COSEWIC
Assessment and Status Report

on the

Red Crossbill
Percna subspecies
Loxia curvirostra percna

in Canada

ENDANGERED
2004

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

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For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: (819) 997-4991 / (819) 953-3215
Fax: (819) 994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

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Red Crossbill — Male Red Crossbill on ornamental Austrian Pine, St. John's, April 28, 2002 (photo © Dave Fifield and used with permission.

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COSEWIC
Assessment Summary

Assessment Summary – May 2004

Common name
Red Crossbill p*ercna* subspecies

Scientific name
Loxia curvirostra percna

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.

Occurrence
Newfoundland/Labrador

Status history
Designated Endangered in May 2004. Assessment based on a new status report.

COSEWIC
Executive Summary

Red Crossbill
Percna subspecies
Loxia curvirostra percna

Species information

The Red Crossbill *percna* subspecies is a medium sized finch found primarily in conifer forests. Like other crossbills, it has crossed mandibles that allow the bird to pry open conifer cone scales to access the seeds within. Compared to other Red Crossbills in North America, the *percna* subspecies has a relatively stout and deep bill, and a dusky colouration.

The commonly used scientific name of this subspecies is *Loxia curvirostra percna* (the subspecies has previously been referred to as *L. c. pusilla* by several authors). There are at least seven other types of Red Crossbills that occur in North America, which exhibit differences in vocalizations and morphology. Recent research has suggested that each of the types of North American Red Crossbills are likely species, and not subspecies as they have been traditionally considered, because they remain reproductively isolated even when they are not geographically separated.

Distribution

Red Crossbill types are found throughout the world's boreal forests, and in more southerly regions with coniferous habitat. Coniferous forests represent the core habitat and range for Red Crossbills. Occasionally, however, they "irrupt" into non-conifer locations in search of food when conifer seeds are in short supply. In North America, different types of Red Crossbills are widely distributed across the continent, with a range that follows the distribution of boreal forests and other coniferous habitat. In Canada, their distribution ranges from British Columbia to the Maritimes and Newfoundland.

Nests of the *percna* subspecies have only been found on insular Newfoundland. The birds apparently move off the island occasionally, and some large-billed birds that could be *percna* have been observed and collected in the Maritimes, New England, and Quebec. The subspecies is, however, difficult to identify in the field, so it is not certain that all Red Crossbill sightings from Newfoundland represent the *percna* subspecies.

Habitat

Red Crossbills are extreme boreal forest specialists as a result of their bill morphology. Like other crossbills, they have co-evolved with their conifer food sources, and all large-billed crossbills, likely including the Red Crossbill *percna* subspecies, are associated with pine forests. Prime Red Crossbill habitat is mature, cone-productive forest. Red and White Pine stands were formerly important habitat for Red Crossbills, but now have severely restricted distributions in Newfoundland. Mature Black Spruce and Balsam Fir forests, also important Red Crossbill habitat, are becoming increasingly fragmented and threatened from harvesting. Forest fires and insect damage have also acted to reduce conifer seed abundance across the island. Forestry companies currently hold the logging tenures for 69% of the Crown land on insular Newfoundland.

Biology

Red Crossbills are monogamous, forming pair bonds but nesting in loose aggregations and foraging in large flocks. They have a flexible breeding strategy, whereby nesting can occur in colder months if conifer seeds are abundant and they possess physiological adaptations that allow them to thrive in cold climates. Crossbills undertake nomadic movements of various scales in search of abundant conifer seed resources, though some island populations, which might include *percna*, tend to exhibit more sedentary patterns. Survival is closely tied to the availability of conifer seeds, and birds at times face starvation if cone crops fail across wide geographic areas. Other causes of mortality for the *percna* subspecies include death from vehicle strikes and predation, as well as potential competition for conifer seeds and nest predation by introduced Red Squirrels.

Population sizes and trends

Red Crossbills were once relatively common in Newfoundland. In recent decades, they have undergone a precipitous and continuous decline. Currently, they are very rare across the island, and are sighted very infrequently and erratically on both formal and informal surveys. A rough estimate of the current population size, 500 – 1,500 individuals, is based on field experience, Christmas Bird Counts, Breeding Bird Surveys and other surveys that suggest that the order of magnitude of the population could be between 100s and low thousands. Much uncertainty is associated with this estimate, due to the relatively limited sampling across the island, the difficulties in counting nomadic birds like Red Crossbills, the lack of recent breeding observations, the difficulty in identifying crossbill subspecies in the field, and the possibility that Red Crossbills may move between the island of Newfoundland and the mainland.

Limiting factors and threats

Boreal forest habitat degradation and change are significant and current threats to the survival of Red Crossbills in Newfoundland. Other threats include potential competition with and predation by Red Squirrels.

Special significance of the species

The Red Crossbill *percna* subspecies, is a distinctive taxonomic group. The subspecies' high level of specialization on the seeds of conifer trees makes their presence a signal of a healthy, mature and productive native forest. They are endemic to insular Newfoundland and intimately associated with local boreal forest ecosystems.

Existing protection or other status designations

The Red Crossbill is protected under the Migratory Bird Convention Act. NatureServe designates Red Crossbills in Newfoundland as imperilled/vulnerable. Populations of Red Crossbills are generally robust in western parts of the country, with most declines recorded in the northeast. Federally and provincially protected lands in Newfoundland account for approximately 8% of the area of the island, a portion of which is expected to offer habitat for Red Crossbills.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species and include the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal organizations (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership, chaired by the Canadian Museum of Nature), three nonjurisdictional members and the co-chairs of the species specialist and the Aboriginal Traditional Knowledge subcommittees. The committee meets to consider status reports on candidate species.

DEFINITIONS (AFTER MAY 2004)

Species	Any indigenous species, subspecies, variety, or geographically or genetically distinct population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as “Vulnerable” from 1990 to 1999, or “Rare” prior to 1990.

** Formerly described as “Not In Any Category”, or “No Designation Required.”

*** Formerly described as “Indeterminate” from 1994 to 1999 or “ISIBD” (insufficient scientific information on which to base a designation) prior to 1994.

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Percna subspecies

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SPECIES INFORMATION

Name and classification

Scientific name: *Loxia curvirostra percna* Bent 1912

English name: Red Crossbill *percna* subspecies

French name: Bec-croisé des sapins de la sous-espèce *percna*

Classification:
Class – Aves
Order – Passeriformes
Family – Fringillidae
Subfamily – Carduelinae
Genus – *Loxia*
Species – *curvirostra*
Subspecies – *percna*

Vernacular names:

Vernacular synonyms (both current and historical) for the Red Crossbill in Newfoundland include Spruce Mope (Peters and Burleigh 1951), Large Spruce Bird (Reeks 1869), and Spruce Bird (Montevecchi and Wells 1987).

Subspecies nomenclature:

Red Crossbills (*Loxia curvirostra*) in North America have historically been classified into a number of subspecies, based on morphological differences in body and bill size/shape, as well as differences in plumage characteristics (Griscom 1937). Further research has demonstrated that the variation in bill size of subspecies results in different conifer seed preferences (Lack 1944; Benkman 1993a) and that Red Crossbill taxa are separated by vocal distinctions that correlate with positive assortative mating (Groth 1993a).

Ornithologists have long recognized Red Crossbills found in Newfoundland as a distinctive crossbill variant, owing to a large body and bill size and darkish plumage. Bent (1912) first identified the Newfoundland subspecies of Red Crossbill in the scientific literature, and designated it *Loxia curvirostra percna*. This taxonomy is accepted in Noble's (1919) subsequent publication on Newfoundland's avifauna, and in the American Ornithologists' Union (AOU) Checklist of North American Birds, 4th edition (American Ornithologists' Union 1931). However, around this period, earlier collections of New World Red Crossbills were being re-examined, given the emergence of new crossbill subspecies. In 1922, Stresemann examined specimens at the Berlin Museum which had been identified as *Loxia pusilla* and/or *Crucirostra americana* by Gloger (1843, as discussed in Groth 1993b). Stresemann gave the larger specimens the designation *pusilla* (Groth 1993b). In 1934, van Rossem concluded that the Berlin

pusilla specimens were morphologically matched to Red Crossbills from Newfoundland, although van Rossem did not consult any additional North American specimens. Thus, van Rossem replaced *percna* with *pusilla* for the Red Crossbill Newfoundland subspecies, even though Stresemann had concluded that the Berlin *pusilla* type came from Georgia (as discussed in Groth 1993b).

Griscom's (1937) major work on crossbill taxonomy supported van Rossem's ideas, and refers to the Red Crossbill Newfoundland subspecies as *Loxia curvirostra pusilla* Gloger. Griscom assumed that the Newfoundland subspecies wandered great distances, thus justifying that "the type [specimen] apparently came from Georgia" (Griscom 1937). The use of *pusilla* for the Newfoundland subspecies was adopted in Peters and Burleigh's (1951) The Birds of Newfoundland and in the AOU's Checklist of North American Birds, 5th edition (American Ornithologists' Union 1957). This taxonomy is also used in Godfrey's (1966) The Birds of Canada and also in the revised edition (Godfrey 1986).

By the 1980s, authors such as Phillips (as discussed in Groth 1993b and Dickerman 1987) were reverting back to the use of *percna* in reference to the Newfoundland subspecies, recognizing that the use of *pusilla* was likely in error. Payne (1987), in a detailed study of variation within *pusilla*, concluded that *percna* is a distinct form, and not a synonym of *pusilla*. Phillips even suggested the elimination of subspecies names in favour of grouping North American crossbill types based on size similarities. Phillips' research led him to suggest that *percna* be grouped with California Red Crossbills into a large-sized type Class III (as discussed in Dickerman 1987).

In the early 1990s, Groth (1993b) published a major revision in North American crossbill taxonomy. This work was based on a study of the morphological, vocal, and genetic traits of the New World Red Crossbill 'complex' of types. Groth concluded that the Red Crossbill complex represents a group of eight reproductively isolated sibling species, and not subspecies. Distinct crossbill types that were identified in his analysis do not generally correspond to the traditional subspecies nomenclature. Many of the crossbill types overlap morphologically and geographically, making call type discrimination an essential feature of identification. Genetic analysis done for this study revealed that Red Crossbill types are very similar, showing genetic differences that are not as large as would be seen among different species within a single genus. Similarly crossbill species in the United Kingdom have also been found to be not genetically distinquishable (Summers and Piertney 2003). Groth (1993b) labelled Red Crossbills from Newfoundland as the Type 8 Red Crossbill, based on morphological differences, and based on one recorded call, which was different from all other recorded North American Red Crossbill calls. Groth (1993b) cautioned, "it is not known if mainland crossbills ever reach Newfoundland, nor is it known if Type 8 birds occur on the mainland." Groth (1993b) stated that scientific binomial names are needed for the 'species' in the North American Red Crossbill complex, and he suggested that the name of the Newfoundland type is "most appropriately *percna* Bent 1912." The name *pusilla* is likely inappropriate for this subspecies of Red Crossbill, as it corresponds most closely to crossbills of Type 2 (Groth 1993b). The American Ornithologists' Union

(1983) stopped publishing subspecies nomenclature after its 1957 5th edition checklist but continued to endorse the use of trinomial subspecies nomenclature. Historical taxonomic revisions affecting the nomenclature of the Red Crossbill, *percna* subspecies are presented in Table 1.

Table 1. Historical taxonomic revisions affecting the nomenclature of the Red Crossbill, *percna* subspecies.

Name	Year	Range	Author (Reference)
L. c. percna	1912	Newfoundland only	Bent (1912)
L. c. pusilla	1934	Newfoundland	Van Rossem (Groth 1988)
L. c. pusilla	1937	Newfoundland, wandering down Eastern Seaboard	Griscom (1937)
L. c. pusilla	1966	Newfoundland, wandering in Canada to Ontario, Quebec, New Brunswick and Nova Scotia	Godfrey (1966)
Size Class III	1981	Newfoundland, but including other "large" North American crossbills on the mainland	Phillips (Dickerman 1987)
L. c. percna	1987	Newfoundland, wandering to North-eastern United States and adjacent Canada	Dickerman (1987)
Type 8	1993	Newfoundland; occurrence on mainland unknown	Groth (1993b)

Current consensus?

Some recent scientific publications concerning this Red Crossbill subspecies use the subspecies name *percna* (see examples in Pimm 1990; Parchman and Benkman 2002). Other recent work advocates an adoption of Groth's (1993b) type classification system for North American crossbills (Pyle 1997; Kaufman 1999; Sibley 2000), with this taxon classified as Type 8.

Knox (1992) suggests that Red Crossbills are most correctly identified as "pseudospecies" because they are temporarily sympatric (when birds from widely different core populations occur together on irruptions), but are reproductively isolated populations. Knox (1992) argues that there is no need to consider many Red Crossbill subspecies as separate species because there is no evidence that they act as separate species when they are within their main ranges although he acknowledges that detailed information is lacking. Groth (1993b), however, concludes that North American Red Crossbills are sibling species: gene flow as a result of their vagility has not homogenized their morphology because the forms are reproductively isolated.

Based on this conclusion, some authors have considered the promotion of Red Crossbill forms to full species status. DeBenedictis (1995), for example, indicates that the eight North American Red Crossbill types fit the contemporary species definitions, and show the same divergence as the Old World Red Crossbills that are recognized as separate species. He recognizes that additional research is required to make definitive assertions about the species statuses of the New World types. The possibility of full species status of the forms *L. curvirostra* has also been recently demonstrated in Europe (Robb 2000; Summers et al. 2002). These crossbills have sympatric distributions but probably reproduce assortatively based on call type discrimination.

Summary

The Red Crossbill taxon *percna* is a distinctive group. It is morphologically different from other North American Red Crossbill forms and is considered one of eight reproductively isolated forms found in North America. The past use of the subspecies name *pusilla* may have been in error, with the more accurate subspecies name for this Red Crossbill taxon being *percna*.

Description

Crossbills are medium sized finches identifiable by their unique crossed mandibles. North American Red Crossbills have no white wing bars, which distinguish them from the other North American crossbill species, the White-winged Crossbill (*L. leucoptera*). Adult male Red Crossbills are generally a dull red colour above and below, with the rump generally brightest, and the back dullest with some brown colouration (Godfrey 1986). Adult females have a generally greyish olive rather than red colouration, with yellowish rumps (Godfrey 1986). Flight feathers are a blackish brown in both males and females, as is the deeply notched tail (Godfrey 1986; Adkisson 1996). Juvenile Red Crossbills have streaked heads and bodies, and a pale grey colouration with hints of olive or yellow (Godfrey 1986), and are generally distinguished from adults by buffy edges on their wing coverts (Adkisson 1996). Immature male birds are variable, and may possess plumages intermediate between female and adult males (Godfrey 1986). Red Crossbills may not undergo regular seasonal moults, thus plumages can vary throughout the year (for example, males can range from deep brick red to reddish yellow or greenish; Adkisson 1996). Bill sizes and body sizes vary according to the subspecies of Red Crossbill (Adkisson 1996). In an examination of Canadian Red Crossbills, left and right bill crossover were found to occur with the same regularity (James et al. 1987).

The *percna* subspecies is larger, has a stouter bill and darker and duskier plumage than other North American Red Crossbills (Pyle 1997). Peters and Burleigh (1951) describe the adult male as “dull red, brighter on the rump, with wings and tail blackish,” the adult female as “dull olive-gray, with yellow on rump and often on under parts, wings and tail dark grayish,” and juveniles as “variable, ranging from olive-green to yellow to reddish.” Griscom (1937) points out that both sexes of the *percna* subspecies are readily recognizable by their dark, dull colouration and that with little practice, specimens of this subspecies can be easily identified. See figures 1 and 2 for photos of Red Crossbills from Newfoundland. Morphometric and bill measurements for Red Crossbills, *percna* subspecies, from literature and museum sources are presented in Appendix 1 and Appendix 2.

Figure 1. Male Red Crossbill on ornamental Austrian Pine, St. John's, April 28, 2002. Photos © Dave Fifield and used with permission.

Figure 2. Male Red Crossbill specimen from a road kill in Terra Nova National Park, 1997.

DISTRIBUTION

Global range

Crossbills are highly specialized holarctic finches that feed on the seeds of coniferous trees. Crossbills are often nomadic or irruptive over their ranges because the production of conifer seeds fluctuates markedly from year to year over continental scales (Bock and Lepthien 1976). Red Crossbills are distributed year-round throughout the boreal forests of North America and Eurasia, and southward to the coniferous forests of northern Spain, northern Africa, the Mediterranean islands, northern India, southern China, Japan, and the northern Philippines (Godfrey 1986).

Red Crossbills follow a boreal/coniferous distribution in North America. In the United States and Mexico, they generally breed in the boreal forests of Alaska, in the western coniferous forests south to California, Nevada, Arizona, Mexico, and Central America, in New England's eastern coniferous forests, and in disjunct populations in the Appalachian mountains of western Virginia, eastern Tennessee, and western North Carolina (Adkisson 1996). Red Crossbills at times appear far beyond this range, particularly in the eastern United States, when birds wander large distances in response to northern food shortages.

Canadian range

The breeding range of Red Crossbills in Canada is variable. Nesting in a given location is no indication that nesting will occur in the same location the following year (Godfrey 1986). In general, Godfrey (1986) reports that 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 Quebec, New Brunswick (except possibly the northwestern region; Erskine 1992), Prince Edward Island, Nova Scotia, and Newfoundland (but are absent from Labrador; Todd 1963). The Canadian range of Red Crossbills is illustrated in Figure 3.

Range changes among Red Crossbills have been noted in the Maritimes and on the island of Newfoundland (see section on Newfoundland range, below). Red Crossbills occurred regularly in the Maritimes until the 20th century (Erskine 1992), but were virtually absent from Nova Scotia after 1922 (Tufts 1986), with no nests found after 1913 (Erskine 1992). This absence may be due to the history of logging Eastern White Pine (*Pinus strobus*) and Eastern Hemlock (*Tsuga canadensis*) in northeastern North America (Erskine 1992), which has been related to the decline of Red Crossbills in New England (Dickerman 1987). Breeding Red Crossbills returned to the Maritimes in the 1960s and 1970s, but remain uncommon, irregular residents showing no recent major irruptions (Erskine 1992). According to Tufts (1986) and more recent Christmas Bird Count data, numbers of Red Crossbills appear to be declining in the Maritimes.

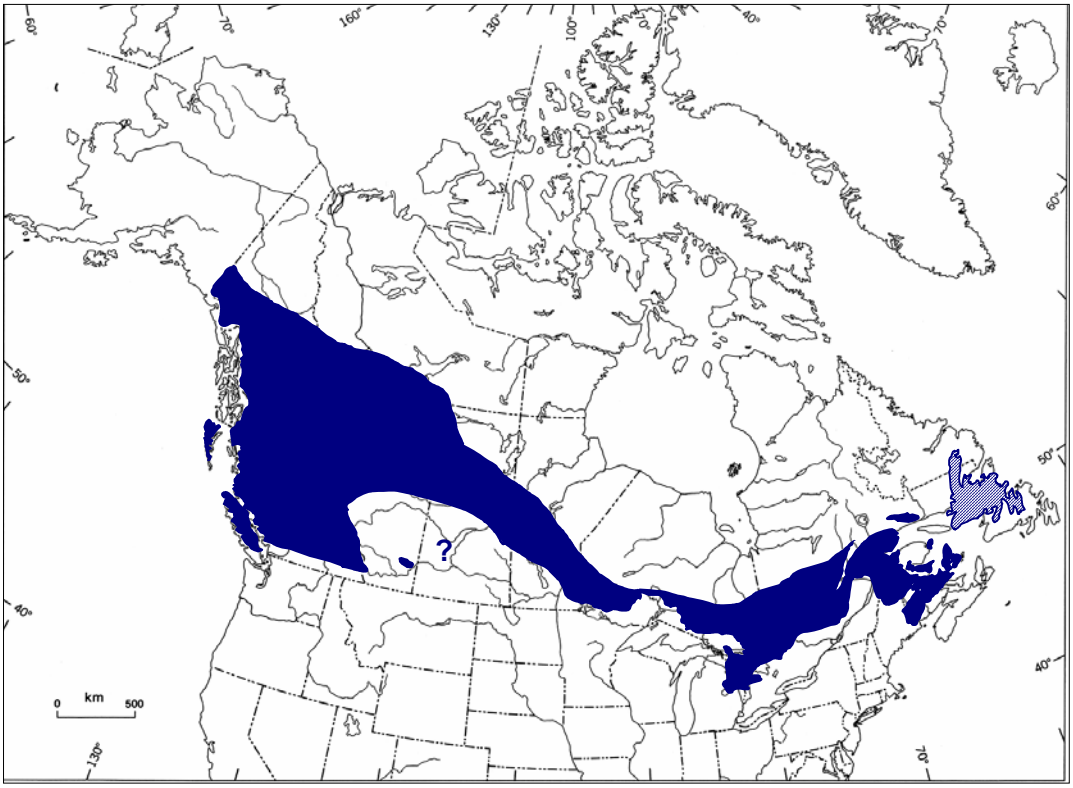

Figure 3. Canadian range of Red Crossbills. Crosshatching represents known breeding range of *L. c. percna*, solid fill represents breeding range of other Canadian Red Crossbill subspecies. Range approximated from Godfrey (1986) and Létourneau (1996).

Newfoundland range – *percna*

The *percna* subspecies is considered to breed only on the island of Newfoundland (Austin 1968). During periods of cone crop failures on insular Newfoundland, Godfrey (1986) suggested that the Newfoundland subspecies may wander to New Brunswick, Nova Scotia, Quebec and Ontario, perhaps escaping food shortages by moving to pine forests in eastern Canada and in the northeastern United States (Dickerman 1987). Large-billed Red Crossbills have been observed and collected in eastern Canada and New England (Griscom 1937; Peters and Burleigh 1951; Griscom and Snyder 1955; Austin 1968; Tufts 1986; McLaren 1991), though these were not considered to be breeding birds, and at least some may not be *percna*. For example, Dickerman (1986) discusses nine Red Crossbill specimens from New York State that are identified as *pusilla*, but he noted that while all of the specimens are large-billed, they are not as heavy-billed as specimens from Newfoundland. Large-billed specimens collected in Massachusetts have been identified as Red Crossbills, *pusilla* subspecies (Griscom and Snyder 1955). There are no reliable breeding records of Red Crossbills from Labrador (Todd 1963), where White-winged Crossbills are considered breeding residents (Benkman 1992b). Peters and Burleigh (1951) state that the Newfoundland race of Red Crossbill breeds in Nova Scotia, but do not substantiate this claim. A female Red

Crossbill designated as *pusilla* was collected from Anticosti Island in 1963 (Ouellet 1969); its morphology is consistent with the *percna* subspecies (M. Gosselin, pers. comm., 2003). Red Crossbills (subspecies unknown) are seen on Saint-Pierre et Miquelon (Tuck and Borotra 1972), but there is no evidence that they breed there (R. Etcheberry, pers. comm., 2003).

Erskine (1992) suggests that one plausible explanation for the recent return of Red Crossbills to the Maritimes could be due to "overflow breeding" of the Newfoundland type. But, Benkman (1993c) argues that there is no evidence that *percna* survives on the mainland. He contends that the Newfoundland subspecies is adapted to foraging on the seeds of the Newfoundland Black Spruce (*Picea mariana*), which he argues, on the basis of very small and very geographically restricted samples, are thin-scaled due to the evolutionary absence of predation pressure from Red Squirrels (*Tamiasciurus hudsonicus*). He contends the *percna* subspecies cannot survive on mainland spruce which has evolved thicker scales in response to evolutionary pressure from squirrel predation. More recent work by Parchman and Benkman (2002), however, contradicts this previous line of reasoning and does not address whether the *percna* subspecies is restricted to Newfoundland conifers as a result of limitations that make mainland conifers un-exploitable by this subspecies. Most available information suggests that *percna* breeds only on insular Newfoundland, but this is not a definitive conclusion. In general, large-billed Red Crossbills tend to be more sedentary than small-billed ones (e.g. Marquiss and Rae 2002), which is a possible scenario in Newfoundland.

It is difficult to define the breeding range of Red Crossbills within Newfoundland, because they are no longer nesting where they were known to nest in the past. They have been observed in many different localities on the island, possibly due to locally irruptive behaviour. The last report of a Red Crossbill nest on insular Newfoundland was made in 1977 (WAM unpublished files, Table 2), and there are no recent reports of reproductive behaviour in Newfoundland.

Breeding bird surveys carried out by Memorial University of Newfoundland from 1980 - 1985 revealed that the highest incidences of Red Crossbills were observed in old growth forests in western Newfoundland. Red Crossbills were also detected on the northeast coast around Bonavista Bay and in the vicinity of Terra Nova National Park and on the Great Northern Peninsula (WAM unpublished data). More recently, Red Crossbills have been observed in a Red Pine (*Pinus resinosa*) stand near Gambo, central Newfoundland, and in and around St. John's, on the Avalon Peninsula. It is not known whether their range has contracted in recent years, though their breeding range certainly seems to have (although survey effort has been very low). Presumably, the potential core breeding range corresponds to the coniferous forests of Newfoundland, but owing to nomadic wanderings they could occupy only parts of this range at any given time.

Table 2. Information on breeding chronology of Red Crossbills on insular Newfoundland (nest record cards held by WAM).

Record	Date	Location	Sources
2 juveniles	12 Dec 2002		B. Mactavish
some males singing	early Feb 1989	Cape Spear	B. Mactavish
immature male	3 Sept 1989	Cape Spear	R. Burrows
imm./female singing	27 Mar 1983	Portugal Cove	WAM
2 fledglings	28 May 1983		B. Mactavish
immature	20 Apr 1980	LaManche	J. Piatt, WAM
2 fledglings	28 May 1980		B. Mactavish
nest with 3 eggs/chicks	3 - 31 May 1977	Torbay	R. Blacquiere
2 immatures	30 May 1975	LaManche	J. Piatt
nest with 3 2-3 d chicks	12 March 1971	Gander Bay	E. Baird
3 flying fledglings	21 May 1971	St. John's	J. Wells
2 flying fledglings	23 May 1971	Salmonier Line	J. Wells
nest with 4 eggs, then chicks and fledglings	14 Jun - 14 Jul 1971	St. John's	J. Landry
fledgling	13 May 1969	St. John's	G. Greenlee
male specimen full breeding condition	21 Aug 1934	S of Grand Falls	(Rooke 1935)
continuous robust singing	26 Aug 1934	S of Grand Falls	(Rooke 1935)
2 juveniles	2 Sep 1934	S of Grand Falls	(Rooke 1935)
2 juvenile males	26-27 Jul 1912	Hobley Hills	(Noble 1919)

It also must be pointed out that it is possible that some Red Crossbills seen in Newfoundland are not the *percna* subspecies, but other mainland subspecies. The information that is available on Red Crossbills sightings in Newfoundland generally does not provide sufficient information to discriminate between subspecies (for further information, see the subsection Field counts and typing of Red Crossbills in the section POPULATION SIZES AND TRENDS, see page 21).

HABITAT

Habitat requirements

On the basis of their morphology and foraging requirements, Red Crossbills are extremely specialized for conifer habitats. The most important habitat requirement for Red Crossbills *percna* subspecies is conifer seed availability. Habitats that provide this on a large scale are mature Black Spruce and Balsam Fir (*Abies balsamea*) stands, and on more restricted scales across the island, Red Pine, White Pine and White Spruce (*Picea glauca*) stands. A key habitat feature for Red Crossbills is a mosaic of conifer seed availability across a large (near island-wide) scale, so that when conifer seed is not abundant in a specific geographic area (or type of conifer), there will be other areas (and/or species of conifer) that offer more abundant seed resources. The Red Crossbill, despite its extreme level of specialization, does not have a restricted distribution. Conifer stands are necessary habitat for foraging, roosting, and nesting *percna*. Foraging sites can be distant from roosting/nesting sites.

The *percna* subspecies is not expected to tolerate habitat disturbance well. Fragmentation of old growth conifer stands and reduced stand rotation ages can result in patterns of cone loss over large areas that would not be able to be escaped by a population that may be relatively sedentary compared to some other North American Red Crossbills. Critical habitat for Red Crossbill *percna* subspecies, will likely be difficult to distinguish, because these areas might not be used on an ongoing basis over successive years (Benkman 1993b), particularly by a small and possibly fragmented population. Current and on-going disturbances to the habitat of the Red Crossbill could be threatening the viability of the small remaining population.

Trends

Forest harvesting

Habitat for Red Crossbills is becoming increasingly fragmented. Harvesting regimes have shortened rotation lengths for conifer stands in Newfoundland (Thompson et al. 1999, 2003), resulting in restricted fragments of mature stands, which have been shown to be the most productive habitat for Red Crossbills in other locations (e.g., Alaska; Holimon et al. 1998) within a matrix of younger age stands and clear-cuts. Remnants of mature forest are currently sparse in Newfoundland (see Figure 4).

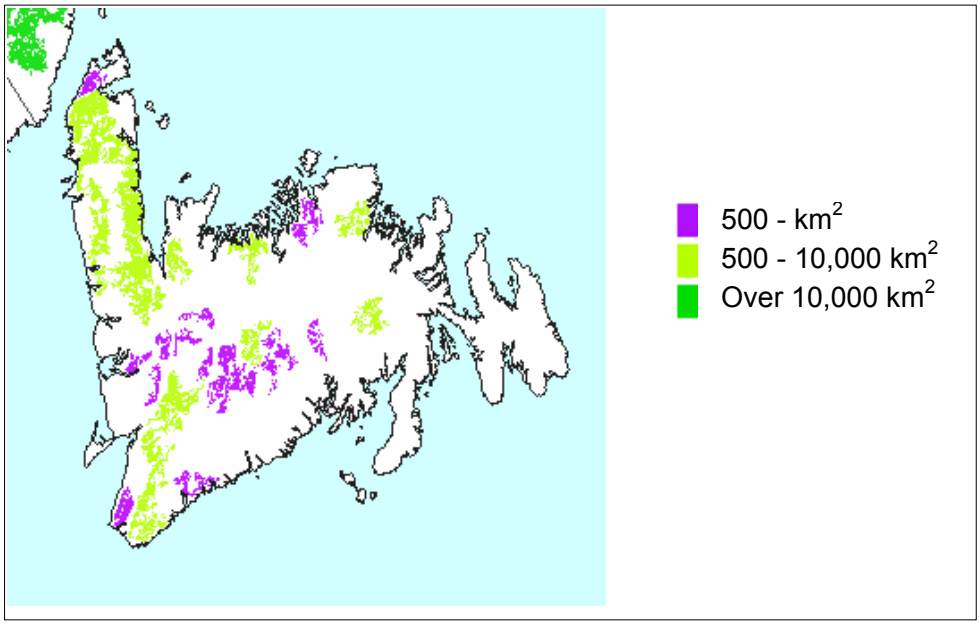

Figure 4. Blocks of intact forest of insular Newfoundland (Global Forest Watch Canada 2000).

Fragmented habitat negatively impacts crossbills (Helle 1985), as fragments may have lower cone production than contiguous stands. Current harvesting regimes are increasing the fragmentation of Black Spruce and Balsam Fir stands (Flight and Peters

1992). Red and White Pines exist only in tiny isolated fragments scattered about the island (Roberts 1985; Rajora et al. 1998) due to historical harvesting, other landscape changes and disease (Page et al. 1974; Whitaker et al. 1996). It is possible that Red Crossbill numbers declined as White and Red Pines declined, as has been observed in other locations (e.g. Dickerman 1987; Erskine 1992).

Insects and fungi

Outbreaks of insects and fungi defoliate large areas of forests in Newfoundland. During the 1970s, softwood forests in Newfoundland had extensive outbreaks of Spruce Budworm (*Choristoneura fumiferana*). Cone production can be significantly reduced by even slight defoliation by budworms. During the past several decades, Spruce Budworm and Hemlock Looper (*Lambdina fiscellaria fiscellaria*) have defoliated millions of hectares of Newfoundland forests (see references in Carroll 1996). Since 1967, Hemlock Looper has been estimated to have killed approximately 14 000 km^2 of Balsam Fir, and Spruce Budworm has been estimated to kill approximately 5250 km^2 of Balsam Fir and about 750 km^2 of Black Spruce (Carroll 1996). Pines are also threatened from outbreaks such as those caused by fungi. White Pine Blister Rust (*Cronartium ribicola*) devastated the small number of surviving White Pine trees and is still preventing regeneration. Red Pines are currently threatened by Scleroderris canker (*Gremmeniella abietina*; Whitaker et al. 1996). Tree loss from insect and fungi damage is higher than loss from harvesting and is an order of magnitude higher than loss from fires.

Forest fire

Fire has had a major cumulative influence in changing and shaping forest composition on insular Newfoundland, particularly in the central and eastern sections of the island. Soon after European incursion in the early 17th century, fishers used fire to clear large tracts of land along the coasts. These uncontrolled fires removed many tens of thousands of km^2 of boreal coniferous forest, much of which has never regenerated and remains as bog and barrens habitat today (Wilton and Evans 1974; Damman 1983). During the 20^{th} century, extensive fires were often started by cinders from locomotive engines (Wilton and Evans 1974; Montevecchi and Tuck 1987). In 1960 - 1961, fire destroyed 4165 km^2 in central and eastern Newfoundland (Hayward et al. 1960, 1961), eliminating cone sources over these areas. This fire, as well as others around the turn of the 20^{th} century, and in 1946, 1977, and 1979, contributed to the decline of Red Pines across the island (Roberts 1985). Fire promotes the regeneration of Black Spruce, which tends to predominate in central and eastern coniferous forests, but not in western Newfoundland where precipitation is greater, forest fire is less frequent and extensive and where harvested Black Spruce forests tend to be replaced by Balsam Fir (Damman 1983). Recent fire suppression activities likely tend to inhibit the regeneration and spread of Black Spruce. A controlled burn in Terra Nova National Park in 2002 was designed to help simulate a natural ecosystem process.

Protection/ownership

Ninety-nine percent of the forest resource of Newfoundland and Labrador is owned provincially. On insular Newfoundland, however, the timber and property rights for 69% of the Crown land has been granted to forestry companies under 99 year licences that were issued in 1905 and 1935 (Natural Resources Canada 2002). The primary forestry companies that hold these licences are Abitibi Consolidated Inc., which manages approximately 18 000 km^2 of forests, and Corner Brook Pulp and Paper Ltd. (a division of Kruger Inc.), which manages 20 620 km^2 of forests. The percentage of provincially and federally protected land is 7.8% of the land and freshwater area of insular Newfoundland. Some potentially important habitat for Red Crossbills could be secured and protected in the Little Grand Lake Provisional Ecological Reserve in western Newfoundland that is currently under consideration by the government of Newfoundland and Labrador for permanent status.

BIOLOGY

Reproduction

Red Crossbills do not follow the breeding phenology typical of many North American passerines. Instead, across the entire *L. curvirostra* range, they can be found breeding during any month of the year (Tordoff and Dawson 1965; Newton 1972; Godfrey 1986). Like some other birds that breed opportunistically, timing of nesting in Red Crossbills cannot be solely explained by photoperiodic cues (Tordoff and Dawson 1965). Instead, breeding is at least partially influenced by abundant conifer food supply (Griscom 1937; Newton 1972), resulting in Red Crossbills breeding during months that could not sustain nesting attempts by avian species not dependent on conifers. The period during which Red Crossbills breed depends on cone supply in the habitat: breeding can occur over a range of many months in mixed conifer forests that have different species of seeds ripening at different times (Newton 1972). This breeding strategy allows Red Crossbills to adapt to predictable (seasonality) and unpredictable (food availability) environmental contingencies (Hahn 1995).

Evidence of temporal flexibility in reproduction of the *percna* subspecies is sparse, as few adequate nest records exist. McCabe and McCabe (1933) present information on one *percna* pair breeding in April. Reeks (1869) considered Red Crossbills to be common early nesters in western Newfoundland. Rooke (1935) considered most crossbills seen during an August/September excursion to Newfoundland to be nesting. Peters and Burleigh (1951) describe Red Crossbills in Newfoundland as “often very early nesters, sometimes nesting in January or February and at other times not until mid-summer.” Information on observations of Red Crossbill breeding chronology in Newfoundland is compiled in Table 2.

Nesting activity and demographic indicators

Red Crossbills are presumably monogamous and frequently occur in pairs, and pair bonds can persist year round, even during nonbreeding periods (Adkisson 1996). Like other cardueline finches, Red Crossbills nest in loose aggregations, with pairs of crossbills defending only a small territory around their nest and foraging away from the aggregation site, which is necessitated by the irregular and local distribution of food supply (Newton 1972). Red Crossbill nests are usually well concealed and generally located in dense foliage on side branches high in conifer trees (Newton 1972; Adkisson 1996). Nests are constructed on a base of twigs and consist of interwoven grass, moss, lichens and bark, and are lined (more heavily in winter) with lichens, moss, hair and feathers (Newton 1972). Females construct the nest, while males may provide nesting material (Austin 1968). Males feed females regurgitated conifer seeds as a form of courtship feeding (Létourneau 1996).

The female incubates the eggs alone, without leaving the nest, where the male regularly feeds her (Austin 1968). If a second nest is started in quick succession to a first successful nesting attempt, the male takes responsibility for the first brood while the female incubates the second nest (Adkisson 1996). Eggs are incubated for 12 – 16 days (Newton 1972; Godfrey 1986), although Austin (1968) states that incubation may last for 18 days. The female tends to lay one egg per day, leading to different aged (and sized) chicks within a brood (Newton 1972). This asynchronous hatching may be an adaptation to crossbills' unpredictable food supply that can result in the youngest perishing during times of seed shortage (Newton 1972). Red Crossbills hatchlings are altricial (Létourneau 1996). The period from hatching to fledging lasts typically for 18 – 22 days, although durations ranging from 15 (Snyder 1954) to 25 days have been recorded, a flexibility that may be due to variable food supply (Newton 1972).

There has not been a directed effort to locate Red Crossbill nests in Newfoundland. Only three records of nests are available for Newfoundland, all of which were found in the 1970s (see Table 2). Limited information exists on demographic indicators in populations of Red Crossbills. Age at first breeding is unknown in Red Crossbills, but occasionally wild birds in immature plumage show evidence of breeding (McCabe and McCabe 1933; Newton 1972; Adkisson 1996). An immature bird has been heard singing in Newfoundland (WAM). While Red Crossbills usually have clutches of 3 or 4 eggs, and occasionally 2 - 5 (Austin 1968; Godfrey 1986; Létourneau 1996), little information is known about *percna*. There are records of a 3-egg and a 4-egg clutches in Newfoundland, as well as a brood of three, 2-3 day old chicks (WAM unpublished files; cf. Peters and Burleigh 1951). The *percna* subspecies may have more than one brood per season, with short intervals between clutches particularly when seed crops are abundant (although no information on the number of Red Crossbill broods in a season is available, Adkisson (1996) speculates that 2-4 broods a year could be likely, as occurs in White-winged Crossbills). There is no information on reproductive success or the proportion of females rearing at least one brood to independence in the *percna* subspecies.

Survival

Little information is available on the life span of Red Crossbills. Banding data show that the North American longevity record for the species is four years and two months, from a bird banded and recovered in British Columbia (Brewer et al. 2000). Captive birds may live up to 8 years, with females suffering higher annual mortality than males in captivity (Adkisson 1996). There is no specific information on the life span or rates of annual mortality of the *percna* subspecies.

The survival of Red Crossbills is most closely linked to abundant conifer seed resources. This dependence on conifer crops occurs across large areas, as crossbills move nomadically in search of food. Low rates of food availability lead to irruptions out of typical ranges that could lead to increased levels of mortality if sufficient food resources are not located. Juveniles may irrupt in greater proportion than adult birds when cone crops are moderate and when only the most vulnerable birds must seek other food sources; the proportion of adult birds irrupting is greater when cone crops are poor (Newton 1972). There is no specific information on age-related differences in irruptive movements and survival for *percna*.

Although Red Crossbills sometimes nest in months with very cold temperatures, the early survival rate of offspring might not be greatly affected by low temperatures. This is because the female Red Crossbill virtually broods the nestlings continuously (Newton 1972) for the first few days after which she helps the male feed the young (R.W. Summers, pers. comm. 2003). Brooding might also increase annual mortality among females. Young Red Crossbills depend on post-fledging parental care, because newly fledged young have not yet developed crossed mandibles essential for accessing seeds from closed cones. They survive on parental feeding for one to two months or longer (Newton 1972). Once young Red Crossbills are feeding independently, they quite likely suffer higher mortality during their first winter than adults due to inefficient foraging (Adkisson 1996).

Recruitment

Recruitment to the breeding population of Red Crossbills is likely highly dependent on food abundance. During years of poor cone availability in Europe, only a fraction of the birds in a population nest (Newton 1972), and it is speculated that this reduced reproductive output might not balance high mortality rates suffered from food shortages. This could also hold for the *percna* subspecies although there is no information on recruitment for this taxon. Red Crossbills have relatively high reproductive potential owing to the possibilities of laying multiple clutches in a year and of juveniles breeding, particularly during periods with abundant conifer seeds. Reproductive potential could be high enough to promote recovery from losses stemming from emigration or starvation in poor cone years (Newton 1972), given that a sufficient breeding population remains and conifer seed availability increases. Specific information on the ability of the *percna* subspecies, as well as other Red Crossbill taxa, to recover from years of poor or no recruitment is not available.

Movements

Red Crossbills, like other cardueline finches, do not undertake regular seasonal long-distance migrations. Instead, they exhibit nomadic and irruptive movements that reflect the productivity of the cone-bearing trees on which they depend (Newton 1972). These movements are evident on a continental scale (Bock and Lepthien 1976) as well as on regional ones. In North America, Red Crossbill irruptions usually occur in autumn when cones ripen, but movements may also be undertaken in the spring or early summer (Adkisson 1996). On a North American scale, Red Crossbills exhibit more extensive irruptive movements than White-winged Crossbills (Bock and Lepthien 1976). In Europe, irruptive birds may return to their core boreal ranges in the year following their movement (Newton 1972). Annual fluctuations in conifer seed abundance are the ultimate driving force behind the nomadic movement of Red Crossbills. Red Crossbills could be stimulated to move by food shortage or possibly based on social assessments of cone and seed abundance in an area (Benkman 1990). An additional proximate factor that could influence crossbill movements is overcrowding within the birds' regular range, which might also stimulate irruptions (Newton 1972).

Movement of the *percna* subspecies is not well known. Birds appear irregularly across Newfoundland, likely as a result of nomadic movements. There is some speculation that Red Crossbills move off Newfoundland during conifer seed shortages on the island (see discussion in the section Newfoundland range – *percna*, above), but only limited data exist to support or refute this hypothesis. Other bird species with subspecific designations are sedentary on insular Newfoundland (Peters and Burleigh 1951). Other large-billed island species of crossbills, the Scottish Crossbill (*L. scotica*) and the Parrot Crossbill (*L. pytyopsittacus*), are also sedentary (Marquiss and Rae 2002; Summers et al. 2002), thus a pattern of limited movements would not be a wholly unexpected strategy in the Red Crossbill *percna* subspecies. Red Crossbills are occasionally seen on the French islands of Saint Pierre et Miquelon (R. Etcheberry, pers. comm., 2003) that lie off the Burin Peninsula on Newfoundland's south coast. These sightings probably do not represent a stable population, as there is no evidence that Red Crossbills breed on the islands. Red Squirrels have been unsuccessfully introduced to the island (R. Etcheberry, pers. comm., 2003), and their demise may be due to the small number of conifer trees there that likely also impedes crossbill breeding.

Foraging and nutrition

Crossbills forage by placing the tips of their mandibles between the scales of a cone and creating a small gap between the tightly closed scales. The birds then abduct their jaw, and sometimes twist their head (Newton 1972), which creates a larger gap between the scales and exposes the seed held within (Benkman 1987a). Crossbills use the spoon-shaped tip of their tongue to bring the seed to their bill, where the seed is husked, and the seed is consumed (Benkman 1987a). The crossed mandibles of crossbills make them unique in their ability to forage on closed conifer cones. Experienced crossbills with bills that have been experimentally "uncrossed" by trimming

cannot forage on closed cones (Benkman 1988). Thus, crossbills are able to exploit the seeds in tightly held cones before they open and become accessible to other conifer seed eating finches such as Pine Siskins (*Carduelis pinus*) and Pine Grosbeaks (*Pinicola enucleator*). Crossbills cannot easily pick up seeds on the ground and must consume seeds from cones (Newton 1972).

Food availability is the most significant limiting factor for crossbill abundance. Fluctuations in conifer seed abundance are the primary driving force in the nomadic movements of crossbills (see discussion in Movements section). Red Crossbills in Newfoundland have been observed feeding on all conifer species. Although Red Crossbills are morphologically adapted for foraging on conifer seeds, they also consume non-conifer seeds. Describing Red Crossbills in Newfoundland, Peters and Burleigh (1951) write "they feed on seeds of fir, tamarack, maple and other trees and sometimes upon the buds of deciduous trees. They also eat weed seeds and even some wild fruits. In the summer they consume a number of insects and larvae."

Key conifer species

There is a robust relationship between the size of a crossbill's bill and the size of cones that it forages on. Larger-billed crossbills forage on large, hard cones like pine, and most smaller-billed crossbills forage on smaller, softer cones like spruce or larch (Lack 1944). Crossbills forage on different types of conifer trees in different seasons, according to which species have seeds available (dependent on both the reproductive phenology of the tree species, as well climatic conditions that influence the opening of conifer cones). Benkman (1993a) identified "key conifers" that provide reliable seed resources for the crossbill types that specialize on them. Crossbill foraging on these key conifers is optimized by the bill size and palate structure that closely match the cone size and toughness (Benkman 1993a). This specialization becomes most important during (and, in fact, arises as a result of) periods of food limitations, which are most severe during late winter. Key conifers for crossbills hold seeds within their cones through the winter (Benkman 1993a).

The *percna* subspecies is large-billed, yet Benkman (1989) proposes that the key conifer species for *percna* is the small-coned Black Spruce. This is because there are rarely years of very poor seed crop within this species, and the conifer's fire adaptation means that some seeds are held throughout the year without being shed (semi-serotinous). An alternate explanation is that, like other large-billed island crossbills (such as *L. megaplaga* on Hispaniola, *L. c. corsicana* on Corsica, *L. c. guillemardi* on Cyprus, and *L. scotica* on Great Britain), the *percna* subspecies is adapted for foraging on Red or White Pines that were once much more common than now (Mannion 1977; Roberts and Mallik 1994; Rajora et al. 1998). Red Crossbills have recently been observed foraging in a small stand of Red Pines in Gambo in central Newfoundland (Whitaker et al. 1996; Lewis 1997) and foraging in non-native cultivated Austrian Pine trees (*Pinus nigra*; interestingly, a key conifer for the large-billed island endemic Red Crossbill on Cyprus, *L. c. guillemardi*; Benkman 1989) on the campus of Memorial University of Newfoundland (discussed in the archives of Nf.birds 2003).

Based on current information , it is impossible to determine whether Black Spruce or Red or White Pine represent the key conifer species that explains the large bill of the *percna* subspecies. What is more certain is that currently, given the restricted range of Newfoundland pine, Black Spruce seed resources must be important for Red Crossbills. It should be recognized that other conifer species can also provide seed resources for Red Crossbills. Balsam Fir is a significant forest resource in Newfoundland, comprising almost 50% of the forest (Page et al. 1974). Many cardueline finches in Newfoundland feed on these seeds that can persist in cones during the winter (Wren 2001). White Spruce could also be of secondary importance to Red Crossbills in Newfoundland that have been observed feeding on both Balsam Fir and White Spruce (WAM unpublished files).

Interspecific interactions

Red Crossbills might compete with other cardueline finches for conifer seeds. Those that are common in Newfoundland (as classified in Mactavish et al. 2003) are the Pine Grosbeak, Purple Finch (*Carpodacus purpureus*), White-winged Crossbill, Common Redpoll (*Carduelis flammea*) and Pine Siskin. While the non-*Loxia* finches are not as highly dependent on conifer seeds for food as crossbills are, they all forage on conifer seeds when they are abundant. Crossbills retain an advantage over other finches when foraging on closed or partially closed cones, but other finches like Pine Siskins have been shown to be more efficient than crossbills when foraging on opened cones (Benkman and Lindholm 1991).

White-winged Crossbills are the most significant avian competitors with Red Crossbills, owing to their shared bill morphology. Competition between the two crossbills species is likely more significant when Red Crossbill taxa with small bills are considered (Benkman 1987b). Thus, the relatively large-billed *percna* subspecies is not nominally expected to be out-competed by the smaller billed White-winged Crossbill for conifer seed resources, but in times of severe seed restrictions, White-winged Crossbills are probably more efficient foragers on smaller, open cones (such as Tamarack and possibly spruce).

Behaviour/adaptability

The Red Crossbill *percna* subspecies' morphological specialization and insularity strongly limits its adaptability to widespread conifer seed shortages. Even if Red Crossbills do irrupt to the mainland to escape Newfoundland conifer seed limitations, there is no evidence that they breed there successfully or return to Newfoundland to breed (European Red Crossbills may return to their original range in the years following irruptive movements; Newton 1972). Breeding site and home range fidelity is not considered to exist in Red Crossbills (Adkisson 1996). Red Crossbills defend only small territories around nest sites and do not defend a feeding territory, due to the variable timing and location of conifer seeds (Newton 1972). Like other cardueline finches, crossbills usually forage in groups or flocks throughout the year. Flocking behaviour allows crossbills to use public information to make more efficient foraging decisions

(Smith et al. 1999) and provides the added benefit of increased predator vigilance (Newton 1972).

POPULATION SIZES AND TRENDS

Historical trends

Although no quantitative information exists, Red Crossbills were formerly considered abundant in Newfoundland. In the mid-19th century, Reeks (1869) described them as common early nesters on the west coast of Newfoundland in the northern portion of what is now Gros Morne National Park.

Around the turn of the 20th century, many songbird specimens were collected in western, central and eastern Newfoundland (Montevecchi and Tuck 1987). Interestingly, among the specimens collected in Newfoundland in the 1890s and early 1900s, Red Crossbills outnumber White-winged Crossbills by more than a 2:1 ratio (21:9). If collectors did not favour Red Crossbills over White-winged Crossbills (they may have as they targeted distinctive sub-species though they seemed to collect everything) and if Red Crossbills were not more vulnerable to collectors, then it is possible that Red Crossbills could have been more common in Newfoundland than White-winged Crossbills around the turn of the century (WAM unpublished files).

Noble (1919) wrote in 1915 “flocks of Crossbills were observed flying over the Humber on many different evenings.” Rooke (1935) described White-winged Crossbills as “commoner” than Red Crossbills, and Peters and Burleigh (1951) considered the Red Crossbill in Newfoundland as fairly common locally in summer, common in the Codroy Valley in September, but uncommon in winter, with erratic and local distribution.

Red Crossbills were considered to be “regular” and “similar” in abundance to White-winged Crossbills in western Newfoundland during the late 1950s/early 1960s (H.Deichmann unpublished records). Erskine (1977) describes Red Crossbills as “common” in spruces in Newfoundland in 1968. In the late 1960s and 1970s, nests and fledglings of Red Crossbills were observed in the St. John’s area and elsewhere in eastern Newfoundland; no nests have been observed since 1977 (WAM unpublished files) but juveniles have occasionally been observed in this area in recent years.

By 1975, White-winged Crossbills were considered to be more common than Red Crossbills in Gros Morne National Park in western Newfoundland (Lamberton 1976). The 1982 and 1989 Newfoundland bird checklists (Maunder and Montevecchi 1982; Mactavish et al. 1989) list both White-winged and Red Crossbills as uncommon (likely to be found monthly in appropriate season/habitat; may be locally common), breeder (known to breed), resident (non-migratory, or maintains a significant year-round population). The 1999 and 2003 checklists (Mactavish et al. 1999, 2003) classify White-winged Crossbills as common (likely to be found daily in appropriate season/habitat), irruptive (irruptive species, much more abundant in some years than in others), breeder,

resident; while Red Crossbills are designated very uncommon (likely to be found annually in appropriate season/habitat; may be locally uncommon), breeder, resident.

Recent trends

It is difficult to estimate the populations of songbirds. It can be particularly difficult to determine the populations and population fluctuations of irruptive species like crossbills, because they often move in large flocks of thousands of birds over continental North America (Bock and Lepthien 1976). Populations can fluctuate with periodic cone failures and abundances (Koenig and Knops 2001; Wren 2001). As a result, it is essential to analyze long-term trends over large spatial scales in irruptive species like crossbills so that multi-year patterns in population trends can be discerned.

Christmas Bird Counts

The longest and most consistent source of information on population trends for Red Crossbills in Newfoundland comes from Christmas Bird Counts (CBCs). CBC methodology involves day-long counts performed annually within a 2-week period of Christmas in hundreds of discrete 24.1 km diameter circles across the continent. Numbers of all birds encountered in each circle are recorded. These counts have been run at 11 sites on insular Newfoundland at some point during the past 5 years (Figure 5), but additional counts in different locations on the island have been performed since CBCs started in Newfoundland in the 1960s. The total number of Red Crossbills counted on all Newfoundland CBCs is presented in figure 6. These data are displayed both in raw number form, and standardized by the number of party-hours in the field to control for variable observer effort (Bock and Root 1981). [Note that each CBC year spans two calendar years, thus for example, the CBC year 1996 represents the count performed during a two-week period in December 1995/January 1996. This method of labelling is used throughout this document.]

While the irruptive ecology of Red Crossbills makes them unlikely to turn up on CBCs with annual regularity, it is apparent from Figure 6 that they have declined greatly, and over the past decade they have not been counted in numbers close to those of high-abundance years in the past. By fitting exponentials to the curve using non-linear least squares regression, an exponent of decay was used to calculate the annual rate of decline of Red Crossbills from this data series. The analysis indicates a 99% decline of number of Red Crossbills per party-hour over the period from 1968 – 2002 (calculated based on the decay exponent -0.1369 from the regression), and a 10-year rate of decline of 75%. This trend analysis changes the count per party-hour from the outlier year 1980 to the mean of its neighbouring values; with that year included in the analysis, the total time period decline is 98% and the 10-year decline is 67% (decay exponent -0.1122).

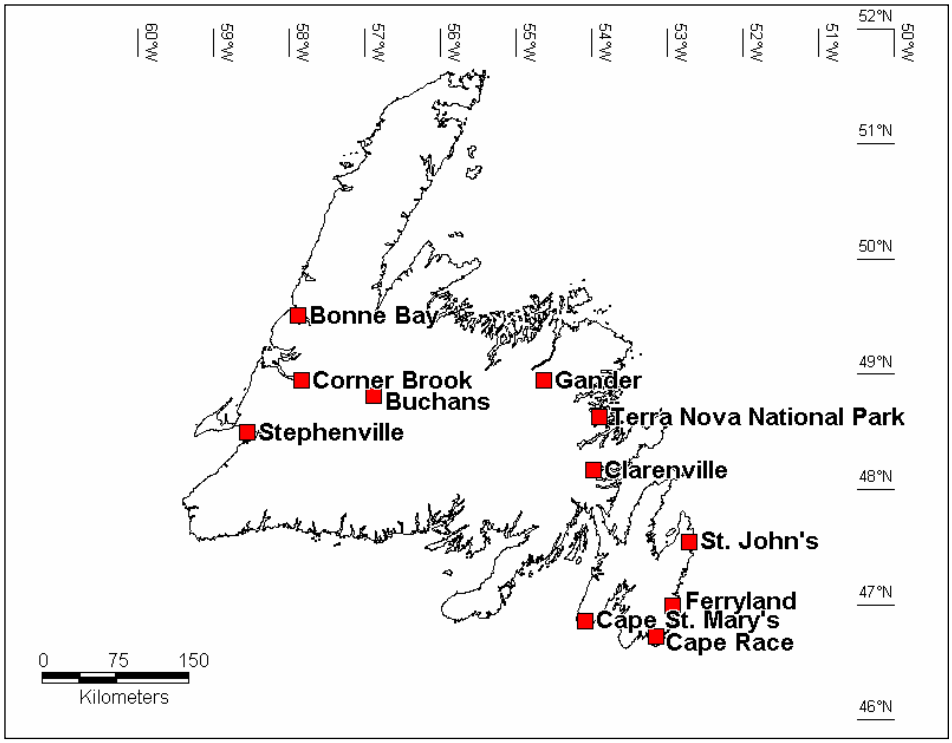

Figure 5. Locations of Christmas Bird Count (CBC) circles on insular Newfoundland active 1997 - 2002. Newfoundland coastline map © 2000, Government of Canada with permission from Natural Resources Canada (2000). CBC count circle geographic information obtained from National Audubon Society (2002).

The longest records of CBCs in Newfoundland come from St. John's on the east coast and from Terra Nova National Park on the northeast coast of the island. The CBCs from Terra Nova National Park show a relatively consistent decline in Red Crossbills from the late 1960s through 2003 (Figure 7). Counts were significantly higher during 1968 through 1973 than from 1974 through 1988 (Mann-Whitney Test, $U = 3.5$, $n = 21$, $P < 0.002$; compare 1968-73 with 1974-88). White-winged Crossbills have also exhibited considerable fluctuations over this same time period but their highest count was obtained in 1996 (Figure 7), an extraordinary cone year in Newfoundland, during which White-winged Crossbills were sighted in large flocks from all parts of the island. There was no increase of sightings of Red Crossbills in Newfoundland during the winter of 1995-96 (WAM unpublished files). In other parts of their range, Red Crossbills and White-winged Crossbills typically irrupt with synchrony (Bock and Lepthien 1976), so it may not be unreasonable to expect high numbers of Red Crossbills in Newfoundland to be normally found during years with high White-winged Crossbill numbers. A similar declining trend for Red Crossbills is demonstrated in the CBC data from the St. John's count. Consistent with the Terra Nova data, White-winged Crossbill abundance has been erratic and some recent CBC counts have had quite high numbers of White-winged Crossbills per party hour, but no Red Crossbills.

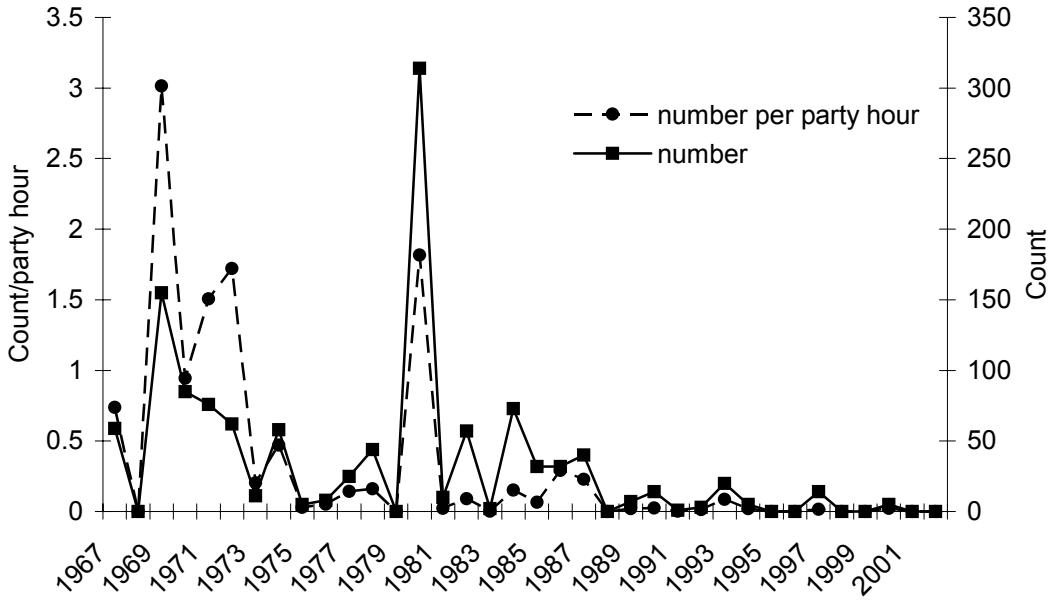

Figure 6. Total number of Red Crossbills per party hour observed on all Newfoundland CBCs, 1967 – 2002 (data obtained from National Audubon Society 2002).

Because there is evidence that Red Crossbill *percna* subspecies may be found in mainland areas such as Anticosti Island and Nova Scotia (although with infrequent regularity and unknown breeding status), it may be useful to include Red Crossbill counts from these areas when considering percna trends. CBC data are available for Nova Scotia, but not Anticosti. While CBC data provide no information on subspecies counted in the field, it is possible that some Red Crossbills counted on Nova Scotia CBCs are the percna subspecies (although CBC data from Nova Scotia will overestimate numbers of percna because the majority of birds recorded are likely other subspecies). CBC data from Newfoundland and Nova Scotia combined indicates a declining trend in Red Crossbills (Figure 8). Regression analysis of log-transformed count per party hour indicates a 90% decline over the period from 1968 – 2002 (slope of line = -0.0281, R2 = 0.4064), and a 10-year rate of decline of 49%. This trend analysis changes the count per party-hour from the outlier year 1980 to the mean of its neighbouring values; with that year included in the analysis, the total time period decline is 92% (slope of line = -0.0307, R2 = 0.3642) and the 10-year decline is 51%. Because CBC data indicate that all Red Crossbills censused in Newfoundland and Nova Scotia have greatly declined, it implies that the unknown portion of Nova Scotia Red Crossbills of the subspecies *percna* which are counted with other Red Crossbills have likely also declined.

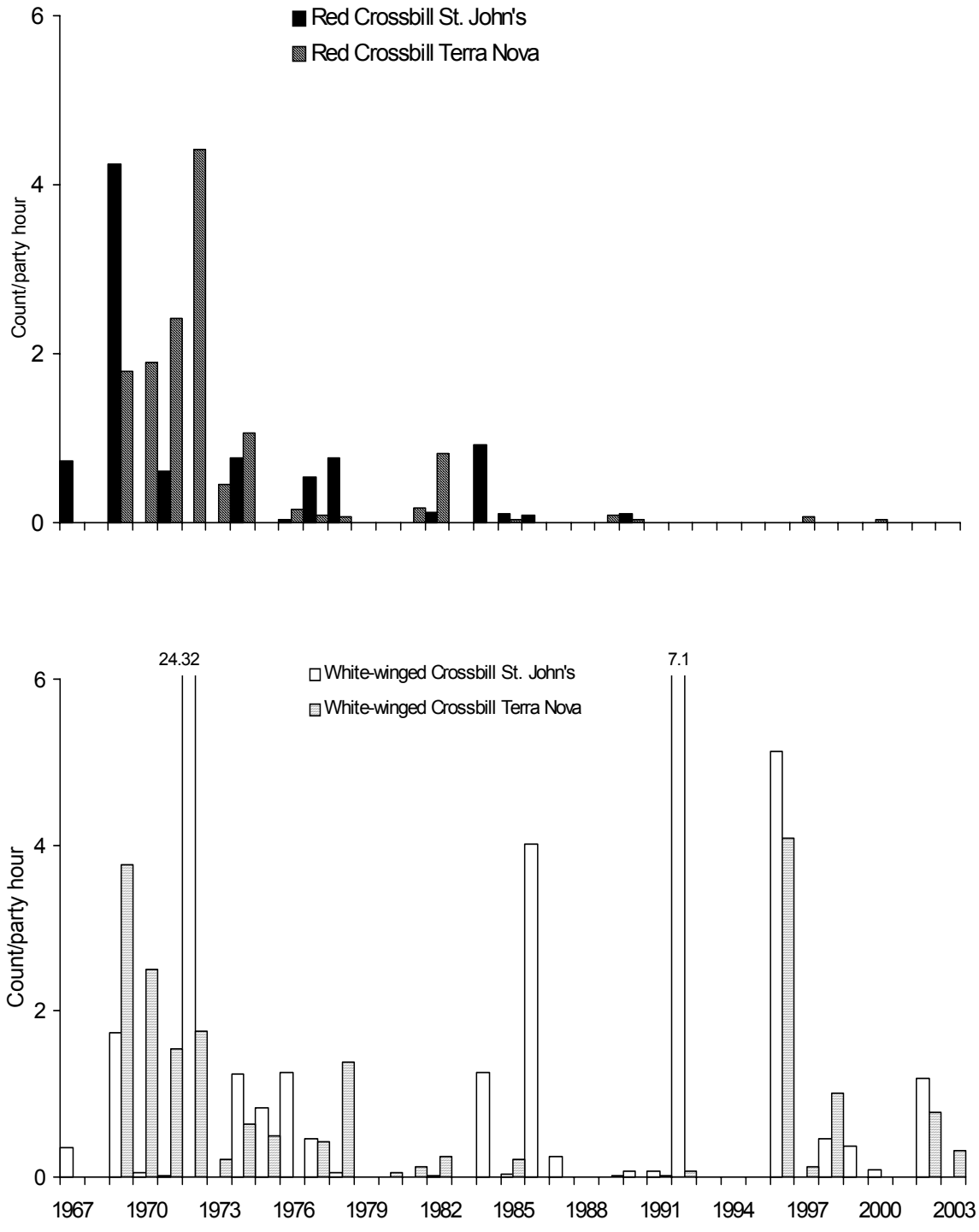

Figure 7. Number of Red and White-winged Crossbills per party hour on St. John's (1967 – 2003) and Terra Nova National Park (1969 – 2003) CBCs (data obtained from National Audubon Society 2002).

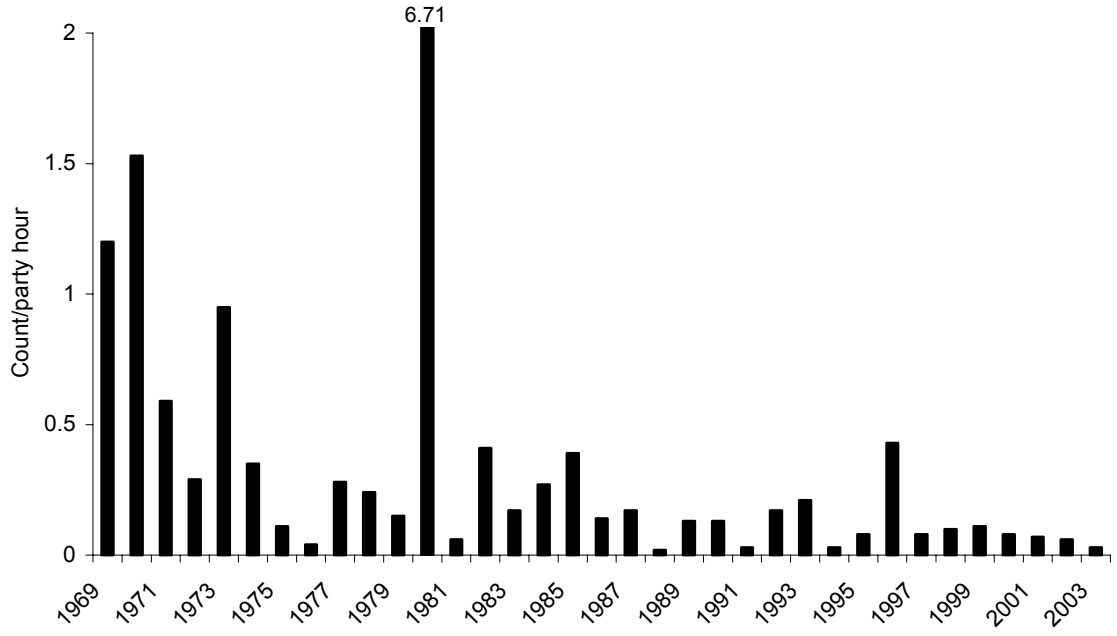

Figure 8. Total number of Red Crossbills per party hour recorded on all Newfoundland and Nova Scotia CBCs, standardized by total party hours for both provinces, 1969 – 2003. Note: high count at 1980 due to one single large flock of birds at Cape St. Mary's, Newfoundland. Data obtained from National Audubon Society (2002).

Although CBCs are the longest running census providing information on the Red Crossbill, there are difficulties associated with using sparse (i.e., one day a year and restricted geographic extent) census data collected by variable numbers of observers of variable capability to analyze long-term trends in an irruptive species like the Red Crossbill (Dunn and Sauer 1997). The CBC data provide a snapshot of early winter bird occurrences in restricted geographic areas (the 24.1 km diameter prescribed count circles). The nomadic nature of Red Crossbills means that their abundance over an entire winter season may not be accurately sampled by CBC methodology (crossbills could be counted in a large flock which does not represent their abundance over a larger geographic area, or crossbills could fail to turn up on a census when they are relatively abundant in nearby areas outside the count circle). However, it might also be expected that large foraging flocks of conspicuous, irruptive species like crossbills might be detected more consistently than other rarer and less conspicuous species. It is important to remember the snapshot nature of the data when assessing crossbill abundances from CBCs, and to consider the data primarily as a source of information on gross trends.

Breeding Bird Surveys

Breeding Bird Surveys (BBS) have been conducted annually in Newfoundland since 1973. The BBS is a standardized count regime that is run in June and early July in Newfoundland. Skilled observers drive a roadside survey route of 39.4 km, stopping

every 0.8 km to record all birds heard/seen within a 0.40 km radius (USGS Patuxent Wildlife Research Center 2003). There are 25 routes with random start points in every degree block with sufficient roadway on insular Newfoundland. Some of these routes occur in primarily forested areas of the province: for example, 2 routes are found in the Western Newfoundland ecoregion, 6 in the Central Newfoundland ecoregion, and 3 in the Northern Peninsula Forest ecoregion.

Analysis of Red Crossbills counted on all Newfoundland BBS routes, 1966 – 2000, indicates a relative abundance of 0.4 birds/route, and a declining trend of 14.4% per year (Sauer et al. 2001). However, this trend is not significantly different from a trend of 0% change per year, as the analysis is based on only four routes, and the results are highly variable (a very large 95% confidence interval). Thus, records from Newfoundland BBSs are not useful in analysing long-term population trend changes of Red Crossbills. This may be partly attributable to the irregular appearance of crossbills (both Red and White-winged) on surveys: that they are not reliably present in a given location from year to year complicates this type of population trend analysis (Link and Sauer 1998).

Newfoundland BBSs can, however, be used as an annual measure of presence/absence and of distributional occurrences/habitat associations of Red Crossbills. Red Crossbills were reported in eight consecutive years of BBSs (1979 – 1986) and since then have been reported only twice; however, coverage and temporal sampling of routes has been poor (USGS Patuxent Wildlife Research Center 2003).

Other accounts

The Newfoundland Forest Service conducts regular summer/early fall wildlife surveys in a variety of forest habitats across the island. In 1,426 surveys over the period from 1996 to 2002, Red Crossbills have only been observed twice (one bird on August 16, 1998 in a Balsam Fir stand in central Newfoundland, and one bird on June 25, 2000 in a second Balsam Fir stand in central Newfoundland; C. Cohlmeyer, Newfoundland Forest Service data files, 2003).

Other recent records of Red Crossbill sightings also exist. For example, birdwatchers from across the province report bird sightings to the newsgroup nf.birds (2003), where Red Crossbills are reported irregularly but not infrequently (Figure 9). Of note are the sightings of Red Crossbills from April/May 2002, when a flock of at least 12 birds was repeatedly observed foraging in non-native pines (*P. nigra*) planted around the campus of Memorial University of Newfoundland. This may partly explain the increase in reporting of Red Crossbills to this newsgroup (as the Newfoundland birdwatching community is centred in St. John's); the increasing trend could also be partly explained by the increased users of the newsgroup in more recent months. Red Crossbills are also occasionally reported on the French islands of Saint Pierre et Miquelon (R. Etcheberry, pers. comm., 2003).

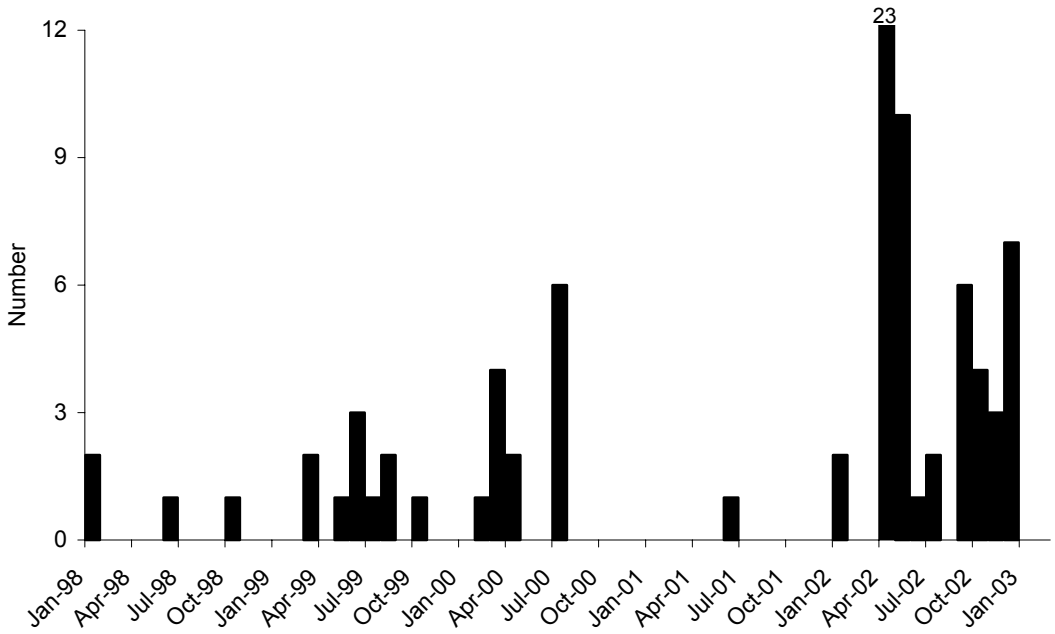

Figure 9. Red Crossbills observed in Newfoundland per month, 1998 – 2002 (data obtained from Nf.birds Newsgroup 2003). Sightings listed as more than one bird, but not specifying the total number, were counted as 2 birds. Some individuals observed more than once.

Red Crossbills have been seen in a Red Pine stand near Gambo in central Newfoundland. In March 1996, a feeding flock of eight Red Crossbills were observed there during a targeted survey of the stand (Whitaker et al. 1996). No other Red Crossbills were seen from May to October 1996 (Whitaker et al. 1996), but were the most abundant bird species recorded from January to April 1997 (Lewis 1997). A total of 28 Red Crossbills were counted during these surveys (which included a flock of 21 birds during March). Interestingly, Red Crossbills were counted in only one region of the census area, where Red Squirrels were not very common (Lewis 1997).

Field counts and typing of Red Crossbills

Estimates of population trends of Red Crossbill *percna* subspecies based on field counts are complicated by questions surrounding crossbill type identification. Based on records from CBCs, BBSs and other accounts, it is generally not possible to ascertain whether Red Crossbills observed in Newfoundland, or elsewhere, are *L. c. percna* birds. No quantitative data exist on potential proportions of *percna* birds found on the mainland, or of mainland subspecies found on Newfoundland. Interestingly, however, of all the Red Crossbill specimens collected on Newfoundland and housed in the Canadian Nature Museum, none have been mainland subspecies (M. Gosselin, pers. comm., 2004).

Parchman and Benkman (2002) contend that "the formerly abundant Newfoundland Crossbill is probably extinct." This opinion is reflected in previous work by Benkman (1989; 1993c) and Pimm (1990) though no evidence is offered to substantiate this claim. Benkman (1992a) states, "although Red Crossbills are still reported from Newfoundland, most of these are probably other, mainland subspecies of Red Crossbill, which apparently move on and off the island like White-wings." There is no definitive evidence that indicates that mainland subspecies of Red Crossbill regularly occur on insular Newfoundland (or that they do not).

Some evidence does exist, however, to support the notion that at least some of the Red Crossbills observed recently in Newfoundland are the *percna* type, and not mainland subspecies birds. A Red Crossbill collected in Terra Nova National Park in 1997 has morphological and plumage characteristics that are similar to those described in the literature for *L. c. percna* (see Figure 2). Similarly, Red Crossbills that were widely observed around the Memorial University campus in April 2002 exhibited the large bill and dusky plumage characteristic of *L. c. percna* (see). Unfortunately, clear morphological and plumage characteristics of recent Red Crossbills sightings/ collections may not be undisputable evidence of the continued persistence of *L. c. percna* on insular Newfoundland. Currently, Red Crossbills from the type complexes in North America (Groth 1993b) and Europe (Robb 2000; Summers et al. 2002; Summers and Piertney 2003) are most reliably separated on the basis of call-note typing. There is a dearth of recordings of Red Crossbills in Newfoundland. Groth's (1993b) call typing was based on only a single recording by Jay Pitocchelli of a Red Crossbill from Newfoundland (Pitocchelli 1981), and current searches have not turned up additional pre-existing recordings, or opportunities to obtain new recordings in the field. When recordings are obtained from mist netted or captured birds in the future, it is important to match calls to bill size (Summers and Piertney 2003).

Conclusions

Red Crossbills in Newfoundland have gone from being a relatively common, breeding, year-round resident during the mid-20th century, to being a species which is rarely encountered today. While the nomadic nature of Red Crossbills makes it difficult to estimate the number of birds in a population, all available evidence indicates that the population size has greatly, and continuously, decreased. It is important to note that the available data set for Red Crossbill abundance (CBCs, BBS, forestry censuses, informal observations, etc.) is concurrently consistent and includes many zero data points. This is not a situation where there is an apparent small population due to a lack of sufficient sampling.

Estimating the number of *percna* individuals is extremely difficult. A rough estimate of between 500 – 1,500 individuals is suggested, based on field experiences, Christmas Bird Counts, Breeding Bird Surveys and other surveys that suggest that the order of magnitude of the population could be between 100s and low thousands. Much uncertainty is associated with this estimate, for several reasons: 1) observer effort across Newfoundland is relatively sparse and limited; 2) there are no recent

observations of breeding so no information on recruitment to the population is available; and 3) the vagility of the birds makes accurate sampling very difficult. Even given the uncertainty surrounding the number of individuals, it is obvious that if the population of *percna* continues its decline, the taxon will be extinct.

LIMITING FACTORS AND THREATS

Habitat loss

The boreal forest landscape that presently exists in Newfoundland is very different from that of previous centuries. Many anthropogenic (forestry activities, human caused fires) and natural (infestations, fire cycle, forest regeneration patterns) factors have combined to reduce the cone crops that Red Crossbills depend on. Red Crossbills are very vulnerable to habitat loss because their nomadic behaviour concentrates them in regions of good cone crops (as compared to generalist songbird species that are more evenly distributed in a habitat; Benkman 1993a). A reduction of cone crops due to forest change, whether it is of possible "key conifers" such as pines or Black Spruce, or alternate conifer species like Balsam Fir and White Spruce, negatively impacts Red Crossbill activity and possibly lowers recruitment to the population. It is not known whether Red Crossbills escape conifer seed limitations by moving to the mainland (and, if this does happen, whether they successfully breed on the mainland, or whether they return to Newfoundland to breed in subsequent years). For further details on habitat loss in Newfoundland, see the sections on Habitat requirements and Trends.

Red Squirrel interactions

Red Squirrels were introduced to Newfoundland in small numbers starting in 1963 (Minty 1976; Payne 1976; Goudie 1978) and are now abundant. They may be presently competitively excluding Red Crossbills by out competing them for food resources in the form of conifer seeds (Benkman 1989, 1993c; Pimm 1990). This could be particularly true of supplies of Black Spruce seeds that are normally held within cones and could be an important food for Red Crossbills when other conifer seeds are in short supply. Red Squirrels are abundant in Black Spruce forests in Newfoundland; in a study in 1998/1999 they were found to be close to four times more abundant in Black Spruce stands than Balsam Fir stands (Wren 2001). The impact of squirrels as seed predators in Newfoundland forests is largest during years of seed shortages. West (1989) found that during a good cone crop year, Red Squirrels harvested less than 1% of cones from Black Spruce trees by October. In small cone crop years, Red Squirrels removed 64 – 96% of cones in a Black Spruce plantation by October. Red Squirrels could also contribute to seed limitations in species other than Black Spruce. One study of Red Squirrel cone predation in Newfoundland White Pine stands estimated an average cone loss of 84% over a three-year period from 1998 – 2000 (with a range of values from 32 to 100%); however, cone loss could not be specifically attributed to squirrels (English 1998). While the impacts of Red Squirrel competition on Red Crossbills in

Newfoundland are speculative and not quantified, studies in other locations have indicated that conifer trees that have evolved in the absence of squirrels do not have the same squirrel-related defences as do conifers that evolve with squirrels, allowing the co-evolution of Red Squirrels and Lodgepole Pine in areas around the Rocky Mountains (Benkman et al. 2001). Thus, it is possible that Red Squirrels could be limiting the food supply and/or hindering the recovery of an important conifer for Red Crossbills in Newfoundland.

The extent to which Red Crossbills can escape competition from Red Squirrels by switching to other food resources is unknown, as are the ultimate population level impacts of competition with Red Squirrels. In Scotland, Summers and Proctor (1999) have shown that crossbills and squirrels show preferences for different shapes and density of pines. Squirrels prefer more dense stands, possibly because they can avoid crossing ground to access other trees, whereas the crossbills more often used the older more open pine stands. Summers and Proctor (1999) suggest that these behavioural patterns likely reduce competition between squirrels and crossbills and that the competitively inferior crossbills may avoid competitive exclusion during periods of low cone abundance by moving to other sites (see also Summers' (2002) consideration of the different sizes of cones utilized by crossbills and squirrels).

Other sources of mortality

Predation is an additional source of mortality for Red Crossbills although the level of this threat is unknown. Gray Jays (*Perisoreus canadensis*) are predators of Red Crossbill nests (Adkisson 1996), and, along with Red Squirrels are the major predators of bird nests in Balsam Fir forests in Newfoundland (Lewis 1999). Although Red Squirrels are a recently introduced species to Newfoundland that may be exerting considerable predation pressure on Red Crossbills, the impacts of Red Squirrel egg and nestling predation on *percna* (or on other Red Crossbill subspecies in other parts of North America), have not been quantified. Some Red Crossbills may be killed on roadways where they are attracted to salt and grit. For example, a recent Red Crossbill specimen in Newfoundland was killed in a vehicle collision in Terra Nova National Park (see photographs of the prepared skin, Figure 2), but the importance of vehicle collisions to the overall level of mortality of Red Crossbills is unknown.

Population growth potential

The potential for growth of the Red Crossbill population under current conditions is likely extremely compromised by low numbers and consequent reduced population viability. Population growth potential is also contingent on years of good cone crops within Newfoundland's boreal forests. Successive years of heavy cone crops cannot guarantee population growth, however, unless breeding pairs are naturally situated to take advantage of conifer seed abundance.

The potential for growth of the Red Crossbill population could be greater under managed conditions. In Britain, recent afforestation through the creation of plantations

has greatly increased the diversity and abundance of conifer seeds (Marquiss and Rae 1994). This has contributed to an independent breeding population of Common Crossbills in Britain, where the population used to depend on immigration from the European mainland (Newton 1972; Avery and Leslie 1990). A managed habitat beneficial to crossbills must contain old-growth or at least mature conifers, because they offer the best yield of cones (Newton 1972; Benkman 1993b; Holimon et al. 1998). Enhanced pine regeneration and production could likely hold some potential for population growth among Red Crossbills in Newfoundland. Large protected expanses of old growth forest that also include pines, e.g. the proposed Little Grand Lake Ecological and Wilderness Reserve, could also be beneficial to crossbills on insular Newfoundland in the long-term.

Management for population growth of the Red Crossbill might promote conifer seed availability, and this might be achieved on three fronts. First, stand rotation ages in Newfoundland should be increased to ensure higher cone yields. Second, relict Red and White Pine stands in Newfoundland should be protected as potential key conifer source for Red Crossbills. Third, a habitat managed to promote Red Crossbill population growth must take into account the competitive limitations of Red Squirrels on conifer seed availability, and possible effects of Red Squirrel predation on *percna*. Another possible management step could be intervention to ensure that squirrel-free islands like Anticosti and the Magdalen Islands where Red Crossbills breed (Létourneau 1996), and which may be refuges for *percna* (although *percna* has not been confirmed for these islands) remain squirrel free. Many smaller coastal islands of Newfoundland which have been suggested as *percna* refuges by Benkman (1993c) would likely not be effective refugia. Many of these islands already have Red Squirrels on them, are not well forested, and only support transient populations of Red Crossbills (WAM unpublished files). For instance, Baccalieu Island which has substantial old growth forests and no squirrels has few Red Crossbill occurrences (Wells and Montevecchi 1984), though it should still be kept free of introduced Red Squirrels.

SPECIAL SIGNIFICANCE OF THE SPECIES

Ecological role

Crossbills are the quintessential birds of the boreal forests of the world. Within the boreal forest, crossbills are distributed where conifer seed resources are sufficient, and their presence is thus a crude indicator of cone availability within an area. Uncut or mature forest is important habitat for crossbills because it offers the largest and most stable cone crops (Newton 1972; Benkman 1993b; Holimon et al. 1998). In Newfoundland, the Red Crossbill has suffered from the effects of habitat degradations that have reduced seed availability. A return to historic population levels, when Red Crossbills were common, would indicate a healthy, functioning native forest ecosystem.

Endemism and speciation

Red Crossbill *percna* subspecies, is endemic to Canada. Available evidence suggests that its breeding range is restricted to insular Newfoundland. Given that recent work has concluded that the North American Red Crossbill group be considered sibling species and not a group of subspecies (Groth 1993b), the threat to the *percna* taxonomic unit is considerable. Were the taxon to be lost, a likely species, and not subspecies, would be extinct.

While the Red Crossbill as a species is generally secure in North America (NatureServe 2002), there are other Red Crossbill forms that are also declining. A Red Crossbill population in the Cypress Hills on the border of Alberta and Saskatchewan might be extinct (Benkman et al. 2001; Parchman and Benkman 2002). Red Crossbill populations in New England (Dickerman 1987) and Canada's Maritime Provinces (Erskine 1992) declined significantly in the early 20th century as a result of extensive logging of Eastern White Pine. Red Crossbills in Ontario have also demonstrated a decline based on CBC data (E. Dunn, pers. comm., 2004). Other *Loxia* forms that are at risk are the Hispaniolan Crossbill (*L. megaplaga)*, which is threatened by forestry and fragmentation of the native West Indian Pine (*Pinus occidentalis*) forest on which it depends (Benkman 1994; Smith 1997), and the Scottish Crossbill which may depend at least partly on native pine stands in Britain (Summers et al. 2002). Both of these species are large-billed, island endemic, pine foraging crossbills.

EXISTING PROTECTION OR OTHER STATUS

International agreements

Red Crossbill *percna* subspecies, as a taxon of the family Fringillidae, is protected under the Migratory Birds Convention Act of 1994. As such, it is illegal to kill a Red Crossbill or destroy its nest without a permit.

Federal laws

Red Crossbill *percna* subspecies is protected by the Migratory Birds Convention Act and the National Parks Act in national parks and historic sites.

Provincial endangered species act

The Red Crossbill is not currently listed in Newfoundland and Labrador.

U.S. Endangered Species Act

Red Crossbill is not listed or proposed for listing in the United States (US Fish & Wildlife Service 2003).

IUCN Red Book

Red Crossbill is not listed. Other crossbills that are listed are the Scottish Crossbill (*L. scotica*; endangered status with low population estimates and a continued population decline) and the Hispaniolan Crossbill (*L. megaplaga*, data deficient; IUCN 2002).

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Red Crossbill is not listed (CITES 2003).

Atlantic Canada Conservation Data Centre

The Red Crossbill is given the global heritage status rank of 5 (demonstrably widespread, abundant, and secure) by NatureServe (2002). National heritage status ranks for the United States and Canada are both also 5. Multiple state and provincial ranks are given (for the different subspecies or types across North America).

NatureServe (2002) gives the Red Crossbill the rank S2S3 for Newfoundland (the two ranks indicate uncertainty as to whether the exact status is S2 or S3). A rank of S2 means the species is "imperilled in the subnation because of rarity or because of some factor(s) making it very vulnerable to extirpation from the nation or subnation. Typically 6 to 20 occurrences or few remaining individuals (1,000 to 3,000)." A rank of S3 means the species is "vulnerable in the subnation either because it is rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals." These assessments for Red Crossbill *percna* subspecies, were based primarily on number of occurrences rather than number of individuals (K. Bredin, pers. comm., 2003).

Protected areas

The total area of Newfoundland (including offshore islands, excluding Labrador) that is protected either provincially or federally is 8692.18 km^2 (Ryan 2003). Some of this protected area may provide adequate habitat for Red Crossbills. Gros Morne and Terra Nova National Parks encompass areas of productive conifers. However, Red Squirrel densities are very high in Black Spruce stands in Terra Nova National Park (Wren 2001) and could severely restrict cone availability for Red Crossbills. Furthermore, the forests in Gros Morne are predominately Balsam Fir that do not always provide a reliable year-round source of conifer seeds for Red Crossbills. The Little Grand Lake Provisional Reserve protects the endangered Newfoundland Marten, and thus, good habitat for Red Crossbills, as Newfoundland Martens are also dependent on mature conifer forests, but this is also generally Balsam Fir forest. The Bay du Nord, Avalon, and Middle Ridge Reserves offer less-favourable crossbill habitat, because they all encompass barrens habitat where caribou are located. Nevertheless, these reserves do have conifer forests including Black Spruce in river valleys that are

more extensive in the Bay du Nord and Middle Ridge Reserves than in the Avalon Reserve.

SUMMARY OF STATUS REPORT

The Red Crossbill *percna* subspecies, has undergone a sustained and precipitous population decline during the latter part of the 20th century. This decline is likely associated with both anthropogenic and natural influences. The former include intense forestry harvesting practices, introductions of Red Squirrels, as well as fire and fire suppression. The large-billed *percna* subspecies might have depended on formerly abundant Eastern White and Red Pine stands that are currently very restricted. Forestry practices and short rotation cycles are direct threats that reduce overall cone production on insular Newfoundland. Introduced Red Squirrels might compete for conifer seeds, particularly during periods of reduced cone abundance. The squirrels might also impose a predation pressure that crossbills and other passerines have not had the opportunity to adapt to. The effects of these factors could be insurmountable for the Red Crossbill population.

Total population size is coarsely estimated at 500 – 1,500 individuals based on field experiences, Christmas Bird Counts, Breeding Bird Surveys and other surveys that suggest that the order of magnitude of the population could be between 100s and low thousands. There is uncertainty associated with this estimate. No nests have been found in Newfoundland since 1977. National and provincial parks and reserves protect some habitat for Red Crossbills.

TECHNICAL SUMMARY

***Loxia curvirostra percna* Bent 1912**
Red Crossbill *percna* subspecies Bec-croisé des sapins de la sous-espèce *percna*
Range of Occurrence in Canada: core, historic breeding range on insular Newfoundland, with occasional/suspected occurrences (and unknown breeding status) in Nova Scotia and Québec (Anticosti Island)

Extent and Area Information	
• *Extent of occurrence (EO)(*km^2 *)* Encompasses the area of the core range of insular Newfoundland, and the area of other known or suspected locations of occurrences (Nova Scotia and Anticosti Island)	172,085 km^2
• *Specify trend in EO*	Stable
• *Are there extreme fluctuations in EO?*	No
• *Area of occupancy (AO) (*km^2 *)* Forested area of insular Newfoundland, not including offshore islands	51,723 km^2
• *Specify trend in AO*	Decline
• *Are there extreme fluctuations in AO?*	No
• *Number of known or inferred current locations*	Not applicable
• *Specify trend in #*	Not applicable
• *Are there extreme fluctuations in number of locations?*	Not applicable
• *Specify trend in area, extent or quality of habitat*	Decline in area, extent, and quality
Population Information	
• *Generation time (average age of parents in the population)*	Approx. 2 years
• *Number of mature individuals*	500 – 1,500
• *Total population trend:*	Decline
• *% decline over the last/next 10 years or 3 generations.*	75% decline based on Nfld. CBCs.
• *Are there extreme fluctuations in number of mature individuals?*	No
• *Is the total population severely fragmented?*	Not applicable
• *Specify trend in number of populations*	Not applicable
• *Are there extreme fluctuations in number of populations?*	Not applicable
List populations with number of mature individuals in each:	
Threats (actual or imminent threats to populations or habitats)	
Habitat loss and degradation from forest harvesting Conifer seed competition with and nest predation from red squirrels Vehicle strikes	
Rescue Effect (immigration from an outside source)	No
• *Status of outside population(s)?* **USA:** [other jurisdictions or agencies]	
• *Is immigration known or possible?*	
• *Would immigrants be adapted to survive in Canada?*	
• *Is there sufficient habitat for immigrants in Canada?*	
• *Is rescue from outside populations likely?*	No
Quantitative Analysis	Not applicable
Other Status	

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	C1

Reasons 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

Applicability of Criteria

Criterion A (Declining Total Population): The population has declined by over 50% in the last 10 years, so A2b may apply. However, this decline is based on the results of Christmas Bird Counts, which occur in a relatively small portion of the available habitat.

Criterion B (Small Distribution, and Decline or Fluctuation): The EO and AO are both greater than 20,000 km^2, so Criterion B does not apply.

Criterion C (Small Total Population Size and Decline): Endangered (C1). The population is less than 2,500 mature individuals (i.e. 500 - 1500), and a decline of at least 20% in 5 years is projected.

Criterion D (Very Small Population or Restricted Distribution): Upper estimates suggest a population greater than 1,000 mature individuals, so Criterion D does not apply.

Criterion E (Quantitative Analysis): The information necessary to conduct a quantitative analysis is not available.

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BIOGRAPHICAL SUMMARY OF THE REPORT WRITERS

L. S. Wren undertook M.Sc. research at Memorial University of Newfoundland, studying spatial and temporal trends in the continental and regional biogeography of cardueline finches. Since completing this degree, she has worked on manuscripts related to this research, and has been employed doing research and writing on conservation challenges to Newfoundland fisheries. Presently, she is working on bird conservation issues at the Canadian Nature Federation in Ottawa.

W. A. Montevecchi is a Professor in the Psychology and Biology Departments and the Ocean Sciences Centre of Memorial University of Newfoundland and an Associate of the Ornithology Department in the Museum of Comparative Zoology at Harvard University. His research is focused on animal responses to environmental change and multi-species interactions in marine and terrestrial ecosystems. Much of his research is directed at conservation ecology. He is a member of the Newfoundland and Labrador Species Status Committee, the former Chair of the Harlequin Duck Recovery Team, a member of the Board of Directors of the Nature Conservancy of Canada / Atlantic Region, Co-Chair of the Newfoundland and Labrador Wilderness and Ecological Reserves Advisory Council, East Coast Co-Chair of the Interdisciplinary Coasts Under Stress Research Project involving Memorial University of Newfoundland and the University of Victoria, and a former Board member of the Canadian Nature Federation.

AUTHORITIES CONTACTED

Brazil, J. Endangered Species and Biodiversity Section, Inland Fish and Wildlife Division, Department of Tourism, Culture and Recreation, Box 2007, 50 Main St. (Commerce Court), Corner Brook, Newfoundland, A2H 7S1
Bredin, K. Zoologist. Atlantic Canada Conservation Data Centre, P.O. Box 6416, Sackville, New Brunswick, E4L 1G6.
Cohlmeyer, C. Conservation Officer. Newfoundland Forest Service, Department of Forest Resources and Agrifoods, Fortis Building, Corner Brook, Newfoundland.

Dunn, E. Migratory Bird Population Division, Canadian Wildlife Service, Environment Canada. 1125 Colonel By Drive, Raven Road, Carleton University, Ottawa, ON K1A 0H3.

Etcheberry, R. Isle Miquelon, France. Gosselin, M. March 2003. Collection Manager, Vertebrate Section, Collection Services, Canadian Museum of Nature, PO Box 3443 Stn D, Ottawa, Ontario, K1P 6P4.

Maunder, J.E. Curator of Natural History, Provincial Museum of Newfoundland and Labrador, Department of Tourism, Culture and Recreation, Government of Newfoundland and Labrador, Box 8700, St. John's, Newfoundland, A1B 4J.

Seutin, G. Coordinator, Species at Risk Program, Parks Canada, 25 rue Eddy, 4ième étage, Gatineau, Québec, K1A 0M5.

Summers, R.W. Royal Society for the Protection of Birds, North Scotland Regional Office, Etive house, Beechwood Park, Inverness IV2 3BW U.K.

COLLECTIONS EXAMINED

Avian Collection, Canadian Museum of Nature, Natural Heritage Building, 1740 Pink Road, Aylmer, Québec, J9H 5E1.

Department of Ornithology. Museum of Comparative Zoology. Harvard University. 25 Oxford Street, Cambridge, MA 02138. (WAM unpublished files)

Appendix 1. Morphometric measurements of Red Crossbill, *percna* subspecies. Values include single measurements, means ± SEs or ranges. Sample sizes in ( ), when specified. F = female, M = male

Source	Body (mm)	Wing (mm)	Tail (mm)	Tarsus (mm)
Griscom (1937)	-	F = 91 – 96.5	-	-
Peters and Burleigh (1951)	140 - 165	About 95	-	-
Godfrey (1966)	-	Adult M = 88.3 – 97.7 (mean 91.7) Adult F = 87.2 – 92.3 (mean 89.5)	53 – 59.4 (mean 55.9)	16.3 – 17.8 (mean 17.1)
Payne (1987)	-	Wing arc: M = 92.70 ± 1.70 (43) F = 90.14 ± 2.31 (21) Chord: M = 92.02 ± 1.70 (43) F = 89.48 ± 2.11 (21)	-	M = 16.52 ± 0.62 (43) F = 16.47 ± 0.76 (22)
Pyle (1997)	-	M = 89 - 97 (43) F = 85 - 93 (21)	M = 52 - 59 (10) F = 49 - 56 (10)	-
Wren (unpublished data)	160.4 ± 5.8 (8)	-	-	-

Appendix 2. Bill measurements of Red Crossbill, *percna* subspecies. Values include single measurements, means ± SEs, or ranges. Sample sizes in ( ), when specified. F = female, M = male

Source	Length (mm)	Depth (mm)	Width (mm)
Griscom (1937)	Culmen: M = 17 – 19	M = 10.3 – 11.5	-
Peters and Burleigh (1951)	17.8	-	-
Godfrey (1966)	Exposed culmen: 17 – 18.6 (mean 17.7)	-	
Payne (1987)	Upper mandible (nares to tip): M = 15.16 ± 0.52 (42) F = 15.05 ± 0.74 (22) Upper mandible (base of feathers to tip): M = 17.91 ± 0.57 (42) F = 17.76 ± 0.93 (22)	M = 10.54 ± 0.35 (41) F = 10.49 ± 0.43 (21)	Upper mandible at anterior edge of nares: M = 7.23 ± 0.33 (42) F = 7.23 ± 0.33 (21) Lower mandible at margins of rami: M = 10.01 ± 0.60 (42) F = 9.69 ± 0.45 (21)
Benkman (1989; 1993c)	Upper mandible (nares to tip): 14.9 ± 0.18 (10) Lower mandible (nares to tip): 11.0 ± 0.16 (10)	At nares: 10.6 ± 0.10 (10)	Upper mandible at anterior edge of nares: 8.1 ± 0.09 (10)
Pyle (1997)	Nares to tip: 13.5 – 16.4	At tip of nares: 9.6 – 11.4	-
Wren (unpublished data)	Upper mandible: 14.3 ± 1.02 (33) Lower mandible: 11.0 ± 0.49 (33)	Upper mandible: 6.4 ± 0.31 (33) Lower mandible: 4.5 ± 0.5 (33)	Upper mandible: 6.3 ± 0.63 (33) Lower mandible: 8.0 ± 0.71 (33)