Nova Scotia Endangered Species Act
Recovery Plan Series

Recovery Plan for the Canada Lynx (*Lynx canadensis*) in Nova Scotia

February 2007

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Recovery Plan for the Canada Lynx (*Lynx canadensis*) in Nova Scotia

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Recovery of this species is considered technically or biologically feasible at this time.

Responsible Jurisdictions

Government of Nova Scotia:
Nova Scotia Department of Natural Resources

Authors

This report was prepared by Amanda Lavers with the assistance of the Nova Scotia Lynx Recovery Team. A list of recovery team members is found on page 26.

Acknowledgments

The Recovery Team for Nova Scotia Lynx has contributed extensively to the writing of this recovery strategy. A list of members and their affiliations is found on page 26. The preparation of this Recovery Plan was funded by Nova Scotia Department of Natural Resources.

Preface

This recovery plan has been prepared by the responsible jurisdiction, the Nova Scotia Department of Natural Resources in cooperation with the Recovery Team for Canada Lynx in Nova Scotia. The recovery plan defines the recovery goal, objectives, strategies, and actions that are deemed necessary to protect, conserve, and recover Canada Lynx in Nova Scotia. The plan does not necessarily represent the views of all of the individuals involved in its formulation, nor of the governments or organizations with which the individual team members are associated. The goal, objectives, strategies, and actions are based on the best existing knowledge and are subject to modification resulting from changed objectives and new findings. The implementation of the recovery plan shall take place over the next 5 years (2007-2012) and will be subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations. Therefore, some aspects of this recovery plan may not necessarily be implemented immediately, concurrently, or in their entirety. Projected costs associated with many of the individual recovery actions identified in this plan cannot be calculated at the time of report writing.

Recovery plans are not designed to provide a comprehensive summary of the biology and status of Canada Lynx in Nova Scotia. For more information, a copy of the Status Report on the Canada Lynx in Nova Scotia written by Gerry Parker in 2001 can be found at http://www.gov.ns.ca/natr/wildlife/biodiv/specieslist.htm

Executive Summary

The Canada lynx (*Lynx canadensis*) in Nova Scotia was designated endangered in 2002 under the Nova Scotia Endangered Species Act. A breeding population of lynx exists only on Cape Breton Island. Lynx on the mainland of Nova Scotia were extirpated by the beginning of the twentieth century. Lynx numbers fluctuate depending on cyclical highs and lows of its primary prey, the snowshoe hare (*Lepus americanus*), which comprises most of its diet. At a regional scale, the distribution of lynx is correlated with prolonged deep snow and the amount of coniferous forest. Lynx forage in habitats that are suitable for hare (habitat with hardwood browse and softwood cover); and maternal dens are typically situated in habitat that includes coarse woody debris. During high points in population cycles lynx disperse from Cape Breton Island through a variety of open, fragmented, and human-dominated habitats that increases their vulnerability to mortality.

Although lynx are among the most studied of North American carnivores, there remain many uncertainties about ecology and conservation in Nova Scotia. Lynx populations across most of the boreal forests of North America are healthy and support sustainable human harvests for fur. At southern edges of the range in North America, lynx are at risk and legal harvesting is not allowed. Threats to the Cape Breton lynx population may include competition with bobcat, and competition with and predation by fisher, and coyote that have recently arrived on the Island. Although bobcat, coyote, and fisher are not as well adapted as lynx for deep snow conditions, they may have competitive advantages in human-altered landscapes where road access is increased and where climate change affects winter snow. Vehicular accidents and by-catch in traps set by fur harvesters for other furbearers are causes of accidental mortality of lynx in Nova Scotia. The numbers of accidental lynx mortalities fluctuate from year to year; numbers tend to follow lynx population cycles and may be related to lynx movement associated with prey population crashes. The impact of accidental mortality on the Cape Breton lynx population requires further investigation. The harvest, traffic, and marketing of fur is closely monitored and regulated across Canada but the level of illegal harvest by hunters and trappers, and its impacts on the lynx population on Cape Breton Island are unknown.

The Cape Breton population is small (density and area of occupancy estimates suggest 50-500 animals depending on the stage of the population cycle) and may become genetically isolated if animals cannot emigrate from the continental population. Preliminary results from a study on the molecular genetics of Cape Breton lynx suggested that such isolation has not yet occurred. Changes to the forested landscape and access brought about by forest management and road development may also threaten lynx recovery. Lynx habitat models remain under development, and in future may help identify necessary recovery actions regarding landscape connectivity, forest age class structure, access by people and natural competitors, refugia from trapping, and forest management. The habitat requirements for lynx in Nova Scotia are not well defined and therefore habitat deficiencies, if they exist, are as yet unknown.

The feasibility of lynx recovery is uncertain given the paucity of available local data applicable to the Cape Breton population. Notwithstanding these deficiencies, this plan describes a broad strategy for recovery, research, education, stewardship, and management activities required to meet three recovery objectives: (1) minimize human-caused mortality, (2) manage habitat for lynx, and (3) maintain and restore functional connectivity for lynx populations in Cape Breton and New Brunswick.

Fur harvesters and governments must work together to minimize accidental mortality of lynx. Governments must consider whether additional regulations or refugia for lynx are required with restrictions that would limit activities such as hunting, trapping, development, forestry, and off-highway vehicle use. Governments and industry must also ensure landscape management and stand-scale best forestry practices are implemented that allow long-term persistence of species at risk including lynx. Researchers must develop reliable and effective monitoring and management tools for lynx recovery, they must examine the genetic structure and health of the metapopulation, and they must determine habitat requirements for lynx throughout Nova Scotia.

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1. BACKGROUND

The Canada lynx (*Lynx canadensis*) was designated an endangered species in 2002 under the Nova Scotia Endangered Species Act (NSESA). A breeding population of Canada lynx (hereafter called lynx) has been extirpated from mainland Nova Scotia but one persists on Cape Breton Island with discernable cyclic trends. This recovery plan describes Nova Scotia's lynx population, the threats it faces, the feasibility of recovery, and recovery actions necessary to meet proposed recovery objectives. In this plan, lynx in Nova Scotia will be considered a single population isolated from New Brunswick and the core of the species' range. Further research is needed to ascertain the nature of the lynx metapopulation in eastern North America (not sure that we have to do this, and what does Warrens work tell us?).

1.1. Species Assessment Information

Common Name: Canada lynx

Scientific Name: *Lynx canadensis*

NSESA 2002 Assessment Summary: Canada lynx formally occurred in areas of suitable habitat across mainland Nova Scotia and Cape Breton Island. The current population is very small and restricted to two areas in the highlands of Cape Breton Island. Historic and current threats to lynx include: harvesting, competition from bobcats and coyotes, habitat loss, disease, climate change and unknown factors.

NSESA Status: Endangered

Reason for designation: Canada lynx is at the southern limit of its range in Nova Scotia and undergoes cyclic population trends likely due to cycles in the abundance of its primary prey, snowshoe hare. Historic trapping pressure combined with conversion of forested lands to agriculture and human development has resulted in the extirpation of breeding lynx from mainland Nova Scotia, although a small population remains on Cape Breton Island. Current threats to this population include accidental mortality in furbearer traps and by vehicular collisions, illegal harvesting, interactions with other predators, climate change, habitat fragmentation, and habitat loss.

Canadian Occurrence: Canada lynx is common across the boreal forests of Canada but is increasingly rare in New Brunswick and in areas of the United States.

COSEWIC Status History: Not at risk. Last examination was May 2001.

1.2. Species Description

Lynx is a medium-sized felid that is native to Nova Scotia. Lynx is similar in appearance to bobcat (*Lynx rufus*) but lynx has longer fur, longer legs, longer ear-tufts, and larger

paws adapted for traveling in snow (Parker and Smith 1983). Lynx has an entirely black-tipped tail and weighs approximately 8-10 kg (Parker 2001). Its fur is a mix of grey, brown, and white with dark spots and streaks. Lynx was traditionally trapped and hunted by aboriginal peoples and European settlers in Nova Scotia but in the last century there has been relatively little fur trade of lynx pelts likely because of fluctuating pelt prices and cyclic lynx numbers (Figure 1). From approximately 1950, almost all lynx harvested in Nova Scotia was taken from Cape Breton (Parker 2001). Average prices for lynx pelts in Canada in the 1980s fluctuated between $200 and $600 per pelt but since then have remained between $50 and $150 (Poole 2003). The lynx harvest in Nova Scotia closed in 1975 with an experimental harvest between 1977 and 1979 when 39, 73, and 45 animals were taken each year.

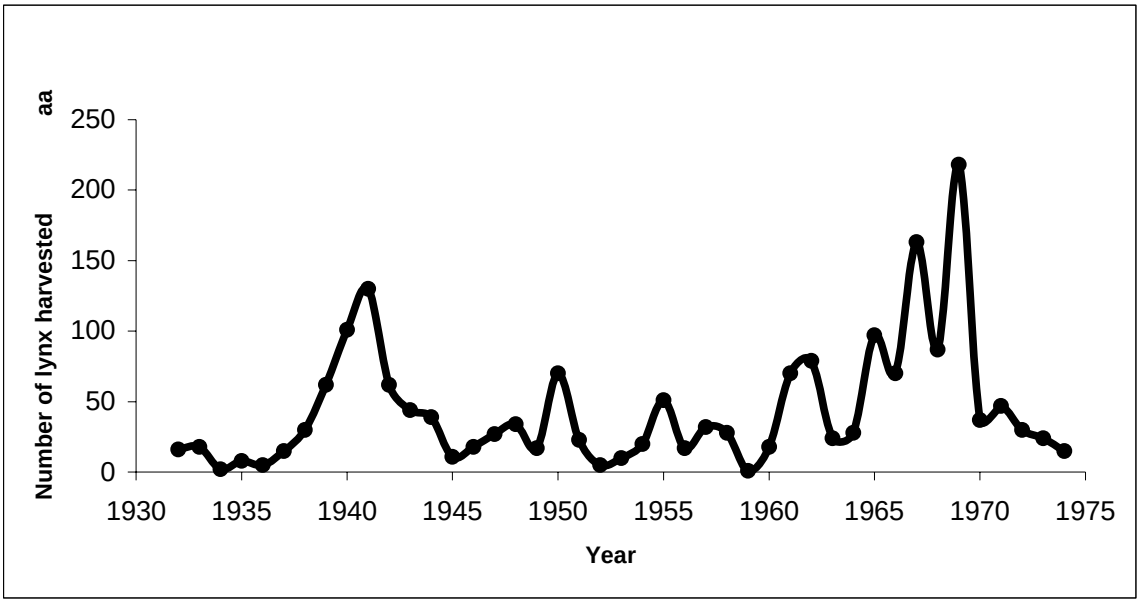

Figure 1. Nova Scotia lynx harvest from NSDNR furbearer harvest statistics.

1.3. Populations and Distribution

Lynx are common across the boreal forests of Canada (Poole 2003) but the species is increasingly rare at the southern edge of its range, for example in New Brunswick and in areas of the United States where it is listed as threatened (USFWS 2000; Ray 2000). The historic breeding range of lynx in Nova Scotia included areas with relatively high elevations such as the Pictou Uplands, Cobequid Mountains, and Musqudobit Hills as well as Cape Breton (Parker 2001). There is some evidence that the historic range of lynx extended into the North and South mountains of Nova Scotia's Annapolis Valley (Gilpen cited in Parker 2001). The current breeding population of lynx is considered to be restricted to Cape Breton; it has been roughly estimated at 50 to 500 animals (Parker 2001). The largest area of contiguous lynx habitat is the Cape Breton Highlands, but traditional knowledge suggests that concentrations of lynx also occur at Boisdale Hills,

East Bay Hills, and South Mountain in Richmond County (Figure 2; Parker 2001, Terry Power pers. comm.).

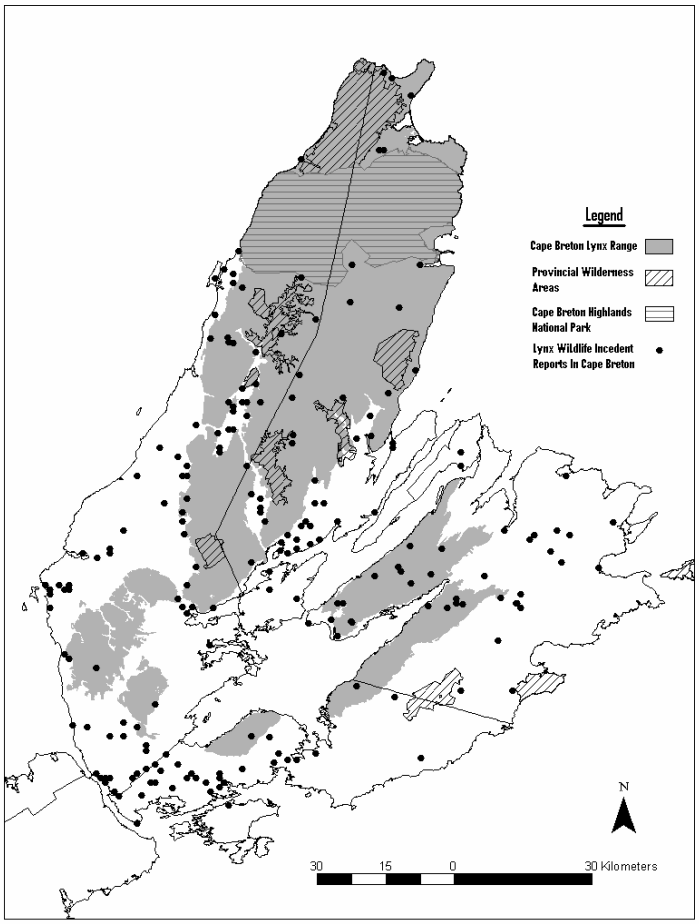

Figure 2. Lynx range and location of Wildlife Incident Reports on Cape Breton Island, 1982-2006 (Map courtesy of NSDNR).

1.4. Description of the species' needs

1.4.1. Habitat and biological needs

Prolonged deep snow cover and coniferous forest cover are important factors in the distribution of lynx in eastern North America (Hoving *et al.* 2004). In the Northern Appalachians and Acadian Forest Region these conditions are patchy and are often restricted to high elevations (>500 feet above sea level) and to areas where there are disturbances such as wind, fire, pathogens, or forestry activities. Cape Breton lynx near the peak of their population cycle use 12-32 km^2 home ranges (Parker *et al.* 1983). Their preferred foraging habitat follows the habitat selection of snowshoe hare and includes regenerating forests 16-30 years old and open mature conifer habitat (Parker

et al. 1983; Murray *et al*. 1994; O'Donoghue *et al*. 1997; Hoving *et al.* 2004; Vashon et al. in press).

There are few data to describe what constitutes suitable denning or dispersal habitat for lynx. Preliminary results from Maine suggest that maternal den sites have downed woody debris equivalent to that typical in a mature 100-year old stand (Organ *et al.* in prep) but other structures in younger stands (*e.g.* a slash pile) have been used as maternal dens (Vashon pers. comm.). In North America, lynx readily disperse long distances (>100 km) through fragmented landscapes across rivers, lakes, roads, open fields, and a variety of managed forest stands (review in Poole 2003). There appears to be little genetic differentiation across the geographic range of lynx (with the exception of a barrier to gene flow across the St. Lawrence River), suggesting that long distance dispersal may be important to the species (Schwartz *et al.* 2002; Johnson in prep.). In Nova Scotia, individual lynx appear to move from Cape Breton to the mainland; they have been reported as far southwest as Digby and Yarmouth counties during lows in the hare cycle (NSDNR). Lynx in Nova Scotia, sometimes move through urban and agricultural land and are more vulnerable in these areas to human induced mortality through interactions with livestock, domestic animals, or vehicle collisions.

1.4.2. Ecological role

Lynx is a largely specialist carnivore that consumes snowshoe hare (*Lepus americanus*) and other small prey such as red squirrels (*Tamiasciurus husdsonicus*). The main dietary component of Cape Breton lynx studied in 1977 and 1978 just after a peak in the lynx population was snowshoe hare (Parker *et al.* 1983). In addition to hunting snowshoe hare, lynx in Cape Breton and Maine opportunistically kill white-tailed deer (*Odocoileus virginianus*) (Parker *et al.* 1983; Fuller 2004). In areas where it has been investigated predation by lynx constitutes a major source of snowshoe hare mortality, although it does not necessarily follow that there are discernible cascading effects emanating from the local extirpation of lynx since coyotes often expand their role in response (Boutin 2005) Lynx are occasionally depredated by coyote and fisher (O'Donoghue *et al.* 1995; Vashon 2003).

1.4.3. Limiting factors

A major limiting factor for lynx, which appears to drive cyclical population trends is the abundance of its primary prey, snowshoe hare, which also exhibits cyclical population trends (Brand and Keith 1979; Poole 1994). In the northern part of its range, lynx densities can fluctuate 3-17 fold during their 8-11 year cycles but on the southern periphery the amplitude of cycles is believed to be lower (Poole 1994). Trapping data in the Appalachians between 1985 and 2003 show lynx population fluctuations between 82 and 200% (Carroll 2001). A minimum threshold density of 0.5 hares/ha may be

required to support lynx populations in the main part of its range (Ruggerio *et al.* 1999) but modeling suggests that at the southern periphery, 1.1-1.8 hares/ha may be required (Steury and Murray 2004). Without abundant prey, lynx suppress breeding, increase home range sizes and increase long-distance dispersal (Brand and Keith 1979; Poole 1994; Slough and Mowat 1996).

The Cape Breton lynx population is small. Few data are available on population sizes but density and area of occupancy estimates suggest 50-500 animals depending on the stage of the population cycle (Parker 2001). Government reports and literature suggest that lynx was extirpated from mainland Nova Scotia in the 1920-30s (Smith 1940; de Vos and Matel 1952). In recent decades, lynx sightings have been sporadic but are usually reported after hare population downturns on Cape Breton Island. Lynx carcasses have been collected from mainland Nova Scotia in Antigonish, Colchester, and Kings counties between January 1999 and September 2004. Among these, at least one was in good condition and showed signs indicative of past reproductive success. There is molecular evidence to suggest that lynx disperse successfully between Nova Scotia and New Brunswick and that the Nova Scotian population centered on Cape Breton is not isolated (W. Johnson, in prep.).

Lynx populations are likely arranged as metapopulations where local habitat suitability and rates of dispersal between habitat islands are key to long-term survival of the species (McKelvey *et al.* 1999). Recent evidence of high gene flow between populations separated by long distances corroborates this hypothesis (Schwartz 2002; Johnson in prep.). It is unlikely that lynx can persist in small isolated refugia even if there is suitable habitat if dispersal rates are insufficient for long-term persistence (Ruggiero *et al.* 1999). While long-distance movements of lynx occur in Nova Scotia and elsewhere (Mech 1977), it is unclear whether they result in successful genetic exchange (McKelvey *et al.* 1999; Poole 2003). For Nova Scotia and New Brunswick populations of lynx, the Gaspé population is likely important as a source (Carroll 2007).

1.5. Threats

1.5.1. Threat classification

The order of threats in Table 1 represents an approximate ordering of priority based on known information. An explanation of the threat table fields is provided in Appendix A.

Table 1. Summary of threats to lynx, their classification, and estimations of each threat's occurrence, frequency, causal certainty, severity, and level of concern.

1. Accidental mortality		**Occurrence**	Current
Threat category	Accidental mortality	**Frequency**	Recurrent
General threat	Vehicular accidents, hunting and trapping	**Causal Certainty**	Medium
Specific threat	Road kill & by-catch	**Severity**	Unknown
Stress	Increased mortality	**Level of**	Medium

		Concern	
2. Climate change		**Occurrence**	Current – imminent
Threat category	Climate and natural disasters	**Frequency**	Continuous
General threat	Climate change	**Causal Certainty**	Medium
Specific threat	Change in snowfall patterns	**Severity**	Moderate - high
Stress	Increased competition for food	**Level of Concern**	High
3. Habitat change & fragmentation		**Occurrence**	Historic – current
Threat category	Habitat loss or degradation	**Frequency**	Continuous
General threat	Forestry & development	**Causal Certainty**	Medium
Specific threat	Habitat conversion, fragmentation, & isolation	**Severity**	Moderate
Stress	Reduced immigration, productivity & genetic health	**Level of Concern**	Medium – high
4. Development of road network		**Occurrence**	Current
Threat category	Habitat loss or degradation	**Frequency**	Continuous
General threat	Road construction	**Causal Certainty**	Low
Specific threat	Increased access for people, bobcats, and coyotes	**Severity**	Low
Stress	Increased mortality, reduced fecundity	**Level of Concern**	Medium
5. Interspecies interactions		**Occurrence**	Current
Threat category	Changes in ecological dynamics or natural processes	**Frequency**	Continuous
General threat	Increased abundance in coyote, fisher, and bobcat on Cape Breton	**Causal Certainty**	Low
Specific threat	Resource competition or direct mortality	**Severity**	Low
Stress	Increased mortality, reduced fecundity	**Level of Concern**	Medium
6. Moose browse		**Occurrence**	Imminent
Threat category	Changes in ecological dynamics	**Frequency**	Continuous
General threat	Alteration of vegetation	**Causal Certainty**	Low
Specific threat	Herbivore competition	**Severity**	Moderate

Stress	Reduced fecundity by decrease in prey abundance	**Level of Concern**	Medium

	7. Disease	**Occurrence**	Anticipated
Threat category	Natural processes and activities	**Frequency**	Unknown
General threat	Disease	**Causal Certainty**	Low
Specific threat	Morbillivirus	**Severity**	Unknown
Stress	Reduced survivorship & fecundity	**Level of Concern**	Low

1.5.2. Description of threats

1.5.2.1. Accidental mortality

Cape Breton lynx are vulnerable to accidental mortality, particularly during lows in the population cycle when they tend to disperse long distances (Parker 2001). Between 1995 and 2004, at least 60 lynx were reported as killed accidentally in Nova Scotia by traps, vehicle collisions, or for predator control (Table 2). Legal traps for furbearers such as bobcat and coyote, account for more than half of lynx carcasses reported to Nova Scotia Department of Natural Resources during this time period. Some workers suggest that lynx is extremely susceptible to trapping, and that trapping is a significant source of mortality (Parker *et al.* 1983; Ruggiero *et al.* 1999b; Poole 2003). More research is required to understand population-level impacts of accidental mortality on Nova Scotian lynx.

Table 2. Summary of Wildlife Incident Reports of lynx accidental mortalities 1995-2004.

	Automobile related mortalities	**Legal snare or trap**	**Illegal shot**	**Depredation control**	**Accidental mortality with unknown or unreported cause**	**Annual Total**
1995	1	1				2
1996	1	2				3
1997	1	1				2
1998		6			2	8
1999	3	4	2			9
2000	4	16	3	3		26
2001		7				7
2002	1	2				3
2003						0
2004			2			2

10 year Total	11	39	7	3	2	**62**

Nova Scotia Department of Natural Resources (NSDNR) collected eight lynx killed in vehicle collisions between January 1999 and September 2004. These collisions all occurred in lowland areas of Cape Breton. Very little research has been done to investigate the relative importance of accidental mortality in lynx conservation. In a study of radio-collared lynx in northern Maine, fur harvesters accidentally killed four of forty-four animals but none were killed by vehicles – the area had a high density of logging roads but low traffic (Vashon 2005). In New York and Colorado, vehicular collisions were a major cause of mortality when re-introduced animals may have attempted long distance dispersals (Steury and Murray 2004).

Lynx are fully protected in Nova Scotia under the Wildlife Act and the Nova Scotia Endangered Species Act. Occasionally, lynx have been killed by hunters who may have mistaken them for a bobcat or who have been unaware of the protected status of lynx. Workshops and other communications efforts directed at hunters, fur harvesters, and forest workers as well as the general public are designed to help address this public awareness problem. The price for lynx pelts has been relatively low for many years but, if it changes, the incentive for illegal harvest may increase. While continued regulation and enforcement of the trade in wild furs is important, there is no evidence to suggest that intentional illegal harvest of lynx has been or is an on-going and significant problem in Nova Scotia. The extent to which illegal harvest in general of lynx in Nova Scotia constitutes a threat to recovery efforts requires further investigation.

The harvest, movement, and marketing of wild fur in Nova Scotia and Canada are monitored and controlled with licenses for fur harvesters, fur buyers, and taxidermists. Lynx are subject to the permitting requirements by the Committee on International Trade in Endangered Species (CITES) (including verification that the lynx was legally obtained in the source jurisdiction) before they can be legally exported from Canada. Open seasons for harvesting lynx occur in Newfoundland, Labrador, and Quebec. Illegal inter-provincial trade of pelts with origins in Cape Breton Island is a potential concern that requires further investigation.

1.5.2.2. Climate change

Climate change may be the most significant long-term threat to lynx on the southern periphery of its range, particularly when combined with other anthropogenic stressors such as overexploitation or habitat fragmentation (Carroll 2007). Lynx apparently rely on deep snow conditions, most likely for competitive foraging advantages over bobcat and coyote or prey availability (Murray *et al.* 1994; Mowat et al. 2000). Indeed, snow cover was one of the most important parameters in a predictive model of lynx presence or

absence in eastern North America that included Nova Scotia (Hoving et al. 2005). Although understanding of the manner in which snow quantity or quality will be affected by a changing climate is imperfect, most climate modeling for the region predict decreasing snowfall patterns (Carroll 2007). The threat of climate change to the long-term recovery of lynx populations in Nova Scotia was recently analyzed using population viability models (Carroll 2007); the results predicted suitable lynx habitat being eliminated from Cape Breton by 2055, implying that Cape Breton is one of the lynx populations in the Appalachians most vulnerable to climate change. These results suggest that a small or relatively isolated population such as Nova Scotia's at the periphery of the species' range would be rendered particularly vulnerable (as compared to core range).

1.5.2.3. Habitat change and fragmentation

The interactions between lynx, snowshoe hare, and forest management are the subject of much interest. The effects of forestry on lynx and its prey are likely mixed, some being positive and others negative. Lynx generally avoid recent clearcuts and partial harvests (Poole 2003; Hoving *et al.* 2004; Vashon et al. in press) and prefer regenerating conifer-dominated forests for snowshoe hare foraging (Fuller et al. in press; Vashon et al. in press). In Maine, regenerating 12-15 year forest that had been clear-cut had the highest densities of hares compared to regenerating partial harvests, mature mixed forests, or pre-commercial thinning (Fuller 1999; Fuller et al. in press). Forest stands can generally regenerate suitable foraging cover in 10-20 years but it may take many decades to regenerate forests with coarse woody debris needed for lynx denning, particularly at high elevations and where moose are over-browsing vegetation.

In Cape Breton, cyclic outbreaks of spruce budworm and other pathogens in balsam fir dominated stands are the dominant natural forest disturbance process. Peaks in spruce budworm populations are followed by prolific mixedwood and shrub regeneration with dense undergrowth, which provides excellent food and cover for snowshoe hare (Parker *et al.* 1983). At the southern periphery of lynx range in the Maritimes and in Maine, insect outbreaks maintain a mosaic of structural stages across the landscape suitable for lynx (Bull *et al.* 2001). In western Canada wild fires produce similar effects.

Most forested land on the Cape Breton Highlands is contained in: (i) crown land leased by Stora Enso and managed for paper products, (ii) a national park, or (iii) provincial wilderness areas. The Boisdale Hills, East Bay Hills, and South Mountain have large crown land blocks but in Boisdale Hills a large proportion of land also comprises the traditional use area of Eskasoni First Nation. Lowland forest on Cape Breton is comprised of a mix of private and public land with extensive forestry operations that manage, in general, for pulpwood and saw timber. Pre-commercial thinning may eliminate the dense cover of early-succession stands preferred by snowshoe hare (Fuller 1999; Fuller et al. in press; Stinson 2001) and spatially extensive harvesting with

short rotations may reduce the proportion of forest stands required in particular age classes for foraging and denning.

The effect of landscape fragmentation on southern populations of lynx is unknown. Fragmentation at the landscape scale does not appear to entirely inhibit long distance dispersal of lynx in Nova Scotia, and road density had insignificant and inconsistent effects on regional models of lynx presence/absence (Hoving et al. 2005). Particularly when interacting with harvesting, fragmentation may increase mortality of lynx during dispersal. Fragmentation at a landscape scale is related to other threats such as genetic isolation and small population size. Fragmentation at the scale of lynx home ranges may affect the suitability of forest stands for foraging or denning and it may affect interspecies competition by increasing edge effects and giving generalist predators a competitive advantage (Buskirk 1999; Stinson 2001); it is also related to other threats such as road development and access (discussed below).

1.5.2.4. Development of road network

The development of a network of roads in the Cape Breton Highlands over time has increased access for people to a remote landscape previously inaccessible to most motorized vehicles (Parker 2001). The threats of accidental mortality, fragmentation, and interspecies interactions are all exacerbated by changes in habitat such as road development. Trapping pressure on furbearers tends to increase with road development because trappers usually work within close proximity to roads. There appear to be, however, few fur-bearing animals on the Cape Breton Highlands plateau to draw fur harvesters to the area so the severity of this particular threat to lynx may also be low, especially given the fact that coyote pelt prices are currently low.

The evidence for or against the contention that disturbance in lynx habitat is both sparse and ambiguous. Some have suggested that recreational activities that use roads such as snowmobiling provide coyote and bobcat with compacted snow routes to otherwise inaccessible lynx habitat. Indeed, one recent study in the intermountain west found snowmobile presence to be a robust predictor of coyote activity in areas of deep snow (Bunnell et al. 2006). On the other hand, other research in Montana shows that coyotes used compacted and uncompacted roads similarly (Kolbe *et al*. 2007). Others suggest that off highway vehicle activity may have direct effects on lynx productivity (Ruediger *et al.* 2000) but work in Cape Breton in the 1980s suggested that radio-collared lynx were tolerant of the presence of snowmobile machines (Parker 2001). Off-highway traffic in Cape Breton has increased since that time but no further information is available.

1.5.2.5. Interspecies interactions

Across its range, lynx are partly sympatric with bobcat (Lynx rufus) and coyote (Canis latrans) (Murray and Boutin 1991; O'Donoghue *et al.* 1997). More research is required to understand the relationships between these three species in Nova Scotia. Bobcat

and coyote are both relative newcomers to Cape Breton; the former appears to have been uncommon or absent on Cape Breton Island before the construction of the Canso causeway in 1958 (Parker *et al.* 1983) and the latter has only been recorded on Cape Breton since 1981 (Parker 1995). There is recent evidence for lynx-bobcat hybridization in the wild (Schwartz 2004) and coyote predation on lynx, which appears to drive it from some areas (O'Donoghue *et al.* 1995; Buskirk 1999). There is speculation that bobcat and coyote may compete with lynx for prey (Buskirk 1999; Parker 2001; Poole 2004). Hoving's (2005) regional model of lynx distribution found the effect of bobcat harvest densities on lynx were inconsistent and not a significant predictor of lynx, but not only is it unknown the extent to which harvest reflect population numbers, but lynx numbers in Maine have decreased as bobcats have increased. Fishers(*Martes pennanti*), also known to be expanding their range having been reported on Cape Breton Island for the first time in 2002 (Austin-Smith pers. comm.), may pose an additional threat; fisher, predation on lynx has been reported on at least 4 (and as many as 7) occasions in Maine (Vashon 2003).

Lynx are better adapted than coyote and bobcat for hunting snowshoe hare in soft deep snow (Murray and Boutin 1991), and snow depth is thought to be a major factor limiting the ranges of both latter species (McCord 1974; Fener et al. 2005). The lynx's long legs and large paws have twice the weight-supporting capacity of bobcat (Parker *et al.* 1983). In non-snow conditions, however, or in hard-packed snow conditions (such as those created on roads and snowmobile trails, from ice storms, or from sun melt in late winter) lynx may be an inferior competitor for food (Murray *et al.* 1994). Although their diets are more diverse than lynx, both coyote and bobcat rely heavily on snowshoe hare for food on Cape Breton (Parker and Smith 1983; Parker 1995). One study at bait stations in Cape Breton in late winter indicated that coyotes were abundant in the Highlands at the peaks of hare populations (Parker 2001).

In the Cape Breton Highlands climatic factors including freezing rain, windpack, sunmelt freeze and thaw often create hard-packed snow surfaces in late winter. Climate change may exacerbate these effects. In addition, an extensive network of roads was built starting in the 1970s when the forest industry began salvage operations for trees killed by spruce budworm (Parker 2001). Roads and hard-packed snow or ice improve the ability of bobcat and coyote to move in deep snow conditions. As discussed above, the extent to which these predators pose direct threats to the recovery of lynx is unknown.

1.5.2.6. Moose browse

Since the last spruce budworm outbreak in the 1970s, the growth of a population of moose introduced to Cape Breton from Alberta in 1947-48 has been exponential. Moose have heavily browsed the post-budworm second growth and reversed normal forest succession. Many areas previously forested by mature balsam fir have been converted to grassland. This change in forest cover could reduce the suitability of habitat for snowshoe hare and secondary prey.

1.5.2.7. Disease

Carnivores are susceptible to a wide array of highly lethal or debilitating parasites, disease transmission from one carnivore to the other (e.g., domestic to wild) is a conservation issue that is little understood but may be significant (Ray 2000). Lynx from Cape Breton have occasionally been collected by NSDNR for veterinary examinations. In the late 1990s, several live and dead lynx were diagnosed with emaciation and parasites likely resulting from a crash in snowshoe hare populations (Parker 2001). Some of these animals were also diagnosed with a morbillivirus neurological disease (canine distemper) or with high levels of antibody against the virus (McBurney et al. 1997) – the first records of this disease in North American indigenous wild felids. This new disease, closely related to canine distemper virus, has also been reported in bobcats in New Brunswick (Daoust & McBurney 1995) and western North America (Biek *et al.* 2002).

1.6. Knowledge gaps

Much research has been conducted on Canada lynx throughout its range, but some data specific to lynx in eastern North America are still lacking. Regionally specific baseline data are required about lynx prey, habitat, recruitment, and mortality factors -- particularly during population lows. In addition, the overall understanding of connectivity between core and peripheral lynx habitat hampers the ability to inform conservation planning for the species along the southernmost border of its range (such as Cape Breton), where it is currently most imperiled at the frontier of rapidly expanding anthropogenically-driven land use changes. This information, when obtained, may improve the identification and prioritization of recovery objectives and activities.

2. RECOVERY

2.1. Recovery feasibility

Recovery of lynx in Cape Breton must be undertaken within the context of the regional population in New Brunswick, Gaspé, and Maine. Recovery is considered to be biologically and technically feasible but there are significant challenges and uncertainties. This population faces a multitude of risks; the relative magnitude of each individual factor and the interaction of multiple factors is unknown. The focus of recovery actions will be to ensure the persistence of a population of lynx on Cape Breton that is functionally connected to the regional population. Some threats to lynx do not have short-term solutions such as the arrival and spread of interspecific competitors to Cape Breton, climate change, extirpated breeding populations on mainland Nova Scotia and resulting small lynx population size and separation from continental

populations as well as the cumulative impacts of all these threats. Other threats such as illegal shooting and accidental by-catch by trappers could be reduced or eliminated through education and regulatory changes. Recovery may be constrained because lynx in Nova Scotia is at the southern limit of its range where suitable habitat may be particularly patchy and where lynx populations are vulnerable to change (Carroll 2007). The long distance movements and high reproductive potential of lynx, however, suggest that recovery may be biologically feasible if recovery actions are undertaken and/or sustained to address threats such as functional connectivity with other northeastern lynx, accidental mortality, forest management, and increased access to lynx. Recovery techniques exist to address these threats but their effectiveness has not been well tested for lynx.

2.2. Habitat requirements & the identification of a Special Management Zone

There is little discussion of core habitat for lynx in the literature but recent models in eastern North America have begun to shed some light on lynx habitat requirements (Hoving 2001; Carroll 2007; Vashon et al. in press; Fuller et al. in press). Research that specifically addresses habitat needs has been completed in Maine, which, in combination with local research, may provide direction for the definition of significant habitat for lynx in Nova Scotia. At this time, the areas comprising the Highlands Plateau as indicated in Figure 2 should be considered a Special Management Zone for lynx. Any work that results in permanent habitat conversion in this zone as determined by the Nova Scotia Department of Natural Resources, Nova Scotia Department of Environment and Labour, and Cape Breton Highlands National Park should address and mitigate impacts to lynx and its habitat and should be reviewed by the Nova Scotia Lynx Recovery Team. Forest management within the Special Management Zone will be directly integrated into recovery actions and long-term planning.

2.3. Recovery goal, objectives, and corresponding activities

2.3.1. Recovery Goal

Recognizing that lynx in Cape Breton are functionally connected to lynx in New Brunswick, Maine, and Gaspé, the goal of this recovery plan is to ensure the persistence of a self-sustaining population of lynx in Cape Breton and to prevent it from being extirpated due to human activities. The population size required for self-sustaining populations in Cape Breton of population viability is unknown.

2.3.2. Recovery Objectives

The strategic recovery objectives in this plan are to minimize human-caused mortality, maintain key habitat for hare and lynx in Cape Breton, and promote and maintain functional connectivity between Cape Breton, New Brunswick, Maine, and Gaspé. An action plan which details the progress made and work to be done for each recovery objectives is outlined in Section 2.3.5.

Recovery Objective 1. To minimize human-caused mortality of lynx in Nova Scotia

Cape Breton lynx are occasionally killed by accident; rates of mortality appear to be higher during lows in the lynx population cycle when they may disperse long distances or be unhealthy (Parker 2001). Some workers suggest that accidental trapping is a significant source of mortality (Parker *et al.* 1983; Ruggiero *et al.* 1999b; Poole 2003). Between 1995 and 2004, there were 39 lynx carcasses reported to NSDNR from legal snares or traps set for other furbearers (Table 2). Research must be undertaken to understand the relative significance of these mortalities. The number of accidental lynx mortalities may be reduced by educating fur harvesters about techniques to avoid the incidental capture of lynx and by engaging their cooperation in recovery efforts or regulatory changes may be required.

Actions required to achieve this objective are outlined in the Action Plan. In summary, they include the following:

- Determine, monitor, and mitigate mortality factors and circumstances surrounding human-caused mortalities
- Educate and engage the co-operation of fur harvesters to minimize accidental mortality

Recovery Objective 2. Manage key habitat for lynx in Cape Breton

Management plans that balance age classes, regeneration conditions, and patch size in a spatially explicit manner are being employed on private and public land across North America to recover species at risk such as lynx and marten (McKelvey *et al.* 1999; Stinson 2001; NSMRT 2003). These management plans should, when possible, be designed to mimic local natural disturbance patterns and they should consider the genetic structure of populations. Such plans are experiments and their success must be monitored carefully in an adaptive management framework so that strategies can be modified, if necessary, according to available information.

In addition to landscape-scale management planning, it is also necessary for foresters to be aware of and adopt best practices that contribute to lynx recovery at the scale of

the forest stands on which they are working. Some best practices, for example, suggest constructing roads narrowly and orienting them to create shade conditions that reduce snow compaction; creating riparian buffers around treed bogs that are important for lynx foraging habitat; and leaving coarse woody debris in harvested areas and plantations to provide structures for lynx maternal dens. Research is required to test best practices and their effects on lynx.

To recover lynx we must determine what constitutes its habitat requirements and then work to ensure that those requirements are met. In general, workers understand that important habitat for maternal denning includes understory structure such as coarse woody debris that provides security and thermal cover (Slough 1999, Aubry *et al.* 1999; Organ et al. in press). The best hare habitat is generally considered to include horizontal structures such as dense regenerating vegetation that provides cover and food (Ruggiero 1999).

Actions required to achieve this objective are outlined in the Action Plan. In summary, they include the following:

- Co-ordinate and implement landscape-scale management to maintain lynx habitat in space and time
- Implement stand-scale best forestry practices to maintain existing and future habitats including a “Interim Special Management Practices for Lynx in Nova Scotia”
- Research foraging and denning habitat requirements for lynx throughout its population cycle

Recovery Objective 3. Promote and maintain functional connectivity between Cape Breton and New Brunswick, Maine, and Gaspé

At the southern edge of lynx distribution in North America, lynx populations have shown signs of decline and even local extirpation, due to the combined realities of marginal habitat and increasing intensive forest conversion. In this southern periphery -- where habitat conditions are highly variable in distribution and quality (Buskirk et al. 1999b; Koehler 1990), are naturally fragmented into smaller sized patches of transitional habitat, and where snowshoe hares do not experience the same population dynamics as in the north and occur at lower densities (Aubry et al. 1999) -- population persistence of lynx likely has been, and continues to be aided by immigration of lynx from the core (Koehler & Aubry 1994; Litvaitis et al. 1991; Thiel 1987). A better understanding of the connectivity between core and peripheral lynx habitat, and the role of northern lynx in populating the southern range is needed to inform the mitigation of range loss at the edges.

Genetic and demographic analyses suggest that such connectivity does exist (Mowat et al. 2000, Aubry et al. 2000, Schwartz et al. 2002), with lynx thought to migrate from the core especially following the cyclic decline in snowshoe hare numbers in the boreal

forest (McKelvey et al. 2000, Murray 2003). While recent genetic investigations have confirmed a relative lack of genetic separation within the Northern Appalachians of which Cape Breton is part, the population as a whole demonstrates some degree of isolation from animals in Quebec, suggesting that gene flow is not occurring across the St. Lawrence seaway (Johnson et al. in prep.).

While southern lynx population viability may be questionable in the absence of rescue from core lynx populations (Steury and Murray 2004) it will be necessary to gain an understanding of what characterizes functional habitat connectivity for lynx in Nova Scotia. For example, there is evidence of periodic movements of lynx between Cape Breton and New Brunswick, indicating that successful dispersal out of Cape Breton does occur, but an absence of knowledge of the means by which they are traversing unsuitable habitats. There is some speculation (Parker ref) that lynx will use sea ice to accomplish this; if this is the case, the extent of such ice will be compromised or disappear under a changing climate and whether alternative routes are possible, will need to be considered in recovery planning. The best time to investigate these issues will be immediate following crashes in hare populations, at which time long-distance lynx dispersal is most likely to occur.

Actions required to achieve this objective are outlined in the Action Plan. In summary, they include the following:

- Research functional connectivity requirements for Cape Breton lynx
- Provide suitable refugia where forestry, development, fur harvesting, and off-highway vehicle use are not permitted
- Ensure functional connections between populations within Cape Breton, on mainland Nova Scotia, and between Nova Scotian and continental populations

2.3.3. Ongoing monitoring

Monitoring can be an important management tool if it is used to set priorities, modify, and evaluate recovery actions. Lynx can be monitored with track surveys, scent posts, marking studies, radio telemetry, collection of carcasses, and investigation of reports of lynx from the public. Monitoring prey can be done with snowshoe hare pellet counts and other hare surveys. The techniques used for monitoring must be reliable and repeatable and the information must be collected and managed consistently. Further monitoring must be accomplished over the long term. Crowley *et al.* (in prep.) found snow track surveys were the most effective technique for detecting lynx in Maine over a large geography (compared to camera and hair-snare techniques).

The Nova Scotia Department of Natural Resources regularly collects lynx carcasses and reports of lynx from the public. From 1999 to 2004, over 170 lynx reports were collected from the public by NSDNR as Wildlife Incident Reports. Reports of lynx observations are also captured on moose hunter report cards and other reports of incidental sightings as special lynx reports and internet reports. In 2004, NSDNR started predator and prey winter track road survey routes in Cape Breton. Twenty-three routes

have been established that are each 5 km long. A monitoring technique for lynx using aerial survey blocks was tested in 2002 and 2003 with limited success. This technique is used for wolves and lynx in some northern areas and may be worth pursuing where access is difficult.

A province-wide monitoring program for snowshoe hare was begun by NSDNR in 1993. The program counts fecal pellets in permanent 1 m circular sample plots at 100 m intervals along 1000 m ungulate monitoring transects. Since 1989 NSDNR has also collected hare abundance rankings from trappers (Figure 3) and more recently from small game licensees. This monitoring suggests that cyclic trends are stronger in the highlands of Cape Breton than in the lowlands.

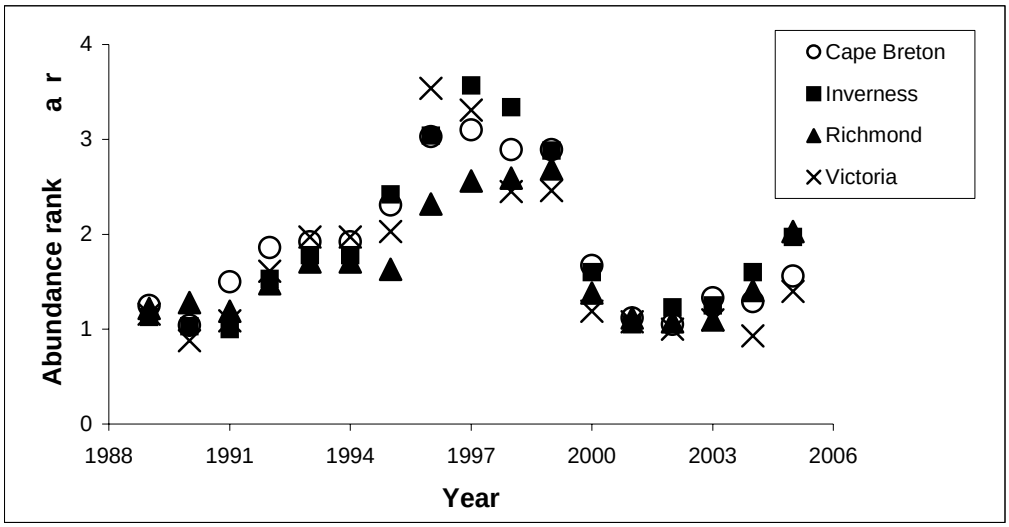

Figure 3. Snowshoe hare abundance rank by trappers and hunters in four Cape Breton counties between 1989 and 2005.

Carnivore snow-tracking surveys are needed for a 10-year period to understand lynx persistence in peripheral and core areas during various stages of hare cycles. Partnerships with interested First Nations groups to monitor carnivores should be investigated. Hare pellet surveys should also be continued. The hare cycle does not appear to be synchronized perfectly across Cape Breton (Figure 3) and this may have implications for lynx persistence in Cape Breton refugia during population crashes.

2.3.4. Broad strategy to be taken to address threats

For all identified threats to lynx, the recovery team will adopt an approach that integrates information, management, stewardship, education, and evaluation. Long term recovery and viability are uncertain and will need to be assessed after the implementation of this plan. The team will improve the information on which recovery initiatives are based through research, monitoring, and traditional knowledge; it will

promote effective and efficient management of lynx and its habitat; it will encourage and implement stewardship initiatives by fur harvesters, landowners, and the forest industry; it will educate Nova Scotians about lynx and research results, and it will regularly evaluate its progress in each of these approaches and the recovery of lynx. The broad strategy of the Recovery Team is to undertake pragmatic short-term (50 year) recovery efforts *in-situ*. If catastrophic events result in the extirpation of lynx from Cape Breton, reintroductions may be considered as a management tool depending on the results of genetic analyses.

Research, education, and management activities needed to meet the objectives

Relevant Recovery Objective	Action	Priority*	Threat(s) Addressed
1	1.1 Determine, monitor and mitigate mortality factors and circumstances surrounding human-caused mortalities	1	Accidental mortality
1	1.2 Educate and engage the co-operation of fur harvesters to minimize accidental mortalities	1	Accidental mortality
2	2.1 Co-ordinate and implement landscape-scale management to maintain lynx habitat in space and time	2	Habitat conversion, habitat loss, fragmentation, access to lynx
2	2.2 Implement stand-scale best forestry practices to maintain existing and future habitats including a “Interim Special Management Practices for Lynx in Nova Scotia”	2	Habitat conversion, habitat loss,
2	2.3 Research foraging and denning habitat requirements for lynx throughout their cycle	2	Habitat conversion, habitat loss, fragmentation, access to lynx
3	3.1 Research functional connectivity requirements for Cape Breton lynx	2	Genetic isolation, fragmentation
3	3.2 Provide suitable refugia where forestry, development, fur harvesting, and off-highway vehicle use are not permitted	3	Habitat loss, accidental mortality, access to lynx
3	3.3 Ensure functional connections between populations within Cape Breton	2	Genetic isolation, fragmentation,

	and between Nova Scotian and continental populations		accidental mortality

**Priority 1 is urgent, an action without which the population will decline; Priority 2 is necessary, an action that is needed to evaluate and guide recovery actions; Priority 3 is secondary; an action that would be beneficial if urgent actions are already underway*

2.3.5. Effects on non-target species

Recovery efforts for lynx will be undertaken in collaboration with the Nova Scotia Recovery team for American marten. The habitat requirements for these two species are not the same but marten and lynx face similar threats and require some common recovery actions undertaken by the same people, industries and agencies. Landscape planning for lynx to include regenerating forests and young age classes should not undermine efforts to conserve remnant old and mature forest stands for marten but should consider biodiversity in general and the needs of a suite of species at risk.

3. ACTION PLAN

Recovery Objective 1. To minimize human-caused mortality of lynx in Nova Scotia

Action 1.1 Determine, monitor and mitigate mortality factors and circumstances surrounding human-caused mortalities

(Progress to date and Work to be done sections are under revision)

Research questions to be answered:

-What is the minimum viable population size?
-What is the relative importance of mortality factors for lynx in Cape Breton throughout the population cycle?
-What are the circumstances behind accidental takes? (*e.g.* What was the target species? Could the take have been avoided? Do accidental takes occur in particular geographic areas? Where are trappers setting traps and snares for cats and coyotes? Are trappers using the highland plateau?)
-How effective are stewardship activities in reducing lynx mortality?

Action 1.2 Educate and engage the co-operation of fur harvesters to eliminate accidental mortalities

Progress to date:

In 2004 and 2005, information sessions and workshops were organized by NSDNR on Cape Breton Island and mainland Nova Scotia (participating groups included *Municipality County of Inverness, Cape Breton Anglers Association, Whycocomagh Band -First Nations, Eskasoni Band -First Nations, Cape Breton Wildlife Association, and Trappers Association of Nova Scotia*). Over one hundred fur harvesters were trained to avoid accidental take of lynx and provided with information about species at risk (including American marten and Canada lynx). A publication produced by NSDNR and the Habitat Stewardship Program of Environment Canada describes how fur harvesters can avoid the incidental take of lynx and how they can distinguish between bobcat and lynx (www.speciesatrisk.ca/martenandlynx). Incidental take of lynx can be reduced by the choice of trapping device, bait, placement and location of trap, staking technique, and by techniques for releasing lynx from traps.

Work to be done:

-Solicit input from the five Unimaki First Nations bands and from hunting and trapping organizations (*e.g.* TANS) to determine what needs to be done to achieve this objective and to develop an updated action plan for it. This may include reviewing existing management and regulatory tools to determine options for reducing accidental mortality of lynx.

-Continue information sessions and workshops about species at risk (including lynx and marten) with landowners and groups such as the Municipal County of Victoria, Village of Baddeck, Membertou Band, Wagmatcook Band, Cape Breton Naturalists Society, Margaree Environmental Association, and Bras D'Or Preservation Foundation. Evaluations (*e.g.* pre and post-workshop surveys) could help determine the effectiveness of workshops and improve their content and delivery.

-Contact trappers who have caught more than one lynx and provide written and illustrated material about avoiding incidental harvest of lynx. Carefully solicit their help with stewardship efforts by clearly communicating the value of lynx and the gravity of accidental harvest.

-Organize special education and stewardship activities during cycle highs just before population crashes when lynx conservation is critical and human-lynx interactions are most common. These activities may include press releases, public service announcements, and presentations targeted at geographic areas important to lynx and to groups such as hunters and trappers.

-Continue to train Guardians and other EFWC and UINR staff to participate in lynx research, education, and stewardship (*e.g*. attend regularly scheduled Regional Wildlife Immobilization Team Meetings which occur twice per year).

Recovery Objective 2. Manage key habitat for lynx

Action 2.1. Coordinate and implement landscape-scale management to maintain lynx habitat in space and time

Progress to date:

The NS DNR has begun to develop a partnership with the forest industry to incorporate a spatial habitat model for species at risk into commercial harvest planning to ensure continued availability of marten and lynx habitat. Large landholders (B.A. Fraser Lumber Ltd., Gaelic College of Celtic Arts and Crafts, Baddeck Valley Wood Producers, and Georgia Pacific Inc.) were invited to join in stewardship of their land for the conservation of marten and lynx populations. Stora Enso's goal for landscape-scale management in 2004 was to keep 17% in 0-25 years, 34% in 25-50 years, 16% in 75-100 years, 8% in

100-125 years, 1% in 125-150 years and 1% in over 150 years. Stora used natural disturbance regimes and habitat availability for indicator species to guide age class proportion goals. Through the IRM process, NSDNR and Stora have committed to set aside 8% of Crown land through the Old Forest Policy, and have provided a 100 m mature forest buffer or equivalent around treed bogs with cone-bearing stands identified as lynx habitat in NSDNR's Significant Wildlife Habitat Database (Figure 3). The Marten Habitat Management Zone (MHMZ) includes management of marten patches as well as other specifications for forest harvesting in this area, and Stora Enso retains undisturbed forest on steep slopes and in inoperable areas (*e.g.* due to rough terrain or poor drainage).

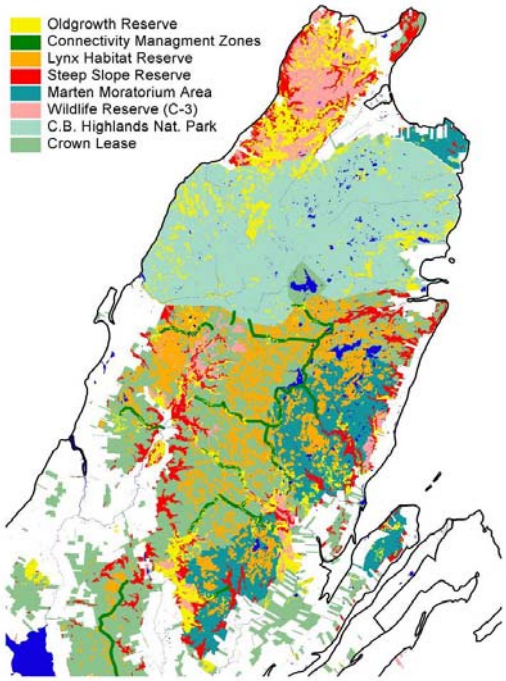

Figure 3. Land use summary Cape Breton Highlands from Stora Enso

Work to be done:

-Determine the amount of forest and the community and maturity types that should be maintained in a comprehensive and integrated public-private-industry landscape-scale management plan. This should be done in collaboration with other researchers in the U.S. and Canada and in tandem with other species at risk models (*e.g.* marten).

-Develop a lynx habitat model (Stora Enso, Acadia University, and the College of Geographic Sciences may work together on such a research project).

-Garner support for a fully cooperative multi-stakeholder landscape scale recovery effort for lynx through communication and education work (including the communication of research results).

-Develop agreements with land managers to incorporate their supply models in planning for lynx habitat. On public land, prior to approval of the operational management plan, the leaseholder is obliged to incorporate measures specified by NSDNR. NSDNR's Integrated Resource Management system is used as a planning tool for all Crown lands in Nova Scotia. It incorporates the most current resource inventory (including wildlife species status and distribution) together with information on other land use values (*e.g.* recreational, aesthetic) to enable land use planning both at the strategic level and in local decision making.

-Plan road construction and maintenance to minimize the total road network, especially through-routes in areas with concentrations of lynx. This may be accomplished by decommissioning roads and actively re-vegetating them, efficiently planning road networks, favouring dead end roads, and using road signs and blocks. NSDNR's road index tool may be useful for achieving this objective.

Action 2.2 Implement <u>stand-scale</u> best forestry practices to maintain existing and future habitats on public, private, and First Nations land including an "Interim Special Management Practices for Lynx in Nova Scotia"

Progress to date:

Current forest practices and regulations such as the Nova Scotia Wildlife Habitat and Watercourses Protection Regulations under the Forest Act have started to emphasize retention harvesting to protect riparian buffers, leaving deadwood on site, and retaining clumps of trees. Forest planners are also beginning to see the value of managing for a diversity of age classes over the landscape. Stora Enso does not spray chemical herbicides or pesticides on any crown or freehold land, and is interested in decommissioning old logging roads and building new roads that are narrower and less straight (less snow compaction) if there is support from First Nations and snowmobile associations.

NSDNR staff have met with Unama'ki (Cape Breton) Institute of Natural Resources (UINR) staff and Eskasoni Fish & Wildlife Commission (EFWC) Guardians to develop projects and the associated funding applications. UINR supported summer lynx live-trapping sessions in Cape Breton Highlands and NSDNR supported winter lynx live-trapping sessions but so far with no success in capturing animals for radio telemetry studies. Considerable experience was gained by the personnel involved who will be useful in future efforts. Eskasoni Fish and Wildlife Commission (EFWC) Guardians have also been trained in a wildlife chemical immobilization course.

Work to be done:

-Ensure that silviculture is compatible with lynx recovery on crown land at Boisdale Hills, East Bay Hills and the Highlands. On public land, there may be potential to incorporate

research-based recommendations for best forestry practices in the Integrated Resource Management process for multiple and adaptive resource use areas.

-Engage the cooperation of private landowners in Cape Breton Highlands, Boisdale Hills, East Bay Hills, and South Mountain (the Lake Ainslie area, in particular, has much privately held land) to participate in stewardship activities to manage their woodlots for lynx and other wildlife. It will be important to have research-based recommendations for private landowners in regards to best practices particularly during spruce budworm outbreaks.

-Promote habitat suitable for snowshoe hare in pre-commercial thinnings and other silviculture treatments by leaving deciduous trees (no herbicide sprays) and seedlings less than 1m tall

Action 2.3 Research foraging and denning habitat requirements for lynx throughout their cycle

(Progress to date and Work to be done sections are under revision)

Research questions to be answered:
-What, if any, components of habitat (*e.g.* competitors, food items, dens) limit the recovery of NS lynx?
-What is the role of young mixedwood stands for foraging and old forest stands with coarse woody debris for denning?
- Is sufficient suitable habitat available to support the species or could it be made available through habitat management or restoration?
-Where do lynx currently remain and what are the characteristics (cover, prey, denning, road density, human settlement) of those habitats?
-During a low in the hare cycle, do Cape Breton lynx show a marked shift in their use of alternative prey? Are treed bogs an important source of secondary prey? Is the prescribed interim special management practices of 100 m bog buffers effective?
-What are the cumulative impacts of development and land use in the SMZ?
-Should roads be de-commissioned for lynx recovery in Cape Breton?
-What are the effects of snowmobiles on lynx by way of direct disturbance or access to other predators or humans?
-What is the relationship between climate change, snow cover, and lynx recovery?
-What are the effects of high moose density on lynx and hare habitat?
-What is the relationship b/w spruce budworm, hares, and lynx?
-What are the current effects of forestry on hare and lynx populations?
-How can forest supply models help recover lynx?

Recovery Objective 3. Promote and maintain functional connectivity for lynx

Action 3.1 Research functional connectivity requirements for Cape Breton lynx

(Progress to date and Work to be done sections are under revision)

Research questions to be answered:

-What are the connectivity requirements for NS lynx and where are local refugia?
-What is the genetic structure of the Nova Scotia and the Atlantic Canadian lynx populations? (investigate using pelts and scent posts)
-What is the value of the NS population to the regional population?
-Is CB a source or sink of lynx recruitment for the regional population? (investigate using stable isotopes)
-Is CBHNP a source of lynx recruitment for the NS population?
-During lows in the lynx cycle where do core breeders go? How are populations re-stocked after a crash? (investigate using VHF telemetry, need to look in inaccessible fringe areas along plateau, could use snowshoe hare as a proxy)
-What is the relative importance of satellite areas compared to main highlands and are there barriers to interchange and short range dispersal?
-How and when do lynx immigrate to Cape Breton – are there barriers?
-How could the landscape be managed for functional connectivity for lynx between Cape Breton and mainland NS populations and NS and continental populations? (are there critical patches of refugia along dispersal routes?)

Action 3.2 Provide suitable refugia for lynx

Progress to date:

Cape Breton Highlands National Park provides a refugia where forestry, development, fur harvesting, and off-highway vehicle use are not permitted. Provincial wilderness areas may allow some fur harvesting but do not allow forestry, development, or off-highway vehicle use (Figure 2).

(Work to be done sections are under revision)

Action 3.3 Ensure functional connections between populations within Cape Breton and between Nova Scotian and continental populations

Progress to date:

In Cape Breton, land is protected in several ways that may contribute to structural landscape connectivity (Figure 3,4). NSDNR has an Old Forest Policy for retaining 8% of crown land in >80 year age class as old growth reserves. Stora Enso sets aside marten home range areas. Eight Wilderness Areas and Nature Reserves in Cape Breton are managed by NSDEL (these areas protect habitat but there are no restrictions there on hunting, trapping, or snaring). Parks Canada manages Cape Breton Highlands National Park. Thirty marten home range patches of at least 500 hectares in size were set aside immediately in 2004 and an additional 25 will come on-stream in 2030 as the habitat matures to meet the stand level criteria for a total of 55 home range patches by 2030 (reference the Marten Action Plan). Stora Enso has Connectivity Management Zones many of which overlap with treed bogs. Connectivity Management Zones developed by NSDNR and Stora to provide some measure of landscape connectivity on crown land on Cape Breton, will all aid in addressing among other things, the balance between lynx denning habitat and foraging habitat.

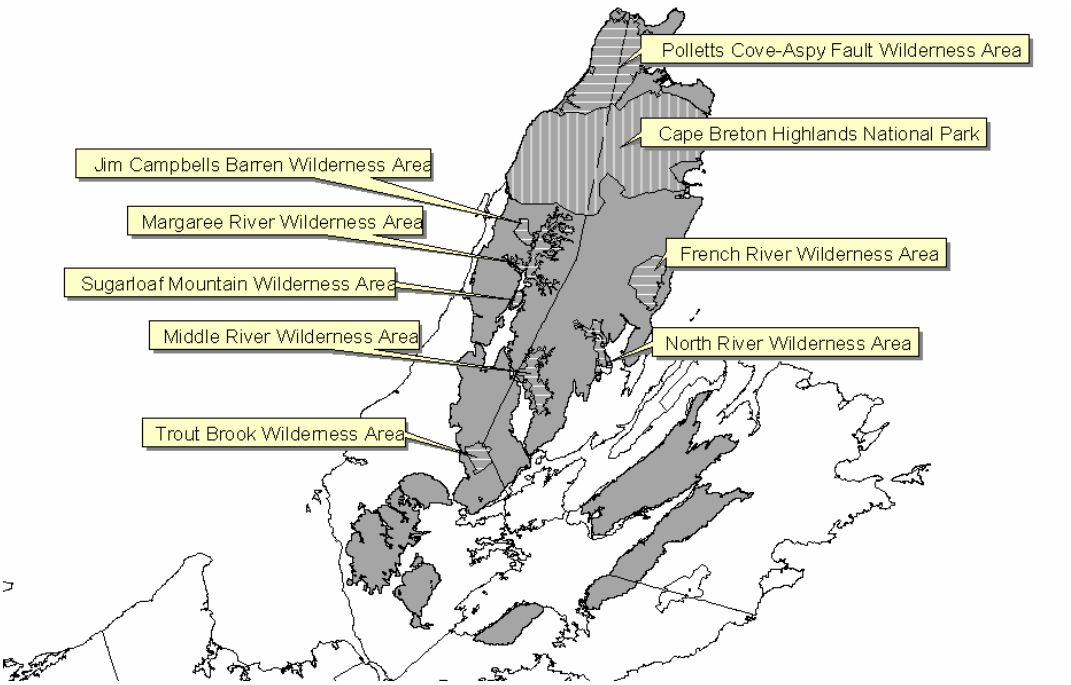

Figure 4. Protected areas within lynx core habitat from NSDNR (Map courtesy of NSDNR).

The Wildlands Project identified suitable habitat for lynx and marten conservation in the Northern Appalachians that may be important for dispersal (Carroll 2005). The Canadian Parks and Wilderness Society and other local conservation and community

groups have been promoting the Isthmus of Chignecto for landscape connectivity between Nova Scotia and New Brunswick and consider lynx a focal species for this work. They have identified four major challenges which include urban sprawl at Moncton, Shediac, Sackville, Amherst, Truro, and Pictou; high densities of roads and highways; uncoordinated land management on private land; and paucity of ecological knowledge about landscape connectivity effects on wildlife (MacDonald and Clowater 2005).

Work to be done:

-An action plan should be developed to specifically address work required on mainland Nova Scotia and Cape Breton Island to achieve the objective of functional connectivity between Cape Breton and continental lynx populations.

-The approach to planning for lynx recovery should be regional and should link effectively to other initiatives. One or more members of the NS Lynx Recovery Team will be involved in and aware of ecoregional initiatives (eastern carnivores group and northern Appalachian initiative) to inform the team of developments and inform regional initiatives about work undertaken in Nova Scotia.

-Consider a network of protected areas for an Acadian-Appalachian connectivity zone and look particularly at the Northumberland Shore.

4. Recovery Team Members

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James Bridgland, Parks Canada
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Mark Elderkin (co-chair), Nova Scotia Department of Natural Resources
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Mike O'Brien (co-chair), Nova Scotia Department of Natural Resources
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Terry Power, Nova Scotia Department of Natural Resources
Justina Ray, Wildlife Conservation Society Canada
Phil Taylor, Acadia University
Ian Thompson, Canadian Forestry Service
Paul Tufts, Trappers Association of Nova Scotia

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APPENDIX A: Explanation of Threat Table

The outline for the threat table is taken from *Guidelines on Mitigating Threats to Species at Risk,* Environment Canada, 2006. A brief definition and explanation of each field in the table is given below.

Threat Category: Broad Category indicating the type of threat

General Threat: Typically the general activity causing the specific threat. To be determined by Status Report author or recovery team/planner.

Specific Threat: The specific factor or threat causing stress to the population. To be determined by Status Report author or recovery team/planner. Note that not every threat can be specified to all three levels in this classification hierarchy. Thus, in these situations, specify either a general or specific threat.

Stress: Indicated by an impairment of a demographic, physiological, behavioral attribute of a population in response to an identified or unidentified threat that results in a reduction of its viability. To be determined by Status Report author or recovery team/planner.

Extent: Indicate whether the threat is widespread, localized, or unknown across the species range.

Occurrence: Indicate whether the threat is historic (contributed to the decline but no longer affecting the species), current (affecting the species now), imminent (is expected to affect the species very soon), anticipated (may affect the species in the future), or unknown. If applicable, also indicate whether the occurrence differs between 'local' populations or smaller areas of the range and the full 'range-wide' distribution.

Frequency: Indicate whether the threat is a one-time occurrence, seasonal (either because the species is migratory or the threat only occurs at certain times of year-indicate which season), continuous (on-going), recurrent (reoccurs from time to time but no on an annual or seasonal basis), or unknown. If applicable, also indicate whether the frequency differs between 'local' populations or smaller areas of the range and the full 'range-wide' distribution.

Causal certainty: Indicate whether the best available knowledge about the threat and its impacts on population viability is high (evidence causally links to the threat to stresses on population viability), medium (correlation between the threat and population viability, expert opinion, etc), or low (assumed or plausible threat only). This should be a general reflection of the degree of evidence that is known for the threat, which in turn provides information on the risk that the threat has been misdiagnosed. If applicable, also indicate whether the level of knowledge differs between 'local' and 'range-wide' distribution.

Severity: Indicate whether the severity of the threat is high (very large population-level effect), moderate, low, or unknown. If applicable, also indicate whether the severity differs between 'local' populations or smaller areas of the range and the full 'range-wide' distribution.

Level of concern: Indicate whether managing the threat is an overall high, medium, or low concern for recovery of the species, taking into account all of the above factors.

Local: Indicates threat information that relates to a specific site or narrow portion of the range of the species.

Range-wide: Indicated threat information relates to the whole distribution or large portion of the range of the species.