Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Red Crossbill, *percna* subspecies (*Loxia curvirostra percna*), in Canada

Red Crossbill, *percna* subspecies

October 2006

Environment Canada Environnement Canada

Canada

About the *Species at Risk Act* Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003, and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (http://www.sararegistry.gc.ca/the_act/default_e.cfm) outline both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the *Species at Risk Act* and recovery initiatives, please consult the SARA Public Registry (http://www.sararegistry.gc.ca/) and the Web site of the Recovery Secretariat (http://www.speciesatrisk.gc.ca/recovery/default_e.cfm).

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Additional copies:

Additional copies can be downloaded from the SARA Public Registry (http://www.sararegistry.gc.ca/).

Cover photo: Red Crossbills in a white spruce tree, Avalon Peninsula, Newfoundland and Labrador © Bruce Mactavish

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DECLARATION

This recovery strategy has been prepared in cooperation with the jurisdictions responsible for the Red Crossbill, *percna* subspecies. Environment Canada has reviewed and accepts this document as its recovery strategy for the Red Crossbill, *percna* subspecies, as required under the *Species at Risk Act*. This recovery strategy also constitutes advice to other jurisdictions and organizations that may be involved in recovering the species.

The goals, objectives and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new findings and revised objectives.

This recovery strategy will be the basis for one or more action plans that will provide details on specific recovery measures to be taken to support conservation and recovery of the species. The Minister of the Environment will report on progress within five years.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment Canada or any other jurisdiction alone. In the spirit of the *Accord for the Protection of Species at Risk*, the Minister of the Environment invites all responsible jurisdictions and Canadians to join Environment Canada in supporting and implementing this strategy for the benefit of the Red Crossbill, *percna* subspecies and Canadian society as a whole.

RESPONSIBLE JURISDICTIONS

Environment Canada
Parks Canada Agency
Government of Newfoundland & Labrador

AUTHOR

This strategy was prepared by Jolene T. Sutton.

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STRATEGIC ENVIRONMENTAL ASSESSMENT

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below.

While the Red Crossbill recovery strategy will clearly benefit the environment by promoting the recovery and conservation of the Red Crossbill, *percna* subspecies, two recovery measures with potentially adverse effects were also considered:

1. The strategy suggests the encouragement of red and white pine regeneration within insular Newfoundland to augment habitat availability for the species.

2. In the event that food resources prove limiting to the Red Crossbill, *percna* subspecies, in Newfoundland, the strategy suggests that steps may be necessary to reduce competition for food and/or nest predation by red squirrels.

At this time, it is not known if these conservation/recovery measures will need to be implemented. Promoting the regeneration of red and white pine in localized areas is unlikely to impact other species dependent on boreal forest habitat in insular Newfoundland. The potential regeneration area would be modest and implemented in a temporal process to offset any immediate impact to other species occupying the habitat. Additionally, both red and white pine are native species to Newfoundland, and this activity would be restoring the ecosystem to its former composition.

Extensive research is necessary to determine the extent, if any, of competition for food resources and/or nest predation by red squirrels. Directly reducing red squirrel populations in Red Crossbill habitat is not viable. Alternatively, modifying habitat to deter red squirrels from populating areas at high densities but not impacting the habitat to the extent that it would deter Red Crossbill is questionable and difficult to accomplish, but it may prove feasible.

Further information is presented in sections 2.2.1 Potential Interspecific Relationships; 2.2.2 Potential Decline, Alteration and/or Degradation of Habitat via Natural and Anthropogenic Factors; and 4.5 Potential Management Impacts on Other Species, of the Red Crossbill recovery strategy. Before any mitigation measures are implemented, it will be necessary to determine that the benefits identified for Red Crossbill recovery are realistic and attainable.

RESIDENCE

SARA defines residence as: *a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating* **[Subsection 2(1)]**.

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the SARA public registry:
http://www.sararegistry.gc.ca/plans/residence_e.cfm

PREFACE

The Red Crossbill, *percna* subspecies, is a migratory bird covered under the *Migratory Birds Convention Act, 1994* and is under the management jurisdiction of the federal government. The Province of Newfoundland and Labrador will have primary responsibility for the management of a significant portion of the Red Crossbill's critical habitat once it has been identified. The *Species at Risk Act* (SARA, Section 37) requires the competent minister to prepare recovery strategies for listed extirpated, endangered, or threatened species. The Newfoundland and Labrador *Endangered Species Act* also requires the development of a recovery plan within one year of listing for an endangered species. The Red Crossbill was listed as endangered under SARA in July 2005 and under the Newfoundland and Labrador *Endangered Species Act* in December 2004. The Canadian Wildlife Service – Atlantic Region, Environment Canada, led the development of this recovery strategy in cooperation with the Province of Newfoundland and Labrador and the Red Crossbill Recovery Team. All responsible jurisdictions have reviewed and approved the strategy. The strategy meets SARA (Sections 39–41) and Newfoundland and Labrador *Endangered Species Act* (Section 23) requirements in terms of content and process. It was developed in cooperation or consultation with:

- Environment Canada
- Parks Canada Agency
- Newfoundland and Labrador Department of Environment and Conservation
- Newfoundland and Labrador Department of Natural Resources
- Canadian Forest Service, Natural Resources Canada
- Corner Brook Pulp and Paper Ltd.
- Abitibi-Consolidated Company of Canada
- Memorial University of Newfoundland
- Newfoundland and Labrador Natural History Society

This will be the first recovery strategy posted on the SARA Public Registry for the Red Crossbill. At this time, the recovery will be implemented using a single-species approach. Recovery of the Red Crossbill may enhance conservation of other boreal species that rely on cone-producing conifer forest. A multispecies approach for boreal species on insular Newfoundland may become appropriate if additional eastern Canadian boreal species experiencing similar threats become listed under SARA or the Newfoundland and Labrador *Endangered Species Act* in the future.

EXECUTIVE SUMMARY

The Red Crossbill, *percna* subspecies (*Loxia curvirostra percna*), is endemic to eastern Canada and is associated with conifer forests on the island of Newfoundland, with evidence of infrequent irruptions off the island (COSEWIC 2004). This subspecies is currently listed as endangered under the *Species at Risk Act* of Canada, as well as the Newfoundland and Labrador *Endangered Species Act*. Although *percna* was once considered common in Newfoundland, steep population declines have been documented since the mid-1900s (COSEWIC 2004). The last documented *percna* nest in Newfoundland was reported in 1977 (W. Montevecchi, unpublished data). However, sightings of a number of Red Crossbills in Whitbourne, Newfoundland and Labrador, along with a photograph of a juvenile Red Crossbill being fed by an adult in June 2005 at the same location, indicate that Red Crossbills, probably including the *percna* subspecies, still nest successfully in Newfoundland (preliminary analysis has determined that some of the individuals observed in Whitbourne may be the *percna* subspecies). Numbers of *percna* in Newfoundland are currently estimated at 500–1500 individuals.

The Red Crossbill, *percna* subspecies, has a restricted distribution, which, combined with its apparent low numbers, makes it potentially very vulnerable to localized as well as broad-scale threats. However, the factors that led to steep population declines, along with current threats and limiting factors, remain speculative. The recovery strategy identifies a series of threats that are believed to be of concern. These include, but are not limited to, disease and insect invasion of cone-bearing trees, food competition from red squirrels and other seed-eating finches, commercial forestry, and the Allee effect. A series of scientific investigations to address these threats will be outlined in more detail in subsequent action plans.

These studies will also help to address the considerable knowledge gaps for *percna*. There is little information on the habitat choice within Newfoundland, as well as limited information on movement patterns and distribution and how these are influenced by the availability of food resources. Additional questions that are raised include whether *percna* is further limited by specific behaviours or whether it has evolved in a closed system that has been invaded by alien species over the last 100 years. The answers to these questions may lead us to a more complete understanding of the threats to the species and the steps needed to address its recovery.

This recovery strategy was prepared in response to the legislative requirements outlined in the *Species at Risk Act* for the development of recovery strategies for endangered species (Sections 37–46) and in response to the Newfoundland and Labrador *Endangered Species Act* (Sections 23–27). The strategy aims to identify processes to assess the presence, distribution, habitat associations, and population status of the Red Crossbill, *percna* subspecies, in Newfoundland, in addition to identifying threats and limiting factors in an effort to reconfirm the feasibility of recovery. If recovery is reconfirmed to be feasible, the long-term population goal will be to restore the population to a sustainable level through a series of recovery objectives that include research, monitoring, threat assessment, critical habitat and recovery habitat designation, habitat protection, stewardship, and educational programs. Future plans for the conservation of the Red Crossbill, *percna* subspecies, should involve improving our understanding of the boreal forest community in Newfoundland to ensure the long-term persistence of not only the *percna* subspecies, but also the suite of other boreal forest species specialists.

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SPECIES ASSESSMENT INFORMATION FROM COSEWIC[1]

Date of Assessment: May 2004

Common Name: Red Crossbill *percna* subspecies

Scientific Name: *Loxia curvirostra percna*

COSEWIC Status: Endangered

Reason for Designation: The *percna* subspecies of the Red Crossbill is considered a distinctive taxonomic group, with breeding likely restricted to the island of Newfoundland. Various population estimates suggest that it has declined markedly and steadily over the last 50 years, along with declines in the extent and quality of its habitat. A few records of the *percna* subspecies exist for Nova Scotia and other locations, but there is not enough information to determine its status there.

Canadian Occurrence: Newfoundland and Labrador

COSEWIC Status History: Designated Endangered in May 2004. Assessment based on a new status report.

1. BACKGROUND

1.1 Species Description

Crossbills are medium-sized finches with crossed mandibles, which allow them to forage on the seeds of conifer cones. Red Crossbills are associated with conifer forests on the island of Newfoundland and can be distinguished from congeners of insular Newfoundland by the crossed mandibles in combination with the lack of white wing bars, which are characteristic of White-winged Crossbills (*Loxia leucoptera*) (COSEWIC 2004). Adult males are mostly red with some brown shading, whereas adult females are greyish olive with yellowish rumps (Godfrey 1986). Both males and females have blackish brown flight feathers and deeply notched tails (Godfrey 1986; Adkisson 1996). Juveniles are similar in appearance to adult females and are usually pale grey with some olive and yellow. They can be distinguished from adults by their streaked heads and bodies as well as their buffy wing coverts (Godfrey 1986; Adkisson 1996). Red Crossbills often forage in flocks.

[1] **Recovery Team comment regarding the information provided by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC):** The Recovery Team believes that Red Crossbills may face multiple threats in Newfoundland, not necessarily those identified in the status report. The intent of this recovery strategy is to lay the framework for future efforts to better understand and subsequently mitigate the factors that are limiting Red Crossbill recovery.

The *percna* subspecies is distinguished from other North American Red Crossbills by its larger body, stouter bill, and darker, duskier plumage. However, owing to the difficulty of identifying subspecies by morphology alone, vocalization may be the best method of distinguishing different Red Crossbill types in the field. The *percna* subspecies is considered one of eight reproductively isolated forms found in North America and is believed to have its own distinct call (Groth 1993).

Since the release of the COSEWIC status report (COSEWIC 2004), additional information on population and/or distribution of *percna* has become available. Recent studies of congeners in Europe stress the importance of vocalization for Red Crossbill identification (Bijlsma 2004; Edelaar and Terpstra 2004). Edelaar and Terpstra (2004) support Benkman's (1989) and Groth's (1993) suggestions that North American Red Crossbills likely represent distinct species and not subspecies; these suggestions were based on studies of morphological, vocal, and genetic traits.

1.2 Distribution of Red Crossbill

For a more detailed summary of the species' range, refer to the COSEWIC status report (COSEWIC 2004).

1.2.1 Global Range

Red Crossbills occur throughout the boreal forests of North America and Eurasia and southward through the coniferous forests of northern Spain, northern Africa, the Mediterranean islands, northern India, southern China, Japan, and the northern Philippines (Godfrey 1986).

1.2.2 Canadian Range

Godfrey (1986) reports that in Canada, Red Crossbills breed in the coniferous forests of southern Yukon, southwestern Northwest Territories, all of British Columbia (including coastal islands), Alberta (in the south, confined to the western mountainous region), northwestern and central Saskatchewan, southern Manitoba, central and southern Ontario (except the extreme southwestern region), southern Québec, New Brunswick (except possibly the northwestern region; Erskine 1992), Prince Edward Island, Nova Scotia, and Newfoundland (but are absent from Labrador) (Todd 1963; Godfrey 1986).

The *percna* subspecies has been identified as extending throughout Newfoundland, with occasional irruptions in the Maritimes. The COSEWIC status report indicated that during years of low cone crops, the *percna* subspecies has been observed in Ontario, Québec, New Brunswick, and Nova Scotia (COSEWIC 2004), as well as potentially in the bordering northeastern U.S. states (Dickerman 1987). It is not known if *percna* has bred in Labrador, as breeding records for Red Crossbill are unsubstantiated (Todd 1963). Their insular Newfoundland range is not fully understood, as it is not clear if there are core breeding areas other than their association with coniferous forests (COSEWIC 2004). Canadian range is illustrated in Figure 1.

1.2.3 Percentage of the Global Distribution in Canada

The *percna* subspecies is believed to nest only in insular Newfoundland, Canada.

1.3 Population Sizes and Trends

Quantitative information does not exist to allow the assessment of historical population numbers or population trends for Red Crossbills in Newfoundland. However, they were once considered abundant, with numbers comparable to those of White-winged Crossbills (COSEWIC 2004). Since the mid-1900s, sightings of this species have greatly diminished, and the population is believed to have experienced a population decline upwards of 75% per decade during the period from 1968 through 2002 (based on Newfoundland Christmas Bird Counts; COSEWIC 2004). The status report suggests that the current total population size is 500–1500 individuals, but states that there is uncertainty associated with this estimate (COSEWIC 2004). This uncertainty is likely due to the sporadic and inconsistent nature of the survey effort across *percna*'s range, as well as a lack of surveys targeted specifically at crossbills.

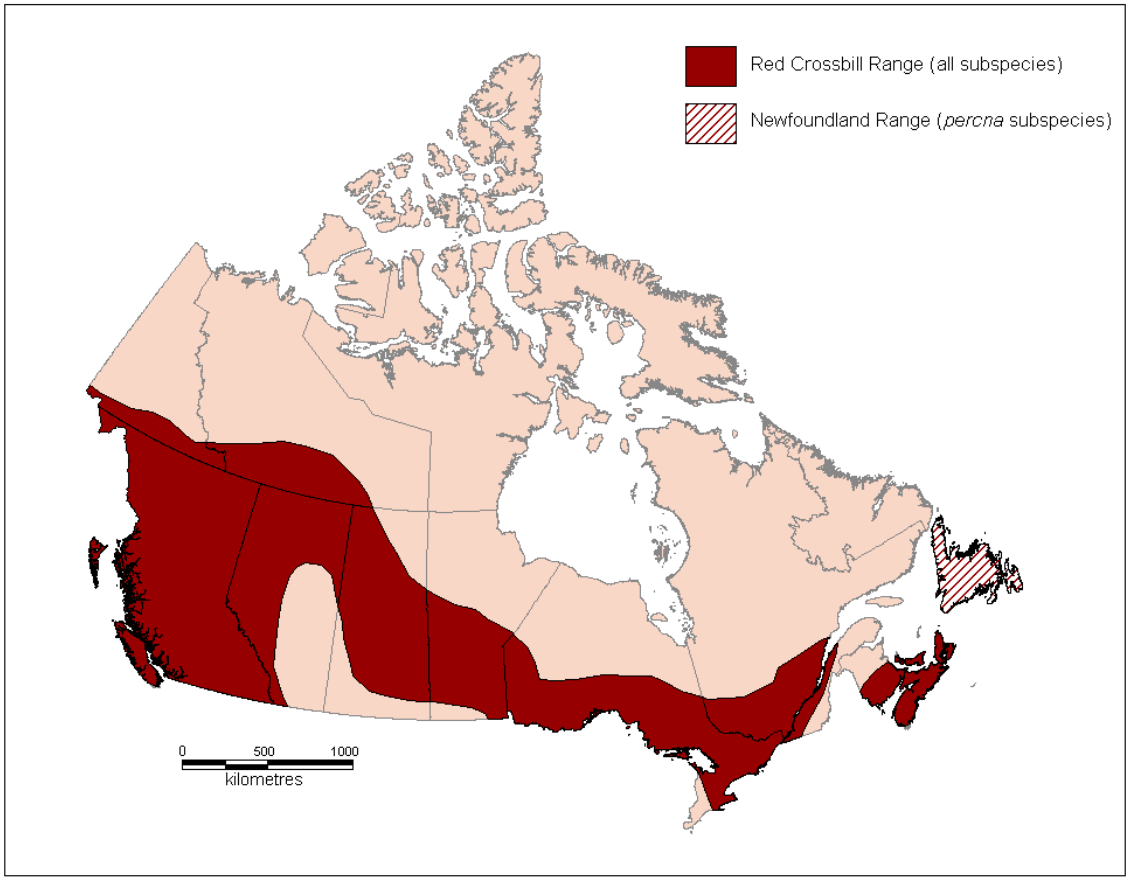

Figure 1. Canadian range map for the Red Crossbill (*Loxia curvirostra*) (from Adkisson 1996).

1.4 Biological Needs, Ecological Role, and Limiting Factors

Due to their bill morphology, crossbills are highly specialized for foraging in conifer habitats. This habitat is also important for roosting and nesting (Adkisson 1996). Red Crossbills are locally irruptive, and their presence in an area is usually considered reflective of cone abundance. They often forage in flocks, suggesting the importance of social behaviour, and nest at any time

of the year, based on cone availability. However, very little is known about the specific needs or life history of *percna*.

Survival and recovery of *percna* may be limited by changes to habitat and/or food abundance, possibly resulting from a combination of anthropogenic and non-anthropogenic factors (COSEWIC 2004). Interspecific competition, Allee effects,[2] and the cumulative effects of all of these factors could also influence Red Crossbill survival.

1.5 Habitat Needs

As previously described, Red Crossbills are believed to require a mosaic of cone-producing conifers for foraging, roosting, and nesting (COSEWIC 2004). However, owing to their irruptive behaviour and ability to breed at any time of the year, based on cone availability, Red Crossbill habitat associations are difficult to identify and are unknown for *percna* at this time. Knowledge gaps regarding habitat associations are considered a priority for future research.

Generally, large-billed crossbills are associated with large cones, such as pine; recent observations of Red Crossbills in Newfoundland have included a number of sightings in pine stands (COSEWIC 2004). Native red pine (*Pinus resinosa*) and eastern white pine (*P. strobus*) stands in particular are believed to have been historically important habitat for Red Crossbills in Newfoundland and may currently be linked to their survival (see section 2.2.2; W. Montevecchi, pers. comm. 2005). Benkman (1993a, 1993c) and Parchman and Benkman (2002), however, contend that *percna* is adapted to foraging on the seeds of black spruce (*Picea mariana*) in Newfoundland and argue that the cones of this species are different from the cones of mainland black spruce. Unfortunately, Parchman and Benkman (2002) do not indicate whether cones of mainland conifers are unexploitable by *percna*, except to suggest that differences arose due to mainland spruce evolving under predation by both crossbills and squirrels, whereas Newfoundland spruce have evolved under pressure from crossbills only (Benkman 1993c). Research to compare the cones of black spruce on the mainland with those of Newfoundland black spruce is necessary to assess the contention by Benkman and colleagues that the scales of Newfoundland black spruce cones are thinner than those of black spruce cones on the mainland; this study was based on a minute and geographically restricted sample (W. Montevecchi, pers. comm. 2005). Other conifer species exploited by Red Crossbills include white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), and tamarack (*Larix laricina*), and there is evidence that Red Crossbills, including those in Newfoundland, also forage on various non-conifer food sources (Peters and Burleigh 1951; Payne 1972; Benkman 1993a; B. Mactavish, pers. comm. 2005). Furthermore, it is likely that all conifers present on the mainland would also be accessible to any *percna* occurring there.

[2] The Allee effect is a biological phenomenon based on the positive relationship of population density with per capita population growth: i.e., the per capita birth rate decreases as population density decreases.

2. THREATS

2.1 Threat Classification

Section 1.4 briefly outlines what are believed to be the current or potential threats impacting on *percna*. Analysis and empirical investigation are required to improve our understanding of the threats. To detail and prioritize research requirements, a Threat Classification Table (Appendix 1) was developed. This table relates threats under broad categories. For each specific threat, information is presented on the following: level of causal certainty (i.e., level of certainty that each threat is impacting or has impacted *percna*), timing, frequency, extent, severity, and level of concern. Categories used in this table are presented in Appendix 1.1.

2.2 Threats Narrative

Throughout this section, the most important questions for threat clarification research are targeted to identify if and how potential threats may be impacting *percna*.

2.2.1 Potential Interspecific Relationships

Parchman and Benkman (2002) theorized co-evolution as a key factor in the decline of the Red Crossbill in Newfoundland. Mainland populations of black spruce evolved with seed predation by both red squirrels (*Tamiasciurus hudsonicus*) and Red Crossbills (along with a variety of other seed predators). Conversely, red squirrels were absent from insular Newfoundland until 40 years ago, and thus black spruce populations there evolved in the presence of seed predation primarily by cone-dependent finches. Parchman and Benkman (2002) further suggested that the absence of squirrels from the island resulted in thinner spruce cone scales compared with those found in mainland populations. The arrival of red squirrels on the island introduced a novel seed predator capable of potentially outcompeting Red Crossbills for food (Parchman and Benkman 2002). Benkman (1989) further suggested that Red Crossbills were more susceptible to this competition than White-winged Crossbills, because the former are more sedentary. Benkman (1993a, 1993c) and Parchman and Benkman (2002) also argued that *percna* is specialized for feeding on the black spruce cones, which are now also targeted by squirrels in Newfoundland. However, further work is needed to confirm the speculations of Benkman and co-workers. In Europe, Summers and Proctor (1998) identified different tree and cone preferences for red squirrels and crossbills in native scots pine (*Pinus sylvestris*) forests that likely reduce competition between the two species. It is unknown if conifer seed–eating finches and/or potentially nest-predating Gray Jays (*Perisoreus canadensis*) (Adkisson 1996) may cause harmful levels of interspecific competition. There is no evidence to suggest that other conifer seed–eating bird populations in Newfoundland have suffered similar declines.

Knowledge gaps regarding interspecific competitors will be filled once habitat associations of Red Crossbills are identified and we know more about the dependency of crossbills on different food sources as well as the extent and quality of the habitat that provides these food sources. The role of interspecific competition in the decline of *percna* will be evaluated through programs laid out in a subsequent action plan.

2.2.2 Potential Decline, Alteration, and/or Degradation of Habitat via Natural and Anthropogenic Factors

The roles that habitat loss or degradation through natural (fire, insects, tree disease) and anthropogenic disturbances (forest harvesting, urban and agricultural expansion, fire suppression) may have played in *percna* declines and the roles they may continue to play in preventing recovery are currently unknown. Knowledge of important habitat as well as seasonal utilization of habitat (section 1.5) is required for proper assessment.

Fire, insect outbreaks, and tree diseases potentially alter the levels and quality of Red Crossbill habitat and food abundance. All three natural disturbances are considered to affect populations with high levels of severity on local and/or widespread scales (Appendix 1).

As a natural feature of the boreal forest ecosystem, fire may destroy large areas of forested landscape at one time, thereby reducing habitat and cone availability. The forests require a number of years to regenerate. Additionally, regeneration may result in a post-fire habitat mosaic that is different from the original. In Newfoundland, fire promotes the regeneration of black spruce (COSEWIC 2004). Fire suppression discourages natural regeneration of black spruce and red pine (Fowells 1965).

Insects may also impact *percna* in several ways. Insects can kill trees and thus deprive crossbills of both food and habitat simultaneously. Insects that kill trees have the potential to more negatively impact crossbills over a longer period of time than insects that do not directly kill trees. Insects could also be a threat to crossbills when they feed on the flowers or seeds of conifers, thereby reducing food availability (B. English, pers. comm. 2005). Spruce budworms (*Choristoneura fumiferana*) in particular feed on conifer flower buds in the spring. Canadian Forest Service research in Newfoundland during the last major spruce budworm outbreak (in the 1970s) showed that no seed was produced, even in areas of light defoliation. Other cone-feeding insects also represent a threat to *percna*, but these generally exist at consistently low levels (B. English, pers. comm. 2005).

In Newfoundland, both red and eastern white pine stands may have been important habitat for Red Crossbills, but both tree species are currently impacted by introduced fungal diseases. White pine blister rust (*Cronartium ribicola*) affects eastern white pines, whereas red pines are affected by scleroderris canker (*Gremmeniella abietina*) (COSEWIC 2004). Eastern white pine, in particular, has undergone a precipitous decline in Newfoundland, whereas red pine has been undergoing a slow but steady decline for thousands of years (B. English, pers. comm. 2005). Tree loss from insect and fungal damage is higher than loss from either harvesting or fire (COSEWIC 2004).

The impact of forest harvesting on *percna* is uncertain. Current forestry practices have shortened rotation ages for conifer stands in Newfoundland (Thompson *et al*. 1999, 2003). While the extent of late successional forest (81+ years) may be somewhat reduced, the overall availability of forest stands of cone-bearing age (i.e., 40+ years of age) across the island remains substantial. Approximately 58% of the productive softwood forest on the island (1.6 million hectares) is age class 3 or higher (i.e., 40+ years; see Appendix 2), and forest management policy in the province

(Government of Newfoundland & Labrador 2003) sets a target of at least 15% forest cover in age class 5 or older (i.e., 81+ years). Further, with a typical minimum age at harvest of 65 years (and more frequent harvest at 81+ years), stands of cone-bearing age would be available for at least 30, and more commonly 50, years following harvest and regeneration.

With regard to habitat quality, fragmentation has been suggested to negatively influence crossbills (Helle 1985). Although forestry practices in general may tend to create a fragmented landscape, it is not clear that this threat is significant for the *percna* subspecies, given the naturally fragmented nature of forest in Newfoundland. Currently, red and eastern white pine exist at low densities in locations scattered across the island, with some notable high concentrations. The sharp decline of eastern white pine and longer-term decline of red pine (B. English, pers. comm. 2005) may indicate a shift in composition of the available food supply and a lowering of habitat quality. It is possible that the long-term decline in red pine and the more recent decline in eastern white pine resulting from 19th- and early-20th-century harvesting and introduced disease, in combination with other threats, may have caused the decline of *percna*. Red Crossbill declines have been associated with declines in these two pine species on the northeastern North American mainland (Dickerman 1987; Erskine 1992).

2.2.3 Potential Allee and Cumulative Effects

Current estimates suggest that *percna* populations in Newfoundland are small (500–1500 individuals; COSEWIC 2004). When there is a positive relationship between population density and the per capita growth rate, population growth slows when densities are low (Courchamp *et al*. 1999). Although these relationships are unconfirmed in *percna*, low population numbers combined with Red Crossbill behaviour, particularly with respect to foraging, suggest that Allee effects will have to be considered as a potential limiting factor. Red Crossbills often forage in groups, and Smith *et al*. (1999) found evidence to suggest that feeding performance of Red Crossbills is affected by "public information" among flock mates. During this study, the variance in both the number of cones sampled and the time spent on empty patches (areas with no seeds) decreased when crossbills foraged with two flock mates compared with when foraging was solitary (Smith *et al*. 1999). Thus, if *percna* populations become small enough to inhibit effective foraging behaviour, this may further reduce survival rates. The cumulative impact of all the possible threats is a legitimate issue for Red Crossbill recovery. Having a more complete understanding of these threats is critical in determining how to approach recovery efforts and research requirements.

3. KNOWLEDGE GAPS

As indicated, very little is known about the *percna* subspecies. In order to fully assess potential threats, limiting factors, and recovery methods, as well as determine measures to evaluate recovery, much more information is required. It may be possible to begin assessing some potential threats, limiting factors, and recovery procedures before all current knowledge gaps are filled.

Specific knowledge gaps that are considered a priority for study focus on five areas:

1. Taxonomy
2. Habitat associations
3. Movement and distribution
4. Demography and behaviour
5. Threats

The specific questions felt to be most important for instigating recovery at this time are:

1. Taxonomy:
    a. Does the *percna* subspecies still exist in Newfoundland?
    b. Are there other subspecies of Red Crossbill in Newfoundland?
    c. Can we develop a simple technique for subspecies identification?

2. Habitat associations:
    a. What is preferred habitat for foraging, roosting, and nesting, and do these preferences change seasonally?
        i. On a fine scale, are there preferences for specific canopy cover, cone density per tree, tree species selection, and/or location for nests in a tree?
        ii. On a larger scale, are there preferences for stand type and/or patch size? Is there evidence of edge effect?
    b. How does proximity to food sources affect nest site selection?
    c. What proportion of the landscape is required to have optimal cone availability for long-term viability of the population?
    d. What is the spatial distribution of *percna* habitat on the island of Newfoundland, and how is this forecasted to change over the long term?
    e. What impacts (positive or negative) are anthropogenic and non-anthropogenic factors having on these habitats?
    f. Should the extent and/or quality of available habitat be improved, and if so, what methods should be used?

3. Movement and distribution:
    a. Does *percna* emigrate or immigrate?
    b. Do other subspecies immigrate and emigrate to and from insular Newfoundland?
    c. What proportion of the Newfoundland population is *percna*?
    d. What is the home range size for *percna*?

4. Demography and behaviour:
    a. What are current age-specific survival and fecundity rates and modelled rates of increase?
    b. What behaviours could be potentially limiting to *percna* success?
    c. Is *percna* semi-colonial?

5. Threats:
    a. What are the effects of predators and competitors on *percna?*
    b. Is there correlation between insect (specifically spruce budworm)–related cone damage and Red Crossbill population levels in Newfoundland?
    c. Have forest fires, fire suppression, or pine diseases impacted Red Crossbill populations in Newfoundland?
    d. Do current forest management practices impact Red Crossbill populations in Newfoundland?
    e. Do current agricultural and urbanization practices impact Red Crossbill populations in Newfoundland?
    f. Is there evidence of Allee effects affecting Red Crossbill populations in Newfoundland?
    g. Do cumulative effects of many, some, or all of the above factors impact Red Crossbills in Newfoundland?

4. RECOVERY

This recovery strategy for *percna* in Canada sets goals and objectives that will respond to knowledge gaps and contribute to the knowledge base of *percna* in Newfoundland to guide appropriate actions to facilitate recovery.

4.1 Feasibility of Species Recovery

Recovery of *percna* is considered to be technically and biologically feasible at this time. However, the threats that led to the species' decline, along with current threats, limiting factors, and assessment of existence, must be better understood before the feasibility of recovery can be reconfirmed.

The success of Red Crossbill recovery in Newfoundland will depend primarily on how the threats to the species are mitigated and the maintenance of viable habitat within insular Newfoundland. Red Crossbills were observed breeding in Newfoundland in 2005 and again in 2006; although it was not known if these individuals were the *percna* subspecies, it does indicate that Red Crossbill breeding activity is still ongoing within Newfoundland. Forest inventory maps of Newfoundland indicate that there are a minimum of 1.6 million hectares of softwood-dominated forest of cone-bearing age on the island of Newfoundland (see Appendix 2). A properly designed survey effort will offer insight into the status of the population and provide information on the limiting factors that need to be mitigated to promote the recovery of the *percna* subspecies of Red Crossbill.

4.2 Recommended Approach/Scale for Recovery

Recovery actions for the Red Crossbill, *percna* subspecies, may occur in the context of a multispecies or ecosystem approach encompassing other species at risk in the boreal forest of insular Newfoundland in the future, if similar threats are found to apply to these other species or if their critical habitats overlap. At this time, however, recovery efforts for the *percna* will follow a single-species approach.

4.3 Recovery Goal and Objectives

The limited information available for this species makes the establishment of quantitative goals and objectives difficult. The vision for the Red Crossbill, *percna* subspecies, **is to restore the species to a self-sustaining population level whereby it is able to withstand stochastic events**. To achieve this vision, three goals will need to be met:

Goals:

1. Prevent extirpation of the *percna* subspecies from the island of Newfoundland.
2. Reduce more complex and root causes of threats to the species, such that the population size can be enhanced to a self-sustaining level.
3. Manage sufficient Red Crossbill, *percna* subspecies, habitat to support a self-sustaining population.

Objectives for 2006–2010 that will contribute to meeting these goals are to:

1. Develop the tools needed to confirm the presence of *percna* in Newfoundland by developing appropriate identification criteria based on surveys, genetic analysis/sampling, vocalizations, and comparative analysis of morphological information.
2. Determine the distribution and abundance of Red Crossbills in Newfoundland by applying these tools and using targeted survey and monitoring programs.
3 Initiate studies of the movements of Red Crossbills across the landscape, including to and from mainland Canada. This could potentially include immigration/emigration of additional subspecies that may be present.
4. Determine habitat associations, and begin to assess life history parameters.
5. Begin assessment of potential threats and limiting factors.
6. Reconfirm technical and biological feasibility of recovery by assessing the following:
    a. Are individuals capable of reproduction currently available to improve the population growth rate or population abundance?
    b. Is sufficient suitable habitat available to support the species, or could it be made available through habitat management or restoration?
    c. Can significant threats to the species or its habitat be avoided or mitigated through recovery actions?
    d. Do the necessary recovery techniques exist, and are they demonstrated to be effective?

7. Determine specific population and habitat goals.
8. Identify critical habitat as defined by the *Species at Risk Act* and critical and recovery habitat as defined by the Newfoundland and Labrador *Endangered Species Act*.
9. Begin development of procedures to mitigate threats.
10. Develop and implement stewardship and education programs, and promote public awareness of Red Crossbills.

4.4 Approaches to Meet Recovery Objectives

The following recovery approaches are premised largely on three points:

1. The presence of the *percna* subspecies as reported by COSEWIC (2004) is still unconfirmed at this time.
2. Red Crossbill populations have drastically declined since the mid-1900s, and reasons for the decline are unclear (although major threats associated with food and habitat availability and/or quality have been suggested).
3. Red Crossbills change their locations based on cone availability, but very little is understood about their distribution and movements in Newfoundland.

Recovery approaches are summarized in Table 1.

4.4.1 Presence of *percna* Subspecies

The *percna* subspecies is a large-billed Red Crossbill with a unique call. Call matching combined with bill measurements is considered the most accurate method to distinguish if a Red Crossbill is the *percna* subspecies in the field (note: capture and measurement protocols are not yet developed for *percna*). Few audio recordings of *percna* exist, but these can be used to match call with bill size to assist with identification. Additionally, responses of the *percna* subspecies to playback of other Red Crossbill types need to be determined. Further effort should be made to collect recordings of Red Crossbills in Newfoundland for comparative analysis. In addition, genetic analysis is necessary to determine the degree of gene flow between Red Crossbills on the island of Newfoundland as well as between populations on Newfoundland and the mainland.

4.4.2 Determine Survey Areas

Red Crossbills have been observed across the entire island of Newfoundland, and this distribution is probably based on locally irruptive behaviour, with movements largely reflecting cone crops in an area (COSEWIC 2004). Large-billed Red Crossbills (like *percna*) tend to be sedentary (Marquiss and Rae 2002), and it is believed that *percna* nests only within insular Newfoundland (COSEWIC 2004). Observations of Red Crossbills within the last 10 years have been concentrated on the east coast of Newfoundland, likely a reflection of the distribution of the birding community. The historical range of *percna* is believed to have included the entire island (COSEWIC 2004).

When determining survey areas, it will be important to target cone-producing conifer habitat. The six conifer tree species native to Newfoundland (black spruce, white spruce, tamarack, red pine, eastern white pine, balsam fir) all begin cone production by 15–25 years of age, with good cone-bearing years usually beginning around age 40 (Burns and Honkala 1990; B. English, pers. comm. 2005). Primary focus areas will likely shift with time, but can be predicted using standard forest inventory maps (i.e., conifer species distribution and stand age-class maps). As Red Crossbill declines in Newfoundland may be linked to loss and fragmentation of native pine, sites with concentrations of sexually mature pine are considered priority target areas, despite Benkman (1993c) having discounted the link between disappearing pine and the decline of *percna*.

A spatially explicit predictive model of potential *percna* habitat in Newfoundland should be created using standard land cover inventories and geographic information system (GIS) technology. Such a model could be useful in developing the survey program.

4.4.3 Develop Survey Protocols to Initiate Long-term Monitoring

Survey protocols need to be targeted to confirm the presence of the *percna* subspecies and to determine the distribution, movements, habitats, and population status of Red Crossbills in Newfoundland.

4.4.4 Habitat Enhancement

If it is determined that there is a relationship between pine and Red Crossbill habitat requirements, forest management activities can be directed towards the increase of pine across the landscape. This would include the protection of existing pine, the planting of pine, and the encouragement of natural pine regeneration. Within a mixed conifer plantation, seasonal changes in crossbill diet that may have been related to seed weight, cone toughness, and seedfall phenology of predominant conifers have been documented, indicating the importance of mixed conifer habitat (Marquiss and Rae 1994; Wren 2001).

4.4.5 Promote Public Awareness

Aside from the birding community and those directly involved with species at risk and/or boreal forest management, it is unlikely that many people are even aware that the *percna* subspecies exists or that it is at risk. Public support for *percna* conservation should be enhanced, especially among people most likely to encounter the subspecies (e.g., birders, foresters, hikers). This support is necessary not only to encourage compliance with protective measures, but also to engage the public in stewardship. Additionally, public awareness may increase occurrence data, as the species is sometimes observed at feeders.

4.5 Potential Management Impacts on Other Species

Management strategies must be developed such that they do not entail significant adverse effects on other species, particularly native ones. Although specific habitat associations are not yet known for *percna*, any strategies that increase the extent and/or quality of Red Crossbill habitat (which at this time is considered to be a mosaic of cone-producing conifers) will likely be beneficial for other species with similar habitat requirements.

Management of non-native, interspecific competitors and predators in Red Crossbill habitat may be deemed necessary for recovery *only* if food competition and/or nest predation are confirmed as limiting factors. Such management efforts must ensure that other species, particularly native ones, are not negatively impacted. Indirect management through environmental modifications to make areas unattractive or unproductive to food competitors will not likely be considered an option, as such a strategy would be expected to negatively impact crossbills and/or other species.

Regeneration of pine is also suggested as a possible method of recovery, pending further studies. Given that red and eastern white pine are native to the island, regeneration of these species may be beneficial to a host of other native species. Modifying current habitat may in turn negatively impact species that rely on predominantly black spruce and balsam fir stands. However, this would likely be at a very small scale.

4.6 Actions Already Completed or Under Way

In an effort to encourage greater awareness of Red Crossbills among a widely distributed population of stakeholders and to initiate the steps towards developing a large-scale, island-wide monitoring program, Red Crossbill brochures and sighting cards were developed and distributed in May 2005 by the Canadian Wildlife Service in partnership with Bird Studies Canada. These products were developed to increase awareness and volunteer participation, in addition to centralizing the sightings from volunteers from forestry companies, Parks Canada, and the bird-watching community with Bird Studies Canada and Environment Canada. Project FeederWatch in Newfoundland was targeted for this project, since participants are already participating in a preexisting bird monitoring project. Because of their nomadic/irruptive nature, Red Crossbills do not show up at feeders every year; in fact, FeederWatchers may go for many years without seeing any Red Crossbills. However, FeederWatchers are ideally situated for reporting this species, and information from these sightings will assist in tracking local irruptions and new *percna* records to the centralized database for use in mapping *percna* distribution and habitat in Newfoundland. Forest inventory crews of the Newfoundland and Labrador Department of Natural Resources have also been involved in the collection of bird data for a number of years and will be particularly on the lookout for *percna*. Copies of the brochure have been sent to Department of Natural Resources District offices.

The mapping of habitat use areas has also been initiated. Red Crossbill sighting information is being compiled and known nesting areas are being mapped to determine forest cover type and any other available information on habitat. These maps will lay the foundation for future survey and habitat assessment efforts.

Table 1. Summary of recovery approaches[a]

Recovery approach	Priority	Objective No.	Specific steps	Effect
Confirm *percna.*	Necessary	All	- Obtain audio recordings of *percna*, other Red Crossbill types, and other boreal bird species - Match bill size to call in the field - Conduct genetic analysis	Identifies feasibility of recovery
Determine survey areas.	Necessary	1	- Map areas of conifer trees by species and age class - Determine cone productivity across the island by species - Map areas of Red Crossbill sightings and nesting records - Communicate with local birding community - Assess relationship between pine and *percna*	Guides recovery actions
Develop survey methods and protocols.	Necessary	2 and 3	- Develop survey techniques and protocols as outlined in the literature - Obtain and make copies of audio recordings of *percna* - Evaluate incorporation of established survey techniques (such as Christmas Bird Counts and Breeding Bird Survey)	Guides recovery actions
Survey to assess presence of Red Crossbills, including a focus on potential nesting habitat.	Urgent	2 and 3	- Count adults, juveniles, and nests	Enhances knowledge base, identifies knowledge gaps, determines feasibility of recovery.
Identify critical habitat.	Necessary	4	- Identify breeding, foraging, and roosting habitat - Identify nesting habitat for productivity assessment - Design models to identify and designate critical habitat	Guides habitat protection
Monitor population size, distribution, movement, and productivity.	Urgent	All	- Continue previous steps - Establish permanent and mobile survey routes - Begin banding study - When nests are located, measure productivity	Enhances knowledge base, identifies knowledge gaps, determines feasibility of recovery; continued monitoring evaluates success of recovery efforts

Recovery approach	Priority	Objective No.	Specific steps	Effect
Protecting habitat.	Necessary	All	- Encourage forest management policies that maintain forest stand type and age structure until there is a better understanding of specific habitat requirements	Maintains potential for food availability
Identifying threats and limiting factors.	Urgent	All	- Conduct research in Red Crossbill habitat to assess potential threats described in section 2 and Appendix 1	Identifies and guides recovery actions
Monitoring threats, and mitigating negative impacts.	Urgent	All	- Monitor severity, extent, frequency, and timing of recognized threats - Develop action plans to determine mitigation techniques	Guides recovery
Promoting awareness.	Beneficial	5	- Promote stewardship - Develop educational material	Motivates and coordinates recovery actions

[a] Each strategy addresses all objectives except as noted. Priorities are defined as follows: Urgent = top priority action, without which population will decline; Necessary = needed to evaluate and guide recovery actions; Beneficial = beneficial if urgent actions are already under way.

4.7 Implementation Schedule

The schedule of actions for the Red Crossbill, *percna* subspecies, recovery program is outlined in Table 2.

Table 2. Schedule of actions for the Red Crossbill, *percna* subspecies, recovery program[a]

Action	Lead	Other	2006	2007	2008	2009	2010
Determine survey areas	CWS NLDNR	For Ind NLWD Researchers	Complete				
Identification of *percna*	CWS Researchers MUN	NLWD	Complete				
Develop survey protocols	CWS Researchers	NLWD	Complete		Ongoing modification		
Surveys to assess presence; monitor population size, distribution, and movements	CWS	NLWD BW Researchers MUN	Ongoing				
Protocols for morphological, vocalization, banding, and genetic studies	CWS Researchers	NLWD MUN	Complete development		Implementation		
Assess population viability	CWS Researchers	NLWD	Develop PVA model		Data collection – ongoing		
Identify critical habitat	CWS NLDNR Researchers NLWD	For Ind					Ongoing
Identify and monitor limiting factors and threats	CWS Researchers NLWD		Ongoing				
Promote awareness	CWS NLDNR Researchers Parks Canada NLWD		Ongoing				

[a] **BW –** bird-watching community; **CWS** – Canadian Wildlife Service; **For Ind –** forest industries; **MUN** – Memorial University of Newfoundland; **NLDNR –** Newfoundland and Labrador Department of Natural Resources; **NLWD –** Newfoundland and Labrador Wildlife Division; **PVA** – population viability analysis

5. CRITICAL HABITAT

The term *critical habitat* is used in both the *Species at Risk Act* and the Newfoundland and Labrador *Endangered Species Act*. The term has subtly different meanings in the two legislations. The *Species at Risk Act* has combined the critical and recovery habitat needs for a species under the critical habitat definition, whereas the Newfoundland and Labrador *Endangered Species Act* has maintained a distinction between the two requirements.

5.1 Identification of Critical Habitat

Critical habitat (*Species at Risk Act*) and recovery and critical habitat (Newfoundland and Labrador *Endangered Species Act*) (collectively referred to here as critical habitat) for the Red Crossbill, *percna* subspecies, cannot yet be described due to lack of knowledge regarding *percna*'s existence, insular distribution, and habitat associations. The status report describes the key habitat feature for Red Crossbills as a mosaic of conifer seed availability across the island, to provide numerous habitat areas and tree species with higher cone abundance during years when cone productivity fails in some areas (COSEWIC 2004). Literature reviews did not provide models for describing Red Crossbill critical habitat, other than providing basic descriptions of common habitat associations (Benkman 1993b; Summers and Proctor 1998; Parchman and Benkman 2002; COSEWIC 2004) and suggesting that a mosaic of conifer species may be important for seasonal and life history utilization (Marquiss and Rae 1994).

Studies of the distribution and habitats of European crossbills have indicated that some species are more frequently associated with one conifer than with others (Summers *et al.* 2002), as expected, based on different bill morphologies and cone variation (Benkman 1993a). Specific habitat associations and life history utilization across a range of habitats will have to be identified prior to describing critical habitat for *percna*. It is probable that critical habitat will not be spatially mapped, except if and when a nest is found. Rather, critical habitat will likely be managed at the landscape level by, for example, maintaining a percentage of the forest landscape with cone-bearing trees, which shifts spatially.

5.2 Schedule of Studies

Sufficient information/data are not currently available to allow the determination of critical habitat for *percna*. A schedule of studies with associated timelines is presented in Table 3, outlining the actions that need to be taken to identify critical habitat.

Table 3. Schedule of studies to identify the critical habitat of the Red Crossbill, *percna* subspecies

Study to be undertaken	Should these actions be incorporated into the action plan?	Specific steps	Timeline
Identify habitat associations and utilization	Yes	Map areas of conifer trees by species and age class	2006
		Annually determine cone productivity across the island by species	Completed annually
		Map areas of Red Crossbill sightings and nesting records	Completed annually
		Communicate with local birding community	Ongoing
		Develop bird survey protocols	2006
		Test protocol and conduct field surveys	2006 onwards
		Use bird surveys to indicate new search areas for Red Crossbills	2007 onwards
Develop habitat models	Yes	Need to be outlined in action plans once habitat associations are identified; may be based on forest cover maps	Beginning 2006 and ongoing
Develop habitat models	Yes	Literature-based development of habitat model	2006–07
		Test model by incorporating Newfoundland data	2007–08
		Based on survey data and habitat model, determine how much habitat is needed to reach the recovery objective	2009 onwards
Identify potential habitat threats, and assess impacts in each area[a]	Yes	Assess potential impacts of natural and anthropogenic factors outlined in section 2	Beginning 2008 or at such time that sufficient information becomes available
Determine land ownership	No		2006
Determine proper techniques for protection	Yes	To be written into future action plans	2010

[a] Needs habitat association before work can be conducted on this project, with additional GIS layers that include squirrel distribution and potential limiting factors. Additionally, Red Crossbill behavioural reaction to threats would be beneficial, but it is unknown if this information can be collected.

5.2.1 Habitat Management

If it is demonstrated that habitat loss or degradation is contributing to the decline of *percna*, it will be vital that Red Crossbill habitat be identified and any disturbance to *percna* critical habitat reduced immediately to facilitate recovery. Sufficient habitat must be protected over the long term to increase the *percna* population in Newfoundland.

The percentage of provincially and federally protected land is 7.8% of the land and freshwater area of insular Newfoundland. Further to these areas already under protection, the status report (COSEWIC 2004) describes the Little Grand Lake Provisional Ecological Reserve in western Newfoundland, which is currently under consideration by the Government of Newfoundland and Labrador for permanent status, as potentially important habitat that could be secured and protected. Eastern white pine in Newfoundland already receive protection through a provincial natural resources forest policy issued in 1999 restricting its cutting, and few, if any, permits are issued for the harvest of red pine in the province (B. English, pers. comm. 2005). The Provincial Sustainable Forest Management Strategy issued in 2003 (Government of Newfoundland & Labrador 2003) also stresses that the protection of eastern white and red pine is important for the long-term conservation of biological diversity.

Critical habitat protection within Newfoundland may be pursued using several methods. The nature of this species includes fidelity to no specific location, but rather dispersal across the landscape in response to food availability. Therefore, philopatry cannot be a tool to determine areas of significance. One protection option is to maintain a mosaic of forest stand types across the landscape to ensure that adequate food resources continue to be available. A second approach would involve assigning specific habitat types and/or locations to be specifically protected for use by the Red Crossbills. However, at this time, there is insufficient information on the species to determine the variables needed to identify such sites.

6. EVALUATION

Recovery objectives and methods must be evaluated to assess their success. Three main factors should be used to evaluate the effectiveness of *percna* recovery: population status, threat status, and habitat status (Table 4). Additional evaluation tools will be written into future action plans.

Table 4. Tabular summary of performance measures to evaluate recovery objectives and methods

Factor	Performance measure to evaluate success of carrying out the action	Performance measure to evaluate the effect of the action
Population status	1. Develop methods to assess population status. 2. Determine static and rotating survey areas scattered across a range of forest stands. 3. Assess effectiveness of monitoring program. 4. Determine viable population goal using population viability analysis. 5. Develop power analysis for detecting population increases/decreases.	Increases in current population size or productivity.
Threat status	1. Mitigate negative impacts to *percna* and *percna* habitat.	Increases in current population size or productivity.
Habitat status	1. Maintain representative habitat. 2. Assess use of spatially predictive habitat models using GIS.	Increases in current population size or productivity.

6.1 Development of Action Plans

An action plan intended to address the initial objectives of this strategy and to fill in the many data gaps associated with this species will be developed within two years of the release of the recovery strategy.

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APPENDIX 1: Threat Classification Table

Stress	Threat[a]	Causal certainty[b]		Timing	Frequency	Extent	Severity[b]		Level of concern[b]
		Local	Range-wide				Local	Range-wide	
Reduced population	**C:** Habitat loss or degradation **G:** Habitat disease **S:** White pine blister rust / Scleroderris canker	Medium	Medium	Historic/ current	Continuous	Widespread	High (1)	High	High
Reduced population	**C:** Habitat loss or degradation **G:** Fire **S:** Forest fire	High	Low	Historic/ current	Recurrent	Localized	High	Low	Low
Reduced population	**C:** Habitat loss or degradation **G:** Insects **S:** Tree loss	High (2)	Medium (2)	Historic/ current	Continuous	Widespread	High	Unknown (3)	Medium
Reduced population	**C:** Exotic species **G:** Food competition **S:** Red squirrels	Medium (5)	Medium (5)	Current	Continuous	Widespread	Unknown	Unknown	Medium
Reduced population	**C:** Natural processes **G:** Nest predation **S:** Interspecific nest predation (jays and squirrels)	Low	Low	Current	Seasonal	Widespread	Unknown	Unknown	Low
Reduced population	**C:** Habitat loss or degradation **G:** Fire suppression **S:** Forest conversion	High	Low	Current/ anticipated	Seasonal	Localized	High	Low	Low

Stress	Threat[a]	Causal certainty[b]		Timing	Frequency	Extent	Severity[b]		Level of concern[b]
		Local	Range-wide				Local	Range-wide	
Reduced population	**C:** Habitat loss or degradation **G:** Spruce budworm **S:** Reduced cone production	High	High	Historic/ anticipated	One-time	Widespread	High (4)	High (4)	High
Reduced population	**C:** Habitat loss or degradation **G:** Loss of forest cover **S:** Urbanization	Medium	Low	Current/ anticipated	Continuous	Localized	Medium	Low	Low
Reduced population	**C:** Habitat loss or degradation **G:** Loss of forest cover **S:** Agricultural expansion	Medium	Low	Current/ anticipated	Continuous	Localized	Medium	Low	Low
Reduced population	**C:** Habitat loss or degradation **G:** Forestry **S:** Commercial harvest	High	Low (6)	Historic/ current	Continuous	Widespread	High	Unknown	High
Reduced population	**C:** Habitat loss or degradation **G:** Forestry **S:** Domestic harvest	Medium	Low	Historic/ current	Continuous	Widespread	Medium	Low	Low
Reduced population	**C:** Natural processes **G:** Not applicable **S:** Allee effect	Low	Low	Current/ anticipated	Continuous	Widespread	Unknown	Unknown	Medium (7)
Reduced population	**C:** Natural processes **G:** Interspecific competition **S:** Seed-eating finches	Low	Low	Current/ anticipated	Continuous	Widespread	Unknown	Unknown	Medium (7)

Stress	Threat[a]	Causal certainty[b]		Timing	Frequency	Extent	Severity[b]		Level of concern[b]
		Local	Range-wide				Local	Range-wide	
Cumulative effects	All, some, or many of the above								

[a] **C** = threat category; **G** = general threat; **S** = specific threat.

[b] Qualifiers:

1 – High if eastern white pine is deemed important.
2 – This may need to be revisited if an insect is discovered to impact red pine.
3 – Severity is dependent upon the effectiveness of monitoring and control programs.
4 – Dependent upon Red Crossbill food preference.
5 – In areas of black spruce.
6 – Dependent upon forestry statistics to indicate management practices of forests to ensure perpetual availability of viable habitat for Red Crossbills.
7 – Level may change if research indicates that there is an increased level of importance for this threat.

APPENDIX 1.1
Clarification of terms used in Threat Classification Table. [3]

Potential threat categories:
- Habitat loss or degradation
- Consumptive use
- Pollution
- Exotic species
- Modification of natural processes
- Changes in ecological dynamics
- Accidental mortality
- Disturbance and persecution
- Climate and natural disasters
    - Natural processes and activities

Potential causal certainty categories:
- High – Evidence causally links the threat to stresses on population viability.
- Medium – The correlation between the threat and population viability is derived from expert opinion.
- Low – Considered a putative or plausible threat only.

Potential timing categories:
- Historic – Likely contributed to population declines, but is no longer affecting the species.
- Current – Is likely affecting the species at the present time.
- Imminent – Is expected to affect the species in the near future unless mitigation is undertaken.
- Anticipated – May affect the species in the future.
- Unknown – Unknown if factor has affected or will affect the species.

Potential frequency categories:
- One-time occurrence
- Seasonal – Either because the species is migratory or the threat occurs only at certain times of the year
- Continuous – Ongoing
- Unknown

Potential severity categories:
- High – Very large population effect expected.
- Medium – Intermediate population effect expected.
- Low – Very low population effect expected.

[3] The list of categories below is representative of all potential categories. Not all categories listed below are used in the table.

APPENDIX 2:

Distribution of productive forestland (i.e., economically viable) on the island of Newfoundland by dominant tree species and age class, and the areal percentage of forested land in Newfoundland.

Dominant tree species	Distribution (ha) by age class						Total (ha)	Total non-productive forest (ha)[b]	Percent area of forested insular Newfoundland[c]
	1	2	3	4	5+	No age[a]			
Balsam fir	398 967	291 929	236 100	177 354	408 727		1 513 076	–	29.5
Black spruce	177 773	173 660	115 500	147 245	346 842		961 021	–	19
Softwood/hardwood	57 237	44 473	36 436	41 899	82 147		262 192	–	5
Hardwood/softwood	10 191	15 400	10 610	15 571	43 674		95 446	–	2
White spruce	25 299	3 875	0	0	0		29 174	–	0.6
White birch	7 214	3 086	2 669	8 873	23 446		45 289	–	0.9
Red pine	128	0	0	0	0		128	–	0.0
Other	–	–	–	–	–	182 418	182 418	–	3.5
Softwood-dominated	659 405	513 937	388 036	366 498	837 716	–	–	2 047 100	39.5
Total	676 810	532 424	401 315	390 942	904 836	182 418	3 088 745	2 130 300	–

[a] Recently disturbed forestland (cutover, wildfire, insect killed) that currently has no forest cover but is expected to revert to forest.
[b] Non-productive forest is considered non-harvestable, but may be relevant Red Crossbill habitat.
[c] Total area of forested land in Newfoundland is ~5.2 million hectares.

Notes:

1. Total productive forestland for insular Newfoundland is ~3 million hectares. Total non-productive forestland for insular Newfoundland is ~2 million hectares. Insular Newfoundland is ~11.2 million hectares in size.
2. Total forest cover, including productive and non-productive forestland, for insular Newfoundland = 5.2 million hectares.
3. Softwood-dominated forest at age classes 3–5 (i.e., cone-bearing) combined with non-productive softwood forest = 32.5% coverage of insular Newfoundland.
4. Non-intensively inventoried land for insular Newfoundland = ~3.2 million hectares.
5. In the case of mixed stands (mixture of hardwoods and softwoods), the leading species is not shown.
6. Age classes are in 20-year increments (e.g., "1" = 0–20 years, "2" = 21–40 years).
7. The data set reflects the forest as artificially updated to December 2005 for the 2006–2010 wood supply analyses.
8. The data do not include the two national parks or those parts of the island that remain uninventoried.
9. The break-out of the age class "5" into multiple categories up to age class "8" has not been completed for all districts. Therefore, the table shows "5+."