PROPOSED

Species at Risk Act
Recovery Strategy Series
Adopted under section 44 of SARA

Recovery Strategy for the Furbish's Lousewort (*Pedicularis furbishiae*) in Canada

Furbish's Lousewort



2010

Environment Canada Environnement Canada

Canada

About the *Species at Risk Act* Recovery Strategy Series

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

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

What is recovery?

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

What is a recovery strategy?

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

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

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

What's next?

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

The series

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

To learn more

To learn more about the *Species at Risk Act* and recovery initiatives, please consult the Species at Risk (SAR) Public Registry (www.sararegistry.gc.ca).

RECOVERY STRATEGY FOR THE FURBISH'S LOUSEWORT (*Pedicularis furbishiae)* IN CANADA

2010

Under the Accord for the Protection of Species at Risk (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the Government of New Brunswick has given permission to the Government of Canada to adopt the Recovery Strategy for Furbish's Lousewort (*Pedicularis furbishiae*) in New Brunswick (Appendix 2) under Section 44 of the *Species at Risk Act.* Environment Canada has included an addition which completes the SARA requirements for this recovery strategy, and excludes the section on Socio-Economic Considerations which is not required by the Act.

2010

This recovery strategy for the Furbish's lousewort in Canada consists of the:

- Addition to the Recovery Strategy for the Furbish's Lousewort (*Pedicularis furbishiae*) in New Brunswick; prepared by Environment Canada.
- Recovery Strategy for the Furbish's Lousewort (*Pedicularis furbishiae*) in New Brunswick; prepared by the Furbish's Lousewort Recovery Team for the New Brunswick Department of Natural Resources.

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Également disponible en français sous le titre
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Addition to the Recovery Strategy for the Furbish's Lousewort (*Pedicularis furbishiae*) in New Brunswick

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(NOTE: Appendix 1 has been removed from the public document to protect the species and its habitat).

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DECLARATION

This proposed recovery strategy has been adopted from the *Recovery Strategy for Furbish's Lousewort (Pedicularis furbishiae) in New Brunswick*, which was prepared by the Furbish's Lousewort Recovery Team and submitted to the Department of Natural Resources, Province of New Brunswick. Environment Canada, as authorized under Section 44 of the *Species at Risk Act* (SARA) has reviewed this document and, with the addition, accepts it as its recovery strategy for the Furbish's lousewort under SARA.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment Canada or any other jurisdiction alone. In the spirit of the Accord for the Protection of Species at Risk, the Minister of the Environment invites all Canadians to join Environment Canada in supporting and implementing this strategy for the benefit of Furbish's lousewort and Canadian society as a whole. Environment Canada will endeavour to support implementation of this strategy, given available resources and varying species at risk conservation priorities. The Minister will report on progress within five years.

This strategy will be complemented by one or more action plans that will provide details on specific recovery measures to be taken to support conservation of the species. The Minister will take steps to ensure that, to the extent possible; Canadians interested in or affected by these measures will be consulted.

RESPONSIBLE JURISDICTIONS

Environment Canada
Government of New Brunswick

STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

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

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

This recovery strategy will clearly benefit the environment by promoting the recovery of Furbish's lousewort. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects. Implementation of the strategy is anticipated to benefit conservation efforts for other rare plants that occur in proximity to Furbish's lousewort habitat (see *Recovery Strategy for Furbish's Lousewort* (*Pedicularis furbishiae*) *in New Brunswick*, Recovery priorities and general steps, Effects on other species).

RESIDENCE

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

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the SAR Public Registry: www.sararegistry.gc.ca/sar/recovery/residence_e.cfm.

PREFACE

The Furbish's lousewort was listed on Schedule 1 of the *Species at Risk Act* (SARA) at proclamation, in June 2003. It was initially assessed and designated as Endangered by the Committee on the status of Endangered Wildlife in Canada (COSEWIC) in 1980. COSEWIC re-examined and re-confirmed the Furbish's lousewort Endangered status in April 1998 and May 2000.

SARA section 37 requires the competent minister to prepare recovery strategies for all listed extirpated, endangered, or threatened species. SARA section 44 allows the Minister to adopt all or part of an existing plan for the species if it meets the requirements under SARA for content (sub-sections 41(1) or (2)).

The New Brunswick Ministry of Natural Resources led the development of this recovery strategy for the species in cooperation with Environment Canada, Canadian Wildlife Service – Atlantic Region. All responsible jurisdictions reviewed and provided support for posting this recovery strategy.

Furbish's lousewort is found in the traditional territory of the Maliseet Nation, including one site less than 1 km from the Tobique Reserve. Furbish's lousewort belongs to the snapdragon family, a group of plants that have traditionally been used by Aboriginal peoples. The Environmental Team from the Tobique First Nation is involved in monitoring the species.

The Canadian recovery strategy has a counterpart in the United States where the species is listed as endangered. A recovery plan was first developed in 1983 and updated in 1991.

SPECIES STATUS INFORMATION

NatureServe ranks the Furbish's lousewort as imperiled globally (G2), imperiled nationally in the United States (N2), and critically imperiled in Canada (N1) and in New Brunswick (S1). The Canadian population likely represents between 5 and 15 % of the global population (Furbish's Lousewort Recovery Team. 2006).

SPECIES AT RISK ACT REQUIREMENTS

The following sections address specific requirements of SARA that are not addressed in the Recovery Strategy for Furbish's Lousewort (*Pedicularis furbishiae*) in New Brunswick (Appendix 2).

1. Consultation

Environment Canada contacted the landowners of sites where the species is known to occur. Either meetings or follow up phone calls were undertaken with all landowners. Additional stakeholders, such as environmental non-governmental organizations, municipalities and aboriginal organizations, were given an opportunity to review the draft strategy. A meeting was also held at the Tobique First Nation with staff from the Maliseet Nation Conservation Council and members of Tobique First Nation's Environmental Team, as the species is found adjacent to the reserve lands. The individuals in Canada who are considered experts on the biology of the species were members of the recovery team or were consulted for information in the course of preparing this strategy. Additional, opportunities for consultation will be afforded through posting on the SAR Public Registry.

2. Socio-economic Considerations

The Recovery Strategy for the Furbish's Lousewort (*Pedicularis furbishiae*) in New Brunswick contains a short statement on socio-economic considerations. As a socio-economic analysis is not required under Section 41(1) of SARA, the Socio-economic Considerations section of the Recovery Strategy for the Furbish's Lousewort (*Pedicularis furbishiae*) in New Brunswick is not considered part of the Minister of Environment's recovery strategy for this species.

3. Recovery Feasibility

Recovery of Furbish's lousewort is technically and biologically feasible as determined by the criteria for assessing the feasibility of recovery.

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

Yes. Once more common than at present, the Canadian population is currently believed to be less than 1000 individuals which appear to be reproducing.

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

Yes. Habitat is available on the shores of the Saint John River even though the dynamics of the Saint John River as it flows through New Brunswick have been altered by dam construction.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Yes. Anthropogenic threats (*e.g.* illegal dumping, removal/alteration of shoreline and bank vegetation) can be avoided or mitigated through development of site management plans, prepared in collaboration with the property owners.

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

Yes. Recovery techniques exist, such as habitat restoration and transplantation, which have been successfully carried out in other situations.

4. Population and Distribution Objectives

Environment Canada endorses the goal and 10-year objectives proposed in the provincial recovery strategy and adopts them as the population and distribution objectives for its recovery strategy. Environment Canada supports the approach of establishing additional self-sustaining populations after investigating, as proposed, the feasibility of a propagation program.

Population and distribution objectives are:

To monitor the existing sites, to increase the population size and the number of occurrences of Furbish's lousewort, and to maintain quality habitat within its range in New Brunswick over the long term.

Ten-year objectives are:

To maintain the existing populations at a minimum of 200 individuals (mature and young) per segment in each of the three river segments where it is known to occur between Grand Falls and Perth Andover.

To maintain the number of Furbish's lousewort at a minimum of 250 individuals (mature and young) in the river segment between the International border and Grand Falls.

To maintain the population at a minimum of 250 individuals (mature and young) at the upland site near Aroostook.

To establish self-sustaining populations of Furbish's lousewort in additional river segments within its range.

To identify and conserve high quality potential sites for Furbish's lousewort.

5. Critical Habitat

Under SARA, critical habitat is defined as the habitat necessary for the survival or recovery of the species, and is meant to represent the habitat needed by the species to meet the stated population and distribution objectives.

5.1. Critical habitat identification

The strategy developed by the Furbish's Lousewort Recovery Team has identified the habitat requirements for Furbish's lousewort and acknowledges that "*all known sites are important to the long-term survival of the species*" and that "*The specific locations of individuals or of small groupings of plants are obviously essential to the survival of established populations*". The species generally occurs on ice- or flood-scoured river shore, where disturbance events have reduced competing vegetation. Establishment of new plants is fostered by moss cover, moist soils and partial shade.

Five sites are known to be occupied by Furbish's lousewort and these five sites are identified as critical habitat. Recovery monitoring efforts and establishment of new sites to ensure the long-term survival of the species may result in additional locations being identified as critical habitat in the future.

At each site, critical habitat for the species occurs in those areas matching the description included under habitat requirements (*Recovery Strategy for Furbish's Lousewort* (Pedicularis furbishiae*) in New Brunswick,* Appendix C).

The figure showing the general location of known sites of Furbish's lousewort and the table giving the coordinates of the Furbish's lousewort sites, are part of Appendix 1. Appendix 1 has been removed from the public document to protect the species and its habitat.

5.2. Activities likely to result in the destruction of critical habitat

Examples of activities that may result in the destruction of critical habitat of Furbish's lousewort include, but are not limited to:

- Change in river dynamics causing erosion or changes to the habitat through dam construction and through local projects, such as docks, residential or commercial construction, construction or maintenance of roads, trails and railways, and bank stabilization or slumping.
- Loss of buffer trees along the river bank or around inland sites reducing the amount of moderate shade which appears to play a role in the establishment or survival of Furbish's lousewort. Specific examples of activities include construction or maintenance of roads, trails and railways, forestry operations, agricultural activities, gravel pits, and residential or commercial development.
- Compression, inversion, or any other type of disturbance to the soil that may result in the erosion or compaction of soil substrates used by the species. Specific examples of activities include indiscriminate disturbances created by recreational activities such as hiking or cycling, residential or commercial construction, construction or maintenance of roads, trails and railways either proximate to the area of occurrence or adjacent to the area of occurrence that may result in small-scale erosion.
- Use of pesticide or herbicides, resulting in changes to the native vegetation.

6. Statement on Action Plans

An action plan addressing the requirements of section 49. (1) of SARA will be posted within two years of the final version of this recovery strategy being posted on the SAR Public Registry.

7. References

Furbish's Lousewort Recovery Team. 2006. Recovery strategy for Furbish's Lousewort (*Pedicularis furbishiae)* in New Brunswick. New Brunswick Department of Natural Resources. Fredericton, New Brunswick.

APPENDIX 1

Critical Habitat Identification and Location

Appendix 1 has been removed from the public document to protect the species and its habitat.

APPENDIX 2

Recovery Strategy for Furbish's Lousewort (*Pedicularis furbishiae*) in New Brunswick

RECOVERY STRATEGY FOR FURBISH'S LOUSEWORT (*PEDICULARIS FURBISHIAE*) IN NEW BRUNSWICK



Submitted to the Director of Fish and Wildlife Branch,
New Brunswick Department of Natural Resources

June 27, 2006

by

New Brunswick Furbish's Lousewort Recovery Team

(disponible en français)

Recommended Citation

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Team Members

Stephen Clayden, Curator of Botany, New Brunswick Museum
Susan Gawler, Botanical Resource Person
Jim Goltz, Botanical Resource Person
Poul Jorgensen, Sentiers NB Trails
Ed LeBlanc, New Brunswick Department of Natural Resources
Jim Samms, NBPower
Margo Sheppard, Nature Trust of New Brunswick
Maureen Toner, New Brunswick Department of Natural Resources

Past Members

Heather Arnold, Nature Trust of New Brunswick (2004-05)
Brian McCluskey, Sentiers NB Trails (2004-05)
Jacques Poirier, Sentiers NB Trails (2002-04)

Disclaimer

This Recovery Strategy was prepared for the New Brunswick Department of Natural Resources as advice on a comprehensive approach to the conservation of Furbish's lousewort. It does not necessarily represent the views of individual members of the recovery team or the official positions of the organizations with which the individual members are associated. It is recognized that implementation of the recommendations will depend on availability of resources and expertise.

Acknowledgements
The Furbish's Lousewort Recovery Team wishes to acknowledge the contributions of Mr. Fred Tribe and the late Dr. George Stirrett to the conservation of the lousewort. Mr. Tribe and Dr. Stirrett initiated the first conservation efforts for the species in New Brunswick and were the driving force behind the recognition of its precarious status in Canada.

We wish also to acknowledge the many other individuals who have contributed to the conservation of Furbish's lousewort. We are aware of and would like to acknowledge the contributions of Hal Hinds (deceased), Patricia O'Brien, Graham O'Brien (deceased), and Bill McCue. There are most certainly people, unknown to us, who have also contributed to the conservation of this species - we wish to acknowledge and thank them.

We would like to underline the role of the Nature Trust of New Brunswick, which has been at the forefront in the conservation of Furbish's lousewort in Canada. The Atlantic Canada Conservation Data Centre and the Maine Natural Heritage Program have also been active contributors in field surveys. Financial support for projects has come from: World Wildlife Fund, Environment Canada Habitat Stewardship Program, Maine Outdoor Heritage Fund, George Cedric Metcalf Foundation, New Brunswick Environmental Trust Fund, New Brunswick Wildlife Trust Fund, McCain Foundation, Shell Environmental Fund, and Environment Canada's Environmental Damages Fund.

EXECUTIVE SUMMARY

Furbish's lousewort is a shoreline plant species that is globally restricted to the shores of the Saint John River in northwestern New Brunswick, Canada and in northern Maine, USA. The species has legal protection under the New Brunswick Endangered Species Act and the Canadian Species at Risk Act, as well as the Endangered Species Act of the United States.

While historic data are lacking, it is believed that population size and habitat availability have declined over time. The current Canadian population is estimated to be less than 1000 individuals and likely comprises between 5 and 15 % of the global population.

The dynamic nature of the habitat and the lack of data on long-term trends make it difficult to determine the population size and the number of sites that would constitute a self-sustaining population. In light of this uncertainty, the recovery goal is to conserve and monitor the existing sites, to increase the population size and the number of occurrences, and to maintain quality habitat within its range in New Brunswick over the long term.

It is recommended that the immediate focus be on the conservation of existing sites, by pursuing conservation options with landowners and through the collaborative development of site management plans. The establishment of a monitoring program will be essential to track the status of the population and the success of recovery efforts. An action plan should be developed to investigate the potential of propagation as a means of augmenting populations or of establishing new occurrences. A second action plan would identify and prioritize research questions related to the management and protection of the species.

Programs to promote awareness of the vulnerability of rare plants along the Upper Saint John River and to encourage wise land use practices will continue to be particularly important in the conservation of potential habitat. Education should also be provided to government staff where appropriate, and a protection policy should be drafted to ensure communication and to promote consistency among regulatory agencies.

The recovery initiatives proposed under this strategy should be developed in the context of the considerable work accomplished to date, particularly in the area of stewardship of the existing sites. In addition, collaboration with American conservation programs should be pursued, given the success of the research and monitoring programs that have been established in Maine.

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Part I: Background

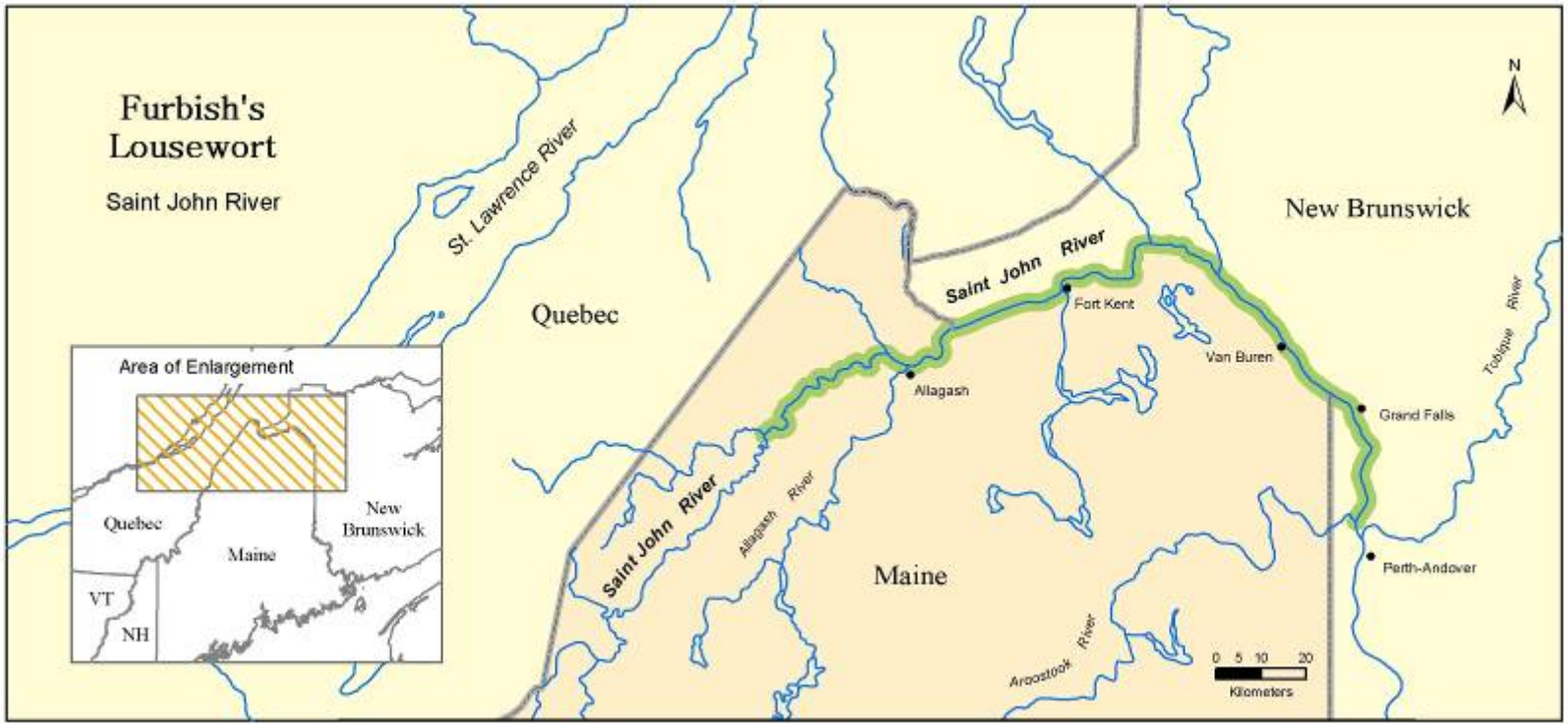
Species status

Scientific name: *Pedicularis furbishiae* Watson.
Common name: Furbish's lousewort
New Brunswick status: Designated Endangered (1982)
Status re-examined and confirmed as Endangered (1996)
COSEWIC status: Designated Endangered (1980).
Status re-examined and confirmed as Endangered (1998, 2000)
Status in the United States: Designated Endangered (1978)
Global range: Northern Maine and Northwestern New Brunswick
Range in Canada: Northwestern New Brunswick
Rationale for COSEWIC status: *Highly restricted range with natural and human-induced habitat loss and significant population decline at the three remaining sites.* (**Note:** Since the COSEWIC designation, two new occurrences have been documented.)

Description of the species
Furbish's lousewort is a perennial herb that occurs on the intermittently flooded, ice-scoured shores of the Saint John River. A member of the snapdragon family, it is recognizable early in the growing season by its basal rosette of deeply cleft or fern-like leaves. Toward mid-summer, mature plants produce one or more flowering stems. These stems have widely spaced leaves along their length and are topped by a tight cluster of small, yellow, tube-like flowers, which bloom only a few at a time.

Current distribution
Furbish's lousewort is globally restricted to the Saint John River Valley in northern Maine and northwestern New Brunswick. Its known distribution consists of a 225 km section of the Saint John River extending from above the confluence with the Big Black River in Maine, United States (U.S. Fish and Wildlife Service 1991) to the confluence with the Aroostook River, approximately 10 km north of Perth-Andover, New Brunswick (see map on page 2). In Canada, its range extends over the last 30 km of this section, beginning at the International border (approximately 5 km above the dam at Grand Falls).

It is difficult to delineate subpopulations or sites of this riparian species and its Canadian distribution might best be described as occurring along four segments of the Saint John River: one within the five-kilometer portion above the dam at Grand Falls and the remaining three within the 25 kilometers between the dam and the confluence with the Aroostook River. In addition, there is a unique occurrence of the species along an abandoned railway near the mouth of the Aroostook River. This is the only occurrence of Furbish's lousewort, in either the United States or Canada, which is not on a river shore.



Global range of Furbish's lousewort

Although there are no data that would generate an estimate of the historic abundance of Furbish's lousewort in New Brunswick, early accounts indicate that it was once more common than at present (Fowler 1885). The alteration of shoreline along the Upper Saint John River has almost certainly resulted in habitat loss and an associated population decline. The Canadian population is currently believed to be less than 1000 individuals (Nature Trust of New Brunswick 2003). This likely represents between 5 and 15 % of the global population, based on the estimates of the American population size, which have varied from 18,000 (U.S. Fish and Wildlife Service 1991) to a more recent estimate of less than 6000 (Gawler and Cameron 2003). The low population size, few occurrences, and continued pressures on its restricted habitat are the basis for recovery planning for the species in its Canadian range.

In developing the recovery strategy for Furbish's lousewort, the recovery team considered the available information on the nature and imminence of threats, the distribution and abundance of the species, the species biology and its habitat requirements. This information is summarized in Appendices A-C.

Part II: Recovery

Recovery feasibility

The long-term survival of Furbish's lousewort in New Brunswick, and therefore in Canada, is likely biologically feasible. However, the dynamic nature of the habitat and the lack of data on long-term trends make it difficult to determine the population size and the number of sites that would constitute a self-sustaining population. For the present, it is recommended that the focus be on the monitoring and protection of existing sites and of potential habitat, and that consideration be given to establishing a propagation program. If it is possible to increase the number of sites, and the numbers of individuals per site, then the probability of extirpation would be greatly reduced. Over time, it will be important to verify the adequacy of these efforts and to adjust accordingly.

Recovery goal, objectives and corresponding approaches

Recovery goal

To monitor the existing sites, to increase the population size and the number of occurrences of Furbish's lousewort, and to maintain quality habitat within its range in New Brunswick over the long term.

Ten-year objectives

To maintain the existing populations at a minimum of 200 individuals (mature and young) per segment in each of the three river segments where it is known to occur between Grand Falls and Perth Andover.

To maintain the number of Furbish's lousewort at a minimum of 250 individuals (mature and young) in the river segment between the International border and Grand Falls.

To maintain the population at a minimum of 250 individuals (mature and young) at the upland site near Aroostook.

To establish self-sustaining populations of Furbish's lousewort in additional river segments within its range.

To identify and conserve high quality potential sites for Furbish's lousewort.

Rationale for goal and objectives

The goal and objectives proposed in this strategy are intended as a first approximation of what would be required to ensure the long-term survival of Furbish's lousewort in Canada. The starting point is the protection of the existing populations. The minimum population size that is proposed for each site reflects the maximum or near maximum numbers recorded in recent surveys (see Appendix B). While it is preferable, in theory, to generate target numbers from population viability analyses, research on this species suggests a complex scenario that is not easily addressed by this application. Results from work in Maine (Menges 1990) indicate that viability varies among individual populations of Furbish's lousewort and varies within the same population over time. The overriding factors are catastrophic disturbance and the dynamic nature of the habitat. It is therefore recommended that steps be taken to protect current sites and that a propagation program be investigated as a means of increasing the number of sites and of responding to catastrophic loss at current sites. It is also recommended that measures be taken to ensure the long term viability of quality potential sites, as habitat degradation continues to be a concern for the species throughout its range (U.S. Fish and Wildlife Service 1991, Nature Trust of New Brunswick 2005.)

Broad strategies and short–term objectives

1. Population and site management/ stewardship

An obvious starting point for the conservation of Furbish's lousewort is the protection of existing populations. Respect for the role and rights of landowners is key to the successful management of the sites where Furbish's lousewort occurs. It is essential that landowners be provided the opportunity to consider the array of conservation options that are available to them. In some cases, land purchase for protection purposes may make the most sense; in others, continued stewardship by the owner may be the preferred option. Purchase for these purposes has generally been undertaken by conservation agencies. However, consideration should be given to purchase by government, in the event that sufficient resources are not available to a conservation organization. Further, it is important to take steps to avoid missing purchase opportunities in the long term. This could be accomplished by inviting landowners to consider sale to a conservation agency should they decide to put their land on the market, and by ensuring that they are provided with the relevant contact information for a potential purchase for conservation purposes.

Site management plans, prepared in collaboration with the property owners, are proposed as appropriate tools for addressing the specific challenges anticipated for each site. Potential threats include anthropogenic factors (*e.g.* illegal dumping, removal/alteration of shoreline and bank vegetation) and natural factors (*e.g.* vegetative succession, catastrophic ice-scour). Please refer to Appendix A for additional detail on threats to Furbish's lousewort.

The three sites of Furbish's lousewort that were documented before 2002 are owned or managed by agencies or organizations. (A fourth site has since been discovered on land owned by one of these agencies and a fifth site has been discovered on privately owned land.) These agencies have participated on the recovery team, and have undertaken or contributed to several conservation activities, including the preparation of site management plans. It is important that the Department of Natural Resources acknowledge their cooperation in a formal manner. Consideration should also be given to ensuring recognition of stewardship activity in the longer term.

Objectives for population and site management/stewardship

1.1. Ensure that landowners are contacted, have access to information on the species and its significance and on relevant legislation, and have an opportunity to discuss land management issues.
1.2. Provide landowners the opportunity to participate in conservation through any of a number of options, such as:
   - acquisition of the property by a conservation organization or government agency
   - participation in a site management plan or a conservation easement
1.3. Establish management plans for known sites
1.4. Establish and implement mechanisms to track changes in land ownership immediately as these occur.
1.5. Invite landowners to contact conservation oriented agencies in the event that they decide to sell their land.
1.6. Establish a program to formally recognize stewardship and volunteer efforts.

2. Protection

Species

Furbish's lousewort is protected under Regulation 96-26 of the New Brunswick Endangered Species Act. This legislation protects individual members of the species, as well as the habitat that is critical to survival of any member of the species. Thus, no individual or organization may possess, sell, harm or attempt to harm any individual plant or its habitat. Exceptions for research or education require a permit, which may be issued by the Minister of the New Brunswick Department of Natural Resources.

Habitat

As of 2006, one of the five known occurrences of Furbish's lousewort in New Brunswick was in a nature preserve and three others were protected through active stewardship by the property owners. Environmental regulations and planning requirements, particularly as related to water courses, potentially offer additional protection to the habitat. It is therefore important that the appropriate regulatory agencies have access to current information in order to provide habitat protection in a consistent and fair manner.

All known sites of Furbish's lousewort should be regarded as important to the long-term survival of the species in New Brunswick. The specific locations of individuals or of small groupings of plants are obviously essential to the survival of established populations. Similar habitat in the immediate vicinity of the plants (on a scale of metres) is the portion of potential habitat that is most likely to be colonized.

Activities at the scale of general sites should be limited to light foot traffic, preferably on the sparsely vegetated lower portion of the shore, and to the activities required for monitoring or targeted education. The existence of a treed buffer along the upper bank appears to contribute to the establishment or persistence of Furbish's lousewort. Planning should therefore address the maintenance of this buffer. Site management plans offer a vehicle for discussions between NB DNR and landowners regarding activities that are likely to occur at a site, stewardship practices that will favour persistence of the plant, and the application of habitat protection provisions of the Endangered Species Act to the property in question.

Protection objectives:

2.1. Record location of plants and of similar habitat in the immediate vicinity of the plants at known sites.

2.2 Foster habitat protection by working with landowners to development site management plans.

2.3 Develop protection policy that includes the Department of Natural Resources and other appropriate government departments and regulatory agencies in order to promote consistent implementation of regulations.

2.4 Ensure appropriate level of staff training/education within regulatory agencies.

2.5 Establish/support education measures to raise awareness of existing protection through the Endangered Species Act, Clean Water Act, Water Course alteration regulations or other measures.

3. Monitoring and surveys

A consistent population monitoring system is required in order to track changes in the populations of Furbish's lousewort and to assess the success of recovery activities. While surveys in New Brunswick have varied in timing and completeness, a formal monitoring program has been in place in Maine since the 1980's (Gawler 1987). A Canadian monitoring program would be compatible with the American methodology, with adjustments to accommodate tracking of the much smaller population of the species in this country.

The monitoring program should not be restricted to censuses of the known occurrences of the species, but should also include periodic surveys that are designed to detect newly established occurrences or occurrences that have been missed in previous searches. The dynamic nature of the river shore environment and the success of recent surveys underline the importance of monitoring on a broad scale.

Monitoring objectives:

3.1 Establish monitoring protocols and program for known sites
3.2 Establish protocols, guidelines and program for searches for new sites
3.3 Foster local and/or landowner involvement in monitoring of known sites

4. Research

Conservation work in New Brunswick has benefited from research conducted in Maine on the habitat requirements, population dynamics and reproductive ecology of Furbish's lousewort. However, a number of data gaps and potential research questions have emerged over the course of recovery planning for the species in the province. An action plan is required to provide context for the questions and to establish priorities for research. Highest priority should be given to questions that are most likely to have an impact on management decisions.

Objective for research requirements: Develop action plan to prioritize research requirements in light of management issues. Potential questions are as follows.

- Accuracy or consistency of monitoring protocols
- Questions on life history as required for site management plans (e.g. longevity of individual plants)
- Adequacy of current genetic information
- Questions related to propagation techniques in green house
- Variation in bryophytes at known habitats and applicability as habitat indicator
- Effect of control measures for shrub encroachment at sites
- Question regarding life span of existing populations in Canada and evidence of recent colonization events.

5. Establishment of new sites

It is important to explore the potential costs and benefits of augmenting existing populations or establishing new populations of Furbish's lousewort, given our inability to define the numeric thresholds required for long-term survival of the species in the province. This would most appropriately take the form of an action plan designed to identify and address relevant issues.

The central question is whether or not transplantation (of seed or plant) would reduce the risk of extirpation of the species. Development of clear, measurable targets and identification of the long-term resource requirements are also basic issues. Technical aspects would include genetic considerations (particularly with reference to Waller *et al.* 1987), propagation techniques (see Macior 1980 and notes from Tribe in NB DNR database), identification of candidate sites (see Gawler 1999), risk of introducing pathogens and monitoring requirements. It is likely possible to generate a list of criteria for selection of potential sites, based on research conducted to date. Landowner cooperation would be a key criterion. The potential impact on other species should also be evaluated, though the low competitive ability of Furbish's lousewort (Menges 1990) and the required habitat protection both suggest that the native flora would benefit from these activities.

The national policy on *Ex situ conservation and translocation in species recovery*, currently in draft form, provides a more thorough treatment of the issues around transplantation and introductions. The national policy should guide the development of the action plan.

Objective for the establishment of new sites: develop action plan to investigate the benefits and challenges of a propagation program. The action plan should address the following elements:

- Biological feasibility, benefits and risks
- Resources required over the long-term
- Goal setting and measures of success
- Questions of genetics and source material
- Habitat selection and protection
- Long-term monitoring
- Additional issues arising from national guidelines on translocation

6. Stewardship and Education for the General Public: planning for the long-term

Stewardship and education should continue to be significant components in the conservation of Furbish's lousewort. The Saint John River shoreline between Grand Falls and the mouth of the Aroostook River appears to be the area that has the highest potential for additional lousewort habitat. This same shoreline is also host to a unique assemblage of plants, many of which are rare or of limited distribution within New Brunswick. Stewardship efforts should therefore be focused on this area with the goal of fostering or reinforcing sound land use practices, particularly in the immediate vicinity of the riverbank.

Objectives for stewardship and education for the general public:

6.1 Encourage/facilitate participation and partnerships among community and conservation organizations in order to establish long-term stewardship programs in the area.

6.2 Establish/support education measures to raise awareness regarding rare and endangered plants

6.3 Establish/support education measures to promote good land use practices along river shores.

Recovery priorities and general steps

Priorities, general steps and measures of success
The specific actions required to attain the goal and objectives of the recovery strategy, with their associated priority and measures of success, are outlined in Table 1. It might be argued that all actions are of high priority given that Furbish's lousewort is an endangered species. However, we have attempted to provide a relative priority that reflects the urgency of the required action in light of three time frames (*immediate, short-term, long-term).* Long-term refers to those activities which should nonetheless be addressed within 10 years. In addition, measures of success have been identified to track the implementation of the recovery strategy.

Costs and additional impacts
Socio-economic concerns have been identified where possible. Their inclusion is not intended as an in-depth cost/benefit study, but rather as an outline of significant considerations for planning purposes. The most obvious concerns are related to the potential implications for the individuals or organizations that have Furbish's lousewort on their property, particularly if they have specific plans for activity in the areas where the plants are located. In the case of residential landowners, river access and habitat alteration in various forms (*e.g.* landscaping near shore) are likely to be the major stewardship issues. Organizations or corporate landowners could anticipate additional light costs in the form of the extra measures and staff time required to protect sites and to participate in discussions on the conservation of the species.

The costs of implementing the recommendations in this strategy have not been identified. However, a number of sources of funding at the provincial and national level have been accessible for initial work by the Nature Trust of New Brunswick (see Acknowledgements). Continued funding will be required for priority stewardship or research activities. New, and probably higher, costs would be associated with a long-term propagation program or further genetic work.

Effects on other species
A number of plant species that are rare in New Brunswick or the Maritimes occur along the shores of the upper Saint John River, and are frequently found in proximity to the lousewort. Thus, measures that protect current and potential habitat for the lousewort will likely contribute to the conservation of other rare species.

Accomplishments to date

The basic biology and ecology of Furbish's lousewort has been described, largely through studies conducted in Maine. These findings are summarized in Appendix C. In New Brunswick, significant progress has been made in the conservation of sites and in addressing threats, as outlined below.

- Purchase of the land now known as Stirrett Reserve by the Nature Trust of New Brunswick, resulting in the protection of roughly 15% of the Canadian population of Furbish's lousewort, as well as several additional rare plant species.
- Clear identification of ownership of additional properties that harbour roughly 65% of the Canadian population of Furbish's lousewort and commitment of several owners to cost-effective conservation through site management plans.
- Stewardship program for Upper Saint John River Valley conducted by Nature Trust of New Brunswick (2000-2005).
- Rare plant surveys of St. John River from international border to Perth-Andover (2001 – 2002) by Nature Trust of New Brunswick and Atlantic Canada Conservation Data Centre.
- Assessment of threats to Furbish's lousewort habitat along the Saint John River from international border to Perth-Andover (2004-2005) by Nature Trust of New Brunswick.

Recovery Planning Table. Recovery objectives and priorities (in bold) for Furbish's lousewort (**FL**). Immediate priorities should be addressed within six months to a year; short-term priorities within one to three years; and long-term priorities between three to ten years.

Broad approach	Short-term objectives or general steps	Priority, potential benefit	Progress to date	Measure(s) of success	Potential socio-economic issues
1. Population and site management/ stewardship	1.1 Notify landowners (and adjacent landowners) of presence of FL on their property 1.2 Provide information to landowners (and adjacent landowners) on range of conservation options; offer opportunities to discuss site management and conservation options 1.3 Develop management plans for known sites in collaboration with landowners 1.4 Establish and implement mechanisms to track changes in land ownership 1.5 Establish program to recognize stewardship and volunteer efforts	**Immediate** Protection of known populations	Landowner notification completed Discussion with landowners ongoing Site management plans have been drafted for 4 of 5 sites	Population size and habitat quality maintained at each site Approval of site management plans by landowners Incorporation of appropriate information in provincial database Positive response of recipients through continued participation in conservation	Potential conflict between goals of landowners and requirements for habitat protection Additional costs to landowners to protect or avoid areas in question Resource requirements for land purchase where appropriate
2. Protection	2.1 Map location of plants and of similar habitat in immediate vicinity 2.2 Incorporate habitat protection into Site Management Plans 2.3 Develop protection policy 2.4 Offer training to staff of regulatory agencies covering biology, threats and locations of FL 2.5 Promote initiatives to raise awareness of existing laws and regulations	**Immediate** Protection of known populations		Reduction in potential threats to habitat and plants	

Recovery Planning Table (continued)

Broad approach	Short-term objectives or general steps	Priority, potential benefit	Progress to date	Measure(s) of success	Potential socio-economic issues
3. Monitoring & Surveys	3.1 Establish monitoring protocols and program for known sites 3.2 Establish monitoring protocols, guidelines and program for searches for new sites 3.3 Foster stakeholder/ local involvement in monitoring	**Immediate - Short term** Essential data on population trends and on success of site management Detection of colonization events or of previously undetected sites Consistency in monitoring and increased stewardship	Protocols established in Maine (USA) Surveys of Canadian range completed (2002-03) Stakeholders engaged in recovery planning; stewardship work by Nature Trust	Timely and accurate counts and surveys as per protocols	Landowner notification and approval Annual costs for field work, data management
4. Research (Action Plan Required)	Develop action plan to prioritize and address research questions	**Immediate** Accuracy of monitoring	Research results from Maine; NB bryophyte survey completed	Research proposals based on research action plan priorities	Research costs and allocation of resources
5. Establishment of new sites (Action Plan Required)	Develop Action Plan to address points outlined in National Policy	**Short term** Potential mitigation of catastrophic events or of loss of individual sites	Research results from Maine; habitat mapping (Nature Trust)	Establishment of new sites or population increases at currently known sites	To be determined
6. Stewardship: General Public	6.1 Foster partnerships to establish long-term stewardship programs in the area 6.2 Promote initiatives to raise awareness regarding rare and endangered plants 6.3 Quantify threats to riparian habitat within New Brunswick range of FL 6.4 Promote initiatives that raise awareness of human land use impacts and that foster best practices along river shores 6.5 Establish communication mechanism within government to ensure awareness of recovery priorities & requirements during decision making processes	**Immediate – Long term** Protection of potential sites	2001-04. Work initiated by Nature Trust – (landowner contact, web site, poster, meetings); Long-term effort required Survey completed by Nature Trust, 2005 Education initiatives - ongoing; long- term effort required	Identifiable stewardship/education programs Improved land use practices compared with 2004 survey of riparian habitat (6.3) Reference to recovery activities by other provincial Departments	

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Appendix A
Assessment of threats and barriers to recovery

An important aspect to the development of this recovery strategy has been the assessment of threats to the species and its habitat, whether human-induced or natural forces. An initial scoring of the imminence and potential impact of identified threats was generated by recovery team members, based on their experience in the field and their familiarity with activities in the river valley (See Tables A and B, below). Our understanding of these threats has since been enhanced through work conducted by the Nature Trust and presented in *Assessing threats to the riparian flora of the Upper St. John River* (Nature Trust of New Brunswick 2005).

One of the most frequently cited threats to Furbish's lousewort is the alteration of river dynamics through construction of hydroelectric dams along the Saint John River, particularly at Grand Falls (1928). While there is little information on the extent of occurrence or the size of the Furbish's lousewort population previous to dam construction, it is likely that both have been reduced as a result of these projects. However, the threat of hydroelectric development is better described as historical, as the most recent project in the region was completed at Beechwood in 1958 and no changes in either the number of structures or the operation of dams in the Upper Saint John River are being pursued at present. Nonetheless, any future projects (e.g. increase in dam height or new construction) could potentially have an impact on the lousewort and this potential impact should clearly assessed in the project review.

Despite the creation of a head pond above Grand Falls, Furbish's lousewort persists as small pockets of one to sixty plants at intervals between the dam and the international border. Below the dam, the river dynamics often mimic pre-dam events through ice jams and extended periods of run-of-the-river flows. It is along these stretches of shoreline that the larger populations and potential habitat are found.

While river dynamics and regulation may be the most conspicuous concern, land use practices and relatively small events may have a significant impact on the habitat of Furbish's lousewort. In the summer of 2004, the Nature Trust of New Brunswick documented changes that had occurred along the Saint John River shoreline from the international border to Perth-Andover, a distance of roughly forty-five kilometers that covers the known Canadian range of Furbish's lousewort. Land use and habitat alteration within 30 meters of the high water mark were compared through a time series of aerial photographs (1944-45, 1974-77, 1996). In addition, a field inventory of habitat alteration provided detailed information not discernable from aerial photos.

The results, presented in *Assessing threats to the riparian flora of the Upper St. John River* (Nature Trust of New Brunswick 2005), underline a number of threats to the potential habitat of Furbish's lousewort and other rare plants. The absence of a treed buffer along over 40 % of the shoreline is of particular concern, as moderate shade appears to play a role in the establishment or survival of Furbish's lousewort (Gawler and Cameron 2001). Roads and old railroads (now recreational trails) were the activities most frequently linked to tree removal, with residential development, forestry operations, fields, gravel pits and commercial development noted as additional sources, respectively. However, the report notes that the potential for additional road and trail development appears to be low and that the amount of

buffer affected by agricultural activities has declined by roughly 50 %. By contrast, the extent of shoreline affected by residential development and gravel pits has increased by two-fold or more since the mid 1970's, suggesting that these two activities represent more current threats.

The field inventory was particularly effective in quantifying threats and habitat alteration at the finer scales. Recreational activities (footpaths, boat docks, marinas, picnic or other access areas) were documented for a combined shore length of over 13 km. The total amount of bank or shoreline altered by dumping incidents exceeded two and a half kilometers. The combination of filling, bank stabilization and slumping attributable to human activity covered close to 6 km or 5 % of the study area. Significant establishment of invasive species (patches > 5 m in length) were recorded over 6 km of shoreline, most often in association with disturbances such as shade removal.

The probability or frequency of incidents of dumping or other disturbances at the known lousewort sites is unpredictable, but the potential impact on the population at any given site would be significant. Education initiatives and stewardship programs would be an appropriate response to the increased demand for residential and recreational access to the river. Adoption of sound shoreline stewardship practices, in combination with site management plans at known locations, would be valuable in protecting Furbish's lousewort. Regulatory agencies are in a position to have an impact on these practices, through enforcement or through assistance to landowners in selecting less disruptive options in land use planning, and there is a particular need for regulatory agencies to address the problem in a concerted effort.

In addition to these human activities, there are a number of natural factors that reduce population levels or alter habitat. While the effects of ice scour and bank erosion may be unpredictable, and at times beneficial, encroachment by shrubs has been noted at more than one site and remains a question to be addressed for each sub population through site management plans. Additional natural factors, such as herbivory (Macior 1978, Menges *et al.* 1986) or seed parasitism (Macior 1978, Macior 1979 in Stirrett 1980) are known to occur, though the long-term effects on population are not quantifiable at this point and there is no obvious mitigation for these problems. Finally, a natural factor that may become problematic by its decline is the potential overall decline in pollinating bees in general (Allen-Wardell *et al*. 1998), though this impact would not be limited to Furbish's lousewort.

In short, the main recommendations to address threats are the elaboration of a protection plan (by the regulatory agencies), development of site management plans, and both targeted and general stewardship or educational programs.

Table A. Threat assessment: human-induced impact. Potential impact on current and potential habitat of Furbish's lousewort, based on observations during site visits and on analysis conducted by Nature Trust of New Brunswick (2005), as indicated by an asterisk.

Potential Threat	Current frequency or extent of occurrence	Probability of future occurrence	Potential impact	Potential Mitigation
Change in river dynamics through dam construction	Historical: Grand Falls Dam (1928) Beechwood Dam (1958) Tobique Dam (1952)	Low - no anticipated projects	Past impact not quantifiable. Future projects could have high impact	None proposed
Change in river dynamics through localized projects (docks, etc.)	Low at current sites High at potential sites*	High	Low	Protection, Stewardship
Loss of buffer of trees along bank (attributable to various activities)	Low at current sites High at potential sites*	Low at current sites High at potential sites	High Moderate shade is important habitat attribute	Stewardship, Protection
Dumping over bank or along shore	High at current and potential sites*	High at current and potential sites	Small to medium - often restricted to small area	Targeted stewardship Protection
Development of shoreline: residential	Intermediate at current sites High at potential sites*	Intermediate at current sites High at potential sites - documented increase*	High - permanent alteration of habitat	Project review/ protection plan. Targeted stewardship for current and potential sites
Development of shoreline: roads, trails, railway	High at current and potential sites*	Intermediate at current and potential sites	High - permanent alteration of habitat	Project review/ protection plan
Recreational activities	Intermediate at current sites High at potential sites*	Intermediate at current sites High at potential sites - documented increase*	Intermediate to High, varies with nature and intensity of activity	Project review/ protection plan
Bank stabilization/ bank slumping	Intermediate	Low at current sites Intermediate at potential sites		Stewardship, Protection
Gravel extraction	Low at current sites High at potential sites*	Low at current sites High at potential sites - documented increase *	High - permanent alteration of habitat	Project review/ protection plan
Use of pesticides/ herbicides	Low at current sites, potential factor at scale of landscape	Low at current sites, potential factor at level of landscape	Low	Stewardship

Table B. Threat assessment: impact from natural events. Potential impact on current and potential habitat of Furbish's lousewort, based on observations during site visits and on analysis conducted by Nature Trust of New Brunswick (2005), as indicated by an asterisk.

Potential Threat	Current frequency or extent of occurrence	Probability of future occurrence	Potential impact	Potential Mitigation
Bank erosion	High at current and potential sites*	High at current and potential sites *	Varies with site and event - potentially beneficial or destructive	None proposed
Ice scour/ flood waters	Not quantifiable	High	Potentially beneficial or destructive	Not applicable
Succession: encroachment by shrubs	Intermediate to high at current sites Unknown at potential sites	Intermediate to high at current sites Unknown for potential sites	Suppression of establishment and reproduction	Site management
Herbivory by insects	Unknown	Unknown	Undefined in short-term	None proposed
Seed parasitism	Unknown	High	Reduced seed crop	None proposed
Browsing by mammals	Low at current sites Unknown at potential sites	High	Reduced seed crop, low probability of occurrence at multiple sites in a single year	None proposed

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Appendix B
Current and historic distribution and abundance

Historic records

Our understanding of the historic distribution and abundance of Furbish's lousewort is incomplete at best. It is based on the brief notes accompanying specimen vouchers and on accounts of earlier botanical excursions from various, and sometimes scattered, sources. The strongest evidence that the plant was once more abundant than at present comes from James Fowler's Preliminary list of the plants of New Brunswick (1885). Referring to early collections, he provides the following entry for *Pedicularis furbishiae*: "Rather common on both sides St. John River between Grand Falls and Andover, *Hay* and *Wetmore*; abundant at mouth of Aroostook, *Vroom.*"

Fowler is most likely referring to specimens that were later also included in Stirrett's (1977) review of botanical collections related to Furbish's lousewort. Stirrett traced the extent of botanical investigations in northern Maine and northern New Brunswick, beginning with the work of Goodale in the early 1860's and ending with a description of his systematic search (with Fred Tribe and Hal Hinds) for the species along the Canadian portion of the Saint John River in 1977. In addition to summaries of field expeditions, he compiled a list of sixty-seven herbarium vouchers of Furbish's lousewort, including the type specimens collected by Kate Furbish, located in nineteen different collections across several countries.

These early records not only suggest that the lousewort was once more abundant, they also provide some of the very scarce indications that lousewort sites were not restricted to the Saint John River proper, though the location information for most vouchers is less than precise. There are two mentions of Furbish's lousewort on the Aroostook River in New Brunswick: one indicating "Aroostook River" collected by J. Vroom in 1884 (#1709, British Museum of Natural History, in Stirrett 1977) and one specifically indicating the mouth of the Aroostook River, collected by Churchill in 1901 (Harvard University, Gray Herbarium, in Stirrett 1977). In addition, a voucher note by Wetmore in 1882 (#2643, New Brunswick Museum, Saint John) cites the Upper Saint John River as a location, but in the details refers to "banks of streams." Furbish's lousewort is not currently known from any tributaries or streams of the Saint John River. Portions of the Aroostook, particularly near the river mouth, were searched in 1977 by Stirrett and companions, and again in 2003 as part of the surveys by the Nature Trust of New Brunswick and the Atlantic Canada Conservation Data Centre. No lousewort were found, though it should be noted that the habitat has been altered; the Tinker Dam was built roughly five kilometers from the mouth of the Aroostook during the early 1900's. The 2003 survey did detect the lousewort on the Saint John River, a short distance upstream and on the shore opposite the mouth of the Aroostook River. An additional historic occurrence opposite Little River (near the Stirrett Reserve) has not been relocated.

Also of interest in the list of museum vouchers are the reports of Furbish's lousewort from Aroostook by Vroom in 1884 (# 97558, National Museum of Canada, in Stirrett 1977) and from Andover in 1882 by Hay (Queens University, Fowler Herbarium, in Stirrett 1977). Though the precision of these data is problematic, they suggest that the species may have occurred further downstream, by perhaps 5 km, from the most southerly occurrence known at present.

Unfortunately, the voucher information provides limited information on the occurrence of the lousewort in the vicinity of Grand Falls. An 1879 collection by Hay at Grand Falls (#2644, New Brunswick Museum) includes the description "copses and banks." A 1943 specimen collected by Stirrett (Agriculture Canada in Stirrett 1977) suggests an occurrence immediately downstream of Grand Falls, a site that has not been relocated. Finally, a voucher collected by Moser in 1878 (Queens University, Fowler Herbarium) was originally misidentified as *P. canadensis*, suggesting perhaps an additional confounding variable in our efforts to understand its historic abundance and distribution.

Current distribution and abundance

Much of our understanding of the current distribution and abundance of Furbish's lousewort stems from the interest generated following its rediscovery in 1976, during preparatory studies related to a proposed hydro-electric project. Systematic surveys (Stirrett 1977) re-confirmed historic accounts of the species above the dam at Grand Falls and below the dam at what is now the Stirrett Reserve. They also resulted in the discovery of the unique occurrence of Furbish's lousewort along the railway embankment near the mouth of the Aroostook River (Stirrett 1980).

Subsequent surveys for Furbish's lousewort were patchy until 2001, when the Nature Trust of New Brunswick and the Atlantic Canada Conservation Data Centre covered the Canadian portion of the shoreline from the mouth of the St. François River to Perth-Andover. Several stretches of shoreline were examined on foot, and two previously unknown pockets of Furbish's lousewort were discovered (Nature Trust of New Brunswick, 2003).

The Table below summarizes the data available from surveys of the Canadian population of Furbish's lousewort, beginning with the extensive efforts of the late 1970's as documented by Stirrett (1977). Inconsistencies in survey techniques and search effort make it difficult to compare results both within and between years. Estimates of the Canadian population of Furbish's lousewort have varied from the low of 220 reported by Hinds in 1997 to estimates of 800 to 900 plants resulting from the increased search effort and discovery of new populations of Furbish's lousewort in 2002 (Nature Trust of New Brunswick 2003).

Table A. Summary of survey results for Furbish's lousewort. Counts of Furbish's lousewort from complete and partial surveys (1977-2002). Numbers in parenthesis represent the proportion of plants in flower/plants not in flower. **DNR** refers to the Department of Natural Resources, New Brunswick.

Year and reference	Aroostook	Above Grand Falls	Stirrett Reserve
1977 Hinds (1998)	178 (63/115)	254	70 (44/26)
1979 Stirrett (1980)	33	254 (154/100)	115 (69/46)
1981 Brown (1982)	80	102	212
1982 Brown (1982)	125	117	213
1983 Drummond (1987)	231	125	175
1984 Brown in Hinds (1988)	234		225
1987 Drummond (1987)	171 (50/121)	120 (41/79)	165
1991 O'Brien (1991)	50+ (12/38)		313+ (112/201)
1996 O'Brien (1997)			136 (90/37)
1997 Hinds (1998)	22 (18/4)	62 (12/50)	
1998 DNR database		67	50
1999 DNR database **[1]O'Brien (1999)**	42 (42/0)	171** (31/3)	65[1]
2000 DNR database	84*		62
2001 DNR database	314 (163/151)	298 (115/183)	146 (73/73)
2002 Nature Trust (2003)	224 (97/127)	243 (105/138)	126 (66/15)

Note: In 2002, two additional occurrences were discovered where counts were 187 (61/126) and 124 (99/25).

***** Count on July 21/00 by DNR, 28 stems damaged.

****** Note: the 1999 total for above Grand Falls was obtained from a survey in July, while the numbers in parenthesis represent the plants that were resurveyed in a more limited August visit.

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Appendix C
Biology and habitat requirements

Biology

Furbish's lousewort is a perennial herb, of apparently poor competitive ability (Menges 1990), such that it depends on periodic scouring or erosion events to create new habitat or reduce encroachment by shrub or other vegetation. Reproduction appears to occur by seed only (Macior 1978, Menges 1990) and there appears to be little in the way of seed dormancy or a seed bank (Menges 1990).

The establishment and phenology of Furbish's lousewort has been described primarily from research by Gawler *et al.* (1987) in Maine. Seedlings may emerge from mid- June through August, with seedlings occurring more frequently on moss than on soil, litter or gravel. High summer survival rate is enhanced by moisture and increases with later germination. Seedlings are obligate root hemiparasites, though they are apparently not host specific (Macior 1980).

In nature, Furbish's lousewort reaches reproductive maturity only during its third summer (Gawler *et al.* 1987). Early in the growing season it consists of a basal rosette of deeply cleft leaves. One or more flowering stems appear in mid-July through August (Macior 1978), and capsules mature in August through September (Menges *et al.* 1986). The only pollinator identified to date is *Bombus vagans* (bumblebee), noted in studies that also indicated that Furbish's lousewort is an obligate outcrosser (Macior 1978). However, the lack of genetic variation within the species raises the possibility that it may also self-pollinate (Waller *et al.* 1988).

Flower initiation is predicted by size, and reproductive output is strongly affected by shade (Gawler *et al.* 1987). Plants under dense cover produce fewer flowers than would be expected for their size (Gawler *et al.*1987) or remain in a vegetative state (Day 1983). The effect of shade is particularly important in relation to succession and encroachment by shrubs. Gawler (1988 in US Fish and Wildlife Service 1991) observed a decrease in the seed production of individual plants at sites where the largest shrub stems were older then 5 or 6 years.

In addition, seed output has been shown to be significantly affected by inflorescence herbivory by spittlebugs (Macior 1978; Menges *et al.* 1986); browsing by mammals (Menges *et al.* 1986; Hoyt, *pers. comm.*); seed predation by plume moth (*Amblyptilia picta*) (Menges *et al.* 1986) and seed parasitism by parasitoid wasps (Menges *et al.* 1986).

While dispersal ability is difficult to measure, studies conducted in Maine suggest that regeneration generally occurs not far from the parent plant, rather than through long-distance dispersal (Gawler 1999). Seeds float, but they lack mechanisms for wind or animal dispersal (Menges 1990).

Genetic analysis (electrophoretic patterns at 22 loci in 28 individuals from four sites) failed to detect variation among individuals or sites (Waller *et al.* 1988). The methods were considered by the researcher to be sufficient in that they routinely detect variability in other species (Waller *et al.* 1988).

Habitat requirements

Furbish's lousewort is restricted to the main stem of the Saint John River, above it's confluence with the Aroostook River. Its distribution is therefore shared between Maine and New Brunswick. Most of our understanding of the ecology and habitat requirements of this species comes from work in Maine, where extinction and colonization events, on the scale of populations or sites, have been linked to the dynamics of ice scour and high energy spring floods and, to a lesser extent, bank slumpage (Menges 1990, Gawler *et al.* 1987). These events damage or remove vegetation, potentially leading to reductions or even complete loss of some colonies of Furbish's lousewort. Conversely, they may prove to be beneficial by creating new habitat or by enhancing the persistence at a site by reducing encroachment by shrubs or other competing vegetation. The net effect of these events at a given site is not likely to be predictable.

The role of additional environmental variables, while not independent of disturbance events, has also been the subject of studies in Maine. Moisture, substrate and cover have been described by Gawler *et al.* (1987) as factors of varying importance in the establishment, survival and reproduction of Furbish's lousewort. Their work identified the significance of soil moisture, relative to other site variables. Survival of seedlings and growth of established plants were higher on saturated soils than on moist soils, and were lowest on dry soils. This is particularly important given that, in the same study, plant size was found to be the most accurate predictor of onset of flowering.

Substrate appears to play a role in germination. Gawler *et al*. (1987) found that seedlings occurred more often on moss than on gravel, bare soil or litter. This pattern was reinforced in a later study on recolonization (Gawler 1999). At a larger scale, the degree of bank consolidation or cohesiveness is a determinant of the vulnerability of a given site to catastrophic disturbance, as described by Gawler *et al.* (1987). The latter note that the conditions that favour lousewort growth (*i.e.* steep slopes, groundwater seepage) are also linked to bank instability and increased vulnerability to slumping or erosion.

Gawler *et al.* (1987) found plant cover to also be a significant variable, though the nature of the impact varied with the life stage of the plant and was confounded by suspected interaction with other variables (Gawler *et al.* 1987). However, they noted that dense cover consistently depressed flowering. This suppression of reproductive output may nonetheless contribute to the persistence of the species at a site. Gawler *et al.* (1987) noted that most of the lousewort plants at a given site occurred within a narrow elevational range. However, a small number of larger than average plants were to be found within the forest edge at the upper margins of this narrow band, providing perhaps a potential source of seed should plants on the more exposed shore be lost to scour. In a later study on recolonization, Gawler (1999) underlined the significance of residual plants in the re-establishment of lousewort following catastrophic disturbance.

While the effect of cover and canopy on Furbish's lousewort appears to be less than straightforward, shade or solar radiance is nonetheless believed to be a significant factor at the scale of site characterization. Furbish's lousewort occurs, for the most part, on north- or west-facing shores (Macior 1978, Stirrett 1980, US Fish and Wildlife Service 1991). It is not clear whether this near consistency in aspect is related to a requirement for light or for moderate shade. Macior (1980) suggested that the species could grow in full sunlight, though Gawler and

Cameron (2001) underline the importance of the treed buffer at the top of the bank in maintaining an appropriate microhabitat.

The interaction of disturbance events and other environmental factors suggests a limited window for establishment of Furbish's lousewort (Gawler *et al.* 1987). The presence of even a small number of residual plants may enhance the probability of re-establishment of a subpopulation. Regeneration is favoured on a moss substrate, which generally requires three years post-disturbance to form. Given that plants in the wild do not produce seed until their third summer (Gawler et al. 1987), a minimum of six years would be required for establishment and reproduction following disturbance. An interval of ten years between disturbances is likely a more accurate estimate of the time required for a sub-population to achieve significant reproduction and to contribute to the overall survival of the species (Menges 1990).

Habitat in New Brunswick

New Brunswick faces some unique scenarios and challenges in the conservation of Furbish's lousewort. The typical habitat as described from Maine's larger populations occurs along free-flowing river where the dynamics that are believed to be responsible for the survival of the species are essentially intact. However, the dynamics of the Saint John River as it flows through New Brunswick have been altered by dam construction and the lousewort occurs in less than typical habitat: along a headpond, along a stretch of river with minimally altered dynamics, and at a site completely away from the river. The effects of these various regimes are not clear and this lack of clarity underlines the importance of protecting and maintaining the population at all currently- known sites. Questions that merit attention are related to site management issues, such as control of shrub cover at the upland sites, and the potential for or evidence of recent colonization events.

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