). As stands began to regenerate, early successional growth created optimal habitat for snowshoe hares (Parker *et al.*, 1983).

Throughout Nova Scotia, the predominant forestry operations are industrial level silviculture, with variable retention harvesting where 10–30% of the stand is retained post-harvest. The impact of this type of harvesting on Canada Lynx is not fully understood. It is suspected that clearcutting may result in a decrease in mature forests with sizeable coarse woody debris required for denning (Nova Scotia Recovery Team, 2006), but may also benefit the Canada Lynx through creating early successional forests capable of supporting high prey densities (Simons-Legaard *et al.*, 2013). Pre-commercial thinning may create unsuitable habitat given the relatively sparse understory cover (Nova Scotia Recovery Team, 2006). Recent changes to forest management in Nova Scotia with the implementation of the recommendations in An Independent Review of Forest Practices (Lahey, 2018) may improve habitat for Canada Lynx through increased retention of live trees during forest harvesting.

Within Cape Breton Highlands National Park, over-browsing by previously hyperabundant moose populations and damage caused by spruce budworm have halted and altered forest regeneration. This has resulted in the conversion of 11% of the park to grass-dominated savannah (Smith *et al.*, 2015). From 2015 to 2018, Parks Canada and the Unama'ki Institute of Natural Resources implemented a plan to restore the boreal forest in areas impacted by heavy moose browsing. The project included testing fenced moose ex-closures, tree planting, and eliminating moose from an area to evaluate options for forest restoration (Smith *et al.*, 2015).

Habitat Protection / Ownership

1201 km^2 of the 2178 km^2 (55.1%) of the identified Canada Lynx core habitat in the province falls within unprotected provincial Crown Land that is licensed for commercial forestry; however, SMP for managing Canada Lynx within the identified Canada Lynx range are in place for these areas (NS Department of Natural Resources, 2012). Canada Lynx habitat also occurs within the Cape Breton Highlands National Park (104 km^2; 4.7% of the total area), within provincial protected areas (357 km^2; 16.4%), and by private land trusts (4 km^2; 0.2%). This means that only 23% of Canada Lynx core habitat is on land not directly managed by the province or under some form of protection. This recovery plan will provide essential information related to core habitat for Canada Lynx to facilitate an update to the existing habitat management policy which may include a new SMP or BCMP.

There is a high density of Canada Lynx living in Cape Breton compared to most other southern populations (Hoving et al. 2005). However, the small size and geographic isolation of the Cape Breton population of Canada Lynx increases the extirpation risk for these animals and also raises concerns about reduced genetic diversity due to limited gene flow from other populations. Long-term monitoring will be required to maintain full understanding of population trends and factors which may be affecting normal fluctuations in this species within its limited range on Cape Breton Island.

4. THREATS

4.1 Threat Assessment

The Canada Lynx threat assessment is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threat classification system. Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). Limiting factors are not considered during this assessment process. For purposes of 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 us understand the nature of the threats are presented in Section 4.2 Description of Threats.

Table 2. Threat calculator assessment

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
1	Residential and commercial development					Not Applicable
1.1	Housing and urban areas					Not Applicable
1.2	Commercial and industrial areas					Not Applicable
1.3	Tourism and recreation areas					May overlap with snowmobiles and ATV use
2	Agriculture and aquaculture	Low	Restricted	Slight	High	
2.1	Annual and perennial non-timber crops					Not Applicable
2.2	Wood and pulp plantations	Low	Restricted	Slight	High	Conversion of forests to forest plantations. This can negatively impact snowshoe hare populations, which in turn negatively impacts Canada Lynx
2.3	Livestock farming and ranching					Not Applicable
2.4	Marine and freshwater aquaculture					Not Applicable
3	Energy production and mining	Low	Restricted	Slight	Moderate	
3.1	Oil and gas drilling					Not applicable
3.2	Mining and quarrying	Low	Restricted	Slight	Moderate	Recent mining exploration permits have been issued near Canada Lynx core habitat. Possible changes to habitat quality/use with mineral exploration activities; possible conversion of forests for surface mining and service roads. In 2025, The Nova Scotia Government identified critical mineral exploration as a priority. This involved streamlining the EA process for mining projects. This may increase the risk of damage

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
						to Canada Lynx core habitat in the future
3.3	Renewable energy	Unknown	Unknown	Unknown	Unknown	Several wind energy projects are proposed within current Canada Lynx habitat in Cape Breton, which may increase the level of threat. Wind projects are often placed at the highest elevations in an area. Higher elevation areas act as climate refuges for lynx as lower elevations warm.
4	Transportation and service corridors	Low	Small	Slight	High	
4.1	Roads and railroads	Low	Restricted	Slight	High	Accidental mortality; increased access by coyotes, bobcats; increased human access facilitating disturbance; harvesting other target species. Roads may increase forest edges, providing suitable prey habitat
4.2	Utility and service lines	Negligible	Small	Negligible	High	Increased access by humans and other predators
4.3	Shipping lanes					Not Applicable
4.4	Flight paths					Not Applicable
5	Biological resource use	Low	Restricted	Moderate	High	
5.1	Hunting and collecting terrestrial animals	Low	Small	Slight	High	Bycatch of Canada Lynx does occur occasionally, typically in traps intended for bobcat or coyote. While such incidents are uncommon in the Highlands, they present a greater risk to dispersing individuals moving through the landscape

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
5.2	Gathering terrestrial plants					Not Applicable
5.3	Logging and wood harvesting	Medium	Large	Moderate	High	Fragmentation of habitat; increased road networks; disproportionate area of young and regenerating forests; reduction of conifer cover for snowshoe hares through thinning and shelterwood; reduced area of mature forests with coarse woody debris for denning.
5.4	Fishing and harvesting aquatic resources					Not Applicable
6	Human intrusions and disturbance	Negligible	Large	Negligible	High	
6.1	Recreational activities	Unknown	Large	Unknown	High	Logging roads create areas for recreational use – especially snowmobiling in winter ATV use in spring, summer and fall
6.2	War, civil unrest, and military exercises					Not Applicable
6.3	Work and other activities					Not Applicable
7	Natural system modifications	Low	Small	Slight	Moderate	
7.1	Fire and fire suppression	Low	Small	Slight	Moderate	Loss of forest to fire. With recent intense windstorms in Cape Breton, there is an increasing risk of fire in the region. A counter point to this is that Canada Lynx are very well adapted to live in boreal forest, which is historically managed by wildfire.
7.2	Dams and water management/use					Not Applicable
7.3	Other ecosystem modifications					Not Applicable
8	Invasive and other problematic species and genes	Low	Restricted	Moderate	High	

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
8.1	Invasive non-native/alien species					Not Applicable
8.2	Problematic native species	Low	Restricted	Moderate	High	Competition with coyotes, bobcats. Browsing by introduced moose in CB interrupts forest regeneration pathways and/or prevents forest maturation.
8.3	Introduced genetic material	Low	Large	Slight	High	Potential introgression with bobcat
8.4	Problematic species/diseases of unknown origin	Unknown	Unknown	Unknown	Unknown	More data needed
8.5	Viral/prion-induced diseases	Low	Restricted	Slight	High	Canine distemper; effects of disease more pronounced in small populations.
8.6	Diseases of unknown cause	Low	Restricted	Moderate	High	Effects of disease more pronounced in small populations.
9	Pollution	Negligible	Negligible	Negligible	High	
9.1	Household sewage and urban wastewater	Negligible	Negligible	Negligible	High	Unknown
9.2	Industrial and military effluents	Negligible	Negligible	Negligible	High	Unknown
9.3	Agricultural and forestry effluents	Negligible	Negligible	Negligible	High	Unknown
9.4	Garbage and solid waste	Negligible	Negligible	Negligible	High	Unknown
9.5	Air-borne pollutants	Negligible	Negligible	Negligible	High	Unknown
9.6	Excess energy	Negligible	Negligible	Negligible	High	Unknown
10	Geological events					Not applicable
10.1	Volcanoes					Not applicable
10.2	Earthquakes/tsunamis					Not Applicable
10.3	Avalanches/landslides					Not Applicable

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
11	Climate change and severe weather	Low	Pervasive	Slight	High	
11.1	Habitat shifting and alteration	Medium	Pervasive	Moderate	High	Alteration to boreal forest, potential reduction in snow depth reducing competitive advantage.
11.2	Droughts	Negligible	Pervasive	Negligible	High	May increase risk /severity of forest fires.
11.3	Temperature extremes	Low	Pervasive	Slight	High	Lynx are adapted for severe cold; prolonged periods of extreme heat may be more influential.
11.4	Storms and flooding	Not a Threat	Large	Neutral or potential benefits	High	Extreme wind events may affect forest structure; could create coarse woody debris for denning, increase cover for snowshoe hare.

[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 = 11–30%; 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 = 11–30%; 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

Threats to the Canada Lynx in Nova Scotia are not well understood but likely include habitat fragmentation and degradation from forest harvesting, moose browse, potential future surface mining or renewable energy development, and climate change impacts such as reduced annual snow cover. Additional risks include accidental mortality from roads and incidental harvest (particularly of dispersing individuals), interspecific competition with coyotes, fishers, martens, and bobcats, disease, and potential hybridization with bobcats. Canada Lynx populations in Nova Scotia may be constrained by their small range, lack of suitable habitat, and restricted gene flow.

Biological Resource Use – Logging & Wood Harvesting (Medium)

Forestry practices can result in the loss of habitat and habitat fragmentation, increased road networks, disproportionate area of young and regenerating forests, reduced areas of mature forests with coarse woody debris for denning and impact prey species numbers through reduction of conifer cover through thinning and shelterwood (Fuller and Harrison 2010). However, limited forest disturbance, including forestry, can be beneficial to Canada Lynx as regenerative often supports higher densities of snowshoe hare (Simons-Legaard et al., 2013). Optimal habitat for this species consists of a mosaic of mature forests, interspersed with regenerating stands from natural disturbances or forest harvesting (Bull *et al.* 2001)

Climate Change & Severe Weather – Habitat Shifting & Alteration (Medium)

With the uncertainty of climate change, impacts to Canada Lynx include alterations to boreal forest (Steenburg et al. 2013) and potential reduction in snow depth reducing competitive advantage (Hoving et al., 2005; Manerikar 2018; Morin et al., 2020). Climate change also negatively impacts snowshoe hare, Canada Lynx's primary food source, through camouflage mismatch (Evan et al., 2019). This occurs when hares have white coats when there is no snow present. This lack of camouflage makes them more susceptible predators, reducing their survival. This effect is thought to be the main cause of snowshoe hare range contraction in their southern range (Evan et al., 2019).

Agriculture & Aquaculture – Wood & Pulp Plantations – (Low)

Forest plantations offer poor Canada Lynx habitat (Bull *et al.,* 2001). So, conversion of forests to forest plantations increases loss of viable habitat for Canada Lynx and their prey.

Energy Production & Mining – Mining & Quarrying (Low)

Potential changes to habitat quality and use due to mineral exploration activities, and renewable energy development, and potential loss of forests for surface mining and renewable energy development, including service roads.

Transportation & Service Corridors – Roads & Railroads (Low)

An increase in road density in an area can increase accidental mortality (Kramer-Schadt et al., 2004), increase habitat fragmentation (Kramer-Schadt et al., 2004), increase access by coyotes and bobcats, which increases competition for prey species (O'Donoghue et al., 2001), and human access and harvesting of other target species, which increases the risk of incidental capture (Buskirk et al., 2000; Kramer-Schadt et al., 2004). One benefit roads may have is increasing forest edges, providing suitable prey habitat and potentially increasing prey presence and prey hunting opportunities (Simons-Legaard et al., 2013).

Biological Resource Use – Hunting & Collecting Terrestrial Animals (Low)

Incidental captures of Canada Lynx in traps and snares set for bobcats and coyotes have occurred but often threaten dispersing individuals more than Canada Lynx in Cape Breton Highlands (Buskirk et al., 2000; Kramer-Schadt et al., 2004).

Natural System Modifications – Fire & Fire Suppression – (Low)

Changes in weather patterns related to snow, rain and temperature fluctuations may increase the risk of forest fires in the coming years (Steenburg et al., 2013).

Invasive & Other Problematic Species, Genes & Diseases –Problematic Native Species (Low)

Impacts of problematic native species could increase the competition with coyotes, bobcats and fishers, and marten (O'Donoghue et al., 2001). Heavy browsing in Cape Breton may be interrupting natural forest regeneration pathways and may have long-term impacts on availability of suitable habitat for Canada Lynx (Smith et al., 2015). The range of snowshoe hare has been contracting across its southern extent (Evan et al., 2019). One of the factors driving this decline is climate induced camouflage mismatch in more southerly areas (Evan et al., 2019). Since most of a Canada Lynx's diet is snowshoe hare, this has had a negatively impacted lynx populations in these areas.

Invasive & Other Problematic Species, Genes & Diseases –Introduced Genetic Material (Low)

Because Canada Lynx and bobcat are closely related and they live sympatrically in Cape Breton, there is a risk that these species will interbreed. There is evidence of lynx-bobcat hybrids in the region (Homyack et al., 2008; Huynh et al., 2019). Species hybridization can result in offspring with lower fitness or even sterility (Marshall and Spalton, 2000). Previous work has shown that the rates of hybridization between these species is very low even where the species are sympatric. This work also shows that hybrids are likely to remain fertile (Koen et al., 2014).

Invasive & Other Problematic Species, Genes & Diseases – Problematic Native Species (Low)

Interactions between species can also increase the susceptibility to canine distemper and other diseases (Daoust et al., 2009; Licht, 2015). The effects of disease in small, isolated populations can be especially detrimental (Heard et al., 2013).

Transportation & Service Corridors – Utility and Service Lines (Negligible)

Like roads, utility and service lines can create habitat fragmentation and increase access by coyotes and bobcats, which increases competition for prey species (O'Donoghue et al., 2001; Kramer-Schadt et al., 2004). Like roads, they may provide benefits by increasing forest edges, providing suitable prey habitat and potentially increasing prey presence and prey hunting opportunities (Simons-Legaard et al., 2013).

Human Intrusions & Disturbance – Recreational Activities (Negligible)

Logging roads provide access for recreational activities, particularly snowmobiling in winter, and, similar to utility or service corridors, can also facilitate access for other species and increase competition for prey (O'Donoghue et al., 2001; Squire et al., 2019). Canada Lynx are known to avoid areas with heavy snowmobile use, but are less impacted by cross-country skiing (Squire et al., 2019)

5. POPULATION AND DISTRIBUTION OBJECTIVES

Viable Status for Recovery

The long-term recovery goal (>20 years) for the Cape Breton Canada Lynx is to maintain genetic diversity in the population and minimize range loss due to climate change by maintaining as much optimal lynx habitat as possible.

Short-term population and distribution objective

The short-term population and distribution objective for Canada Lynx is to identify as much optimal Canada Lynx habitat in Cape Breton as possible and then to work to protect and maintain this habitat. To determine the current lynx population and its genetic diversity. To better understand snowshoe population dynamics in this area to better predict Canada Lynx population changes in the future. All these goals will be accomplished through continued research in this area.

Rationale

Although Canada Lynx may no longer be found in portions of their former range, the remaining habitat may still be capable of supporting a viable population(s) of the species. The exact historical range of Canada Lynx in Nova Scotia is unclear; however, accounts from the 1800s suggest that they occurred throughout Nova Scotia and were common, though limited in distribution to elevated, forested areas (Gilpen 1864). By the early 1900s, their range had contracted significantly, and they were considered extirpated from the mainland by 1950 (Parker, 2001). The population and distribution of Canada Lynx in Nova Scotia is very restricted. Currently, there is a resident, breeding population of Canada Lynx that is largely restricted to the high elevation areas in Victoria and Inverness Counties on Cape Breton Island.

Several recommended actions to address further research related to short-term and long-term objectives can be found in Table 4 and Section 6.3.5 *Research to Address Knowledge Gaps.*

6. BROAD STRATEGIES AND GENERAL APPROACHES TO RECOVERY

6.1 Actions Completed or Underway

The Government of Nova Scotia has taken a variety of management actions towards the recovery of Canada Lynx. These actions provide a foundation for future recovery efforts for Canada Lynx in Nova Scotia. These actions include:

- Tracking furbearer harvesting statistics since 1932 (ongoing).
- Closed the Canada Lynx trapping season since 1980 (ongoing).
- Delivered workshops to trappers to aid in minimizing, to the extent possible, mortality from incidental catch in traps and snares set for bobcat and coyote (2007-2009).
- Held workshops with the Trappers Association of Nova Scotia to engage stakeholder involvement in the recovery of Canada Lynx (2007-2009).
- Distributed an annual newsletter with an article on Canada Lynx in Nova Scotia: "Species at Risk in Nova Scotia" (produced by Nova Scotia Department of Natural Resources and Trappers Association of Nova Scotia). Newsletter publication stopped in 2010.
- Distributed a report card within the annual *Nova Scotia Hunting and Fur Harvesting Summary of Regulations* booklet that outlines requirements for reporting nontarget species, including species at risk (ongoing).
- The Moose Harvester Information Booklet contains a section on reporting requirements for encountering Canada Lynx while moose hunting (ongoing)
- Initiated a province wide program in the 1983 to track snowshoe hare abundance through annual pellet group surveys conducted in conjunction with annual deer pellet surveys (ongoing).
- Managed and protected most of the identified Canada Lynx breeding range in Nova Scotia (Cape Breton Highlands National Park (950 km^2 in 1936);

provincial protected areas (~680 km^2); other provincial Crown lands (~1900 km^2).

- Implemented special management practices for Canada Lynx on provincial Crown lands in the Cape Breton Lynx Range in 2012 (ongoing).
- Collaborated with Port Hawkesbury Paper on the management of 246 km^2 of habitat buffers around spruce bogs to benefit Canada Lynx (ongoing).
- Investigated reported sightings of live or dead Canada Lynx or their sign received from the public and with cooperation from the Cape Breton Highlands National Park (ongoing).
- Tracked mortality factors and disease through the collection and necropsy of Canada Lynx carcasses submissions to the Department of Natural Resources with collaboration of the Canadian Wildlife Health Cooperative (ongoing).
- Implemented predator and prey monitoring transects from 2005 to present to improve knowledge on the distribution and abundance of Canada Lynx (ongoing).
- Tracked snowshoe hare population trends through harvest report cards and ranking of relative abundance for 50+ years. Officially initiated a province-wide snowshoe hare abundance monitoring program through fur harvesters and small game hunters in 1993 (ongoing).
- Examined the effects of buffer zones for Canada Lynx in cooperation with Acadia University between 2013 and 2015.
- Held Recovery Action Forums on species at risk in Nova Scotia, beginning in 2020 (concluded).
- Raised public awareness of the concern for Canada Lynx and involved the public and relevant stakeholders through stewardship activities and social media (ongoing).

6.2 General Approaches to Recovery

The following table (Table 3) summarizes recovery actions and specific steps recommended to address threats and achieve successful recovery of Canada Lynx in Nova Scotia, along with their priority and relative costs.

Table 3: Conservation Measures and Implementation Schedule. Threats and Concerns are derived from those in Table 1 with a calculated impact of low or higher.

Recovery Measures	Threat(s) Addressed*	Actions	Priority**	Cost***	Benefit
Habitat Protection, Management and Stewardship					
Undertake landscape-level planning that considers Canada Lynx habitat requirements	2.2, 3.2, 4.1, 5.3	• Consider management of core habitat at different levels of ecological land classification schemes such as eco-districts and eco-sections. • Conduct a review and analysis on the practical and theoretical implications of managing designated core habitat. • Develop and implement a robust detection and monitoring program to gather data for habitat-based occupancy modelling for Canada Lynx on Cape Breton Island.	Medium	$$	Protect known occurrences outside of designated areas of Core Habitat. Protect and maintain habitat for non-listed species and biodiversity benefits
Collect and combine data to understand Canada Lynx populations, including data on snowshoe hare abundance and habitat requirements	8.3, 11.1,	• Use data from DNR *Biodiversity Investigation Reports* (BIR), public sighting reports, predator/prey survey data, and accidental catch data from trappers to determine where Canada Lynx have been found; Include data from snowshoe pellet surveys. • Use trail cameras in the Cape Breton Highlands to determine lynx abundance and core habitat use in this region.	High	$$	Provides baseline information regarding Canada Lynx population trends, habitat use, and if done over multiple years how these things change over time. Determine knowledge gaps where more research is needed to better inform management decisions about Canada Lynx.
Understand habitat needs for Canada Lynx and evaluate existing habitat to determine what areas are highest priority for protection	3.2, 5.3, 7.1, 11.1	• Determine which types of habitats, including that of snowshoe hare should be prioritized for active management to ensure the survival and recovery of Canada Lynx. • Integrate snowfall data in modeling and mapping exercises.	High	$$	Protect and maintain current Canda Lynx and Snowshoe Hare habitat Ensure the correct type and amount of habitat for Canada Lynx to meet their needs is afforded protection

Surveys and Monitoring					
Increase knowledge of distribution and abundance of Canada Lynx in NS	8.3, 11	• Employ a range of methods including passive monitoring and active surveys.	Medium	$	Ensure effective protection of Canada Lynx and their habitat. Expand knowledge of Canada Lynx range in Nova scotia
Communication, Education and Outreach					
Mortality management	4.1, 5.1, 8.2, 8.5	• Continue to work with the trapping community on preventing accidental mortality of Canada Lynx	Medium	$	Reduce Canada Lynx mortality
Public Communication	5.1,6.1	• Outreach and Education. Encourage the public to report Canada Lynx sightings.	Medium	$	Gain a better understanding of Lynx distribution
Law, Policy and Enforcement					
Special Management Practices (SMP), Biodiversity Conservation Management Practices (BCMP)	2.2	• Review or update as required work with industry. • Ensure SMP or BCMP is compliant with legislation and recovery goals. • Continue to implement SMP on Crown land.	High	$	Protect Canada Lynx habitat Reduce Canada Lynx mortality
Endangered Species Act, Wildlife Act, Fur Harvesting Regulations	5.1	• Continue to implement and enforce existing legislation to ensure adequate protection of Canada Lynx and their habitat	High	$	Protect Canada Lynx habitat Reduce Canada Lynx mortality
Research to Address Knowledge Gaps					
Address Knowledge gaps in population estimate and habitat use of Canada Lynx	8.3, 11.1	• Explore the feasibility of different methods (camera traps, hair snagging for genetic analysis, presence-absence modelling with sighting records) that could be used to detect Canada Lynx on the landscape to further understand and monitor the area of occupancy.	High	$$$	Better able to inform management decisions for the protection of Canada Lynx and their habitat

*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 Broad Strategy.

**Priority should be classified as High, Medium, or Low. "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.
***Cost categories: $ = < 10 000; $$ = 10 000-50 000; $$$ = 50 000-100 000; $$$$=>100 000

6.3 Narrative to Support the Recovery Options Planning Table

Adaptive landscape-level planning initiatives aimed at conservation of Canada Lynx in Nova Scotia should strive to adopt a holistic approach and consider community and ecosystem processes at various spatial and temporal scales. Forestry management planning should consider both the extent and location of proposed silvicultural regimes, alongside the potential effects of various landscape mosaics on Canada Lynx, their prey species, and competitors within Canada Lynx core habitat. An understanding of both current and future threats facing the species are required for effective landscape-level planning and underlines the inherent link to other Canada Lynx conservation measures and their proposed actions: habitat management, management of human-caused mortality, and population monitoring.

It is important to note that in the context of the broad strategies to recovery, consideration should also be given to the cumulative impacts of potential threats identified in Table 2 as “negligible”, namely, service roads, recreational activities, pollution, and droughts. The concerns associated with increased access from the development and maintenance of forestry roads also apply to utility and service lines. Increased use and access by humans can lead to an increased risk of pollution, either through wastewater effluents from forestry or agriculture, or from (illegal) dumping of garbage or other waste. Periods of drought could reduce snow accumulation in winter and drought at any time of year can increase the risk of forest fires, which could also impact habitat availability in the Highlands.

As with all adaptive management practices, ongoing monitoring, assessment, and revision are key to long-term success. Research and monitoring should address knowledge gaps, starting with assessing the feasibility of different methods for monitoring population trends and abundance. To maintain a self-sustaining Canada Lynx population on Cape Breton Island in a changing climate, effective assessment requires the development of indicators of habitat alteration and extreme weather events. Acquired data can then be applied in iterative habitat models to inform effective management of habitat and mitigate against degradation to meet current and future needs for Canada Lynx.

6.3.1 Habitat Protection, Management and Stewardship

The Cape Breton Island, Canada Lynx population is at least somewhat genetically isolated from the nearest mainland Canada population, which occurs in New Brunswick. The Cape Breton population is small, which makes it more vulnerable to inbreeding depression and disease (Prentice et al., 2017). As such, landscape-level planning efforts should aim to facilitate range expansion and contraction during the population cycle. Increased connectivity may help Canada Lynx to adapt to long and short-term changes in habitat conditions (e.g., climate change, disturbance, and stochastic events).

Landscape-level planning should consider current and future habitat requirements of Canada Lynx in the Cape Breton Highlands. Such an approach should encompass all foreseeable (real or potential) projects, undertakings, or developments at relevant spatial and temporal scales. Consideration should also be given to the costs and benefits of road networks, which may result in an increase in recreational activities, create additional suitable prey habitat, and facilitate the distribution of competitors for Canada Lynx, particularly in areas with deep snow.

Landscape-level planning efforts would be well informed by an estimate of the minimum viable population size for Canada Lynx in the Cape Breton Highlands. Having a target minimum absolute population size would guide the development of habitat management regimes across the landscape.

There are currently limited available metrics to monitor the population status of Canada Lynx in Nova Scotia. It will, therefore, be essential to assess options for monitoring abundance. Some approaches to monitoring relative abundance (i.e., hair snags or samples from scats) could provide a minimum known alive estimate. Genetic analysis of hair samples may also provide information useful in assessing the extent of introgression of Canada Lynx with bobcat in Cape Breton. Since Canada Lynx populations can fluctuate substantially over time as part of an established cycle, long-term monitoring will be essential to gain further understanding of these cycles and determine trends in abundance on Cape Breton Island.

Climate change is expected to have a significant impact on the forests of the Cape Breton Highlands. As this could directly impact the availability of Canada Lynx habitat, it was identified as a high concern in the recovery strategy for the species (Nova Scotia Recovery Team 2006). Monitoring trends in climate conditions, habitat conditions, frequency of extreme weather events, and their effects on Canada Lynx in Nova Scotia will be critical to adaptively managing the species. Canada Lynx in Nova Scotia is at the southern limit of its range and has likely persisted in the Cape Breton Highlands with the protection of a limited area of higher elevation. It is not possible to predict the viability of the species in the province into the distant future, given the uncertainty of a changing climate.

6.3.2 Surveys and Monitoring

Habitat management should ensure that the landscape meets current and future habitat needs for Canada Lynx by accounting for both direct and indirect causes of habitat loss and fragmentation. Management of the location and extent of anthropogenic and natural disturbance is necessary. The potential impacts of logging and wood harvesting – including the development and maintenance of road networks – should be considered alongside ecosystem-level threats or limitations, such as pollution and fire risk, in conjunction with landscape-level planning initiatives. Disturbed areas may need to be improved or restored to reduce habitat fragmentation of Canada Lynx range on Cape

Breton Island, and additional habitat may need to be designated for some level of protection.

Long-term monitoring of Canada Lynx may be used to determine the effectiveness of habitat management initiatives that may experience a lag time after being implemented, as well as the impacts of a changing climate. The extended time commitment is particularly important given the substantial natural cycling of Canada Lynx in response to fluctuating snowshoe hare densities.

6.3.3 Communication, Outreach and Education

With such a small, isolated population, minimizing human-caused mortality, competition, disease, and hybridization with bobcats is critical to ensuring the long-term viability of Canada Lynx on Cape Breton Island. These factors become most critical during lows in the population cycle and for animals that remain within the known permanently occupied range. Dispersing individuals are expected to suffer a higher rate of mortality due to motor vehicle collisions or incidental trapping and snaring, for example.

Small populations are more subject to genetic drift meaning they have potentially less variation in major histocompatibility loci that help recognize foreign bodies and fight pathogens. As such, the ability of a population to fight unknown diseases is usually expected to be lower for smaller populations. Measures to help reduce local coyote and bobcat populations may be beneficial to Canada Lynx in Cape Breton by reducing the prevalence of disease to the population and limiting the potential for introgression of the species with bobcat. Education efforts and monitoring of catch data from hunters and trappers will be important when considering strategies to reduce incidental catches of dispersing individuals.

6.3.4 Law, Policy, and Enforcement

Under the NS Wildlife Act, Canada Lynx is identified as a fur-bearing animal and is protected from being pursued, hunted, taken, killed, or possessed throughout the year without a permit. These provisions are in effect on all lands in Nova Scotia. The fur harvesting season for Lynx has been closed since 1980. Under the General Wildlife Regulations, any Canada Lynx accidentally killed must be immediately reported to a Conservation Officer and the carcasses of all Canada Lynx bycatch must be turned over to DNR. Lynx may not be held in captivity and live or dead Lynx or Lynx parts may not be imported or exported from Nova Scotia without a permit. As a fur-bearing animal, it is also illegal to damage, disturb or destroy or attempt to destroy the den or usual place of habitation of Canada Lynx.

Under the NS Endangered Species Act, the following prohibitions apply to Canada Lynx as an Endangered species:

One must not:

(a) kill, injure, possess, disturb, take, or interfere with or attempt to kill, injure, possess, disturb, take, or interfere with an endangered or threatened species or any part or product thereof.

(b) possess for sale, offer for sale, sell, buy, trade, or barter an endangered or threatened species or any part or product thereof.

(c) destroy, disturb, or interfere with or attempt to destroy, disturb, or interfere with the specific dwelling place or area occupied or habitually occupied by one or more individuals or populations of an endangered or threatened species, including the nest, nest shelter, hibernaculum, or den of an endangered or threatened species.

(d) contravene any regulation made with respect to a core habitat.

As part of the response to this Recovery Plan, enforcement actions regarding the prohibitions on activities related to Canada Lynx under both the Wildlife Act and Regulations, and under the NS Endangered Species Act should be reviewed and evaluated and recommendations brought forward for implementation. In addition, education and outreach opportunities should be reviewed and recommendations brought forward to address key threats identified in the Recovery Plan. Existing outreach programs to engage the public in addressing human-caused mortality factors and in reporting Lynx occurrences should be reviewed and new opportunities explored.

With the completion of this document, existing guidance on management of threats to Canada Lynx must be reviewed and updated and new policy tools to implement the goals and objectives of the Recovery Plan must be developed. The current Endangered Canada Lynx Special Management Practices (NS Department of Natural Resources, 2012) must be reviewed and updated as appropriate. Identified core habitat must be protected and surrounding areas managed properly for the survival of the species. New/updated policy and guidance which may include a new SMP must provide for the effective protection of core habitat while also providing opportunities for management and development of natural resources and vital public infrastructure on both public and private lands.

6.3.5 Research to Address Knowledge Gaps

Long-term monitoring of Canada Lynx may be used to determine the impacts of threats such as climate change, and to determine the effectiveness of habitat management initiatives that may experience a lag time after being implemented. Habitat disturbance should be managed with land-use planning that accounts for both the current and future habitat needs for Canada Lynx. Additionally, successful habitat management will require collaboration and cooperation among stakeholders.

7. RECOMMENDED COURSE OF ACTION FOR RECOVERY

The Mammal Recovery Team has identified the following high-priority actions for the recovery of Canada Lynx for the next 5 years:

- Protection of core habitat on public and private land, through conservation planning, and the potential for land acquisition and incentivizing protection of private land.
- Communication and outreach activities to raise awareness among interest groups (e.g., hunters, fur harvesters), landowners and the public.
- Coordination of internal government programs and policies to support increased protection.
- Regular monitoring and surveys, and support of relevant research to address priority knowledge gaps.

Table 4. Recovery actions and implementation schedule.

Broad Strategy: Habitat Protection, Monitoring, and Stewardship		**Implementation Schedule**
Approach 1.1: Undertake landscape-level planning that considers Canada Lynx habitat requirements - Land-use for planning forestry (harvesting, silviculture (including forest plantations) and forestry roads) as well as other industrial development.		
Action 1.1.1	Incorporate biodiversity values when planning forest harvesting, silviculture (including plantations) and forest roads, including utility, communications, and transportation corridors.	2026
Action 1.1.2	Consider management of core habitat at different levels of ecological land classification schemes such as NSELC eco-districts and eco-sections.	2030
Action 1.1.3	Conduct a review and analysis on the practical and theoretical implications of managing designated core habitat.	Ongoing
Action 1.1.4	Develop and implement a robust detection and monitoring program to gather data for habitat-based occupancy modelling for Canada Lynx on Cape Breton Island.	Ongoing
Approach 1.2: Population monitoring		
Action 1.2.1	Use data from the Biodiversity Investigation Report to determine where Canada Lynx have been found; combine with other map layers of relevant data.	Ongoing
Broad Strategy: Surveys and Monitoring		
Approach 2.1: Habitat Management		
Action 2.1.1.	Assess previous habitat goals to determine whether habitat management goals were achieved (per Special Management Practices) and whether habitat continues to be occupied.	Ongoing
Action 2.1.2	Determine which types of habitat should be prioritized for active management to ensure the survival and recovery of Canada Lynx.	Ongoing
Action 2.1.3	Include snowfall data in modeling and mapping exercises.	Complete

Broad Strategy: Communication, Outreach, and Education		
Approach 3.1: Manage causes of Canada Lynx mortality and reduce the risk of incidental take.		
Action 3.1.1	Increase education and training of trappers to avoid catching Canada Lynx and provide education on how to safely release them if they are live trapped.	Ongoing
Action 3.1.2	Continue to encourage reporting of incidental catch.	Ongoing
Broad Strategy: Law, Policy, and Enforcement		
Approach 4.1: Ensure the protection of Canada Lynx core habitat.		
Action 4.1.1	Update the Special Management Practice for Canada Lynx and ensure forestry practitioners follow the outlined requirements.	Ongoing
Broad Strategy: Research to Address Knowledge Gaps		
Approach 5.1: Conduct research on Canada Lynx biology and ecology.		
Action 5.1.1	Explore the feasibility of different methods (camera traps, hair snagging for genetic analysis, presence-absence modelling with sighting records) that could be used to detect Canada Lynx on the landscape to further understand and monitor the area of occupancy.	Ongoing

8 IDENTIFICATION OF CORE HABITAT

8.1 Core Habitat Definition and Attributes

Under the Nova Scotia *Endangered Species Act* core habitat as "specific areas of habitat essential for the long-term survival and recovery of endangered or threatened species and that are designated as core habitat pursuant to Section 16 or identified in an order made pursuant to Section 18 of the act.

Core habitat areas are essential for the recovery and long-term viability of Canada Lynx in Nova Scotia. It should be noted that the most suitable tracts of habitat for the species will change over time: forests are successional, meaning that suitable habitat for Canada Lynx and their prey species will evolve and change over time with maturity and disturbance. Some areas that may be considered for inclusion as core habitat may serve different functions to Canada Lynx over time. It is important to preserve and manage core habitat areas across the landscape to consistently provide a matrix with suitable relative proportions of habitat types for Canada Lynx at all life history stages. This will be particularly important during the lows in the normal population fluctuations. Such an approach will help prevent (permanent or temporary) extirpation in localized pockets of habitat within the range, supporting long-term objectives for the population.

Geographical Location

The range is the geographic unit that delineates the area within which core habitat is located. Based on Biodiversity Investigation Reports provided by the Nova Scotia

Department of Natural Resources, the relevant scale to identify core habitat for Canada Lynx in Nova Scotia is the Cape Breton Highlands and uplands regions (Figure 4).

Biophysical Attributes

Younger forests with dense softwood regeneration are important for production of snowshoe hare, which are the main prey item of Canada Lynx (Hodges et al., 2000). Mature forests provide coarse woody debris for denning sites and support alternative prey species such as red squirrels, voles, and other small mammals (Squires and Laurion, 2000). Snowfall and forest type were found to have direct effect on Canada Lynx movement in winter (snowfall) and higher prey density (coniferous forest) (Hoving et al., 2005).

At a landscape-level, modelling by Hoving *et al*. (2005) indicated that core areas for conservation should have >270 cm snowfall annually, high levels (>75%) of coniferous or mixed-wood forest, and low levels (<25%) of deciduous forest.

Definition of Core Habitat

Core habitat for survival of Canada Lynx incorporates lands that have been identified as:

- Areas identified as breeding zones/Canada Lynx range in Cape Breton based on Eco-districts (i.e., Eco-districts – 100, 210, 310, and portions of 510),
- Areas with known and verified Lynx occurrences based on survey data
- Lands present at high elevations (minimum 300 metres)
- Areas of significant snowfall
- Known to have high occurrences of Canada Lynx.

Elevation is a proxy for deep snow, which Canada Lynx are adapted to, but which restricts their competitors (i.e., bobcat, fisher, coyote). The age of the forest stands, slope and aspect have not been incorporated into the core habitat model as this time. Determination of core habitat was determined from a landscape level approach and incorporates a variety of land ownership.

8.2 Activities Likely to Result in the Destruction of Core Habitat

Destruction of core habitat occurs when part of the identified core habitat is degraded (temporarily or permanently) to such an extent that it can no longer serve the species. Destruction may occur because of a single event, because of longer-term repercussions of a single activity, or from cumulative impacts of multiple activities over time. It is important to note that destruction of core habitat occurs on a landscape scale, involving various forest types and age classes over time; it is not an automatic consequence of stand-specific destruction. Snowshoe hare the main food source of Canada Lynx benefits from moderate forestry activities (Mallett, 2014; Olsen, 2015). In Maine, 13 to 40-year-old conifer or mixed wood forests had the highest snowshoe hare densities (Mallett, 2014). This was also found to be the preferred habitat for Canada Lynx, even when snowshoe hare numbers were low. Olsen (2015) found this pattern when she compared regenerating conifer clearcuts to select cut forests and mature forests.

Table 5: Activities Likely to Result in Destruction of Core Habitat.

Description of Activity	Rationale
Wood and pulp plantations: Mature forests converted to plantations.	Prevents natural forest succession which may reduce carrying capacity. Increases likelihood of road networks and associated effects on the species.
Mining and quarrying: Natural forests converted for surface mining.	Decreases forest habitat on the landscape and increases fragmentation. Increases likelihood of road networks and associated effects on the species.
Roads and railroads: Increased access by humans, predators, and competitors.	Increased risk of incidental catch or other direct causes of human mortality. Increased access by competitors in areas of deep snow. May contribute to increased chances of introgression with bobcat. May increase edge habitat, benefitting local prey populations.
Hunting and collecting terrestrial mammals: Incidental catch	Manage causes of Canada Lynx mortality and reduce the risk of incidental take. Increase education and training of trappers to avoid incidental take.
Logging and wood harvesting: Direct loss of mature forests, fragmentation, reduced quality of remaining forest for denning and prey habitat.	Decreases availability of mature forests on the landscape. Decreases coarse woody debris (den sites) and understory (prey habitat) depending on silvicultural regime. Increases likelihood of road networks work and associated effects on the species.
Fire and fire suppression: Loss of habitat due to fire.	Decreases the amount of forested area on the landscape, decreasing carrying capacity. May increase edge habitat, benefitting local prey populations.
Problematic native species: possible interaction with competitors	Mange population growth of problematic native species and reduce access to suitable Canada Lynx habitat.
Viral/Prion disease and disease of unknown cause: Increased susceptibility in small populations.	Monitor risk and prevalence of disease and continue to collect carcasses and perform necropsies
Introduced genetic material; introgression with bobcats	Monitor rates of introgression
Habitat shifting and alteration: Alteration of boreal forest and reduction in snow depth.	Climate change may result in reduced snow depth, decreasing competitive advantage. Monitor climate change and habitat conditions.
Temperature extremes: Prolonged periods of extreme heat may be detrimental.	Monitor impacts of extreme weather events and reassess management plants to maintain forest composition even in extreme weather events.

9 MEASURING PROGRESS

9.1 Performance Indicators

The performance indicators identified below are a means by which progress towards population and distribution objectives for Canada Lynx can be measured.

Table 6. Performance measures used to determine whether Canada Lynx recovery objectives are being met.

Performance Measure	Check-In
Planning	
Two Recovery Team meetings annually to discuss recovery activities and assess performance to date	Annually
Number of initiatives and groups involved in delivering conservation messaging	Annually
Number of individuals or teams assigned to, or supported to implement, recovery-related projects such as land protection efforts, GIS mapping, the production of educational material, research on seed viability and propagation, forest management experiments, etc.	Annually
Conservation	
Number and type of communication products that target public, miners, foresters, government, and others identified in the recovery actions table	Annually
Improve coordination and implementation of governmental permitting or approval process that can address a threat to this species and effective communication with appropriate staff.	Annually
Increased percentage of core habitat protected	Every five years
Known occurrences and population maintained	Yearly
At least 50% of knowledge gaps addressed by published research	In five years; recurring
All governmental permitting or approval processes that can address a threat to this species addressed to include this species specifically and formally, and the results communicated with appropriate staff	In one year
Number of new records or documented effort to survey for new occurrences	Every five years

9.2 Monitoring

The Canada Lynx monitoring plan is aimed at providing consistent data over time to assess population dynamics, habitat parameters and threats in Nova Scotia. Canada Lynx populations will be monitored annually through various surveys (e.g., cameras, fur snags, tracks, etc.), disease monitoring and prey populations. Success of this monitoring plan will be reviewed and adjusted as needed and as management actions change.

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