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A Focal-Species Approach to Biodiversity Management in Nova Scotia

Volume 1

by

Karen F. Beazley

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy

Interdisciplinary Ph.D Programme
Faculty of Graduate Studies

at

Dalhousie University
Halifax, N.S.

April 1998

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Abstract

This thesis examines biodiversity management in Nova Scotia with a particular focus on protected areas. The necessity for species-population level considerations in biodiversity management is demonstrated. An approach for identifying focal-species is developed and tested. Potential focal-species are identified. The focal-species approach is then adapted and utilized to select indicator species to monitor biodiversity in Kejimkujik National Park. Finally, links are made between focal-species and landscape-level considerations in Nova Scotia by considering habitat requirements of viable populations.

Losses of biodiversity have occurred in Nova Scotia, including wolf and woodland caribou species and populations of other species. Existing and proposed parks and protected areas in Nova Scotia will not serve to maintain current levels of native biological diversity. Few, if any, of the areas are large or connected enough to maintain viable populations of native species over time. Biodiversity objectives must be integrated into broader landscape planning.

A focal-species framework for identifying species warranting special biodiversity management attention in Nova Scotia was developed and tested with the participation of wildlife biologists and other experts through a Delphi survey approach. This constitutes the original or primary research component of the thesis. Variables considered include rarity and population status, biological characteristics, habitat-related vulnerability, ecological importance, human impact factors, and information status.

The framework was found to be useful for identifying potential mammal, reptile and amphibian, and freshwater fish focal-species, including Gaspé shrew, eastern cougar, lynx, eastern pipistrelle, wood turtle, Blanding's turtle, four-toed salamander, Atlantic salmon, Atlantic whitefish and lake trout. Five of these species are also listed as endangered by COSEWIC (1996). Potential focal-species which do not appear on other lists of concern include: Arctic shrew, bullfrog, pickerel frog, northern leopard frog, and several fish species such as Atlantic salmon, brook trout and blueback herring. New information suggests that American moose is also a potential focal-species. The value of a focal-species approach is in identifying potentially vulnerable species before they become at risk.

The focal-species framework was also found to be useful for identifying potential indicator species for monitoring population dynamics as a measure of biodiversity. Potential indicator species for Kejimkujik National Park include fisher, American marten, American moose, Blanding's turtle, snapping turtle, yellow perch and brook trout.

Focal-species may also be linked to the landscape-level by defining parameters relative to the resource or habitat requirements of the most demanding focal-species. If the landscape requirements of the most vulnerable and demanding focal-species are met, then many other species will also be protected. Focal-species were characterized according to threats and habitat or resource requirements. They were also categorized as area-, dispersal-, resource-, or process-limited, after Lambeck (1997). Focal-species requiring landscape-level biodiversity management attention include: American moose, fisher, eastern cougar, lynx, little brown bat, northern long-eared bat; wood turtle, Blanding's turtle, northern ribbon snake and pickerel frog; Atlantic whitefish, Atlantic salmon, and brook trout. Additional information regarding specific species-population-habitat relationships for particular regional or biogeographical contexts is required to make precise prescriptions for landscape-level parameters such as habitat requirements.

The thesis concludes that species-population-level considerations are necessary for biodiversity management. The focal-species approach may be the best way to integrate and focus information and initiatives at various levels. A regional population-level approach is recommended to take into account variations in population and habitat status and biogeographic context. The approach could also be adapted for other applications and jurisdictions.

In summary, several focal-species were identified in every assessment and thus warrant special biodiversity management attention at all levels: Eastern cougar, lynx, American marten, fisher, American moose; wood turtle, Blanding's turtle, northern ribbon snake, blue-spotted salamander, four-toed salamander; and, Atlantic sturgeon, Atlantic salmon, Atlantic whitefish, brook trout, lake trout and blueback herring. Other potential focal-species requiring additional research include bats and frogs. Other classes of flora and fauna should be assessed to identify a full suite of focal-species for biodiversity management attention in Nova Scotia. These focal-species can provide a focus for numerous biodiversity planning and management initiatives including partnership and co-operative arrangements and education.

List of abbreviations

BP	Before present
BWG	Biodiversity Working Group
CEAC	Canadian Environmental Advisory Council
CCEA	Canadian Council on Ecological Areas
CESCC	Canadian Endangered Species Conservation Committee
CITES	Convention on International Trade in Endangered Species
COSEWIC	Committee On the Status of Endangered Wildlife In Canada
EC	Environment Canada
IBP	International Biological Programme
IUCN	International Union for the Conservation of Nature and Natural Resources
MAB	Man and the Biosphere Programme
MCA	Minimum critical area
MDA	Minimum dynamic area
MVP	Minimum viable population
NBDNRE	New Brunswick Department of Natural Resources and Energy
NCC	Nature Conservancy Canada
Ne	Effective or ideal breeding population size
NFSC	National Forest Strategy Coalition
NSDFA	Nova Scotia Department of Fisheries and Aquaculture
NSDLF	Nova Scotia Department of Lands and Forests
NSDNR	Nova Scotia Department of Natural Resources
NSDOD	Nova Scotia Department of Development
NSDOE	Nova Scotia Department of Environment
NSDOEd	Nova Scotia Department of Education
NSRTEE	Nova Scotia Round Table on Environment and Economy
PVA	Population Viability Analysis
TNC	The Nature Conservancy (United States)
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Environment and Society Conservation Organization
WCED	World Commission on Environment and Development
WMI-LAIG	Whitehorse Mining Initiative-Land Access Issues Group
WMI-LCA	Whitehorse Mining Initiative-Leadership Council Accord
WWF	World Wildlife Fund Canada

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Thank you, Dalhousie. I'm glad to be home. And I'll be proud to call you my *alma mater*.

Chapter 1

A responsibility to manage for biodiversity in Nova Scotia

1.1 Introduction

As a society and as a species we have responsibilities and obligations towards other species and future generations and for the environment which we share. International, national and provincial initiatives reflect this responsibility and call for sustainable development, and the maintenance of ecological integrity, biological diversity (biodiversity) and life-supporting systems (IUCN et al. 1980; 1991; WCED 1987; UN 1992; BWG 1994; NSRTEE 1992). Protected areas and broader landscape management have significant roles to play towards these conservation goals in general and towards the maintenance of biodiversity in particular. Biodiversity management is being informed by ideas in conservation biology and landscape ecology that call for the maintenance of key ecological processes such as the continued viability of populations of native species over time.

The thesis examines biodiversity management in Nova Scotia with a particular focus on protected areas and focal-species and populations. Ecological considerations for protected area planning and management are described and Nova Scotia's parks and protected areas systems plan is assessed relative to these considerations (Beazley 1997a). The necessity for species-population level considerations is demonstrated. A focal-species approach to biodiversity management is developed and tested for Nova Scotia with the assistance of local ecologists, biologists and wildlife managers through a Delphi survey (Linstone and Turoff 1975). This represents the original or primary research component of the thesis. Potential focal-species are identified (Beazley 1997b). The approach is adapted and applied at the regional level for selecting indicator species to monitor population dynamics as a measure of biodiversity in Kejimkujik National Park (Beazley 1997c). Finally, links are made between species-population and landscape-level considerations in Nova Scotia by considering the habitat and resource requirements of the most demanding focal-species.

The research presented through this thesis represents a truly interdisciplinary approach. It draws upon geography, particularly biogeography, palaeoecology, conservation biology, landscape ecology, wildlife management, landscape planning and design, philosophy, social science, political science, and perhaps a little religion in responding to a critical and timely challenge. It represents an integration of ethics, science and management. The result is a synthesis of many disciplines and levels or scales, integrating history and context, yet strategic and future-oriented in its direction towards the goal of maintaining biodiversity, or evolution itself in the form of speciation, over time. It also is completed within the spirit of bioregionalism and responsibility toward this place called home.

This introductory chapter describes the broader context for the thesis, as well as its content and methodologies. Biodiversity is defined and the philosophical, political and scientific rationales for its protection are summarized. A brief historical context is provided including the biogeographic evolution of Nova Scotia and land-use history and landscape change. Major changes in biodiversity in Nova Scotia are described, as well as the main causes of those changes. Current threats to species are explored and the need for species-population level considerations in protected areas and other biodiversity management is introduced.

1.2 What is biodiversity?

Maintenance or enhancement of current levels of native biodiversity is a critical objective of protected area planning and management and a fundamental component of ecological integrity and sustainability. Recovery, maintenance and enhancement of biodiversity provides the underlying purpose for this thesis. Biodiversity may be defined as "the variety and variability among living organisms and the ecological complexes in which they occur" (United States Congress, Office of Technology Assessment 1987, as cited in NSDNR 1994, 4). Elements of biodiversity may be organized into various levels including regions, landscapes, ecosystems, species, populations, and genes. Biodiversity also encompasses the number, frequency and relative abundances of these elements. Most current protected areas planning initiatives in Canada are focused at the level of regional, landscape, or ecosystem diversity (Hummel 1989; Canadian Heritage 1994a; NSDNR 1994). Many initiatives such as endangered species legislation are focused at the species or sub-species level (NSDNR 1997b; Environment Canada 1996). Daily and Ehrlich (1997-1998) suggest that the most appropriate level for focus within the temperate zone, including Canada and Nova Scotia, is the population level. For example, although the extirpation of the wolf from Nova Scotia does not represent a loss at the species-level, there is a loss to biodiversity, not only in Nova Scotia, but in the overall genetic, and social or demographic variation among populations of wolves.

1.3 Why is biodiversity important?

Biodiversity and its preservation are important for a wide range of utilitarian and intrinsic reasons. A case for the contrary view, that biodiversity is not important, would be very brief because there seem to be no defensible scientific or philosophical arguments to support such a view. Biodiversity provides utilitarian values through the supply of virtually every resource for human sustenance and economic livelihood, recreational, spiritual, aesthetic, and scientific opportunities, and ecological services and life-supporting systems. Without biological diversity we cannot survive (IUCN et al. 1980; 1991; WCED 1987; Ehrlich and Ehrlich 1992; NSDNR 1994). However, an ethically compelling argument other than self-interest for the preservation of biodiversity is that it may possess intrinsic value. Those who hold this view claim that elements of biodiversity have intrinsic value simply because they exist, as products of evolution, regardless of their utility to humans or other entities (Taylor 1986; Singer 1992; Rolston 1995). Biodiversity has intrinsic value as the process and product of evolution (Rolston 1995).

1.4 Moral considerability of biodiversity

Ethical arguments for the value of biodiversity and its protection can be categorized as primarily anthropocentric, biocentric or ecocentric. Anthropocentric or human-centered ethics attach value to biodiversity through human self-interest, duties to future generations of humans, and religion-based duties related to dominion or stewardship responsibilities over other species, the earth, or creation (Passmore 1974). Biocentric or life-centered approaches attach value to all forms of life and recognize that humans are just one part of a larger mixed community including non-human life (Taylor 1986; Midgley 1983). As members of a common, inter-related community, rights or consideration of interests must be extended to other forms of life. Ecocentric perspectives recognize the values inherent in both living and non-living components, including rocks, soil, air, water and holistic entities such as ecosystems as part of the community. As such, ethical consideration can be extended to ecological communities, including the physical environment. This perspective was first expressed in Aldo Leopold's land ethic (Leopold 1949).

All of these perspectives may utilize extensions of moral approaches developed through the western philosophical tradition to address human-related problems and define social morality. Aristotelian, Kantian and Utilitarian approaches (Sterba 1995a) may be extended to other living and non-living entities by recognizing or arguing that the greater good or net utility is accomplished by protection of biodiversity, and that this could be realized by everyone concerned if biases and self-interests could be eliminated from consideration. For example: protecting biodiversity would *maximize the net utility or satisfaction of everyone affected by it* (Utilitarian); protecting biodiversity would *further one's own proper development* (Aristotelian); protecting biodiversity would *unanimously be agreed to by individuals behind an imaginary veil of ignorance* (Kantian, as developed by John Rawls).

These arguments could be extended to consideration of biodiversity and successfully defended from a human-centered point of view. However, they become particularly compelling if non-human entities are considered part of the community and within the mix of entities for which benefit, utility, satisfaction and proper development is calculated. Further, the Kantian *imaginary veil of ignorance* could be extended to encompass future generations, non-human entities, and others who would not profit from the over-exploitation of biodiversity, thus masking self-interest and knowledge of the generation or species to which you belong. As a rational, moral thinker you would then be deciding on the best distribution of goods and values from the point-of-view of all sentient beings, rather than from that of your own species, your own generation, or your own self. The argument is further extended by recognizing issues of inter-generational (Norton 1991) and international equity (Rollin 1995), not to mention inter-species equity, or issues of "speciesism" (Singer 1992).

It is necessary to kill or utilize individuals of other species to satisfy our basic or essential needs; this may be considered morally acceptable on the grounds that most species behave in this same way. Indeed, this may also be considered morally defensible in interactions with other humans, such as in self-defense or attending to our own or our children's survival. However, it is not considered acceptable to kill, exploit or aggress against another being to satisfy non-essential or luxury wants (Sterba 1995b).

1.4.1 The case for preserving species

When Sterba's argument about aggressing against individuals is extended to the species level of biodiversity it becomes even more critical. The elimination of species, populations or whole communities may be considered a kind of "super-killing" that should not occur without "super justification" (Rolston 1995). Species represent a life form expressed in individuals; destroying a life form destroys genetic material or information that evolved over time and in response to environmental and other changes:

> What humans ought to respect are dynamic life forms preserved in historical lines, vital informational processes that persist genetically over millions of years, overleaping short-lived individuals. It is not *form* (species) as mere morphology, but the *formative* (speciating) process that humans ought to preserve, although the process cannot be preserved without its product. (Rolston 1995, 320-321)

Valuing speciation and evolution for its own sake is a recognition of intrinsic value and that value must extend to the species itself.

Rolston argues that humans have a responsibility to not destroy these life forms which he sees as "process, product, and instrument in the larger drama to which humans have duties, reflected in duties to species" (1995, 326). Further, he suggests that maintaining this process and product of biodiversity is "about as near to ultimacy as humans can come in their relationship with the natural world" (Rolston 1995, 327).

1.4.2 The case for preserving populations

Similar arguments may be made regarding sub-species or populations as genetically, socially and demographically distinct life forms within species, adapted to specific biogeographic context. Populations represent regional variability in genetic composition and social-demographic behavior within species which may reflect adaptations to local environments. Populations may be the appropriate level of life form to protect in the temperate zone where the species diversity is not so high as, for example, in the tropics (Daily and Ehrlich 1997-1998). Geographic ranges of species are two to three times larger in temperate regions and extend across various environments. This has undoubtedly resulted in a greater subspecies or population diversity. Significant genetic and other variation or diversity within species exists at the population level. Further for species with large geographical distribution or range, species can be extirpated from numerous and large areas without being threatened with extinction, however tremendous biodiversity will have been lost through losses of populations through most of the species range. Loss of populations may represent the most important facet of loss of biodiversity in temperate regions (Daily and Ehrlich 1997-1998).

Populations constitute the sub-units of both species and ecosystems. The populations that live in an area constitute the community which interacts with the environment to compose the ecosystem (Daily and Ehrlich 1997-1998). Populations are important for preserving species and ecosystems and for expressing the values of biodiversity such as resource utilization or economic benefit, recreational, aesthetic, ecological and intrinsic values at a local or regional level. Ecological services and life-supporting systems are provided by populations (Ehrlich 1992).

The quality of local ecosystem services is tightly tied to the populations in a given area; extirpation of a population of one species can lead to a cascade of extinctions or more subtle interactions (Gilbert 1980 as cited in Daily and Ehrlich 1997-1998). Species composition maintains the integrity and functioning of ecosystems. Losses of diversity contribute to loss of stability or ecosystem plasticity; a diversity of populations of species can allow an ecosystem to adapt to changing environmental conditions such as climate change, although the species composition may change through migration and dispersal to reflect new conditions (Daily and Ehrlich 1997-1998).

Daily and Ehrlich (1997-1998) conclude that the emphasis given to loss of species is important but that it is largely an historical artifact and that it should not detract from the equally important problem of the loss of populations. Further, the extinction of populations is closely tied to the loss and fragmentation of habitat; greater attention should be given to the relationship between populations and habitat.

The philosophical rationale for preserving whole ecosystems including natural processes, ecological integrity and wilderness values has also been explored (Leopold 1949; Noss 1991b; 1991c; 1995; Oelschlaeger 1991; Rolston 1991; Grumbine 1994a; Strittholt 1994) (Beazley 1995a provides an overview).

1.5 Political and institutional context for maintaining biodiversity

1.5.1 International initiatives

Perhaps in recognition of these utilitarian and ethical values, and in response to growing awareness of the biodiversity or extinction crises, political reasons for maintaining biodiversity have arisen. International initiatives such as the *World Conservation Strategy* (IUCN et al. 1980), *Caring for the Earth* (IUCN et al. 1991), and *Our Common Future* (WCED 1987) call for the protection of biodiversity.

The *World Conservation Strategy* (IUCN et al. 1980) urges all countries to develop national and regional conservation strategies to maintain essential ecological processes and life support systems, preserve genetic diversity, and ensure the sustainable utilization of species and ecosystems. The "establishment of a comprehensive network of protected areas, securing the habitats of threatened, and other important species, unique ecosystems, and representative samples of ecosystem types" is identified as a priority national and international requirement (IUCN et al. 1980, section 20, no page numbers).

Our Common Future (WCED 1987) outlines the need for sustainable development, considering both ecology and economy in national planning and decision making. It suggested that "the total expanse of protected areas needs to be at least tripled if it is to constitute a representative sample of Earth's ecosystems", bringing the land area "managed explicitly to conserve species and ecosystems" from nearly 4 percent to 12 percent (WCED 1987, 166, 147). *Caring for the Earth* (IUCN et al. 1991) calls for 10 percent of each ecological region to be safeguarded in some category of protected area.

Canada was instrumental in negotiating the *United Nations Convention on Biological Diversity* (UN 1992). The Prime Minister signed the Convention at the Earth

Summit in Rio de Janeiro in 1992, and Canada became the first industrialized country to ratify it in December of the same year. One of the key obligations of being a signatory is to prepare a national biodiversity strategy. Further, Article 8 calls for the establishment of protected areas to preserve biodiversity, and the development of guidelines for the selection, establishment and management of those protected areas (BWG 1994).

1.5.2 Canadian Initiatives

These international calls for action have resulted in Canadian initiatives. The *Endangered Spaces Campaign* was launched by World Wildlife Fund Canada (WWF) in 1989 (Hummel 1989), and, a *Wildlife Policy for Canada* (Wildlife Ministers Council of Canada 1991), the *Green Plan* (Environment Canada 1990), and *A Protected Areas Vision for Canada* (CEAC 1991) were released. The *Green Plan* makes commitments to set aside 12 percent of lands and waters as protected areas and to protect representative samples of each of Canada's 39 natural regions by the year 2000. *A Protected Areas Vision for Canada* outlines Canada's international and national affirmations of the need for action towards protected areas, and provides a vision for establishment of protected area networks (CEAC 1991).

A Statement of Commitment to Complete Canada's Networks of Protected Areas (Tri-Council 1992), also known as the *Tri-Council Agreement,* is a public statement of political will to complete Canada's networks of protected natural areas by the year 2000 and identify and protect critical wildlife habitat (Dearden and Rollins 1993). It is endorsed by the *Canadian Council of Ministers of the Environment*, the *Canadian Parks Ministers' Council*, and the *Wildlife Ministers' Council of Canada* (1991). Commitments include the identification of critical wildlife habitat, frameworks for completion of protected area networks, and the inclusion of protected areas as integral components of sustainable development strategies.

Canada's commitment to represent each of the 39 natural regions by 2000 is the responsibility of Parks Canada, although its efforts are constrained by the actions of other government bodies such as the Treasury Board of Canada. Fifteen natural regions are not yet represented by national parks or national park reserves (Parks Canada 1997, 4). The efforts of other government agencies such as the *Canadian Wildlife Service*, and non-government groups such as the *Nature Conservancy of Canada* also contribute towards the national effort. Parks Canada is also given a mandate to maintain ecological integrity within National Parks as a first priority as outlined in Bill-30 (1988, amendment to the *National Parks Act*, 1930). Parks Canada's policy recognizes this mandate and promotes a co-operative or "greater ecosystem approach" to management (Canadian Heritage 1994b).

The *Canadian Biodiversity Strategy* is a response to obligations in the Green Plan and as a signatory to the International Convention on Biological Diversity. A goal of the Strategy is to conserve biodiversity and sustainably use biological resources through the maintenance of viable populations, completion of networks of protected areas, restoration and rehabilitation, and the maintenance of connectivity (BWG 1994).

The National Round Table on Environment and Economy (NRTEE) conducted cross-Canada round tables that resulted in several reports including *Canadian Choices for Transitions to Sustainability/Toward a National Sustainability Strategy for Canada* (Projet de société 1995). The round tables reaffirmed the commitment of Canadians to maintain biodiversity and establish protected areas. Industry related initiatives such as the *National Forest Strategy* (NFSC 1997) and the *Whitehorse Mining Initiative* (WMI-LCA 1994) also recognize and support government commitments to biodiversity. The Whitehorse Mining Initiative explicitly endorses the commitments of the Tri-Council Agreement, including identification and protection of critical wildlife habitat (WMI-LAIG 1994).

Canada has also developed and introduced an *Act Respecting the Protection of Wildlife Species in Canada from Extirpation and Extinction, Bill C-65* (Environment Canada 1996). The federal government is currently re-examining the proposed Act and will re-introduce it in 1998. The legislation was proposed in compliance with the *United Nations Convention on Biological Diversity* and has been subjected to public consultation (Environment Canada 1995a; 1995b). The proposed purpose of the enactment is "to prevent Canadian wildlife species from becoming extirpated or extinct and to provide for the recovery of those that are extirpated, endangered or threatened as a result of human activity" (Environment Canada 1996, 1a). The proposed Act would apply to sub-species and geographically distinct populations of wildlife, as well as at the species-level, and contains provisions for emergency habitat protection action, and a mandatory recovery planning process, including habitat protection.

1.5.3 Initiatives in Nova Scotia

Provincial initiatives also make a commitment to biodiversity and protected areas. The *Sustainable Development Strategy for Nova Scotia* (NSRTEE 1992) calls for protection of 12 percent of the land and water base. *A Proposed Systems Plan for Parks and Protected Areas in Nova Scotia* identifies 31 candidate protected areas, representing 26 of 77 natural landscape types (NSDNR 1994; NSDOE 1997). An Integrated Resource Management planning process which considers biodiversity values is currently in the public consultation stage (NSDNR 1997c). *Towards a Sustainable Forestry* (NSDNR

1997d) recognizes the commitment to protect biodiversity and the need for integrated resource management. Further, it recommends the development of regulations for the *Forest/Wildlife Guidelines and Standards* (NSDNR no date). Nova Scotia's forestry policy (NSDLF 1986) also calls for protection of wildlife, wildlife habitat, and other resources of the forests, but at the same time it is directed toward a doubling of forest production by the year 2025.

The Province also introduced *An Act Respecting Endangered Species, Bill No. 51* (NSDNR 1996d) to the General Assembly in December 1997, after public consultations. Draft status evaluations for mammals have recently been completed, and reptile and amphibian evaluations are in progress (NSDNR 1996a; 1997b). This initiative is part of a larger national designation system (Elderkin and Boates 1996; Harper et al. 1996).

1.6 Geological history and biogeographical context in Nova Scotia

Nova Scotia has been shaped over 600 million years since its origin in the Hadrynian phase of the Precambrian era. Major geological events include the continental collision between what is now North America and Africa around 400 million years ago and the continental rifting apart and opening into ocean about 200 million years ago, leaving part of the African continent attached to the North American continent at Nova Scotia. This resulted in the formation of Nova Scotia as two geologically distinct zones divided by the Minas Geofracture or Cobequid-Chedabucto Fault Zone into the Meguma zone and the Avalon zone (Figure 1.1). Biological life has been evolving since the earliest invasion of land plants around 400 million years ago in the Devonian period of the Paleozoic era, during the Acadian orogeny (Goldthwait 1924; Keppie 1977; Roland 1982).

In the more recent geological history of the Pleistocene or ice age, Nova Scotia experienced numerous stades and interstades of glaciation. The Scotian Stade is the most recent of the Wisconsinan glaciation, retreating 14,000 to 11,000 years ago. The Holocene period comprising the last 10,000 years has been largely free of glaciation in Nova Scotia (Roland 1982), enabling re-colonization by the migration of plants and animals, including humans, into the area (Davis and Browne 1996) (Table 1.1). This geological history of Nova Scotia has resulted in a physiographic diversity, and an accompanying biological diversity, that belies its size (Figure 1.2). A detailed description of the geology, species, habitats, and a hierarchical biophysical classification of the province into theme regions, is provided in the Natural History of Nova Scotia (Davis and Browne 1996).

Table 1.1: Geological, biological and human history in Nova Scotia - Glaciation to AD 1500 (Pre-Euro-American settlement)

Date	Geological and biological character	Human settlement and subsistence
18,000-10,000 BC	**Wisconsinan glacial ice and tundra** Ice sheet retreat begins 13,000 BC	Non-existent
9500-8200 BC	**Localized glacial ice, tundra and lichen woodland** (plant recolonization begins)	**Palaeo-Indian/Fluted point people:** Archaeological sites at Debert, c. 9600 BC, and Cape Blomidom Highly mobile hunters of caribou, beaver, fox, hare; also fish, birds, sea mammlas, perhaps shellfish (salmon, gaspereau, grey and harbour seals, walrus)
8000 BC	**Lichen woodland and tundra:** spruce-birch	
7700 BC 7200 BC	Charcoal peaks (fires) followed by sharp biological community compositional changes (pollen analysis-southwest N.S.)	
7000 BC	**Boreal forest:** spruce-fir-birch Temperatures similar to present	**Eastern Plano people:** hunters with water craft; associated and merged with Maritime/Early Archaic
6300 BC	Charcoal peak (fire) followed by increase in hemlock (pollen analysis-southwest N.S.)	**Maritime Archaic** (7000-4000 BC): **Early and Middle Archaic**
5000 BC	**Great Lakes-St. Lawrence forest:** pine-oak-birch; Warm period begins; Recolonization by temperate animals	
4700 BC	Charcoal peak (fire) followed by changes in species composition	
3000 BC	hemlock-birch-white pine-maple-beech-oak small regular fires; Temperatures cooling	**Maritime Archaic** (4000-1500 BC) **Late Pre-Ceramic:** archaeological sites at Tusket Falls, Rafter Lake, and McEvoy; Sophisticated sea hunting technology; Primarily utilized sea resources for food: swordfish, grey and harbour seals, walrus, codfish, sturgeon, sea birds, sea mink; also land mammals , primarily caribou
2400 BC 2000 -1700 BC	**Major community composition changes:** Large charcoal peak signifying widespread fire followed by long period of adjustment; Sharp reductions in pine, birch and oak; increase in beech (pollen analysis-southwest N.S.)	
1500 BC	**Forest community stable:** birch-white pine-beech-maple-fir-spruce	**Proto-Mi'kmaq-Maliseet** (1000 BC-AD 500): increased exploitation of shellfish
AD 500	Changes from 2000 years BP to present are more gradual and subtle than previously; small regular fires (pollen analysis-southwest N.S.) ;	**Ceramic period (500 BC- AD 1500)** **Mi'kmaq-Maliseet-Passamaquody** Algonquian linguistic group; Introduction of ceramics/pottery for food/cooking; Archaeological sites at White's Lake, Tusket Falls, Bear River, Mahone Bay, Shubenacadie, Pictou, Merigomish Harbour, Antigonish Harbour;
AD 1000	birch-hemlock-pine-fir-maple-spruce; Temperatures almost at present levels	Land and sea resources: deer, moose, caribou, beaver, seals, sea birds and fish **Early voyages of European explorers (AD 800-1200):** Abundance of marine life **First Peoples/European contact c. 1300**
AD 1500	**Cool temperate - Great Lakes-St. Lawrence forest province:** sugar maple-yellow birch-red spruce-balsam fir-hemlock-white pine; "Little Ice Age" (AD 1200-1800)	**French traders:** Entire Atlantic/Mi'kmaq coast of mainland (Roseway Bank to Canso Bank); **Basque and Portuguese fishers:** Atlantic coast at Canso and Cape Breton **Mi'kmaq-Maliseet:** Abandon pottery in favor of European copper kettles

(Sources: Green 1982; Tuck 1984; Harris 1987, Plates 1, 2, 4-9, 17-18, 20, 22; Davis and Browne 1996)

Notes:

1. BP - Before Present
2. References to charcoal peaks and pollen analysis from time series spectral analysis of preserved pollen and charcoal from Everitt Lake in southwestern Nova Scotia (Green 1982); results may not apply to the entire province, particularly Cape Breton Island
3. For additional information refer also to Goldthwait 1924; Roland 1982; and Miller 1986

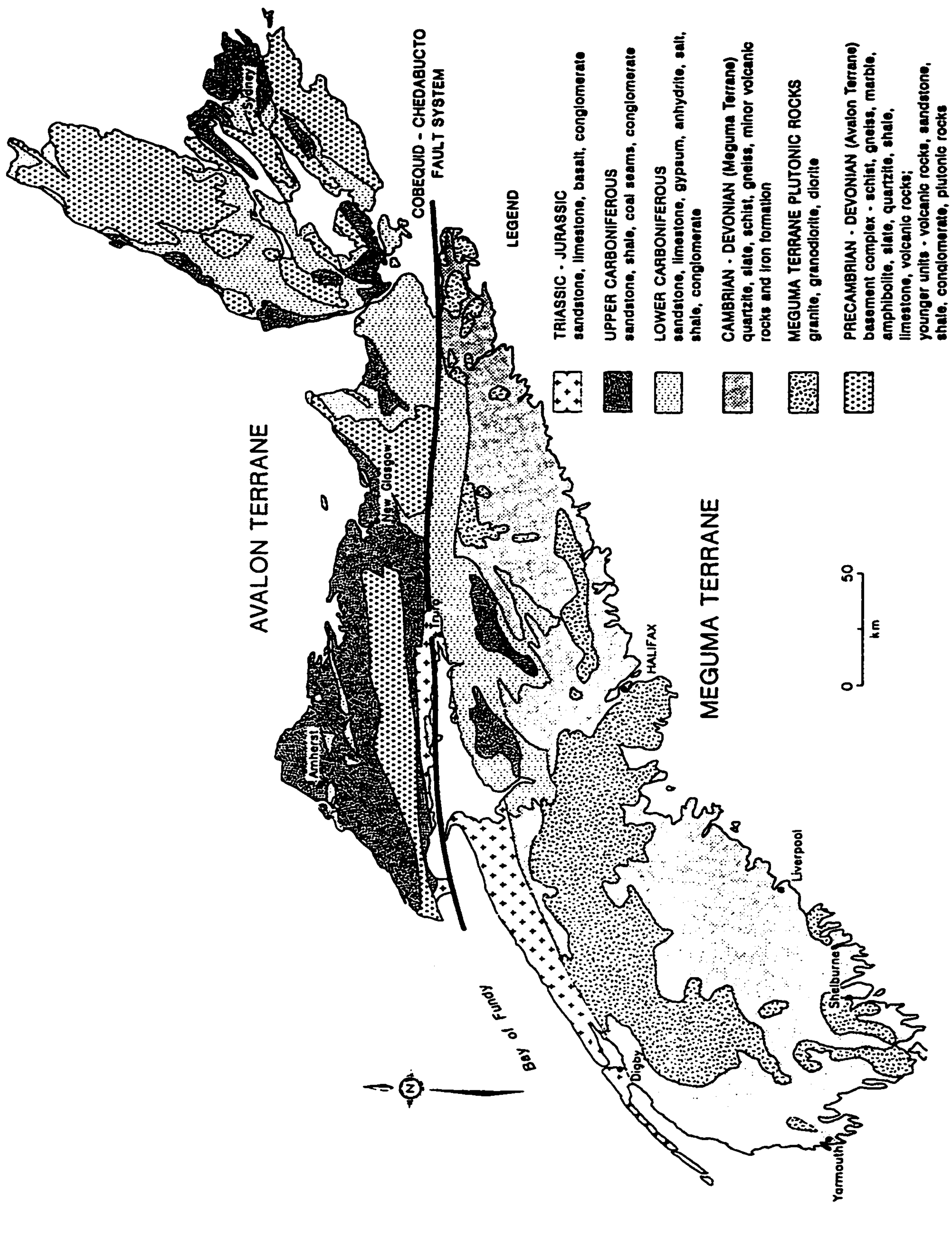

Figure 1.1: Simplified geology of Nova Scotia - The Cobequid-Chedabucto Fault System
Source: Davis and Browne 1996 (Nova Scotia Museum and Nimbus Publishing, with permission)

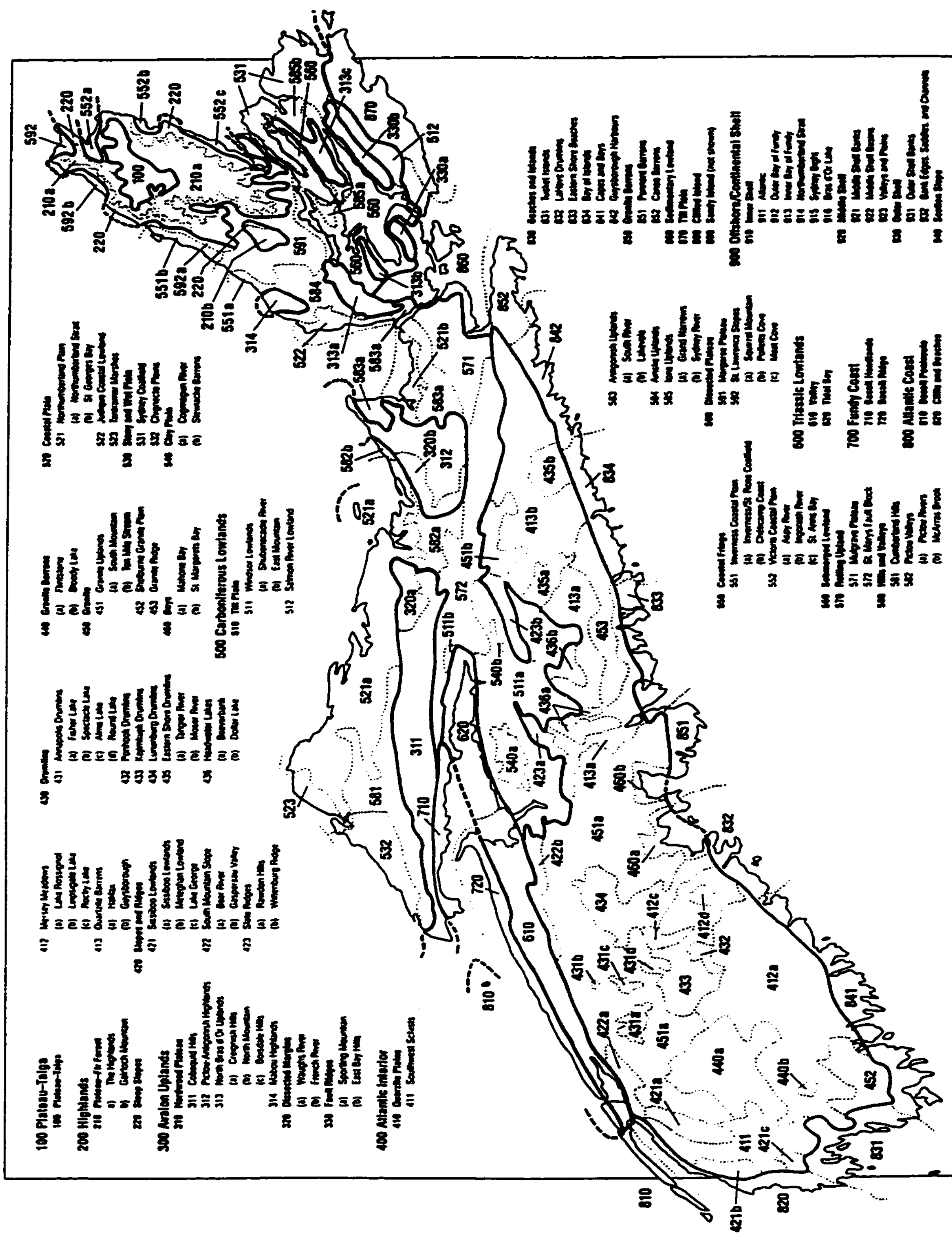

Figure 1.2: Natural theme regions, districts and units in Nova Scotia

Source: Davis and Browne 1996 (Nova Scotia Museum and Nimbus Publishing, with permission)

The geological events combined with post-glacial sea-level rise and coastal submergence since about 5000 years ago (Grant 1975 as cited in Roland 1982) has resulted in a peninsular land mass which constitutes the mainland of Nova Scotia. Cape Breton was a separate island until very recently when it was connected to the mainland by a causeway constructed in 1955. Although connected to New Brunswick and the rest of the North American continent by the relatively narrow Chignecto Isthmus, this peninsular land mass functions much like an island in terms of biogeography (Herman 1996 pers. comm.). Dispersal, migration, range shifts and other spatial dynamics of species and communities over time are restricted except by sea, by air or across the narrow and low-lying land connection at the Isthmus, which has been partially converted from natural habitat through human activities and developments.

The Chignecto Isthmus was comprised of a more substantial land area when the sea level was lower between 10,000 and 2,000 years before present (BP). Species were able to migrate freely from the continent. Species may also have been able to migrate at this time across the continental shelf, in the area of the current Gulf of Maine (Davis and Browne 1996).

However, since about 5000 years ago, the increasing isolation of the populations of species in Nova Scotia has resulted in a relatively large number of disjunct populations, including 61 Arctic-alpine and Boreal plant species (Davis and Browne 1996, 86), many species of coastal plain flora, at least six species of mammals, and Atlantic whitefish. Disjunct species of mammals include Arctic shrew, Gaspé shrew, long-tailed shrew, southern flying squirrel, white-footed mouse, and rock vole (Scott 1996). Populations of these and other species may be genetically distinct from those in other areas in Canada and the United States because of limited out-breeding opportunities with continental populations. Over 450 of the known species occurring in Nova Scotia are considered to be provincially rare (NSDNR 1994, 17).

The geological history and resulting diversity and configuration has resulted in a biogeographical context which makes protection of biodiversity particularly important but challenging. With the exception of migratory birds or marine species, the populations of species which exist in Nova Scotia at present are those which we will need to protect if we wish to maintain current levels of biodiversity in Nova Scotia over time. Opportunities for land-based migration of additional individuals or new populations into the province are limited. Further, these populations are wholly dependent upon and restricted to the finite land and resource base or habitats, which exist within the province. Opportunities for individuals or populations to disperse or migrate out of the province are limited. For these reasons, we are particularly behooven to set aside sufficient lands and waters to recover, maintain and enhance viable populations of the species which currently exist within Nova Scotia.

1.7 Changes in biodiversity in Nova Scotia

A large portion of eastern mainland Nova Scotia and Cape Breton Island have been identified as having a high degree of risk to biodiversity (Turner et al. 1997). Risk to biodiversity was calculated by indices of pressures, sensitivity, and remediation. Pressure indices included land-use and land-cover, road access, population changes and density and industrial activities. Sensitivity indices included species richness and species at risk, endemic species and land cover diversity. Remediation primarily considered the presence of protected areas.

Changes have occurred in biodiversity in Nova Scotia at community, ecosystem, species and population levels. Forests and other ecosystems have been lost, degraded and fragmented as a result of clearing for urban areas and settlements, farm lands, and industrial and infrastructure developments such as transportation and electrical corridors (Tables 1.2 to 1.6). This is particularly the case around bays and inlets along the coasts, on soils with high capability for agriculture such as the Annapolis Valley and Truro area, and in areas accessible to forestry (Harris 1987; NSDOD 1986).

Forests have also been and continue to be degraded, fragmented and converted through forestry activities such as clear cutting and silviculture. Fernow (1912) predicted that forests already extensively altered in 1909-1910 would continue to be further converted to hardwood in response to extensive culling of softwood trees from coniferous and mixed forests. He also suggested that forests might be further converted to coniferous species through silvicultural practices which favour commercially valuable softwood species.

Fernow's predictions may have been accurate. There appears to have been a significant increase in both hardwood and softwood, particularly softwood, and a significant decrease in mixedwood. This may be illustrated by comparing the ratio of hardwood-softwood-mixedwood areas at the time of Fernow's (1912) forest survey in 1909-1910 with those of 1980 (Table 1.7).

These changes may also be a result of historic fire regimes, from both natural and human causes, especially after fires occurring around the turn of the century and in the 1920's and 1930's (Wein and Moore 1979; Fernow 1912; Refer to section 3.14 in Chapter 3 for further discussion of historic fire regimes and effects on vegetation in Nova Scotia). Comparisons with earlier or pre-Euro-American settlement forests may demonstrate an even more significant change because mixedwood forest types are predominant in the Acadian Forest Region which includes Nova Scotia (Rowe 1972).

Table 1.2: Settlement patterns and land and resource use - AD 1600 to 1800

Date	Human settlements and land use
AD 1600	**Mi'kmaq:** Subsistence fishing and hunting: fish, moose, fowling, sea mammals; gathering: shellfish, vegetables Populations: Epigoitnag (250-500) (Tatamagouche area); Onamag (1000-2000) (Bras D'or Lake area, Cape Breton); Esgigeoag (250-500) (Sherbrooke-Country Harbour area); Segepenegatig (500-1000) (Bedford Basin/Halifax Harbour area); Gespogoitnag (500-1000) (Shelburne area) **New England and French inshore fishery:** Atlantic coast of mainland and Cape Breton Island; perhaps some over-wintering of caretakers and families in port settlements: Chedabucto, Canso, Chebucto, LaHave **Animals and plants introduced from Europe** **Mining for coal and other minerals begins**
AD 1700-1750	**Acadian/French settlements:** Dyked field/ marshland agriculture along Bay of Fundy coast at Port Royal; Grand Pré; Cobeguit; Beaubassin Fishery and trade in Cape Breton (Isle Royale) **English settlement at Halifax (AD 1749)**
AD 1750-1780	**Acadian/French deportation by British** **Pre-loyalist immigrations** (American, Scots, Irish, English, German): Settlements along Atlantic and Bay of Fundy coasts with concentrations around Halifax, Lunenburg, Shelburne, Annapolis Royal, Windsor-Grand-Pre, Truro, Amherst and Canso **Acadian/French return**
AD 1780-1800	**Loyalist immigrations** (approximately 19,000; largely American-born; including approximatley 3550 Free-Black-Loyalists of African origin, from the New York area: Major concentrations in Halifax, Lunenburg, Shelburne, with numerous settlements along all coasts, particularly in basins and harbours and in southwestern N.S. ; More than 1500 small land grants to Black Loyalists in Shelburne; others in Halifax, Preston, and Chedabucto areas; 550 Trelawny Maroon immigrants from Jamaica to work on constuction of the Citadel at Halifax (1796) **Farming and fishing:** Productive farming with forestry and some fishing: Annapolis royal; Windsor-Cornwallis; Truro; Amherst Subsistence farming with forestry and some fishing: Bay of Fundy coast, Annapolis Valley and Shubenacadie River Limited farming with mainly fishing: entire length of Atlantic coast **Forest changed by cutting and fire** **Extirpation of wolf and caribou from Nova Scotia**
AD 1800	**Euro-American population:** approximately 55,500, primarily English speaking; Settlements concentrated around Halifax, Lunenburg and Shelburne; Scattered settlements: Windsor to Cornwallis; Annapolis Royal; Truro Exports: dried cod and wood **Mi'kmaq population:** approximately 2000 (1000-3500) remaining in 12 main areas: Whycocomagh/Bras d'Or Lake; Shubenacadie Grand Lake; Tatamagouche; Shelburne; Tobeatic/Kejimkujik; Antigonish; Head of St. Margaret's Bay; Mahone Bay/Chester Basin; Grand Pré/Gaspereau; Digby; Milford; and, Yarmouth Largest population concentration in Bras d'Or Lake area (500-1000).

(Source: Compiled from Harris 1987, plates 23-24, 29-32, 68-69; Saney 1998, 6-7)
Note: For additional information regarding Mi'kmaq and Euro-American settlement and land and resource use interactions refer to Miller 1986 and Beazley 1994; for additional information regarding Afro-American migration and settlement refer to Saney 1998.

Table 1.3: Settlement patterns and land and resource use - AD 1800 to 1900

Date	Human settlements and land use
AD 1800	**Settlement areas:** Largest settlements: Halifax (pop. 8000); Lunenburg (pop. 500); Shelburne (pop. 2000); Other larger settlements, mostly in Windsor to Grand-Pre, and Annapolis Royal areas; Settled area primarily along Atlantic and Northumberland Strait coasts, Chignecto-Amherst, Truro area, Annapolis Valley, Digby-Annapolis Royal, Sydney area, C.B.; Approximately 1500-2000 Afro-American refuges migrate from Delaware and Chesapeake Bay to Halifax area (1813-1815)
AD 1830-50	**Immigration from Europe**: mostly English, Scottish, Irish - approx. 15,000 people **Emergence of transportation system:** Boat and coach service between major ports and settlements (some daily); Railway construction from Halifax to Windsor and Halifax to Truro (1836-1864); Shubenacadie canal - Atlantic coast to Minas Basin (Halifax to Truro area)
AD 1850/51	Population in rural N.S. approx. 256,105; population in Halifax approx. 20,750; Other populated centres in Liverpool, Lunenburg, Yarmouth, Pictou and Sydney; Large portion of the province under timber exploitation, with exception of central-inland areas of mainland and northern Cape Breton; Large production centers/mills in Pictou-Pugwash, Digby-Weymouth, Liverpool and Halifax areas, and other smaller sites Agricultural lands throughout northern sections of mainland, particularly Annapolis Valley, Truro area, Amherst-Pugwash, mostly producing hay, oats and potatoes Major port at Halifax, particularly for imports; Shipping and shipbuilding centers at Pictou, Chignecto, Windsor, Annapolis Royal, Digby, Weymouth, and Yarmouth Fishery primarily inshore - makerel fishery (BNA); offshore - cod fishery (American)
AD 1851-74	Positive net migration but population growth mainly due to natural increase British garrisons/forts along coasts especially at Halifax-Chebucto; Lunenburg-Chester area; Digby/Annapolis Royal; Louisbourg Fishery by 1874 mostly cod; large makerel fishery; lobster, herring and other; Industrial transition: Increased per capita production; coal-gas and electricty production Women in the work force; increased civic/societal structure- schools, churches, libraries
to AD 1890/91	Negative net migration but still population growth by natural increases; moderate out-migration except from Halifax area (neutral migration); Afro-Americans migrate from Barbados and the U.S. to work in steel mills; settlements in Sydney, Glace Bay, Whitney Pier Railway construction: 1865-82 - Windsor-Yarmouth; Truro-Amherst; Truro-Mulgrave; 1888-91 - to Sydney, C.B.; Pictou-area coast; across mainland at Lunenburg-Middleton; Forest industry: mostly primary production; secondary production at Halifax, Sydney and Pictou; Forestry extensive in northern mainland and Chignecto area Fishery: entire Atlantic coast Agriculture: northern mainland Mining: Sydney area; Ship building and shipping: peak tonnage 1868-1891; Yarmouth, Windsor, Halifax, Pictou, Sydney More extensively settled: settlements in all areas except central southwestern and central southeastern mainland and northern Cape Breton Approximately 36 native reserves throughout the century, all less than 5000 ha; of these 5 were abolished or surrendered; 31 remaining by 1900; 8 proposed

(Compiled from Gentilcore 1993, plates 4-5, 9, 11, 12, 15-16, 24-26, 29-32, 37,38-39; Saney 1998, 6-7)
Note: For additional information regarding Mi'kmaq and British North America interactions refer to Miller 1986; for additional information regarding Afro-American migration and settlement refer to Saney 1998

Table 1.4: Land-cover and use as reported in the Nova Scotia Forest Survey, 1909-1910

Land classification	Total area	Description and location
Cleared land or farm area	655,228 ha (17%)	Census of 1901
Nova Scotia Forest Survey (mainland and Cape Breton Island), 1909-10		
Cleared land or farm area	918,792 ha (18.8 %)	Fields, pastures, orchards, abandoned farms and old fields, excluding farm woodlots which have been included with forest area; estimate is liberal to include potential farm area; farm areas in Annapolis, Yarmouth and Antigonish counties were lower than Census figures and many abandoned pastures were found; highest percentages in Kings, Pictou and Antigonish
Natural meadows &	24,069 ha (0.5 %)	Areas which, "by a little drainage work could be greatly improved" for agriculture; extensive in western mainland; Digby, Shelburne and Queens
Savannas		Open bogs of peaty or muck soil; western mainland
Forest Existing total	2,666,687 ha (54.6 %)	Total green forest area including timber remaining on recently burned areas, farm woodlots, and young growth
Type (Percent of total forest area)	213,206 ha (4.4 %)	Hardwood forest (probably a considerable area was originally mixed forest from which the conifers have been removed): highest in Inverness Co.
	767,262 ha (15.7 %)	Coniferous forest: highest percentages in Lunenburg Co. and all of Cape Breton Island
	1,686,219 ha (34.5 %)	Mixed forest: highest percentages in Kings, Digby, Annapolis, Yarmouth, Hants, Colchester, Pictou and Antigonish Counties
Condition	<40,500 ha	Virgin or semi-virgin timber
(Condition and Potential figures for mainland only)	1,133,160 ha	Severely culled forest (culling of pine, spruce and hemlock from primarily mixed forests; likely to regenerate to hardwood)
	91,870 ha	Second Growth (culled forest that may now or soon be lumbered again)
	566,600 ha	Area furnishing the log supply of current mills
Potential (Mainland only)	2,698,000 ha (70%)	Also includes recently burned areas and the better class of barrens which can eventually be reforested (see below)
Old burns and barrens	985,416 ha (20.2 %)	Area so severely burned that it is now barren or semi-barren of commercial trees; older stages than recent burns (still without considerable second growth of timber trees 10 -80 years after fire); include barren conditions resulting from both natural causes and repeated burning because of difficulty distinguishing, however estimates in one case that somewhat less than half of the area appears to be natural barrens, and in another case that a relatively small portion is natural barrens; largest areas are in Halifax County: Halifax Harbour to St. Margarets Bay; granite hills east of Halifax Harbour; interior-central Guysborough; Shelburne and Annapolis Counties; and Richmond Co., C.B.
	11%*	Better class barrens which can eventually be reforested
	9.2%*	Hopeless barrens (*barrens sub-classes estimated from mainland figures)
Recent burns	225,814 ha (4.6 %)	Most extensive were in Annapolis-Kings, Cumberland, and Shelburne-Digby-Yarmouth-Queens counties from fires in 1903; largest burn in Annapolis and King's Counties - 400 km^2 (40,000 ha); in Cumberland County - 250 km2 (25,000 ha); no area calculation for Shelburne-Digby-Yarmouth-Queens, however about half of the burned area is regenerating to heath scrub, the other to birch-red maple-poplar-red oak.
Unclassified	64,040 ha (1.4 %)	Small remote areas for which information could not be obtained due to field access limitations
Total	4,884,818 ha (100 %)	

(Source: Compiled from Fernow 1912, 14-17, 18-19, 21, 82-85)

Notes:

1. Land classifications, descriptions and terminology are Fernow's (1912)
2. Area figures include mainland Nova Scotia and Cape Breton Island although Fernow (1912) considered these areas separately
3. Area figures have been converted to hectares from acres; percentage figures are calculated from total area in mainland N.S. and Cape Breton Island and from Fernow's (1912) original (acreage) figures.

Table 1.5: Settlement patterns and land and resource use - AD 1900 to 1961

Date	Human settlements and land use
AD 1900-21	Emergence of urban system; increases in schooling Increases in production/mining of coal, coke, iron, steel in Sydney and New Glasgow
AD 1931-45	Migration from the Prairie provinces during Great Depression Establishment of Cape Breton Highlands National Park
AD 1941-61	Increased production in agriculture, mining, fishery and forestry (in decreasing order of production value) Increase in manufacturing production Sydney - steel producing center <u>Net decrease in improved agricultural area at Provincial level:</u> >40% decrease along southwest coast, Antigonish-Pugwash area, and southwest Cape Breton; 20-40% decrease along Bay of Fundy coast from Digby to Truro and north to Amhest and area west of Halifax <u>Further expansion of transportation system:</u> Expansion of railways; Expansion and paving of roadway system; Trans-Canada highway Growth in urban network, particularly around Halifax and Sydney Expansion of financial institutions; growth of retail Establishment of 7 provincial parks, all <50,000 ha

(Source: Compiled from Kerr and Holdsworth 1990, plates 6, 36, 49)

Table 1.6: Current settlement patterns and land and resource use in Nova Scotia: c. 1985

Land-use	Description	Location
Land cover N.S. Dept. of Lands and Forests, 1965-70 data	**Cleared land (mostly agricultural) and urban areas**	Locations reflect areas of historic use and settlement patterns: Annapolis Valley - Windsor to Digby; Truro coastal and inland area; Amherst and coast of Northumberland Straight; New Glasgow-Antigonish; Sydney-Glace Bay; Halifax-Dartmouth and surrounding region; Lunenburg; Liverpool; Shelburne; and, Yarmouth
	Cleared forests or rock barrens	Portuguese Cove-Tantallon (southwest of Halifax); Canso-Country Harbour; northern Cape Breton
	Wetlands	Southwestern mainland (Tobeatic-Yarmouth-Liverpool); north of Sherbrooke; south of Antigonish; north of Port Hawkesbury; northern Cape Breton
	Forests: Softwood (50.5%*), Mixed (21.5%), Hardwood (19%)	Widespread/predominant land cover (91%*): throughout mainland and Cape Breton Island
Land ownership N.S. Dept. of Lands and Forests, 1975-82, 1984 data	**Small private:** 2,736,550 ha (49%)	Central mainland and coastal areas; southern Cape Breton; northern mainland-Northumberland coast
	Provincial crown: 1,624,450 ha (29 %)	Northern Cape Breton; southeastern and extreme southwestern mainland
	Commercial and large private: (primarily pulp and paper companies): 1,035,360 ha (19%)	Central and southwestern mainland; northwest mainland-Parrsboro
	Federal: 153,140 ha (3 %) (Figures include water area)	Cape Breton Highlands and Kejimkujik National Parks; Louisbourg National Historic Park
Wildlife* N.S. Dept. of Lands and Forests, Wildlife Division, 1984 data	**Game sanctuaries**	Liscomb; Chignecto; Tobeatic; Waverley
	Salt marshes: 15,273 ha **Wetlands:** 265,925 ha **Wildlands** (undefined): 4,479,371 ha	High potential wetlands: Southeastern Cape Breton; Amherst area; Yarmouth area; and, scattered throughout the mainland
	Critical islands	Bras d'Or Lake, Bird Islands, Margaree Island, C.B.; Pearl Island
	Principal bird migration stops	Clam Bay-Musquodoboit-Cole Harbour coastal area; Shelburne and Clark's Harbour to Yarmouth coastal areas; St. Mary's Bay; Minas Basin; Tatamagouche Bay-Gulf Shore coastal area
Forestry N.S.Dept. of Lands and Forests, 1982 data	**Pulp wood and Lumber** 50.5%* of N.S. area is forest that has been cut over and/or cultivated	Predominant industry/mill locations around Pictou area, Port Hawkesbury, and southwestern mainland; Smaller mill locations scattered throughout
	Classes 3 and 4 land capability for forestry (highest classes in N.S.)	Scattered throughout; highest predominance in Antigonish/Pictou -Truro to immediately north of Halifax-Dartmouth; Predominantly in small private ownership
Agriculture N.S. Dept. of Agriculture and Marketing, Agricultural Statistics 1982	**Multi-crop area:** 376,650 ha (7%) **Limited-crop area:** 773,955 ha (15 %) Primarily corn, grain and mixed grain, potatoes, barley, oats and wheat	Agricultural crop areas reflect generalized soil areas for loamy pozols; luvisols; and mix of stony and sandy podzols with loamy podzols: Antigonish area; Pictou area; Amherst area; Truro to Windsor area; Windsor through Wolfville and Middleton to Digby area (Annapolis Valley); northwest of Bridgewater; north of Yarmouth; and, localized valley-lands on Cape Breton Island
	Highest capital value of farms	Kings County; Hants and Annapolis Counties
Fishery N.S. Dept. of Fisheries, and Fisheries and Oceans Canada, 1984 data	**Predominantly groundfish:** cod, haddock, halibut **Shellfish:** lobster, scallop **Pelagic and estuarial fish:** predominantly herring **Other** (undefined)	Widespread and distributed along most of north, northeast, south and southeast coasts; Primary landings in Cheticamp, Sydney-Glace Bay, Port Hawkesbury, Canso, Sherbrook-Country Harbour, Lunenburg, Liverpool, Shelburne, Yarmouth and Digby. (Significant changes may have occurred since the collapse of the cod fishery)

Table 1.6 (continued)

Land-use	Description	Location
Mining N.S. Dept. of Mines and Energy, 1984 data; Soil surveys, 1985 data; Metallogenic Map of the Province of N.S. 1983 data; Industrial Mineral Commodities Map, 1983	**Coal resources**	Northern mainland: Joggins-Chignecto, Debert-Kemptown, and Pictou coal fields; Cape Breton Island: Port Hawkesbury; Port Hood, Mabou, Inverness, St. Rose-Chimney Corner, and Sydney coal fields
	Peat resources	Southwest mainland; Guysborough County; and southwest Cape Breton Island
	Metallic minerals: gold, iron, uranium, zinc, copper, tungsten, lead, tin, silver, others	Actual and probable metallic minerals and commodities are widespread throughout, particularly: inland and central mainland; eastern shore; and, eastern Cape Breton Island
	Structural minerals: granite, clay, shale	Current mining in the Enfield-Shubenacadie area
	Sand and gravel	Current mining and occurrences north of Cobequid-Chedabucto fault zone; Annapolis Valley; southwestern mainland; and western Cape Breton Island
	Large crushed rock	Current mining north of Halifax-Dartmouth; Pictou
	Industrial minerals: gypsum, limestone, salt, barite	Current mining in Windsor, Truro, Amherst areas; Cape Breton Island Probability: south of Windsor-Truro; Antigonish area; west and central Cape Breton Island
Infrastructure N.S. Dept. of Environ., 1985; N.S. Dept. of Transportation, 1985 data	**Water supply systems and protected water areas:** surface and groundwater	Generally concentrated around communities
	Transportation Major freeways and arterials; railway lines	Along the coast of southwestern mainland; Annapolis Valley; Windsor to Halifax; Halifax to Truro; Truro to Amherst; Truro to New Glasgow, Antigonish, Port Hawkbury and Sydney.
	Collector and local roads	Collectors generally located along the coast and dissecting the mainland at approx. 50km intervals. Local roads throughout except Tobeatic and Cape Breton Highlands areas.
N.S. Power Corporation, 1985 data	**Electrical energy: Transmission lines**	**Major lines:** Amherst to Truro; Truro to New Glasgow, Antigonish, Sydney/Glace Bay and Ingonish/Wreck Cove; Truro to Halifax, Bridgewater, Liverpool, Shelburne and Yarmouth; Halifax to Kentville; **Minor lines:** Annapolis Valley to Digby to Yarmouth; Liverpool to Digby; New Glasgow to Sheet Harbour and Musquodoboit; Antigonish to Canso; Parrsboro to Amherst; Truro to Tatamagouche; Port Hawkesbury to Inverness
	Generating plants: 44 in total Hydro (32)	Predominantly located in Halifax and Western Zones: west of Halifax; Kentville area; Annapolis Valley; Weymouth; Yarmouth; Lake Rossignol to Liverpool; north of Sheet Harbour; Wreck Cove, CB.
	Tidal (1)	Annapolis
	Steam turbine/thermal (7)	Glace Bay area; Point Tupper; Trenton (Pictou); Maccan (Amherst); and Dartmouth area
	Gas turbine (3)	Burnside (Dartmouth); Tusket (Yarmouth); Sydney
	Wind turbine (1)	Wreck Cove (Ingonish, C.B.)
N.S. Dept. of Development, 1981 data	**Industrial Parks**	Halifax-Dartmouth-Bedford area; Musquodoboit Harbour; Bridgewater-Liverpool; Windsor-Kentville; Debert-Truro; Amherst area; Stellarton; Port Hawkesbury-Point Tupper-Louisdale area; Sydney

Sources: NSDOD 1986, 9, 13, 15,17, 20-21, 27, 33, 35, 45-51, 57-63; and Davis and Browne 1996, 195
Note: 1. * Percentage figures derived from Davis and Browne (1996, 195, as derived from NSDNR (Lands and Forests) c. 1980); significant additional areas have been cut in the interim to present (NSDNR 1997d)

Table 1.7: Comparison of ratio of hardwood-softwood-mixedwood forests as percentage of total forest area in Nova Scotia (mainland and Cape Breton) - 1910 and 1980

Forest type	1909-1910 (in percent)	1980 (in percent)	Percent and direction of change
Hardwood	8	21	+ 13
Softwood	29	55	+ 26
Mixedwood	63	24	- 39
Total	100	100	0

Sources: Derived from Fernow (1912, 18-19, 21) and Davis and Browne (1996, 195)
Notes:
1. 1909-1910 data derived from Fernow (1912, 18-19, 21); 1980 data derived from Davis and Browne (1996, 195) as derived from NSDNR (Lands and Forests) 1980 data

The vast majority of forested lands are composed of younger stands regenerating after extensive harvesting; much of the forest cover in Nova Scotia has been and continues to be maintained at an early or secondary successional growth (Fernow 1912; Davis and Browne 1996). Rates of harvesting may be unsustainable in comparison with regeneration and growth rates, age structure and other factors. Over-harvesting on forest lands in Nova Scotia is considered to be "a potentially serious problem demanding immediate action" (NSDNR 1997d, 6).

Forests and other ecosystems have also undergone changes in composition, extent and distribution as a result of changes in the fire regime. Although fire played an important role in post-glacial biological community development, it is not considered to be a major factor in more recent times prior to Euro-American settlement (Green 1982; Russell 1983). However, extensive fires in the late 1800s and early 1900s resulted in large areas of barrens. Over the past 250 years, fires caused by humans have burned over much of the province. Changes in the fire regime due to human influences, including fire suppression, have no doubt had an impact on natural processes of disturbance and succession with resultant changes in community composition and distribution (Refer to Table 1.1 and to Section 3.13.1 in Chapter 3 for descriptions of historic fire regimes in Nova Scotia) (Fernow 1912; Wein and Moore 1979; Davis and Browne 1996, 187).

Species and populations that previously existed in Nova Scotia have been extirpated or gone extinct. These may all be related to human causes, primarily through habitat loss, degradation and fragmentation, excessive exploitation or persecution and introductions of exotic species. At least five species of mammals which existed previous to Euro-American settlement are no longer present in Nova Scotia. Extirpated species include the wolf, Atlantic walrus, Atlantic grey whale and woodland caribou (Scott

1996). Sea mink is considered to be extinct but is reported to have occurred along the Atlantic coast of Nova Scotia until about 1894 (COSEWIC 1996; Scott 1996).

Wolf was extirpated as a result of a combination of exploitation, harassment or persecution and loss of major prey species such as caribou, deer and moose, if not outright loss of habitat. Woodland caribou, American moose and white-tailed deer were virtually eliminated through over-harvesting by hunting as well as stresses caused by loss, fragmentation and degradation of habitat. American moose was extirpated on Cape Breton Island in 1924 and re-introduced from Alberta in 1947-48 (Scott 1996; NSDNR 1997b; Pulsifer and Nette 1995). White-tailed deer were extirpated and reintroduced or re-invaded between 1894 and 1910 (Scott 1996).

American marten and fisher were extirpated through over-trapping and loss, fragmentation and degradation of habitat, possibly as a combination of intensive forestry practices and fires. American marten was probably extirpated on the mainland before the middle of 1970s and reintroduced in Kejimkujik National Park in the 1980s; a small remnant population exists in the northern highlands of Cape Breton Island. Fisher was extirpated around 1922 and reintroduced in southwestern and northeastern mainland.

Lynx has been essentially extirpated through habitat loss and conversion and the resulting interspecific competition with bobcat and, more recently, coyote. Eastern cougar may also have been extirpated by over-exploitation for fur, habitat loss and conversion and related factors such as competition for prey (Pulsifer and Nette 1995; NSDNR 1997b). Coyote was prehistorically present in New Brunswick (circa 2000 years before present) and probably in Nova Scotia, and has invaded from New Brunswick since the late 1970s (Scott 1996), possibly in response to the extirpation of the wolf and decreases in lynx.

All of the species described have large habitat requirements, special habitat or resource requirements, or sensitivities to impacts caused by human presence such as interspecific competition. This gives an indication of the variables that make certain species more vulnerable than others in landscapes shared with humans. The land- and resource-use and land-cover changes described suggest potential factors that threaten the viability of species and populations in human-utilized landscapes. The changes represent significant losses of biodiversity at landscape, ecosystem, species and population levels within Nova Scotia.

Current status evaluations identify species considered to be at risk at national and provincial levels (Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 1996; NSDNR 1997b) (Refer to Appendix 1.2 for status of land-based mammals, reptiles and amphibians and freshwater fishes in Nova Scotia). At least thirty-five species found or once found in Nova Scotia are listed on Canada's endangered species list (COSEWIC 1993 as cited in NSDNR 1994). Mammal, reptile, amphibian, and freshwater fish species currently identified as nationally endangered include eastern cougar, beluga whale, northern right whale, and Atlantic or Acadian whitefish. Status of eastern cougar is uncertain in Nova Scotia; it may currently be extirpated. A status report on the eastern cougar in Nova Scotia is pending (NSDNR 1997b). Threatened species include Atlantic harbour porpoise and Blanding's turtle. Vulnerable species include Gaspé shrew, humpback whale, southern flying squirrel, and wood turtle (COSEWIC 1996).

American marten, lynx, American moose, and Blanding's turtle are considered to be at risk in Nova Scotia. Several other species are considered to be particularly sensitive to human activities or natural events (Elderkin and Boates 1996; NSDNR 1996a; 1997b). Small remnant and introduced populations of American marten are considered to be threatened by their small population size, isolation, habitat loss and fragmentation, low fecundity and survivorship, accidental capture by trappers, and illegal kill. Lynx is considered to be extirpated on the mainland; small, isolated remnant population(s) exist on Cape Breton Island, however these are threatened by interspecific competition with coyote and bobcat, habitat loss and fragmentation, accidental capture by trappers, and illegal kill. The small remnant mainland population of native moose is threatened by interspecific competition with white-tailed deer, fatal infections by the brainworm, *Parelaphostrongylus tenuis*, habitat loss and fragmentation, increased road access into remote regions and illegal kill. Populations of American moose on Cape Breton Island are not considered to be at risk (NSDNR 1997b). Floral and faunal species in classes other than mammals may also be considered to be at risk at the provincial level, however status evaluations have not yet been completed.

1.8 The need for a focal-species approach to managing for biodiversity

Current approaches for protected area planning and management and other initiatives to protect biodiversity recommend a landscape or ecosystem approach (Peterson and Peterson 1991; Kavanagh and Iacobelli no date). Recent initiatives aim to set aside representative samples of natural regions or landscapes (Hummel 1989; Canadian Heritage 1994a; NSDNR 1994). While this is a good start, protected areas selected on the basis of biophysical representivity will not in most cases protect current levels of native biodiversity on their own. Additional ecological considerations are necessary to protect other components and processes of biodiversity.

Noss (1995) refers to these other considerations as constituting the realm of ecological integrity. Ecological integrity requires maintenance of ecological processes, including continued viability of populations of native species over time, and patch dynamics of succession and disturbance within landscapes (Noss 1992a; 1992b; 1995; Grumbine 1994b; Woodley 1996a). Longer-term viability of populations of many species require in the order of 50 to 500 breeding individuals as a minimum ideal breeding population (Ne) (Franklin 1980); real or census populations in the wild will likely require much larger numbers of individuals. For many species, especially space-demanding/wide-ranging ones, viable populations require significant spatial areas with specific habitat characteristics. Further, because natural landscapes or ecological communities are dynamic, changing over time with disturbances and succession, even larger areas are required.

The bottom line is that very large areas are required to maintain viable populations, especially of space-demanding species, and ecological processes of disturbance and succession over time. Such areas are generally much larger than the representative samples already established or currently being delineated as protected areas. Representative areas do not necessarily reflect home-ranges of populations nor encompass resource needs of species with special habitat, dietary or reproductive requirements.

Protecting small representative samples of natural regions or landscapes does not constitute, in and of itself, a landscape approach and will not protect current levels of native biodiversity. Further ecological considerations such as habitat requirements of viable populations of native species, and disturbance and succession regimes need to be incorporated into protected area and broader regional and landscape planning and management

Current pressures on a finite land and water base require that the rationale for setting aside protected areas be well grounded in science. While it is recognized that generally speaking the more land set aside the more biodiversity will be protected, precise prescriptions for how much land is enough, and where it should be and the characteristics it should encompass are required (For a summary of the literature on this subject see Shafer 1990). Approaches such as biosphere reserves, greater ecosystems and multiple-use modules with corridors require specific information to define ecologically meaningful boundaries and to manage for transboundary phenomena such as species migration and dispersal.

It is also recognized that it is not possible nor necessary to consider the habitat and other requirements of every species (Hunter 1990; Noss 1990b; 1991a). Certain species have larger home-range sizes, more specific habitat requirements, or are more sensitive to human activities. Populations of certain species are more vulnerable than others in landscapes shared with humans and are in greater need of protected areas for their continued survival. Species with these characteristics can form a multiple-species suite of populations that can act as an "umbrella" for biodiversity management. If the habitat needs of these most vulnerable and resource-demanding populations of species are protected, populations of most if not all other species will also be protected (Soulé and Simberloff 1986; Hunter 1990; Noss 1990a; 1990b; 1991a; 1995; Theberge 1995; Lambeck 1997).

1.9 Terminology: Focal-species defined

Within this thesis, these key species which warrant special biodiversity management attention are referred to as focal-species. Further, the concept of considering the needs of focal-species in order to provide information and set priorities to guide and focus protected area and other biodiversity management is referred to as a focal-species approach. Although the terminology refers to species, its utilization within this thesis includes populations and the term should be interpreted as referring also to focal-populations, particularly at the regional level. Separate terminology will generally not be utilized to refer to focal-populations. Reference to the focal-species approach may also be more accurately interpreted as referring to a focal-population approach in many instances.

The challenge in utilizing a focal-species approach is in identifying these key or focal-species. The suite of focal-species will vary by region or by biogeographical context. Species composition, population status and habitat types and quality will vary in different regions. Therefore, appropriate focal-species should be identified at no larger than the provincial scale, and ideally at a smaller regional scale, reflecting regional variations in species-population and biogeographic context.

1.10 Thesis purpose, content and organization

This thesis attempts to justify, develop and test a framework for identifying focal-species in Nova Scotia. The concept of focal-species and the role of a focal-species approach is introduced. A framework for identifying focal-species warranting special biodiversity management attention is developed. A Delphi survey method is utilized to test the method and gain input from expert wildlife biologists, ecologists and managers. Priority species for special biodiversity management attention in Nova Scotia are identified. The focal-species approach is then applied at a regional level to species existing in Kejimkujik National Park. Potential priority indicator species for monitoring biodiversity measures at the species-population level are identified. A framework for linking focal-species to the landscape is tested for species identified as priority species at provincial and regional levels. Development and application of the focal-species approach to various aspects of biodiversity management in Nova Scotia constitutes the original or primary research component of this thesis, and is considered to represent an important contribution to the field (Noss 1997 pers. comm.; Soulé 1997 pers. comm.; Elderkin 1998 pers. comm.).

The approach is described within the context of a broader mix of approaches and ecological considerations required for protected area design in Chapter two (Beazley 1997a). Chapter three describes the parks and protected area context in Nova Scotia and shows that while there is some public support and recognition for broader ecological considerations in protected area and larger regional planning, species or population information and processes of disturbance and succession have not been considered. Area requirements for viable populations of native species and ecological processes have not been incorporated into protected area design in Nova Scotia. The proposed wilderness protected areas are not large enough and do not include enough diversity of habitat types to maintain minimum critical habitat for viable populations of certain species found in Nova Scotia.

Chapter four describes a process for selecting focal-species in Nova Scotia and identifies potential focal-species warranting special consideration in biodiversity planning and management (Beazley 1997b). Chapter five applies the approach to identify focal-species at a regional level. These focal-species may constitute indicator species for monitoring biodiversity at the species-population level, such as population viability (Beazley 1997c). They may also serve to define parameters for monitoring landscape-level measures of threats to biodiversity such as habitat fragmentation, relative to specific habitat requirements of focal- or indicator-species.

Chapter six explores ways of linking focal-species at both provincial and regional levels to the landscape. The most resource-demanding species are identified according to factors limiting their populations such as spatial area of habitat, dispersal, specific dietary or other resources, or exploitation or ecological interactions. While the approach appears to hold promise, further information is required regarding regionally specific species-habitat relationships and habitat quality, extent and distribution.

This thesis suggests that species-population level considerations are necessary for biodiversity management including protected area design and management. The focal-species approach may be the most appropriate way to integrate and operationalize species-population information with landscape-level considerations for biodiversity management and planning purposes. A focal-species approach is useful for identifying focal-species and populations and for defining landscape parameters such as size, shape, distribution, and quality of critical habitat. Focal-species can provide a multiple-species umbrella for protected area design and biodiversity management, including monitoring. The approach should be extended beyond protected areas to broader regional and provincial scale planning and management, including integrated resource management and land-use planning.

A focal-species approach is necessary to identify critical or key species such as space-demanding and wide-ranging species, those with special habitat, dietary, and reproductive requirements and those sensitive to human activities. A range of the most habitat- and resource-demanding focal-species may be identified, and may represent a multiple-species umbrella of protection for other, less resource-demanding species (Lambeck 1997). Information on the habitat requirements of focal-species is necessary to make meaningful landscape-level decisions related to the protection of biodiversity. Landscape-level approaches and measures have no meaning outside of the requirements and interactions of the particular species which constitute the specific landscape. Without this type of information, ecological considerations for biodiversity will not be adequately incorporated into land-use decisions. Further, the timing is critical; options for biodiversity are being foreclosed. Protection is much easier than restoration, and extinction is forever.

More information on ecological processes such as disturbances and succession is also required and should be incorporated into habitat requirement considerations for focal-species. Enough area should be protected that habitat needs will be met while natural processes of disturbance and succession such as fire and insect cycles continue. Obviously large areas will be required to maintain or enhance current levels of native biodiversity. Thus biodiversity management considerations must be extended into the broader landscape.

An important proviso is that the approach described and tested within the thesis explicitly addresses only mammals, reptiles, amphibian and freshwater fish species native to Nova Scotia. A suite of focal-species should also include plants, birds, and invertebrates. Butterflies and avifauna may serve as early indicators of environmental change and habitat loss (Daily and Ehrlich 1997-98). However, a landscape designed to meet the requirements of mammals, reptiles and amphibians and freshwater fishes with large home-ranges, special habitat needs, and sensitivities to human activities will go a long way towards protecting populations of species in other classes.

The following chapter gives an overview of ideas in the literature which provide insight into protected and biodiversity management area system design towards the goal of maintaining current levels of biodiversity. Ecological considerations from island biogeography, conservation biology, and landscape ecology, such as population viability, critical habitat area, patch dynamics, and landscape context, are related to protected area site selection, boundary delineation and management (Beazley 1997a). Autecological, biogeographical, population viability and gap analysis at regional or local levels are recommended as critical areas of research for protected area system design. The need for context-specific, species-population level information for landscape-level decision making is demonstrated. The potential utility of a focal-species approach to integrate and focus research and other aspects of biodiversity management is introduced.

Chapter 2

Ecological considerations for protected area system planning

2.1 Introduction

Historically, parks and protected areas have been established with little contribution from ecological science (Newmark 1985; Schonewald-Cox and Bayless 1986; Theberge 1993). Consideration of ecological criteria could improve park and protected area system design for conservation objectives such as the maintenance of current levels of native biodiversity (Soulé and Simberloff 1986; Shafer 1990; Noss 1995). Through various conventions, agreements and initiatives, Canada and the Province of Nova Scotia have made commitments to maintaining biodiversity (UN 1992; BWG 1994; NSRTEE 1992). Parks Canada has a mandate to maintain ecological integrity and complete a system of parks to represent the natural regions in Canada (Canadian Heritage 1994a). The Province of Nova Scotia is currently in the process of delineating and establishing a province-wide parks and protected areas system (NSDNR 1994). There is much interest in how these objectives may best be accomplished (Kavanagh and Iacobelli, no date; Noss 1995).

This chapter examines ideas from ecological science that provide insight into protected area system design for biodiversity objectives (Beazley 1997a). These include: island biogeography; concepts from conservation biology such as viable populations, critical habitat area, and patch dynamics; landscape ecology; palaeoecology; and, non-equilibrium perspectives. The need for strategic and multiple integrated methodologies in planning and designing protected area systems is demonstrated. A selection of methodologies and their relationship to each other is described. Design and planning concepts are introduced, along with approaches for integrating protected areas into the broader regional context. Finally, the importance of context-specific information related to target- or focal-species, habitat requirements and population viability is established.

The focus of the discussion is on ecological considerations that address the question of how much area is required to maintain current levels of native biological diversity over time, and how this might be determine. Ecologically defensible prescriptions of how much is enough are necessary at this time of increasing pressures on a finite land and resource base. Defining the habitat requirements of focal-species, or those most especially in need of protected areas or biodiversity management attention, can provide critical information for landscape-level management and land-use decision making. Identifying focal-species and defining landscape-level connections remains a challenge in Nova Scotia and elsewhere.

2.2 The role of protected areas

Protected areas have been established for various purposes. In examining the role of protected areas in maintaining biological diversity, many questions arise. For example, are protected areas *alone* expected to fulfill this role? And, are they intended to fulfill this role in perpetuity? If the answer is "yes" to these questions, then the prospects for biodiversity are grim. While it is recognized that small protected areas contribute to regional biodiversity (Boecklen 1986; Simberloff and Cox 1987; Falkner and Stohlgren 1997), it is generally agreed that existing protected areas are too few, too small and too isolated to enable most large mammals to persist in the shorter term, and many species will be lost over the longer term (See for example: Newmark 1985; Frankel and Soulé 1981; Soulé and Simberloff 1986; Shafer 1990). Protected areas must work in concert with surrounding working landscapes to maintain biodiversity.

Protected areas have been variously defined as, "an area of land which has effectively been removed from the development stream for the purpose of perpetuating natural conditions", the central role being to protect natural diversity (Pyle 1980, 319); "a region set aside for the protection of the aggregate of species contained therein, as well as the supporting physical environment . . . to maintain, hopefully for perpetuity, a highly complex set of ecological, genetic, behavioral, evolutionary and physical processes and the co-evolved, compatible populations which participate in these processes" (Frankel and Soulé 1981, 98). More simply, "protected areas provide a repository for species and their gene pools, together with the natural selective forces that mould them" (Theberge 1993, 138). Protected areas may also refer to "biological management areas" within working landscapes, wherein human activities compatible with conservation objectives take place (Scott et al. 1993).

2.3 Theoretical contributions to protected area system design

2.3.1 Lessons from island biogeography

Island biogeography theories have led to applications of its models to terrestrial habitat "islands" and protected area design. Island biogeography theory suggests that species numbers will be larger on larger islands due to the species-area relationship (Preston 1960), and on islands closer to a continental land mass due to the distance or isolation effects of the equilibrium model (MacArthur and Wilson 1967). Principles for the design of protected areas were proposed (Diamond 1975), widely disputed and largely discredited (Soulé and Simberloff 1986; Margules et al. 1982; Shafer 1990). Substantial debate ensued about whether a single large protected area or several small protected areas (SLOSS) of equal total area would capture more species (for an overview see Shafer 1990).

Theoretical and empirical evidence has been presented both to support and dispute the theories, general design principles, and SLOSS arguments. The resolution seems to be that undue emphasis should not be placed on the application of general rules to the practice of conservation but, in most cases, a large protected area will capture more species than a small one. However, small protected areas are important to capture rare or endemic species with limited distribution. There are benefits to having several protected areas rather than a single one, for example: to reduce effects of disturbances such as disease, fire and pests; to maximize genetic diversity; to provide redundancy; and, to increase habitat variability, and environmental and biological diversity. However, several small protected areas may not protect wide-ranging species, interior species, those sensitive to human interference, and viable populations.

Several reasons have been given for the perceived deficiencies of island biogeographic theory for application to protected area design. The equilibrium theory has not been sufficiently tested and seems to hold true in a few systems and not in others; the species-area relationship is not best explained by the dynamic equilibrium theory and probably is affected primarily by the fact that larger sites tend to have more habitats; and, scientific findings from one system are not necessarily applicable in another (Margules et al. 1982; Soulé and Simberloff 1986). With regard to SLOSS, whether a single large or several small protected areas would capture more species is more likely to be explained by heterogeneity of habitat than by area considerations alone.

Shafer (1990) compiled a set of guidelines for the design of protected areas from consensus in the literature. Table 2.1 provides a selection of these guidelines. However, general guidelines should be applied with caution and with respect to the particular context. Decisions should be based on field studies, with a major consideration being to conserve enough habitat for the target- or focal-species. This view reflects a "pre-equilibrium theory" idea of effective protected area design and supports a return to autecological and context specific research (Soulé and Simberloff 1986; Shafer 1990; Pickett et al. 1992).

2.3.2 The distinction between site selection and boundary delineation

Selecting and evaluating protected areas from within a broader region requires quite different processes and criteria than for delineating a protected area boundary once a site has been selected. Both site selection and boundary delineation are part of the design process of a protected area system and relate to the question of how large of an area is required to maintain biodiversity. While site selection criteria will be briefly described, the main focus in this paper will be on boundary delineation.

Table 2.1: Selected guidelines for protected area design

- The more land you set aside, the more species you will preserve.
- A larger area usually captures more species of plants and animals, but returns typically diminish as area increases beyond a certain point.
- Habitat fragmentation and protected area insularization should be discouraged.
- Protected area boundaries should not create abrupt transitions that discourage animal movement to surrounding habitat.
- A large protected area is better than a small one, everything else being equal.
- Many large protected areas are needed in as many biotic communities as possible.
- Small protected areas can serve a useful purpose in any overall system design to conserve some species or to facilitate migration of other species.
- Small populations should be avoided; populations should be as large as possible, and should be replicated.
- Rare species and large-bodied, wide-ranging species are likely to be the most vulnerable to extinction.
- The establishment of corridors to facilitate animal movement should be based on autecological study of individual species and individual situations.
- The establishment of a new protected area should be based on studies of the distribution of species and communities in the region or country to avoid the sample effect.
- Autecological studies of individual species and their relationship to other species should be given a high priority.
- Protected areas for large mammals should usually be increased in size where opportunities exist to do so; buffer zones are an alternative.
- Under ideal conditions, protected area size should be such as to accommodate the largest, widest-ranging mammals, on the basis of their life history and territorial behavior, and will then serve as an area umbrella for other species.
- Protected area design should seek the theoretical ideal of maximizing alleles by preventing genetic drift in small populations and of preserving heterozygosity by discouraging inbreeding.
- Smaller protected areas probably will withstand less internal or external stress than larger ones.
- The design and management of protected areas should be viewed as potentially an interactive regional matrix.

(Source: Selected from Shafer 1990)

2.3.2.1 Site selection

Criteria for site selection are well documented (Margules and Usher 1981; Smith and Theberge 1986; 1987; Kavanagh and Iacobelli, no date). The most commonly stated reasons for establishing and selecting protected areas are to conserve diversity of habitats and species, and characteristics of rarity or uniqueness, naturalness, representativeness, and large size (Table 2.2). A procedure for selecting protected areas may consider various criteria in stages: 1) pre-evaluation classification or sorting stage; 2) representativeness; 3) threshold criteria (naturalness, area); 4) ranking criteria (diversity, rarity, or any other ecological criteria); and, 5) pragmatic criteria such as threat of interference (Margules 1986; Usher 1986).

Table 2.2: Evaluation criteria for assessing and selecting protected area sites

Margules and Usher (1981)	Smith and Theberge (1986)	Usher (1986)
Diversity Rarity Naturalness Area Threat of human interference Typicalness or representativeness Educational Value Amenity value Recorded history Scientific value Uniqueness Wildlife reservoir potential Ecological fragility Position in ecological/ geographical unit Potential value Availability Replaceability Management consideration	Rarity, Uniqueness Diversity Size Naturalness Productivity Fragility Representativeness or typicalness Importance to wildlife, Abundance Threat Educational value Recorded history/ research investment Scientific value Recreational value Level of significance Consideration of buffers and boundaries Ecological/geographical location Accessibility Conservation effectiveness Cultural resources Shape	Diversity (habitats and/or species) Naturalness, Rarity (habitats/species) Area/size Threat of human interference Amenity value Education value Representativeness Scientific value Recorded history Population size Typicalness Ecological fragility, Position in ecological/ geographical unit Potential value Uniqueness Archaeological interest Availability Importance for migratory waterfowl Management factors Replaceability Silviculture gene bank Successional stage Wildlife reservoir potential

* Criteria listed in order of frequency of use (Compiled from Margules and Usher 1981; Usher 1986; and Smith and Theberge 1986; 1987)

Currently in Canada, most protected areas are established with the objective of representing the biophysical regions of the particular planning jurisdiction. Both Parks Canada and the Province of Nova Scotia use representivity as a primary criterion for site selection (Canadian Heritage 1994a; 1994b; NSDNR 1994). Selecting representative protected areas requires that the jurisdiction be classified into regions. Approaches for classification can be of various types. Environmental approaches are based on climatic regions or a combination of land form, soils, lithology, vegetation and climate. Biological approaches focus on floristics, species distribution or biogeographic regions, or vegetation communities distribution (Usher 1986). World Wildlife Fund-Canada's gap analysis for assessing respresentivity supports an environmental classification approach based on enduring features (Kavanagh and Iacobelli, no date). Nova Scotia's Department of Natural Resources utilized a combined approach, identifying 77 natural landscapes in Nova Scotia (NSDNR 1994).

2.3.2.2 Boundary delineation

Many protected areas were originally created within areas of larger similar wilderness or habitat and for reasons unrelated to ecological integrity or biodiversity, such as scenic beauty, recreation or tourism. As the surrounding wilderness disappears, boundary issues become more critical in terms of conservation objectives. Greater protection inside the protected area results in a generated edge that reflects changes that occur along and across the boundary in human behavior and in species and resource distribution (Schonewald-Cox and Bayless 1986). If the generated edge is inside the protected area, effective size is reduced.

In eight of the largest protected areas in western Canada and the United States, the legal protected area boundaries are smaller than the ecological or biotic boundaries. Biotic boundaries are "those necessary to maintain existing ecological processes and a given assemblage of species" (Newmark 1985, 197). As these protected areas become increasingly insularized by surrounding land-use change they may experience faunal collapse.

Protected area boundaries need to be compatible with ecological realities to maintain biodiversity. Theberge (1989) described abiotic, biotic and cultural guidelines for delineating ecologically sound boundaries (Table 2.3). These guidelines may be adapted for particular applications with consideration of the specific biogeographic context.

Table 2.3: Guidelines for drawing ecologically sound boundaries

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<u>**Abiotic Guidelines**</u>
1. encompass the greatest possible proportion of the area drained by the river of highest order
2. include headwater areas
3. consider subsurface transbasin water flow
4. should not cross active terrain
5. include rare geomorphic and hydrologic features and processes

<u>**Biotic Guidelines**</u>
Community level:
6. should not sever rare or unique communities
7. should not sever highly diverse communities
8. should not sever communities with a high proportion of dependent faunal species

Species level:
9. should not jeopardize the ecological requirements of either numerically rare or distributionally rare (uncommon) species
10. should not jeopardize the ecological requirements of niche specialists
11. should not jeopardize populations of spatially vulnerable species
12. should not jeopardize populations of *k*-selected species
13. should not jeopardize populations of range-edge or disjunct species
14. should take into special account pollution-susceptible species
15. should take into special account the ecological requirements of ungulate species

<u>**Cultural Guidelines:**</u>
16. consider nodes of human activity, especially where land use is increasing
17. consider corridors of human activity, especially where land use is increasing
18. include areas of cultural significance and areas for interpretation of human impacts on environment
19. consider areas of competing land uses and of large scale, rapid and controversial land use change

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(Source: compiled from Theberge 1989)

2.4 Ecological considerations for determining area requirements

It is generally agreed that what is needed is as many, as large and as connected protected areas as possible (Shafer 1990). However, in light of the increasing competition for land resources, as well as demands for guidelines from protected area designers and managers, the idea that "bigger is better" must be refined to more precise prescriptions for how much area is enough to maintain biodiversity. This question remains unanswered. E.O. Wilson was referring to the task of determining the minimum area required to retain native biodiversity when he stated that "no process being addressed by modem science is more complicated or, in my opinion, more important" (1984 in Shafer 1990).

The ecological considerations in this process are complex and interrelated. However, they can be organized into three broad groups: 1) viable population and critical area; 2) patch dynamics and disturbance regimes; and, 3) landscape level considerations.

These considerations may be informed by palaeoecology and non-equilibrium perspectives.

2.4.1 Viable populations and critical habitat area

If the aim of protected areas is to preserve the processes of evolution in perpetuity rather than the present diversity of species *per se*, then the forces that affect species extinction and evolution must be considered. Factors leading to extinction include systematic pressures and stochastic perturbations. Protected areas remove or compensate for systematic pressures, however sources of uncertainty remain to which a population may be subject: demographic, genetic, and environmental stochasticity; natural catastrophes; and, dysfunction of social behavior at small population sizes (Shaffer 1981; Soulé 1983 in Boecklen 1986) (Table 2.4). A minimum viable population (MVP) is one which has a high probability (for example, a 99% chance) of enduring these sources of uncertainty within its own particular biogeographic context, over a relative time frame (for example, 1000 years) (Shaffer 1981).

Table 2.4: Sources of uncertainty threatening species persistence

Extrinsic factors:

Environmental stochasticity due to deleterious changes in habitat parameters and the populations of competitors, predators, parasites, and diseases;

Natural catastrophes, such as floods, fires, droughts, which may occur at random intervals through time;

Intrinsic factors:

Demographic stochasticity, which arises from chance events in the survival and reproductive success of a finite number of individuals, such as random variations in sex ratios or birth and death ratios;

Genetic stochasticity resulting from changes in gene frequencies due to founder effect, random fixation, or inbreeding;

Social dysfunction or behaviors that become maladaptive at small population sizes.

(Compiled from Shaffer 1981; and Soulé 1983 as cited in Soulé and Simberloff 1986)

Genetic criteria have provided some understanding for minimum viable population calculations and protected area design (Shaffer 1981; Boecklen 1986; Shafer 1990; Soulé and Simberloff 1986; Grumbine 1990a; Soulé 1980; Frankel and Soulé 1981). The two aims of genetic conservation (preservation of heterozygosity and preservation of alleles) may be antithetical from a protected area design standpoint.

Alleles are best maintained in subdivided populations with no migration, and heterozygosity is best preserved over the short term in intact populations and over the long term in subdivided populations with high rates of migration. It may not be possible to maintain sufficient numbers of individuals of some species at the present time, with the protected areas we have or are likely to establish in the near future, to allow evolutionary changes (Frankel and Soulé 1981; Soulé and Wilcox 1980). The best short-term objective may be to maintain enough genetic fitness for short term survival of species in order to maintain enough evolutionary potential for long term survival, in the hope that future protected area and land-use planning may leave enough space for ecological processes to reestablish an equilibrium (Frankel and Soulé 1981). Therefore, preservation of alleles should have the higher priority because heterozygosity can be reconstituted by increasing gene flow in the future or artificially. Thus, several protected areas and populations with occasional migrations among them may represent the optimal design strategy for genetic conservation (Franklin 1980; Boecklen 1986).

There are lower limits to the size of sub-populations where extinction probabilities increase, and these lower limits should not be violated. Although there is no "magic number" applicable to all species, Franklin estimated that, from inbreeding considerations alone, a minimum effective population of 50 is needed for short-term, and 500 for long-term survival (1980, 147). It is important to note that *effective* population size is significantly lower than census or total population size, because it assumes an *ideal* breeding population. Effective population size (Ne) may also be higher if other sources of uncertainty are considered along with inbreeding considerations. Further, Franklin's numbers were determined using the 1% rule of maximum tolerable rate of inbreeding developed by domestic animal breeders; effective population sizes for wild species in natural habitats may be significantly higher than Ne=50.

Clearly, minimum viable population size would be higher than effective population size, both in the short- and long-term. Franklin's numbers have been disputed: they are probably only correct in that they are within the right order of magnitude for most species; and, they are probably too low for real or wild populations (Grumbine 1990a; Lande and Barrowclough 1987 in Grumbine 1990 a). Thus, these figures could be dangerous if used as protected area design criteria. Subsequent estimates suggest that a short-term (50-100 years) minimum viable population for wolves is 148 breeding individuals, and for grizzly bears is 393 (Hummel and Pettigrew 1991).

Considerations of viable populations and critical habitat area should ideally be based on long-term survival, thus utilizing figures in the order of magnitude of Ne=500 and applying it to a target species. Minimum critical area (MCA) is determined by calculating the amount of habitat required to sustain the minimum viable population, including home range and migration patterns. The minimum critical area required to protect a viable population has been calculated as approximately 39,000-78,000 km^2 for wolves (Frankel and Soulé 1981, 122), and 12,233-122,330 km^2 for grizzly bears, depending on the location of the habitat (Craighead and Mitchell 1982 in Newmark 1985; Hummel and Pettigrew 1991).

Large mammals, particularly carnivores, are appropriate focal-species for area requirement calculations because as a group they tend to be sensitive indicators, vulnerable due to their low densities, and important or keystone in their communities. As well, they act as umbrella species, encompassing many other species with smaller area requirements (Frankel and Soulé 1981; Hunter 1990; Noss 1990a; 1990b). Thus, protected areas are generally too small: 93% of all protected areas in the world are less than 5000 km^2, and 78% are less than 1000 km^2 (IUCN 1975 in Frankel and Soulé 1981, 124).

A methodology for determining protected area size is to: 1) identify focal-species; 2) determine the minimum number of individuals needed for survival; and, 3) estimate the area needed to sustain the minimum number, ensuring that: a) enough habitat exists to support the number of individuals in a population needed to guarantee a high probability of survival over a long time period; and, b) the dynamics of succession do not eliminate critical habitat (Soulé and Simberloff 1986).

2.4.2 Population viability analysis

Population viability analysis (PVA) is a tool for determining MVP and MCA by incorporating biogeographic distribution patterns, species-specific turnover rates and available population data into computer simulations designed to test extinction probabilities (Gilpin and Soulé 1986). Earlier population viability analyses focused on demographic approaches (MacArthur and Wilson 1967), while later studies focused on genetic aspects (Frankel and Soulé 1981; Gilpin and Soulé 1986) and environmental factors such as patch dynamics (Pickett and Thompson 1978). A combination of approaches is necessary to provide an integrated model of all the factors of extinction, but such a model may be too complex to use.

Population viability analysis encompasses at least three fields: 1) population phenotype; 2) environment-habitat quality and quantity; and, 3) population - structure and fitness. For PVAs associated with protected areas, the disturbance regime is often the most important factor in the environment because populations may be restricted to island-like habitats and be unable to escape to other suitable habitat areas (Gilpin and Soulé

1986). Thus, PVA requires the consideration of the biogeographic context, particularly patch dynamics and landscape structure. Meta-population viability analysis incorporates considerations of regional sub-population groups (meta-populations) and their relationships.

2.4.3 Minimum dynamic area and effective protected area size

Succession and disturbance regimes such as fire, windstorm, disease and herbivory are often the most significant aspects of the environment. These processes at various spatial and temporal scales across the landscape determine the size, density and temporal frequency of patches and result in heterogeneous patches or "patch dynamics" (Pickett and Thompson 1978) which together over time and space represent a "shifting mosaic steady state" (Bormann and Likens 1979). Patch dynamics should be considered in the design of protected areas because some species in protected areas may not be able to disperse to new sites in the face of disturbances that threaten their survival. Further, patch dynamics are ecological processes which create diverse habitat, resources and communities. Protected areas should allow for these processes, therefore consideration of disturbance regimes, including rare events and the associated patterns of succession, is required (Ricklefs et al. 1984).

The design of protected areas should be based on analysis of the minimum dynamic area (MDA). MDA is "the smallest area with a natural disturbance regime, which maintains internal recolonization sources, and hence minimizes extinction" (Pickett and Thompson 1978, 34). In a protected area, the minimum dynamic area should be defined relative to the focal-species. In other words, viable population and critical area requirements must be combined with patch dynamic considerations to make decisions on effective protected area size. Protected areas should be large enough to contain regionally specific processes such as tree falls, wind throws, fire and disease, without affecting all of the habitat of any particular type. In the face of disturbances enough habitat should remain to support a minimum viable population of the focal-species.

2.4.4 Biogeographic context and regional landscape ecology

Protected areas alone will not preserve the present levels of native biological diversity, let alone provide for evolutionary speciation. Very few, if any, protected areas are large, connected and protected enough to support viable populations of large mammals or encompass minimum dynamic areas. Regardless of the care we exercise in utilizing ecological criteria, protected area boundaries are unlikely to remain congruent with biotic boundaries over time.

Species, materials and processes cross protected area boundaries in both directions. The ecological integrity of most protected areas will depend upon the suitability of surrounding lands as supplemental habitat, migration and dispersal routes and buffers. The maintenance of biodiversity will require utilization of protected areas and working land as habitat. For these reasons, protected area and broader land-use planning must be integrated to maintain biodiversity.

Protected area design should take into account potential edge-, buffer- and isolation- or connectivity- effects of surrounding land-uses and land-cover. At the landscape level, habitat fragmentation remains the principle threat to most species in the temperate zone (Wilcove et al. 1986). Fragmentation reduces habitat area and results in the redistribution of communities or populations into disjunct fragments. The various effects of fragmentation have been widely discussed (Wilcove et al. 1986; Burgess and Sharpe 1981; Harris 1984; 1988; Soulé 1986; Yahner 1988; Harris and Silva-Lopez 1992).

Recognition of the threat of fragmentation has resulted in debate about the potential role of corridors for migration and dispersal, including wide corridors for dispersal in response to climate change (Forman and Godron 1986; Noss 1987; Simberloff and Cox 1987; Shafer 1990; Peters and Darling 1985; Graham 1988; Hunter et al. 1988). However, the value of corridors *per se* is debatable, because characteristics that define an effective corridor vary according to the species in question; a corridor for some species may constitute a barrier for others. Connectivity may be a more useful concept than that of corridors; it is generally beneficial to maintain and restore pre-existing connections among protected areas. Areas which provide connectivity among protected areas include buffer zones, riparian strips, and areas of compatible land-uses.

Buffer zones provide a transition zone between protected areas and intensely used lands. They can increase the effective protected area, provide increased connectivity, and ameliorate boundary- or edge- effects. Considerations that have been used to determine buffer zones include: 1) the need of threatened wildlife species for resources outside of the protected area; 2) the need for buffer zones to serve other protective functions; 3) the need to contain wildlife species likely to move outside of the protected area; 4) the reasonable needs of the local people; and, 5) the amount of land actually available for buffer use (Mwalyosi 1991). These criteria are very general, however context specific criteria could be derived from biogeographical and population viability analysis for particular applications.

2.5 Integrative theoretical perspectives

2.5.1 Palaeoecology

Palaeoecology gives insight into considerations of long-term processes such as climate change and lends support to the coarse-filter approach of protecting areas representative of physical environment variability. Long-term studies of processes show that species respond to environmental changes in individual and novel ways; communities do not respond *in toto*. This suggests that, because biological communities are ephemeral over time, the long term survival of species will depend on their ability to move and survive in response to environmental changes.

Thus an effective protected area system design would focus on protecting representative physical environments rather than biological communities. Protected areas should be located and delineated according to the distribution and range of physical environments; and, should be connected with large-scale corridors with both north-south and east-west orientations to accommodate changes in species distributions in response to shifts in temperature and precipitation patterns. Further, they should be located near the northern limit of species range; in areas of high species diversity; where topography and soil types are diverse; and, in areas containing altitudinal variability. In the case of accelerated climate change due to anthropogenic influences, many species could not disperse fast enough to compensate for climatic shifts and management intervention may be required (Peters and Darling 1985; Hunter et al. 1988; Graham 1988).

2.5.2 The non-equilibrium paradigm

The non-equilibrium paradigm (Pickett et al. 1992) can be characterized as accepting natural systems as open, and emphasizing process. It can be portrayed metaphorically as patch dynamics or the shifting mosaic. This paradigm replaces aspects of the classical equilibrium paradigm which can be characterized by Clements' (1916) more static concept of the climax state.

Resulting considerations for protected area design include a recognition of the importance of environmental and historical context, a focus on processes and heterogeneity at various scales, and the inclusion of people as agents of flux and disturbance. The goal of protected area design becomes to maintain the integrity of the processes that have generated the system, specific to the particular historic and biogeographic contexts, rather than attempt to conserve a slice-in-time or static community. Natural systems should be viewed as *processes* rather than *entities* (Pickett et al. 1992; Noss 1992b). Ecological considerations for protected area systems design may be derived from the non-equilibrium perspective (Table 2.5).

Table 2.5: Information and strategies applicable to protected area system design

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Information to be applied (Pickett et al. 1992):
1. processes governing the system;
2. context in which it is embedded;
3. historical range of flux in the system;
4. evolutionary and physiological limits of the organismal components; and,
5. nature and impacts of episodic and long-term phenomena, including the roles of people

Temporally expanded conservation strategy (Noss 1992b):
1. based on long-term ecological and economic sustainability;
2. more dynamic, non-equilibrium view; concentrate on maintaining physical conditions and ecological processes rather than particular species associations;
3. recognize necessity for habitat connectivity and continuity for migration; and,
4. supplement interest in sustaining existing species with the notion of future evolutionary diversification

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(Compiled from Pickett et al. 1992 and Noss 1992b)

2.5.3 Hierarchy theory

Hierarchy theory provides a useful model for organizing spatial patterns and complex landscape dynamics at various scales. For example, a forest landscape may be understood as a hierarchical system of gaps, stands, watersheds and region. Non-equilibrium dynamics or spatial heterogeneity at one scale can be translated to equilibrium or constancy at a higher level, as in the shifting mosaic steady state (Bormann and Likens 1979) and minimum dynamic area concepts (Pickett and Thompson 1978). It is possible to define or bound an equilibriating landscape, which is large enough to contain disturbance regimes while maintaining a constant but shifting distribution of patches of all types at all times (Urban et al. 1987).

Shugart and West (1981) simulated a forest "quasi-equilibrium" landscape and determined that the ratio of the "bounded" landscape to the disturbance regime was at least 50:1. Smaller landscapes were referred to as "non-equilibriating". Thus, protected areas should be approximately 50 times larger than the size of the characteristic disturbance regime in order to encompass a quasi-equilibriating landscape.

2.6 Integrative design and planning concepts

Integrative and strategic approaches to protected area system design include the biosphere reserve model, multiple-use modules, the greater ecosystem concept, wilderness recovery networks, the triad concept, coarse- and fine-filter approaches, and target-species approaches. These approaches have common elements such as buffer zones around core protected areas, linkages with other protected areas and/or the broader region, and co-operative or partnership arrangements with adjacent land owners and managers for furthering protected area values. Multiple-use modules and wilderness recovery plans are more explicit in recommending that connectivity be maintained and restored among "nodes" of protected areas, and, along with the coarse- and fine- filter approaches, include the concept of a larger system or network of protected areas.

The biosphere reserve model (UNESCO/MAB 1974) explicitly calls for integration among strictly protected core areas, buffer areas, and the surrounding zone of influence or co-operation. Research and monitoring to determine effects of human activities on core and buffer areas are integral components. Such research could advance our understanding of processes and causes of change and boundary issues (Francis 1985).

The multiple-use module (MUM) concept has been used to design a protected area system to support wide-ranging species and help reconcile species-level and ecosystem-level approaches (Harris 1984; Noss and Harris 1986). MUMs include nodes of high ecological value that are protected in an inviolable core and that are integrated into a functional regional network through an interconnected system of corridors. Thus, the MUM approach integrates protected areas into the regional context, and extends the focus from species and communities to heterogeneous landscapes.

The greater ecosystem approach attempts to manage protected areas as part of the larger region (Grumbine 1990b). The boundaries of the greater ecosystem often vary with the particular ecological relationships, processes and issues in question. Components of a greater ecosystem approach include: consideration of ecological relationships and hierarchical context; research, monitoring and adaptive management; co-operative and partnership arrangements; and, a recognition that humans are part of the system. The goal is to sustain ecological integrity, including viable populations of native species, evolutionary and ecological processes, and compatible human uses. The greater ecosystem concept is being applied in and around various protected areas in Canada and the United States (Woodley and Freedman 1995; Skibicki 1995).

The wilderness recovery network approach is essentially a land conservation strategy promoted by several conservation biologists (Soulé 1993; Johns 1993; Foreman et al. 1993; Noss 1994). Protected areas with connectivity or linkages among them and buffer zones are delineated at a bioregional level and ultimately could combine to form a continent-wide system. The approach integrates several ecological considerations including representation of all ecosystems, population viability of sensitive species, and perpetuation of ecological and evolutionary processes (Table 2.6). Estimates of land required to fulfill these considerations range in the order of 25 to 75 percent of a region, depending on the particular bioregional context (Noss 1994).

Table 2.6: Principles and approaches for a wilderness recovery plan

A. Set ecological goals
B. Representation
C. Viable populations (especially vulnerable species and large carnivores):
1. species distribution across their native range
2. large blocks of habitat containing large populations
3. blocks of habitat close together
4. contiguous blocks rather than fragmented
5. interconnected blocks rather than isolated
6. roadless blocks and blocks inaccessible to humans

D. Maintain ecological and evolutionary processes, allowing for change
E. Land Conservation:
1. protect populations of rare and endangered species
2. maintain healthy populations of species that play critical roles
3. protect examples of all communities
4. manage greater ecosystems and landscapes for conservation and sustainability

F. Reconnaissance and selection of core protected areas:
1. select areas in roadless, undeveloped or natural condition
2. add areas relatively undeveloped and restorable
3. map rare species distributions and add imperiled species
4. select clusters or constellations of rare species and community types
5. add unprotected and under-protected vegetation types and centers of species richness
6. determine core protected areas and linkages, add corridors and buffer zones

G. Components:
1. core protected areas
2. buffer (multiple-use) zones
3. connectivity/linkages as habitat, for seasonal movement, dispersal, and range-shifts

H. Size:
1. protected areas and population viability
2. protected areas and disturbance regimes

(Compiled from Noss 1994)

The triad approach is basically a model for characterizing the continuum of land-uses from 1) intensive commodity production areas, to 2) areas with little or no resource use by people, and to 3) areas where modest resource use compatible with ecological values occurs (Hunter and Calhoun 1993). It explicitly recognizes that all three levels of land-use are valid and it includes protected areas and buffer zones as critical components of a larger ecologically sustainable landscape. Considerations for integrating protected areas with the broader landscape context have been widely discussed (Forman 1990; Hannson and Angelstam 1991; Nelson 1991; Shafer 1990; Wilcove et al. 1986; Diamond 1986; Pickett et al. 1992).

The coarse-filter approach is based on the idea that biological diversity will be maintained by protecting representative ecosystems or physical diversity. Canada's and Nova Scotia's initiatives to protect representative natural regions are both coarse-filter approaches. A gap analysis methodology developed by World Wildlife Fund (Canada) to assess progress in these initiatives describes a systematic coarse-filter approach based on representing enduring or physical features at various scales from ecoregions to soil landscapes (Kavanagh and Iacobelli, no date). Other coarse-filter approaches focus on biological communities and utilize gap analysis to identify typical communities not yet represented, as well as rare ecosystems and hot-spots of species richness and diversity (Scott et al. 1993).

One serious shortcoming is that the coarse-filter approach does not fully protect biodiversity. Although samples of biodiversity may be captured within representative protected areas, the boundaries are not necessarily congruent with the habitat requirements of viable populations or other ecological processes. This deficiency in the coarse-filter approach may be addressed through application of a fine-filter layer of ecological integrity considerations such as natural processes, viable populations and critical area, and compatible human uses (Noss 1995). This fine-filter layer should encompass the realm of ecological considerations that have formed a large part of this paper.

Ecological considerations suggest that protected area design for biodiversity objectives be driven at least partially by species-habitat information relating to focal-species. Protected areas designed on the basis of ecosystem or landscape representivity are highly unlikely to be congruent with habitat requirements of viable populations of native species over time. Species-population-level information is required to identify those species which warrant special management attention and to define their habitat requirements or other limiting factors. These species are focal-species and may include vulnerable, functionally important or keystone species, sensitive or indicator species, wide-ranging or space-demanding species, or special populations (Hunter 1990; Noss 1990b; 1991a; 1995).

It is not necessary nor feasible to conduct autecological or population viability analysis for all species. For example, some species are able to adapt and persist or thrive in landscapes utilized by humans. Some species have relatively small or general habitat requirements, thus they will be protected if the requirements of more demanding species are met. Thus, the most appropriate method is to identify focal-species or those which may be the most vulnerable to threats and the most demanding in their habitat and resource requirements. Once focal-species are identified, habitat requirements for viable populations of these species may be determined from context-specific autecological studies such as population viability analysis (PVA). As previously discussed, PVA calculates viable population size and critical area within the context of the specific species-population and region, including natural disturbance regimes. Subsequent assessment can help to identify important sites, area requirements and boundaries for protected areas, as well as important connections with broader landscape components.

If properly selected, a suite of focal-species may act as a multi-species umbrella by defining landscape-level parameters that meet the requirements of the most demanding species (Lambeck 1997). Boundaries for biosphere reserves and greater ecosystems, as well as important corridors and sites of connectivity, should be determined at least partially by landscape parameters defined from species-population considerations if viability of resident populations of native species are to be maintained. Boundary delineation of areas selected on the basis of landscape representivity should also take the habitat requirements of viable populations of focal-species into account. A significant challenge lies in selecting the most appropriate suite of focal-species.

Planning concepts which promote the integration of ecological considerations into broader land-use decision-making include the eco-development model, sustainable development, conservation strategies and heritage (Dasmann et al. 1973; IUCN et al. 1980; 1991; WCED 1987; Nelson 1995). These approaches aim to integrate conservation and development, share a fundamental goal or ideal of sustainability, and envision a process of preparing and implementing comprehensive and integrative plans or strategies at various geographical scales. These approaches recognize parks and protected areas as an essential part of the larger system and suggest that these areas should be an intrinsic part of conservation strategies or sustainable development. Protected areas represent a staring point for broader sustainable landscape planning and management, and their agencies can play a critical role in initiating and encouraging this process. Joint regional planning and management bodies are needed to lend institutional support to these approaches (Nelson 1995; See, for example, Woodley and Forbes 1997).

2.7 Summary conclusion

Ecological considerations for protected area design have evolved in response to new ecological understanding and conservation goals. To maintain current levels of native biodiversity over the long-term, various criteria must be considered. Protected area system planners must ensure representation of typical, unique, and gradients of physical environments, with additional areas for rare species and communities, and hot-spots of species richness. However, at the same time, species-population-level considerations must be taken into account to ensure that protected areas or biodiversity management areas are large and connected enough to maintain viable populations of focal-species over time, while encompassing ecological processes such as patch dynamics. Corridor linkages or connectivity for dispersal, migration and range shifts of species, populations and individuals should be included. Protected area size and connectivity should be primarily determined by habitat requirements of viable populations of focal-species. Sufficient habitats and resources should be set aside to sustain viable populations of focal-species over the long-term while allowing dynamics of succession and disturbance. If this is accomplished, most other species would also be protected within these habitats.

None of these considerations can be reduced to general design principles or models. Species and context specific information such as autecological, biogeographical, population viability and gap analyses are required. Multiple and integrated approaches that are goal and context driven are necessary. Maintaining population viability of focal-species could represent a shared goal and provide a focus for integrating various approaches and levels. Generally, protected area system design needs to incorporate both coarse-filter (representative) and fine-filter (ecological integrity and population viability) approaches.

There remain many questions that ecological science cannot answer. Considerable uncertainty exists regarding processes beyond the normal human scale of observation. It is important to be cautious and to choose design guidelines and management thresholds that are well above ecological minimums. Interventionist and adaptive management including on-going research and monitoring is required. Social, political and economic criteria also need to be considered along with ecological ones in protected area system design. Protected areas that are not supported by or do not benefit local people and governments are at risk as land-use pressures and competition for scarce resources increase (Beazley 1997d).

Ecological considerations illustrate the complexity of the task of maintaining biodiversity and other ecological processes, as well as the extent of land area required. It is unlikely that protected area initiatives alone will be comprehensive and extensive enough to meet biodiversity and ecological integrity objectives. However, protected area systems are critical components of sustainable regional landscapes and should be integrated with broader strategic land-use planning initiatives.

As discussed, a key consideration for strategic planning and management towards biodiversity objectives is the viability of populations of focal-species. Context-specific planning based on the habitat requirements of viable populations of focal-species is recommended by conservation biology. However, identification of the most appropriate suite of focal-species is a critical process in itself. It is important that the species identified represent those which most warrant special biodiversity management attention, or those most in need of protected areas. These could include, for example, a range of vulnerable or threatened, space-demanding or wide-ranging species, species with limited dispersal abilities, or specific habitat or resource requirements, or functionally or genetically important species. The particular suite of focal-species will vary in different regions as a reflection of the specific species-population and biogeographical context. Further, in many regions and in relation to many species and habitats, the information for making such determinations is likely to be insufficient. Best professional judgment and consensus amongst experts may represent the most reliable source or process for compiling the range of information required to make comparisons across a wide range of species and variables. These issues and others related to focal-species and their identification in Nova Scotia will be addressed in greater detail in Chapters 4, 5 and 6. It will constitute the focus of the thesis as well as the original or primary research component of the research.

In the next chapter, protected area systems planning in Nova Scotia will be assessed relative to the key ecological considerations discussed in this chapter. Particular reference will be made to *A proposed systems plan for parks and protected areas in Nova Scotia* (NSDNR 1994), including comments submitted by the public in support of greater ecological considerations and protection. Disturbance regimes such as fire, along with estimates of home-range requirements of viable populations of native species are introduced to give an indication of the size of areas required to accommodate ecological processes that maintain biodiversity in Nova Scotia.

Neither species-level considerations nor disturbance regimes were incorporated into Nova Scotia's protected areas system plan. Protected areas were selected primarily on the basis of representivity of natural landscapes, and delineated through pragmatic considerations such as land tenure and natural area remaining. Less than half of the natural landscapes are considered to be adequately represented. As a result of these factors, existing and proposed protected areas in Nova Scotia are not likely to be sufficient to maintain current levels of landscape, ecosystem, or species-population biodiversity over time.

Chapter 3

Protected area systems planning in Nova Scotia: An assessment

3.1 Introduction

Parks and protected area systems are being planned and established in many parts of the world in response to international and national initiatives to preserve natural and cultural heritage (UNESCO 1972; UNESCO/MAB 1974; IUCN/UNESCO 1984; McNeely 1993). With growing awareness of the threat of unprecedented rates of extinction as a result of human activities these efforts have taken on a greater sense of urgency. The role of parks and protected areas in maintaining biodiversity has been recognized in modern science and translated into commitments at international, national and provincial levels. Planning, establishment and management of protected areas to maintain ecological integrity and biological diversity is increasingly being mandated in legislation and policies. *A Proposed Systems Plan for Parks & Protected Areas in Nova Scotia* (NSDNR 1994) has emerged from this broader context.

When considered in reference to other protected area initiatives, Nova Scotia's systems plan seems well grounded. However, the extent to which it responds to the ecological considerations discussed in the previous chapter remains to be determined. This chapter will examine specific aspects of the systems plan in reference to the goal of maintaining biodiversity and ecological considerations for protected area design. These ecological considerations include: population viability, minimum dynamic area, biogeographic and landscape context, hierarchy theory, palaeoecology, and models such as the biosphere reserve, greater ecosystem, and wilderness recovery. Natural disturbance regimes and home-range sizes of viable populations of selected species will be discussed as a reference for area considerations. Submissions to the Public Review Committee in response to the proposed systems plan will be assessed to determine the extent of public support for ecological considerations, protected area systems, and biodiversity management.

3.2 Institutional and legislative context

Nova Scotia's parks and protected areas systems plan acknowledges that the provincial commitment responds to direction at the global and national levels (IUCN et al. 1980; 1991; WCED 1987; McNeely 1993; UN 1992; Hummel 1989; Environment Canada 1990; CEAC 1991; Wildlife Minister's Council of Canada 1991; CCFM 1992;

Tri-Council 1992). Most of these initiatives and agreements call for 10 to 12 percent of lands and waters to be set aside as protected areas to represent the natural regions of Canada.

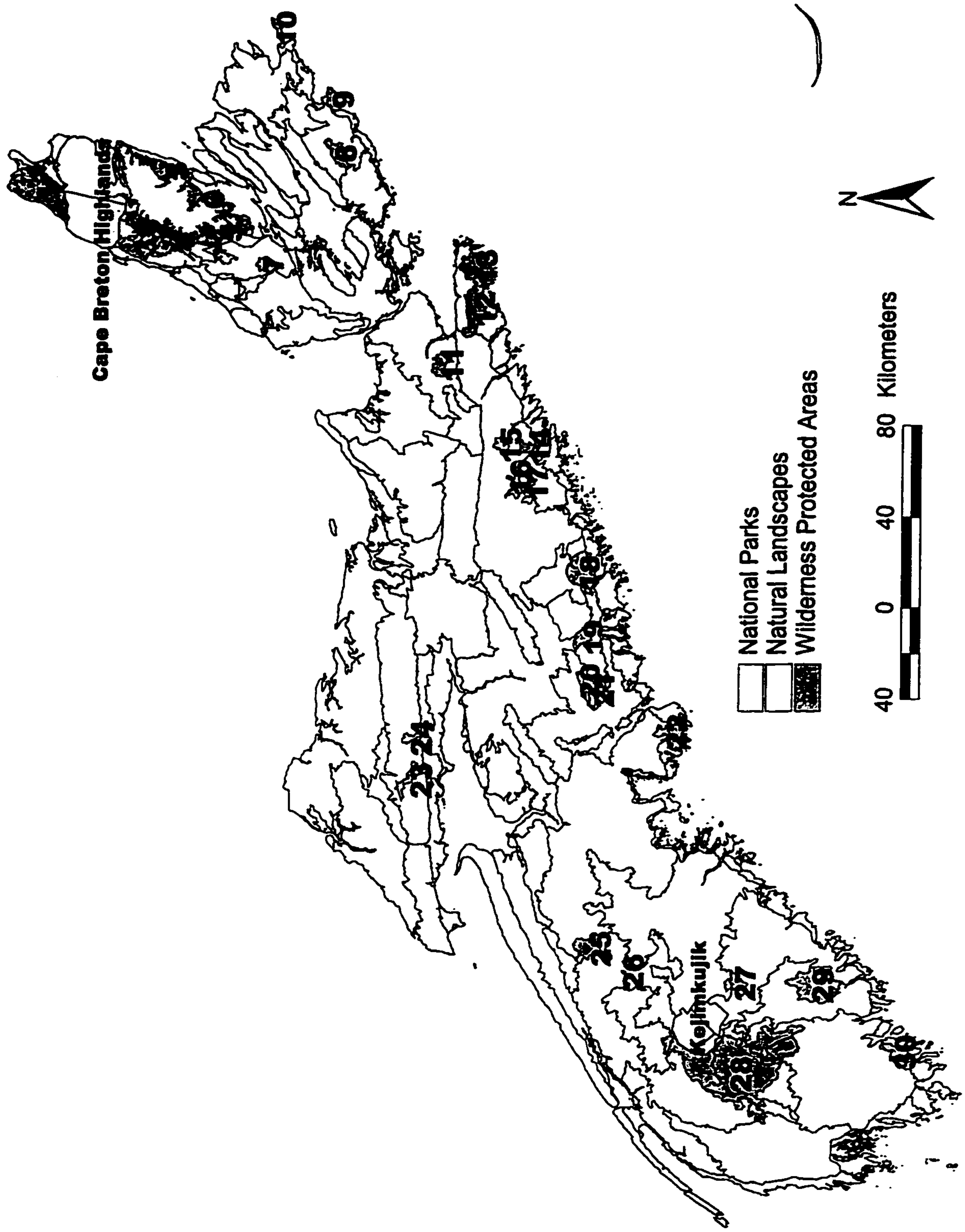
Parks/A new policy for Nova Scotia (NSDLF 1988) was legislated with amendments to the *Provincial Parks Act* in 1989 and 1992. Within the Act, provincial parks are to be developed and operated: to provide opportunities for recreation; to "preserve unique, rare, representative or otherwise significant elements of the natural environment"; and, to "assemble and maintain, within a system of provincial parks and park reserves, a land base adequate to meet present and future needs of Nova Scotians for outdoor recreation and heritage resource protection" (Province of Nova Scotia 1989, R.S., c. 367, s.1, 1989, amended 1992, c.30). Provincial parks policy includes a new emphasis on preserving the integrity of the natural environment, and provides for the establishment of wildland parks and for designation of environmental protection zones within parks.

According to Leduc and Smith, *A Proposed Systems Plan for Parks & Protected Areas in Nova Scotia* represents "a major initiative toward the implementation of the 1988 parks policy" (1992, 139). Further, it has received recognition as an important contribution toward the *Sustainable Development Strategy for Nova Scotia* (NSRTEE 1992).

3.3 A proposed systems plan for parks and protected areas in Nova Scotia

A Proposed Systems Plan for Parks & Protected Areas in Nova Scotia proposes to set aside 5.5 percent of the total land area of Nova Scotia within 31 candidate protected areas to be managed as scientific reserves, wilderness areas or equivalent to national parks as defined by IUCN categories I and II (IUCN 1990; IUCN 1994; NSDNR 1994) (Figure 3.1). This initiative would bring the total amount of land protected in Nova Scotia to approximately 8 per cent. Although this is less than the 10 to 12 percent that is often recommended, it represents a significant first step.

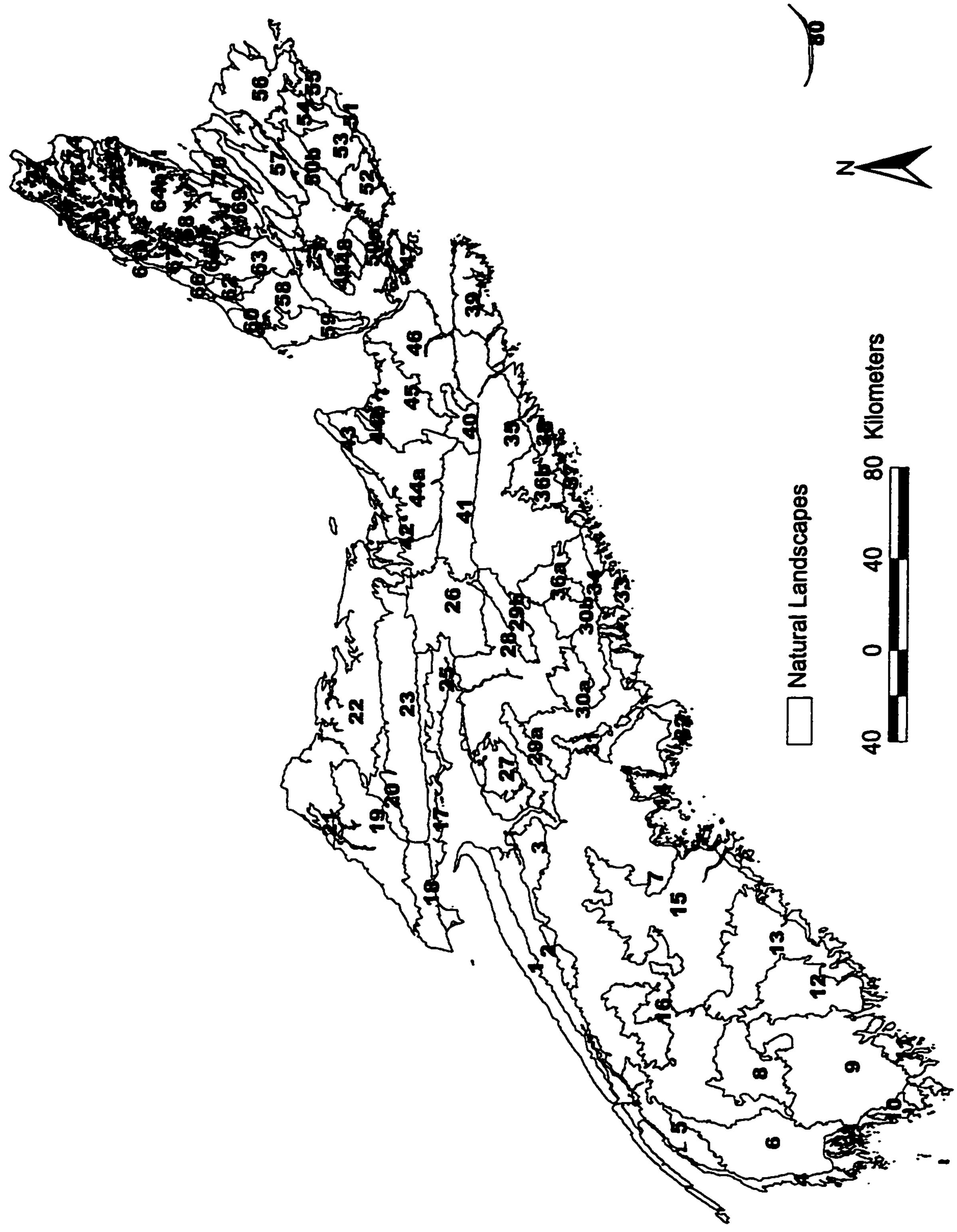
The systems plan also includes proposed future actions towards protecting International Biological Program (IBP) sites and other significant areas as ecological reserves under the *Special Places Protection Act* (Province of Nova Scotia 1989, R.S., c. 438, s.1, 1989, amended 1990, c.45). Gap analysis and the encouragement of initiatives on private land and through non-government organizations are described as future initiatives. The systems plan recognizes the need for integrated management to protect ecological values on all Crown lands, as well as sustainable planning and management of all of Nova Scotia through co-operation and partnerships.



Map A: Existing and proposed parks and protected areas (Refer to second overleaf for key)

Figure 3.1: A proposed systems plan for parks & protected areas in Nova Scotia

Source: Compiled by Walsh 1998 from NSDNR 1997 data (with permission)



Map B: Natural landscapes (Refer to overleaf for key)

Figure 3.1: (continued)

Source: Compiled by Walsh 1998 from NSDNR 1997 data (with permission)

Keys to Maps A and B

Map A: Proposed wilderness protected areas		
1. Pollett's Cove-Aspy Fault 2. Margaree River 3. French River 4. Sugarloaf Mountain 5. Middle River 6. North River 7. Trout Brook 8. Middle River Framboise 9. Gabarus 10. Scatarie Island 11. Ogden Round Lake	12. Bonnet Lake Barrens 13. Canso Coastal Barrens 14. Liscomb River 15. The Big Bog 16. Alder Ground 17. Boggy Lake 18. Tangier-Grand Lake 19. White Lake 20. Clattenburgh Brook 21. Waverley-Salmon River-Long Lake	22. Terence Bay 23. Economy River 24. Portapique River 25. Cloud Lake 26. McGill Lake 27. Lake Rossignol 28. Tobeatic 29. Tidney River 30. Bowers Meadow 31. Jim Campbell's Barrens

Map B: Natural landscapes		
1. North Mountain Ridge 2. Annapolis Valley 3. South Mountain Foothills 4. St. Mary's Bay Cliffs and Beaches 5. Sissiboo Low Hills 6. Tusket River Drumlins 7. South Mountain Rolling Plain 8. Shelburne River Plain 9. Roseway River Glacial Plain 10. Tusket Islands 11. Shelburne Headlands 12. Sable River Basin 13. Lake Rossignol Hills 14. Mahone Bay Islands 15. LaHave Drumlins 16. Fisher Lake Drumlins 17. Minas Basin Headlands 18. Chignecto Slopes 19. Chignecto Ridged Plain 20. Cumberland Foothills 21. Tantramar Marshes 22. Northumberland Strait Plain 23. Cobequid Mountain 24. South Cobequid Foothills 25. Cobequid Tidal Bay 26. Central Rolling Hills 27. Central Clay Plains 27a. Cogmagun River 27b. Stewiake River 28. Shubenacadie River Rolling Hills 29. Central Interior Slate Ridges 29a. Rawdon Hills 29b. Whittenburg Ridge	30. Grand Lake Rolling Hills 30a. Shubenacadie Lake 30b. Fish River 31. Sackville Drumlins 32. Pennant Granite Barrens 33. Eastern Shore Beaches 34. Eastern Shore Granite Ridge 35. Eastern Shore Quartzite Plain 36. Eastern Shore Drumlins 36a. Tangier River 36b. Mosher River 37. Eastern Shore Islands 38. Guysborough Headlands 39. Canso Granite Barrens 40. Aspen Drumlin Plain 41. St. Mary's Plain 42. Pictou River Hills 43. McArras Brook Dissected Hills 44. Pictou-Antigonish Hills 44a. Pictou 44b. Antigonish 45. South River Low Hills 46. Mulgrave Hills 47. Isle Madame Coastal Plain 48. Bras d'Or Lake Plain 49. North Mountain Ridge 50. Bras d'Or Fault Ridges 50a. Sporting Mountain 50b. East Bay Hills 51. Forchu Till Cliffs and Beaches 52. Barren Hill Drumlins 53. Mira River Drumlin Plain 54. Mira River Hills and Ridges 55. Louisbourg Cliffs 56. Sydney Plain	57. Boisedale Hills 58. Skye River Hills and Valleys 59. Judique Plain and Hills 60. Mabou Hills 61. Western Cape Breton Coastal Plain 61a. Inverness 61b. Cheticamp 62. Mason's Mountain 63. Keppoch Mountain 64. Cape Breton Boreal Plateau 64a. Gilander's Mountain 64b. Central 64c. Franney Mountain 65. Margaree-Middle River Valleys 66. Dunvegan Fluted Hills 67. Squirrel Mountain Foothills 68. Interior Steep Slopes 69. Central Cape Breton Hills 70. Kelly's Mountain 71. Eastern Coast Steep Slopes 72. Northern Cape Breton Taiga 72a. MacKenzie River 72b. North Barren 72c. Mica Hill 73. Ingonish Valleys 74. Northern Cape Breton Atlantic Slope 75. Aspy River Valley 76. Aspy River Steep Ridges 77. Meat Cove Steep Ridges 78. Pollett's Cove Dissected Hills 79. Western Coast Steep Slopes 80. Sable Island Sand Bar

Figure 3.1: (continued)
Source: Walsh 1998 from NSDNR 1997 data

3.4 Planning process and current status

Initiated around 1990, *A Proposed Systems Plan for Parks & Protected Areas in Nova Scotia* (NSDNR 1994) was released for public review in 1994. In January and February of 1995 a Public Review Committee held a series of 26 public meetings in thirteen locations across Nova Scotia. The Committee received over 600 submissions during the public review phase, from March 31, 1994 to May 24, 1995, including both written comments received by mail and presentations made at the public meetings (Beazley 1995b).

The Public Review Committee prepared a report summarizing these comments and making recommendations to the Minister of Natural Resources. *Protecting Nova Scotia's Natural Areas* (NSDNR 1995a), the report of the Public Review Committee, was released in December of 1995, along with a formal response from the Nova Scotia Department of Natural Resources (NSDNR) (1995b) accepting all of the Public Review Committee's recommendations. These recommendations "support in principle the proposal to establish a comprehensive system of parks and protected areas in Nova Scotia, and reflect the interests and concerns of Nova Scotians that emerged through the public review process" (NSDNR, 1995a, 7).

With a formal announcement in December 1995, the Minister of Natural Resources, Hon. Don Downe, announced the government's intention to designate the 31 proposed candidate protected areas. However, in January of 1997 Jim Campbell's Barrens was subsequently removed from the list under the new Minister, Hon. Eleanor Norrie, who, at the same time, released *Keeping the Wilderness Wild, Nova Scotia's Protected Areas Strategy* (NSDNR 1997a). The Minister also announced the government's intention to introduce legislation designating the remaining candidate protected areas to the General Assembly in the fall of 1997. After substantial public outcry, media attention, and efforts of non-government organizations, Jim Campbell's Barrens was re-listed in December of 1997 by the new Premier of Nova Scotia, the Hon. Russell MacLellan. The Premier also announced the government's intention to transfer the Parks and Recreation Division and responsibility for parks and protected areas from NSDNR to the Nova Scotia Department of the Environment (NSDOE).

In 1997, *An Act to Protect Wilderness Areas* in Nova Scotia was introduced to the General Assembly by the Hon. Wayne Adams, Minister of the Environment (NSDOE 1997). The Act is to be reintroduced to the General Assembly in the spring or fall sitting of the legislature (Leduc 1998 pers. comm.). The *Provincial Parks Act* is not considered to be appropriate for wilderness protected areas because it focuses mainly on recreation and tourism and does not contain sufficiently protection-oriented objectives and mechanisms. Currently the proposed protected areas have no legislative protection, however interim protection is provided by a moratorium on new commitments relating to land use and resource development and to any significant changes in land tenure. This moratorium was placed on all of the potential candidate protected areas in January 1993 to provide interim protection during the planning and transition period (NSDNR 1994).

Many contributing factors were critical to the initiation, development and acceptance of *A Proposed Systems Plan for Parks & Protected Areas in Nova Scotia*. The successful efforts of World Wildlife Fund's Endangered Spaces campaign to encourage governments into action; the recent development of conservation biology and landscape ecology; the roles of key ministers and the commitment of key individuals both within and outside of governments; an increasing public interest in the environment and in resource issues and protected areas; and growing acceptance of the need to balance the environment and economy in a sustainable way, were all contributing factors (NSDNR 1998). Timing is also believed to have been critical in that if the proposed protected areas had not been protected by the moratorium placed on their use in 1993 through the protected areas systems planning process, the majority of the areas may have been fragmented, lost or converted by roads and resource harvesting by the present time (Leduc 1998 pers. comm.).

3.5 Goals and objectives of the proposed systems plan

While *A Proposed Systems Plan for Parks & Protected Areas in Nova Scotia* does not explicitly state a goal nor objectives, they may be inferred. The document suggests that the systems plan responds to global and national initiatives for preserving biodiversity through protecting representative sites; it describes biodiversity as "the science behind protected areas"; and, the maintenance of essential ecological processes, preservation of diversity of species and genes, and the continued evolution of wild species through natural selection are described as benefits of protected areas (NSDNR 1994, 4). The systems plan includes goal setting as part of a recommended broader public participation and vision building process for the future.

The systems plan clearly is intended to contribute to the maintenance of biodiversity through the representation of natural areas. A goal is put forward for review and discussion toward a common vision of the role of protected areas in Nova Scotia: "to preserve Nova Scotia's natural diversity and enhance the quality of the environment and human welfare through the establishment and management of a system of parks and protected natural areas" (NSDNR 1994, 20). The first objective is, "to maintain the full spectrum of the province's geological, ecological and species diversity within a system of parks and protected areas" (NSDNR 1994, 20). However, the proposed plan does acknowledge that current levels of biodiversity will not be maintained within these proposed protected areas alone.

In confirmation of these implied goals, the proposed *Wilderness Areas Protection Act* (NSDOE 1997) explicitly includes the maintenance of biodiversity and the integrity of natural processes as the first objective. The stated purpose of the Act is:

> to provide for the establishment, management, protection and use of wilderness areas in perpetuity for present and future generations, in order to achieve the following objectives:
>
> (a) maintaining and restoring the integrity of natural processes and biodiversity;
>
> (b) protecting representative examples of natural landscapes and ecosystems and outstanding, unique, rare and vulnerable natural features and phenomena;
>
> (c) providing reference points for determining the effects of human activity on the natural environment; and
>
> (d) promoting public consultation and community stewardship in the establishment and management of wilderness areas,
>
> while providing opportunities for public access for wilderness recreation, sport fishing, traditional patterns of hunting and trapping and for scientific research and environmental education. (NSDOE 1997, 3)

3.6 Systems planning hierarchy: Provincial contributions within a national context

Conservation theory calls for systems planning to take place within an historical and broader regional context, recognizing the role of human processes as well as natural ones. Nova Scotia's systems plan is well embedded in the social-political context of broader national initiatives such as the national parks systems planning process.

Parks Canada aims to protect representative areas in each of 39 natural regions by the year 2000. Nova Scotia contains two of these natural regions, both of which are considered to be well represented by existing national Parks. The regions are: the Maritime Acadian Highlands, represented by Cape Breton Highlands National Park; and, the Atlantic Coast Uplands, represented by Kejimkujik National Park and Seaside Adjunct. No new terrestrial national parks are anticipated for Nova Scotia, although marine conservation areas may eventually be established to represent marine regions.

Nova Scotia's aim of representing each natural landscape with at least one protected area contributes to the protection of Canada's biological diversity at the provincial scale. More detailed representation could occur at the local level through the efforts of municipal and non-government agencies, private stewardship, and the designation of ecological reserves or special places. This nested systems approach distributes responsibility for protected areas to various levels.

3.7 Biophysical land classification: Natural landscapes

In order to select representative sites, it is important to have an ecologically based land classification system. The natural regions used as a land classification by Parks Canada closely approximates the Canadian ecoprovinces. However, these ecoprovinces are divided into ecoregions and ecodistricts. The 64 natural districts and units delineated in the *Natural History of Nova Scotia* represent the ecodistrict scale (Simmons et al. 1984; Davis and Browne 1996) (Refer to Figure 1.2 in Chapter 1). These districts and units provide the basis upon which NSDNR distinguished 77 natural landscape types. More recently, NSDNR has revised this classification scheme to distinguish 80 natural landscape types (Burt 1997 pers. comm.) (Figure 3.1, Map B).

Approaches for classifying regions can be either environmental, based on climate and landform, or biological, based on biogeography and community distributions (Usher 1986). NSDNR's classification of Nova Scotia into 77 natural landscapes revised the hierarchical classification system of the *Natural History of Nova Scotia* through more recent geologic, geomorphic and ecosystem distribution information, primarily aerial photography. The revised classification system provides an ecological basis from which to select representative sites within the systems planning process.

Geological or abiotic divisions represent the diversity of the physical environments in which the more ephemeral biological elements evolve and upon which they depend. Representing the physical diversity of the environment is important for maintaining biodiversity over the longer term in consideration of processes of change such as climate change. However, it is also important to define classes and represent elements of biodiversity such as species-populations and community types and distribution. The classes reflect factors other than the physical environment such as patterns of re-colonization, migration and dispersal, interspecific competition and other biological or ecological interactions.

3.8 Issues of scale

The systems plan recognizes that biodiversity occurs at various levels - ecosystems, species, genes. The "natural landscapes" represent the landscape level, and are composed of "landscape ecosystems" (NSDNR 1994). The systems plan is aimed at representation at the natural landscape level; some landscape ecosystems, species and genes existing within these landscapes will be captured within these representative protected areas. The systems plan states that, "Protecting entire ecosystems within landscapes . . . is an inclusive approach that incorporates the protection of both known and undiscovered species and processes" (NSDNR, 1994, 7). However, without detailed inventories of ecosystems and species distribution, representation of substantial biological diversity could be missed as a result of a sampling effect.

The issue of scale of representation has received considerable attention within the NSDNR. Minerals and Energy Branch representatives are not satisfied with the "natural landscape" classification or with the classification scheme in the *Natural History of Nova Scotia* (Simmons et al. 1984) upon which it was based (Stea 1996 pers. comm.). While the Minerals and Energy Branch was given opportunity to review the Nova Scotia Museum's classification scheme when it was originally proposed, they contend that they were not given sufficient indication of how the information might be used. Although they consider the classification scheme to be adequate for public education and information purposes, they do not believe that it is an appropriate basis for a protected areas systems plan which removes areas of land from mineral and other resource use without further exploration and assessment of mineral potential.

Minerals and Energy Branch's objections are primarily four-fold: 1) Minerals and Energy Branch were not adequately informed about the purpose of the classification scheme at the time that they were asked to review it; 2) they were not adequately consulted in the systems planning process regarding physical (geological, mineral and energy resources) factors; 3) the districts and units defined in the *Natural History of Nova Scotia* are inconsistent because the level of detail or scale varies across the classification; and, 4) the natural landscape level is too detailed, resulting in too many units for representation, based primarily geological on rather than ecological parameters (Stea 1996 pers. comm.).

Stea suggests that an internally consistent geological classification could be developed and applied by overlaying Goldthwait's (1924) ten physiographic divisions (significant Quaternary geology features) with surficial geology or land form, to result in approximately 20 to 30 classes. Other layers of information such as elevation or altitude, coarse-scale forest regions such as from palaeoecological data, and climate could be overlaid if desired. Various levels of detail could be reached according to the number of layers of information, but the level of information at each layer would be at a consistent scale (Stea 1996 pers. comm.) (See also Stea and Finck, no date; and, Stea et al. 1992).

The underlying issue for Minerals and Energy Branch representatives is that land use decisions are being made without adequate mineral and energy information. Lands with high mineral and energy potential may be removed from the resource development stream without an adequate understanding of the resource potential. Exploration, inventory and assessment has not been conducted and is restricted within proposed protected areas by a moratorium under the interim management guidelines. Although Minerals and Energy Branch representatives accept that approximately eight percent of the landscape will be protected, a more internally consistent and coarse-scale classification scheme, such as Goldthwait's (1924) ten physiographic divisions or the Natural History's nine theme regions, would allow for greater flexibility in site selection to accommodate mineral and energy resource potential (Stea 1996 pers. comm.).

A Protected Areas Gap Analysis Methodology (Kavanagh and Iacobelli, no date), developed for World Wildlife Fund-Canada's *Endangered Spaces Campaign* (Hummel 1989), recommends a classification of enduring features based on the *Soil Landscapes of Canada* (Agriculture Canada 1994), national series level of 1:1,000,000 scale. These soil landscapes (approximately 500 in Nova Scotia) are generalized into soil polygons delineated from larger scale, soil survey source maps and the accompanying reports (Shields et al. 1991 cited in Kavanagh and Iacobelli, no date). Local surface form and slope class of the soil landscapes are generalized into four topographic divisions; and, parent material origin and texture are generalized into three textural classes. Community types and ecological processes within each generalized soil polygon are to be identified at 1:250,000 scale. This identification is intended to show connections among the biota and disturbance-recovery cycles within each enduring feature type, thus integrating enduring features (coarse filter) and ecological integrity (fine filter) considerations (Kavanagh and Iacobelli, no date).

World Wildlife Fund-Canada (WWF) states that Nova Scotia' s natural landscape framework is based on a more detailed level of analysis than is usually assessed in other jurisdictions in Canada (Kavanagh and Iacobelli, no date). The level of classification delineated by the theme regions in N.S. is more consistent with the scale of regions delineated in other provinces for the purpose of planning representative systems of protected areas. However, the "units" or the "natural landscapes" delineated by the Nova Scotia Museum and NSDNR closely parallel the level of enduring features at which WWF assesses representivity within these larger regions in other provinces, for the purpose of reporting on progress towards representivity. In other words, Nova Scotia's natural landscape classification system closely corresponds with WWF's system for assessing representation based on enduring features. By using natural landscapes rather than larger regions as a basis for selecting protected areas based on representivity, there is less risk of failing to represent enduring features (Stewart 1996 pers. comm.).

3.9 Hierarchical approach within Nova Scotia

Nova Scotia's systems plan, in combination with the national systems plan, has the potential to provide a hierarchical approach as recommended by Wilcove et al. (1986). Wilcove et al.'s approach represents a trade-off between capturing more habitat diversity (by having many smaller protected areas) and maintaining viable populations of area-sensitive species (by having larger protected areas), in light of pragmatic considerations such as funding. They recommend establishing a smaller number of large reserves at the national or provincial level, a network of regional mid-size reserves, and a larger number of small reserves clustered at the local level.

The national parks in Nova Scotia could be considered to represent the large reserves, especially in combination with adjoining provincial protected areas and sensitively managed Crown lands. The remainder of the proposed and future "gap filling" protected areas could constitute "nodes" of diversity in a regional network in which connectivity could be maintained wherever possible through landscape planning considerations and private stewardship agreements. A large number of smaller protected areas such as Special Places, county or municipal parks, Nature Conservancy lands, and future Nature Trusts could round out the system at the local level. Leduc and Smith suggest that, "Because the full representation of the province's natural landscapes can only be accomplished through a comprehensive approach involving a "family " of parks and protected areas, the systems plan currently in preparation should consider strategies which address the complete range of conservation options" (1992, 144).

The systems plan recognizes the potential of completing a system through broader co-operation and land-use planning in its future actions and priorities and ideas for a common vision. However, the systems plan does not explicitly describe nor stress the need to maintain and restore connectivity, nor the large extent of natural areas required to maintain biodiversity and ecological processes in the longer term.

3.10 Site selection and evaluation

The systems planning approach is aimed at protecting biodiversity primarily through representation of typical natural areas. Representivity, along with diversity, rarity or uniqueness, naturalness, size, and fragility, is among the most commonly stated reasons for establishing and selecting reserves (Smith and Theberge 1986). The process of site selection utilized by NSDNR (1994) resembles one recommended by Margules (1986), including: a pre-evaluation classification or sorting stage; consideration of representivity, and threshold criteria such as naturalness or area/size; ranking, based on criteria such as diversity or rarity; and, pragmatic considerations such as threats to the site or land tenure.

The classification of the land base of Nova Scotia into natural landscapes and the selection of possible sites for further consideration comprise the pre-evaluation classification or sorting stage. The next phase of the systems plan involved the identification of roadless natural areas of a size greater than 200 hectares. Subsequently, seventy-four areas of a size greater than 2000 hectares occurring on predominantly Crown land were selected for further evaluation. These 74 sites were evaluated and rated according to four criteria: representivity; outstanding features; wilderness recreation opportunities; and, occurrence of private land-holdings and land-resource commitments. The most highly-rated sites were field checked for verification. This led to the identification of 31 proposed protected area sites (NSDNR 1994; Figure 3.1, Map A). These criteria constitute representivity, threshold and pragmatic considerations. However, the application of size criteria and land tenure at the earlier stage may have excluded potentially significant representative sites. While the site selection process utilized in the systems plan may not be exemplary in respect to the theory, it is perhaps appropriate given the social-political context, and economic, technical, and time constraints.

3.11 Level of representation

The criteria of representivity can be slightly problematic because although it allows for protection of some typical sites and ecosystems, it generally does not capture the total variety of ecosystems nor ecotones which exist between and among the natural landscape regions. It also does not capture atypical features, although these have been included by the use of additional criteria such as rarity in the systems plan. Noss (1994) suggests that the most important criteria is representation, which strives to capture *all* of the variety of diversity in a region, including gradients, through a comprehensive landscape protection approach to conservation. The systems plan as it presently stands does not protect all representative landscapes or ecosystems, although it may come close if future priorities and visions are fulfilled. However, it will never fulfill the goal of representation, which incorporates all elements of community or ecosystem-level diversity. The plan recognizes this when it states that "this system of protected areas alone will not ensure biodiversity" (NSDNR, 1994, 4).

Currently, only 7 of the 77 natural landscape types are considered to be satisfactorily represented by existing protected areas. The proposed systems plan would bring the number of satisfactorily represented landscapes to 23. Another 3 natural landscapes are "near satisfactory" in representation. This means that 51 natural landscapes remain with only partial representation (11 landscapes) or inadequate representation (40 landscapes) (NSDNR 1994; Refer also to Figure 3.2). Satisfactory representation means that there is "*one* or more large contiguous protected area with *only a few major landscape ecosystems and elements missing*" (NSDNR, 1994, 9, 14, emphasis added).

Exclusion of a few major landscapes and elements from each natural landscape considered adequately represented comprises a significant risk of loss of biodiversity, even in the natural landscape areas indicated as satisfactorily represented. Further, natural landscapes may be represented by a single protected area, therefore redundancy is not provided in the system. Redundancy is recommended to reduce the risk of loss of biodiversity through disease, fire, or other demographic or environmental change or catastrophe.

Thirty-five natural landscapes contain no existing or proposed protected areas. Another 29 natural landscapes contain less than eight percent of total area as protected area. In 70 natural landscapes less than 12 percent of the total area is existing or proposed for protection (compiled from Walsh 1998) (Refers to a total of 80 natural landscape types as revised by NSDNR in 1997) (Figure 3.2).

Fully three-quarters of the natural landscapes are not considered satisfactorily represented according to NSDNR's (1994) own criteria. This is not an acceptable record for a protected area systems plan. The plan does recommend assessing the gaps and rounding out the representation. However, it also acknowledges that this will not be easy because the prime opportunities on Crown land have already been proposed for protection. In addition, many natural landscapes contain very little area of Crown land. Subsequent announcements by the Ministers of Natural Resources have specified that no additional large, representative protected areas will be designated on Crown land (Downe 1995; Norrie 1997). However, there is a commitment to protect smaller, unique areas as mature or ecological reserves through the Special Places Protection Act. Five nature reserves are to be designated within 1998 (Leduc 1998 pers. comm.).

Some natural landscapes appear to contain significant amounts of Crown land, yet no protected area sites are proposed, such as, for example, 8b and 8c, 9, 19, 27a, 35a, 40, 41 (Refer to Figures 3.1 and 3.2 for locations and key). The reason for these gaps is not apparent and can only be assumed to be land-resource commitments or fragmentation by roads. Although the proposed systems plan indicates that there are Crown lands greater than 200 hectares in size within these natural landscapes, there is no indication of whether these lands are in a natural and unroaded state (See NSDNR 1994, 10-11 for map).

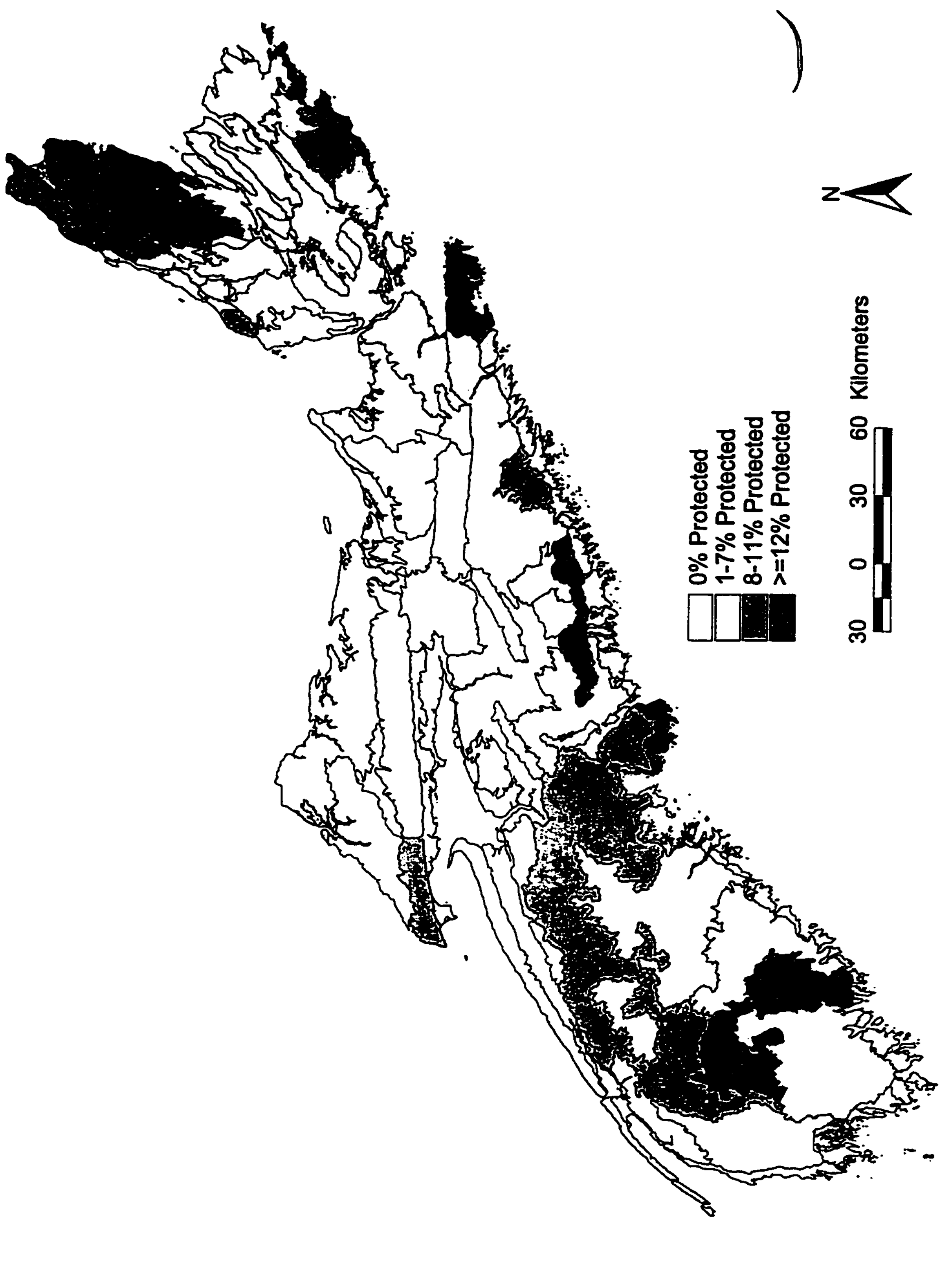


Figure 3.2: Percentage of protected area within each natural landscape in Nova Scotia
Source: Compiled by Walsh 1998 from NSDNR 1997 data (with permission)

Unrepresented areas such as the Annapolis Valley (2), North Mountain Basalt Ridge (1), Rawden Hills (29a), Northumberland Strait Coastal Plain (22), Wittenburg (29b), Pictou River Hills (42), and others contain little or no Crown land (NSDNR 1994). These natural landscapes will need to be represented primarily on private lands. It is unclear whether there are natural areas remaining on private lands in these landscapes.

At least eleven natural landscapes may actually be satisfactorily represented. In these landscapes the protected areas appear to encompass most or all of the natural regions. The Shelburne River Barrens is very well-represented by the Tobeatic candidate protected area. Ten small natural landscapes are well-represented by Cape Breton Highlands National Park and the Pollett's Cove/Aspy Fault candidate protected area (Figures 3.1 and 3.2). These groupings of protected areas provide significant benefits by representing ecotones between natural landscapes and landscape ecosystems, containing complete watersheds, and providing larger areas for wildlife habitat, disturbance regimes and other natural entities and processes.

3.12 Size and boundary delineation: How big is big enough?

The boundaries of the 31 selected sites were adjusted through an internal NSDNR review to reflect contractual resource commitments. These sites became the 31 proposed candidate protected areas, presented for public review. It appears that the boundaries were delineated primarily through pragmatic considerations such as land tenure and pre-existing conditions such as land development or transformation. Pragmatic considerations are largely unrelated to ecological considerations beyond the immediate idea that it may be more ecologically feasible to have protected areas in "natural" areas.

The need to be pragmatic in respect to the political-economic context, as well as the fact that in many cases boundaries may be largely pre-determined, are acknowledged in the literature. However, it is also important to consider ecological criteria and recognize that future adjustments in land use and land tenure, including restoration, may provide opportunities to adjust or expand boundaries. Key considerations include the population viability of focal-species, minimum dynamic area, and landscape parameters such as connectivity. These considerations were not incorporated into the protected areas systems plan.

Shaffer's (1981) suggestion that precise prescriptions are needed for how much land is enough to maintain biodiversity is instructive for the Nova Scotia systems planning context. Information about the present complement and distribution of species, ecosystems and processes, and historical disturbance regimes is incomplete. Home-range requirements and migration patterns are unknown. Yet this information is critical in planning areas for protection of biodiversity.

Minimum viable populations are also unknown, although these may be generalized from studies of populations elsewhere to provide an interim guideline. However, field autecological studies should be conducted because minimum viable population (MVP) and minimum critical area (MCA) are specific to the particular biogeographical conditions. Focal-species could be identified as priorities for population viability analysis in regions of Nova Scotia.

Historical patterns of disturbances such as fire, wind throw, spruce budworm infestations, and disease could be studied to determine approximate minimum dynamic areas and level of redundancy required in the system. The protected areas systems plan does not acknowledge or accommodate patterns of ecological change and the concepts such as the shifting mosaic steady state (Bormann and Likens 1979).

The broader context should be considered in terms of biogeography or landscape ecology to determine patterns of flows in the landscape and across protected areas boundaries, including migration and dispersal of populations of focal-species. Potential edge and isolation effects of surrounding land uses, both existing and future, should be recognized and mitigated. The systems plan should incorporate measures to minimize effects that reduce the effective size of protected areas, and aim to optimize landscape configurations that increase effective size for functions such as habitat.

Palaeoecological considerations could make the systems plan more effective for long term maintenance of ecological processes and biodiversity (Refer to sections 2.5.1 and 3.14.1 for examples). An appropriate long term goal is to accommodate ecological processes of change rather than to maintain particular community assemblages. In consideration of long term processes such as climate change, physically diverse environments should be protected along with areas that contain populations of species at the limits of their range. Broad corridors could be maintained to allow latitudinal and altitudinal shifts. Such considerations are particularly important in reference to accelerated climate change resulting from human activities. The systems plan could also consider the implications of rising sea-levels.

The protected areas systems plan does not take into account particular regional-landscape contexts. For example, the relative size of the protected area, the degree of connectivity with other natural areas or protected areas, and the types of adjacent land uses should be taken into account. Habitat-area for populations of focal-species such as those with the largest home-range requirements in the region, should also be considered, along with regional disturbance regimes.

Ideally, legislated boundaries of protected areas should be determined by ecological boundaries. The presence of a legislated boundary, with areas of differing management regimes on either side, will act as a filter and result in gradients of change across the boundary. This will result in a "generated edge" which could be located outside the legal boundary or inside the legal boundary. Buffer areas are particularly critical in areas where gradients are steep. Protected area could be buffered from boundary influences that might reduce its effective size (Schonewald-Cox and Bayless 1986). The systems plan does not provide any allowance for buffer zones. If areas do not exist outside of protected area boundaries to act as buffer zones this function will be performed within the boundaries of the parks, reducing their effective size. It is unclear whether this process could be absorbed within the protected areas with acceptable risk. A biosphere reserve or greater ecosystem model could be effectively applied in this respect.

3.13 Broader landscape considerations

The systems plan focuses on physical diversity and ecosystems as characterized by natural landscapes. Considerations at the species population level such as habitat requirements of viable populations of native species are not recognized at the landscape level. Proposed protected areas do not incorporate habitat continuity or connectivity to accommodate home-ranges, migration and dispersal. The success of the protected area system will depend upon the surrounding land and its suitability as supplemental habitat, dispersal routes, source and sink potential, and overall buffering capacity. The systems plan, while recognizing the need for broader planning, does not include any mechanisms for incorporating these considerations.

Significant opportunities exist for maintaining connectivity among protected areas such as proposed candidate areas 14 to 22, Canso Coastal Barrens to Waverley-Salmon River by utilizing other Crown lands (Figure 3.1, Map A). Crown lands that may provide supplemental habitat, buffer and connectivity functions could be managed in a way that increases the effective size of adjacent protected areas and extends the area for biodiversity management objectives. Opportunities may also exist to consolidate protected areas through recovery of Crown lands after resource use or commitments.

The systems plan included provisions for co-operative agreements and partnerships, particularly under future priorities. This could have provided the opportunity to incorporate broad landscape planning for a protected area system and compatible land uses into province-wide land-use and integrated planning. Biosphere reserves, multiple-use modules, or greater ecosystem models could be utilized to combine government and non-government efforts toward an ecologically sustainable landscape incorporating protected areas as an integral part. For example, the idea of a Kejimkujik biosphere reserve has been proposed (Francis and Munro 1994; Drysdale 1997a).

Potential exists for "greater ecosystem" management and planning for protected area values in at least three large areas in different ecoregions in Nova Scotia: 1) Kejimkujik-Tobeatic; 2) Canso-Waverley-Salmon River; and, 3) Cape Breton Highlands-Pollett's Cove-Aspy Fault (Figure 3.1, Map A). These greater ecosystems could be based on existing and evolving models at Yellowstone, Waterton Lakes-Glacier, and Fundy National Parks (Woodley and Freedman 1995).

The description of the Tobeatic candidate protected area within the systems planning document contains the only explicit reference, albeit a very brief one, to wildlife habitat for specific species, American moose and American black bear. However no prescriptions for the protection of viable populations of these species are incorporated (NSDNR, 1994, 13).

The Tobeatic is significant in terms of conservation because it constitutes the largest remaining wilderness area in the Maritimes (99,000 hectares). The Tobeatic and Kejimkujik National Park zones I and II together comprise approximately 130,000 hectares. Approximately 80,000 hectares of Crown land is contiguous to these areas, resulting in a substantial combined area of approximately 210,000 hectares. This represents a potential greater ecosystem or biodiversity management area (Refer to additional discussion in section 3.17).

Based on Shugart and West's (1981) calculation of a ratio of 50:1 in a forested region, an area of this size could be considered "quasi-equilibriating" if disturbance regimes did not exceed approximately 4200 hectares. Disturbance regimes are not considered in the systems plan, and are not well documented in Nova Scotia, however a rough estimation may be possible. For example, Wein and Moore calculated a mean annual burn of approximately 2400 hectares in the years between 1915 and 1975 (1979, 169). Although this figure is generalized for all of Nova Scotia, it is well within the disturbance regime figure of 4200 hectares calculated above. Other disturbances such as windthrow and pests also occur in the area, however they are considered to be of a gap-level replacement regime. Fire is considered to be the only stand-level replacement regime in the area, outside of clear cutting for forestry. (Disturbance regimes will be further described in the following section: 3.14.)

Further research and monitoring could be conducted to better understand disturbance regimes and their effects on species in the Tobeatic-Kejimkujik region and in others. The Tobeatic-Kejimkujik greater ecosystem may represent a quasi-equilibriating landscape and serve to illustrate the large size of areas and connectivity required to maintain ecological processes and products such as biodiversity, speciation and evolution. If it does not, then even larger areas will be required.

The Tobeatic-Kejimkujik greater ecosystem represents a significant opportunity to conduct studies to plan and manage a protected area system utilizing conservation theory that conceives of wilderness as a process rather than an entity (Figure 3.1, Map A). A similar situation exists in the Pollett's Cove-Aspy Fault-Cape Breton Highlands National Park area in Cape Breton where approximately 122,500 contiguous hectares are protected. These areas represent the largest remaining natural areas in the province and may provide valuable information for biodiversity management with strategic research and monitoring. Research in these areas could determine the size of areas required to maintain viable populations of the most habitat-demanding native species in Cape Breton and in mainland or southwestern Nova Scotia.

Research towards this goal should incorporate the following steps or objectives: 1) select focal-species and determine population viability, including minimum viable population and minimum critical area; 2) determine the minimum dynamic area related to the disturbance regimes; and, 3) determine the area required to ensure that the focal-population remains viable, allowing for disturbance regimes including episodic events. The final size or area-figure will represent the sum of the minimum critical area and the natural disturbance regime. This total area is the minimum dynamic area (Pickett et al. 1992; Noss 1994).

3.14 Disturbance regimes

The systems plan makes no reference to information on historical or typical disturbance regimes. Generally it does not consider information that should be applied to conservation problems, such as: processes governing the system; the context in which it is embedded; historical range of flux in the system; the evolutionary and physiological limits of organisms; and episodic and long-term phenomena, including roles of people, in the past and present (Pickett et al. 1992).

In the southwestern Nova Scotia uplands region, the typical natural disturbance regime is a combination of both gap-level and stand-level replacement dynamics. Gap-replacement disturbances tend to predominate in pockets of drumlins and other types of hills that support hardwood stands, for example in instances of wind throw of individual trees (Lynds 1997 pers. comm.). Although windthrow may generally be a gap-level event restricted to hilltops and edges, stand-level wind throws have occurred in the past such as with the Saxby gale in 1867 (Gimbarzevsky 1975).

Insect-related disturbances also appear to be at a gap-replacement level. There have been no major pest infestations since the establishment of Kejimkujik National Park approximately 30 years ago. Insects such as oak leaf shredder and roller and gypsy moth are prevalent, however there have been no infestations resulting in significant areas of disturbance (Brown 1997 pers. comm.). Current levels of insect infestations are considered to be related to the amount of human disturbance in the landscape. For example, occurrences of hemlock looper outside of highlands areas in Cape Breton are largely confined to managed forests and are related to human-caused changes (Lynds 1997 pers. comm.).

However the most prevalent disturbance is fire and it has often been at the stand-replacement level. The area has historically been prone to fire, with large-scale fires occurring earlier in this century. In the Tobeatic area, natural landscape number 8, fires have tended to be larger because there is relatively little water in the areas to act as a barrier. In the larger southwestern Nova Scotia region there are more lakes and rivers which stop the spread of fire (Lynds 1997 pers. comm.).

Fire has probably been more prevalent in southwest Nova Scotia since Euro-American settlement in the region. Fires were set for land clearing, for agriculture and as a result of logging practices. Without deliberate or accidental setting of fires, the forest may have retained a higher proportion of white pine. Black spruce is better adapted to soils degraded by larger or more intense fires. Prior to Euro-American settlement, white pine probably dominated the forests. White pines would have been very tall and large, forming a superstory with a mixture of spruce, pine, and other species beneath. Historically, fire would probably have killed the understory species but the superstory of white pine would survive and persist. The current forest and barren land cover in southwestern Nova Scotia is largely a result of human-caused fire as opposed to natural or pre-Euro-American settlement fire. The natural fire regime has not been of a frequency nor an extent to produce the widespread barrens that presently exist; these are considered to be primarily a result of human activities (Lynds 1997 pers. comm.).

3.14.1 Historic fire regimes in Nova Scotia

Examination of disturbance regimes such as fire requires consideration of various time scales. The palaeoecological record such as glacial ice or lake bottom sediment cores can be examined for the presence of charcoal or pollen and subjected to spectral analysis to indicate dates and sequences of fire events and species composition of pollen producers (See for example, Green 1982). Existing trees provide evidence such as fire-scars which may be dated. Recorded history such as land surveys, diaries and, more recently, fire control records and aerial photography also provide evidence (Wein and Moore 1979).

Spectral analysis of sediment cores from Everitt Lake in southwestern Nova Scotia, suggests that intense widespread fires occurred during the period of 11,000 to 6000 years before present (BP), and at least once again around 4400 years BP (Green 1982). These fires were followed by periods of significant change in the composition of pollen producing forest species. Green suggests that these fires cleared large tracts of land upon which invading species could compete for new territory.

In the more recent part of the record (3400 years BP to the present), a large proportion of fire-adapted conifers seem to have been replaced by species more sensitive to fire. This may indicate that fires in the more recent period have been smaller and less intense, perhaps as a result of a cooler climate. Small regular fires between 6000 and 4400 years BP probably contributed to community stability by suppressing species such as beech that may otherwise have increased in prominence. A decrease in the frequency of small fires after 4400 years BP may have caused a decline in the numbers of pine, birch and oak trees and increased the numbers of beech trees (Green 1981 as cited in Green 1982). In general, it appears that fire during the post glacial period played a significant role in the development of current forest communities in southwestern Nova Scotia, by allowing establishment of more recently migrating species in areas that had previously been dominated by earlier colonizing species.

Palaeoecological results from southern Nova Scotia may not be generalized to other areas of the province. Regional differences in climate and topography influence fire regimes within the province. For example, coastal areas, the interior of the southwestern half of the mainland, the Annapolis Valley, and Chignecto display various characteristics which may place them at greater risk of fire, such as wind throw, high evaporation, and summer water deficiencies (Wien and Moore 1979). These areas have also been identified as having a high fire weather hazard (Simard 1973, in Wein and Moore 1979).

There seems to be no evidence that Mi'kmaq peoples in Nova Scotia deliberately used fire to clear or change the land, although there is much evidence for the use of fire farther south (Wien and Moore 1979; Refer to Russell 1983 for an overview). Studies of historical documents and pollen analysis in the northeastern United States and Nova Scotia conclude that the deliberate use of fires by native peoples in northern New England and Nova Scotia to burn the forests was probably at most a local occurrence (Day 1953; Livingston 1968; Russell 1983).

Use of fire is not considered to be an important part of Mi'kmaq and other Maritime Woodland cultures because as much as 90 percent of their diet came from the sea. They lived in coastal camps for most of the year, and in camps adjacent to rivers or streams for winter months when they hunted primarily for moose, caribou and beaver (Miller 1986). The relatively moist environment of coastal, lowland, and mixed conifer and tolerant hardwood forests are generally not conducive to, tolerant of, or favored by burning, in contrast to the drier oak-pine savannas and forests predominant in southern New England. Fires caused by the Mi'kmaq, like those in northern Maine, were probably accidental, infrequent and in close proximity to camps, and merely augmented the number of natural fires, thus having some limited effect on vegetation (Russell 1983).

Livingston (1968) concluded from pollen analysis that early human occupation of Nova Scotia had no noticeable effect on forest composition until agriculture was introduced by Euro-American settlers. However, during and after Euro-American settlement, fires from land clearing operations were probably allowed to escape unless they threatened private property, until about 1761 when the first fire legislation was passed to protect the 90 sawmills in the province. The earliest records of a substantial number of fires was made by Smith (1801-02), who reported a number of burned areas that measured 5 to 13 km in length in the northern, western and eastern sections of the mainland (as cited in Wein and Moore 1979, 168). Fires were noted in southwestern Nova Scotia in 1720 and 1820, and several fires were recorded in the eastern mainland in 1825. In 1864, 1884 and 1904, additional fire legislation were passed. After this point, the fire record improves with fire statistics published by the Province of Nova Scotia from 1857 to the present, and with a detailed survey by Fernow in 1909-10 (Refer to Table 1.4) (Fernow 1912).

Based on these records, Wein and Moore (1979) have characterized recent fires and rotation periods in Nova Scotia. From 1915 to 1975, the annual number of fires ranged from 15 to 920, with a mean of 330, showing peaks in the mid-1930's and mid-1960's. The total area burned since 1915 was approximately 340,000 hectares, with a mean annual burn of 2400 hectares. Larger annual burns were common up to the mid-1930's. Since then, until the time of publication in 1979, there has been a gradual decline in the annual area and mean annual size of burn, probably reflecting earlier detection and control, and an increase in the number of fires, probably related to recreational activities and industrial activities such as pulpwood cutting. Lightning caused only one percent of fires, or a long-term mean of three per year. Ninety percent of fires occur from April to August, with over 30 percent in May (Wein and Moore 1979, 169-170).

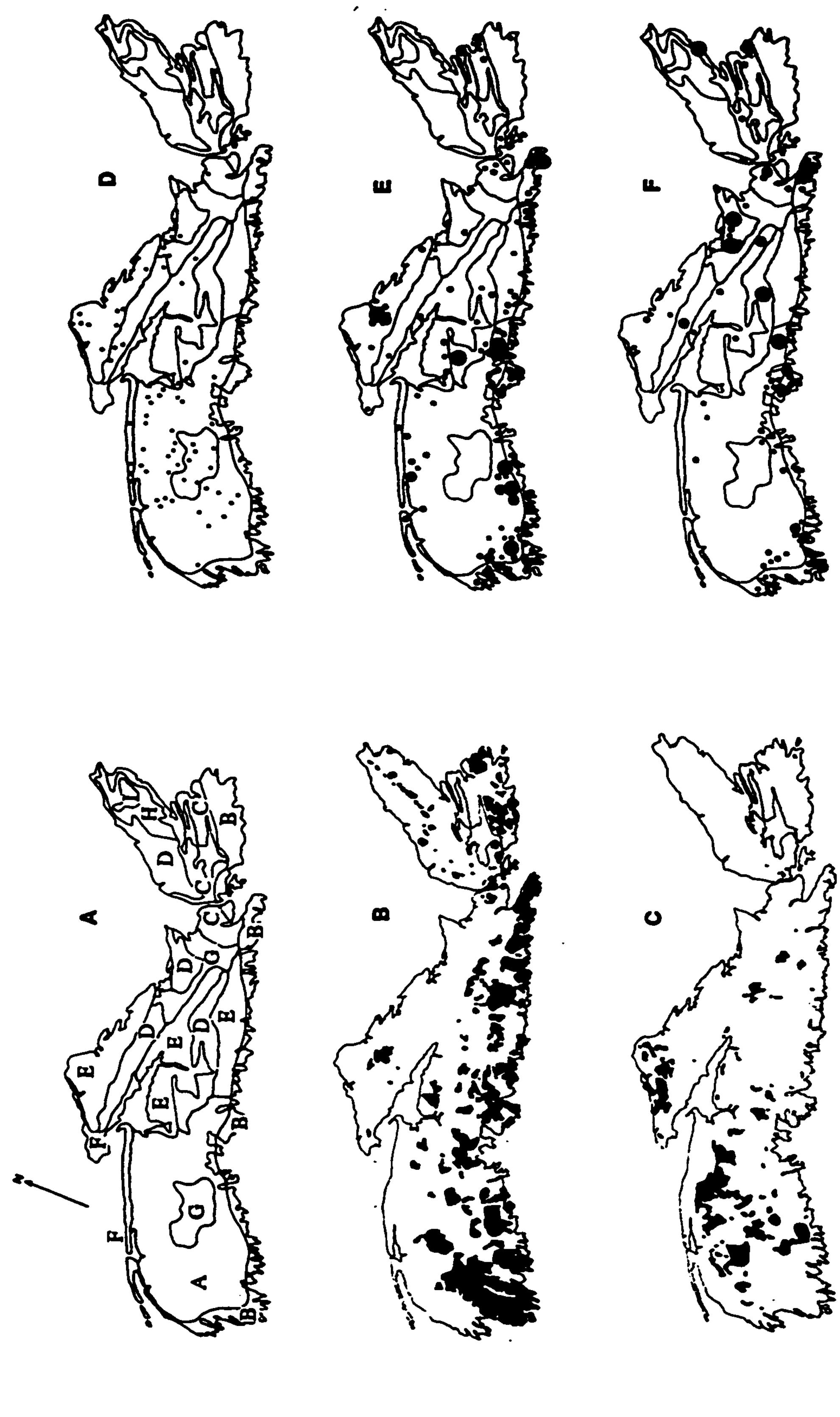
Fire locations from the 1900 to 1910 period occur throughout southwestern Nova Scotia and show a strong relation to fires started by lightning from 1958 to 1975. In contrast, fires from 1958 to 1975 generally occur around large urban areas on the southern coast. Areas burned prior to 1900 and mapped as barrens by Fernow (1912) occur primarily along the coast in the vicinity of settlements and were presumably caused by Euro-American settlers (Wein and Moore 1979) (Figure 3.3, Maps B and C).

Wein and Moore calculated the mean annual burn (mean percentage or area of a given area that burns each year) and the fire rotation period (the length of time required to burn an area given the mean percentage burn). Fire rotation periods were calculated from the 1915 to 1975 provincial fire records as well as from Fernow's account (1912), thus representing periods before and during effective fire suppression. The fire rotation period for the total land area of Nova Scotia during the period of fire suppression was calculated from the mean percentage annual burn as approximately 3300 years. Calculations for the pre-suppression period resulted in a fire rotation period of approximately 200 years (Wein and Moore 1978, 172). Thus, fire was a more significant factor at the turn of the century, although primarily related to human causes.

Wein and Moore also calculated the mean annual burn and the fire rotation period by vegetation type as defined by Loucks (1959-1960). Based on the 1958 to 1975 data, Loucks' red spruce-hemlock-pine, spruce-fir coast, and sugar maple-hemlock-pine vegetation types have fire rotation periods of about 2000 years (Refer to Figure 3.3, Map A: Areas designated as A, B, and C). These are the areas of the largest annual fire size and largest numbers of fires per year.

However, based on information calculated from Fernow (1912) the estimated fire rotation period for the most fire-prone area (Louck's red spruce-hemlock-pine vegetation type) is approximately 65 years (Figure 3.3, Map A: Area designated as A). The area designated E, red spruce-hemlock-pine, has a fire-rotation period of approximately 120 years, and area designated as G, sugar maple-hemlock-pine, has a fire-rotation period of approximately 160 years (Figure 3.3, Map A) (Wein and Moore 1979, 173). These figures reflect primarily human-caused and pre-fire-suppression-era burns.

Green (1976) estimated the fire rotation period to be about 400 years for the years 6600 to 2200 BP, from charcoal particles in core samples of lake sediments from southwestern Nova Scotia (Area also designated as A on Figure 3.3, Map A) (as cited in Wein and Moore 1979, 167). Green's figures probably more accurately reflect the natural or pre-Euro-American settlement fire regime for the southwestern Nova Scotia area.



A. Vegetation types adapted from Loucks (1959-1960) (Refer to overleaf for key to vegetation types)
B. Area burned before 1900 and not regenerating to trees, plus barrens (derived from Fernow 1912 by Wein and Moore 1979)
C. Area burned in approximately a 10-year period preceding 1909-1910 (derived from Fernow 1912 by Wein and Moore 1979)
D. Lightning-caused fires: 1958-1975
E. Locations of fires over 20 hectares in size: 1958-1965
F. Locations of fires over 20 hectares in size: 1966-1975
Note: Increasing dot sizes represent fires of 20-40, 40-200, 200-400, and 400-4000 hectares

Figure 3.3: Fires in Nova Scotia: 1900; 1909-1910; 1958-1975

Source: Compiled and adapted from Wein and Moore 1979 (with permission)

Key to Map A: Loucks' (1959-1960) vegetation types in Nova Scotia:

A - Red spruce-hemlock-pine zone (Clyde River-Halifax ecoregion)
B - Spruce-fir coast zone (Atlantic shore ecoregion)
C - Sugar maple-hemlock-pine zone (Restigouche-Bras D'or ecoregion)
D - Sugar maple-yellow birch-fir zone (Maritime uplands ecoregion)
E - Red spruce-hemlock-pine zone (Maritime lowlands ecoregion)
F - Spruce-fir coast zone (Fundy Bay ecoregion)
G - Sugar maple-hemlock-pine zone (Magaguadavic-Hillsborough ecoregion)
H - Fir-pine-birch zone (Gaspé-Cape Breton ecoregion)
I - Spruce taiga zone (Cape Breton plateau ecoregion)

Figure 3.3: (continued)
Source: Loucks (1959-1960)

Cape Breton Island had a much longer fire rotation period, with no fires mapped during the ten year period preceding 1909-1910 by Fernow (1912) (Figure 3.3, Map B) and no historic evidence of wide-spread fires in the spruce-taiga vegetation type (Figure 3.3, Map C, Area designated as I). This vegetation type is considered to be susceptible to large fires after defoliation by spruce budworm, *Choristoneura fumiferana* (Fleiger 1970, as cited in Wein and Moore 1979). There is historic evidence of periodic outbreaks of this insect including 1910-1920, therefore Wein and Moore concluded that the climatic conditions in the area are not conducive to widespread fires.

Wein and Moore further concluded that the present vegetation patterns in Nova Scotia reflect many influences including the historic fire regime. Many forests became established after fires occurring around the turn of the century and in the 1920's and 1930's. The fire regimes under which present ecosystems developed since Euro-American settlement may also be significantly different from those of a natural fire rotation period. To these conclusions may be added the observations that the distribution of fires, and thus of vegetative communities, has been affected by human causes of fires and fire suppression.

A fire history study of Kejimkujik National Park has just been concluded although the report is pending. There was a surprising amount of evidence of fire activity, much of it of a low intensity, non-stand-replacing nature. However, there was some evidence of fires at the stand-replacing level in the past. Eighty-seven percent of sampling sites, *a priori* determined to be of fire-origin or possibly of fire-origin, showed evidence of fire. Within this data set, 42 percent of sample sites showed evidence of low intensity ground fire (cambium scarring) and 40 percent showed conclusive evidence of their fire origins. One 72 year-old pine exhibited five fire scars. Fire scars were found on twelve species (Basquill 1997 pers. comm.; Woodley 1997 pers. comm.).

A fire history is also being conducted in Cape Breton Highlands National Park based on computer-based geographic analysis of biophysical inventory data (Brigland et al. 1995).

3.15 Future actions and priorities in *A Proposed Systems Plan for Parks and Protected Areas in Nova Scotia*

The systems plan document outlines proposed future plans and priorities that would extend the strength of the systems plan in terms of biodiversity management. It provides for rounding out representation and gap analysis, as well as the inclusion of future smaller sites and atypical sites, and sites on private lands. Proposed special places, IBP sites, and other documented sites of ecological significance represent priority sites for protection. Other important actions include the proposal to establish a scientific advisory board to provide advice on science-based management approaches. Further, the establishment of a protected areas working group to develop a coherent strategy for protected areas and a common vision for a comprehensive protected areas system in Nova Scotia is recommended (NSDNR 1994).

Integrated planning is described as contributing to protected area objectives by considering compatible uses of adjacent lands and integrating the protected areas system into the full mix of land and resource uses on Crown land. These considerations should be extended on a province wide basis to include private lands.

The goals and principles proposed within the systems plan for review and discussion toward developing a common protected areas vision reflect ecological and biodiversity objectives. It is hoped that this vision is accepted by a good percentage of Nova Scotians and decision makers. It is unfortunate that these principles were not included as a *bonafide* component of the current phase of the systems plan. However, it responds to a growing awareness of the need for greater public participation and a co-operative, multiple interest, process-oriented approach to protected areas and biodiversity management.

Statements in *Protecting Nova Scotia's Natural Areas*, the report of the Public Review Committee, indicate that the entire proposed systems plan for parks and protected areas in Nova Scotia, including future actions and priorities, was given support. However, statements recommending acceptance of the plan are sufficiently ambiguous as to allow interpretation to be swayed by politics or public opinion or support regarding future directions and further commitments. While the Committee recommended acceptance of the systems plan, the Ministers have accepted only the 31 protected areas on Crown land and have said that no further large, representative protected areas will be designated on

Crown land. Future priorities and visions are not being pursued or planned at this time but may be addressed in the future if political support or constituency arises.

3.16 Ecological considerations in submissions to the Public Review Committee

During the public review phase of *A Proposed Systems Plan for Parks and Protected Areas in Nova Scotia,* 638 verbal and written submissions were received by the Nova Scotia Department of Natural Resources. A quantitative assessment of a summary of public comments (NSDNR 1995c) indicates that 487 or 76 percent of submissions express overall support for the systems plan (Table 3.1). Less than 5 percent of the submissions oppose the proposed systems plan.

Table 3.1: Quantitative summary of public support for and opposition to A Proposed Systems Plan for Parks and Protected Areas in Nova Scotia (NSDNR 1994)

Categories and Sub-categories of relative support and opposition	Number of submissions: Sub-category	Number of submissions: Category
Explicit support for proposed plan		348
Implicit support for proposed plan		41
Support with concerns		98
General and Planning process	5	
Forestry, mining, development and recreation loss	21	
Management and recreational access	67	
Landowner access	3	
Aboriginal rights	2	
Sub-total: Support for proposed plan		487
Concerns about proposed plan		82
General and Planning Process	7	
Forestry	8	
Mining	7	
Management and recreational access	58	
Landowner access	2	
Opposed to proposed plan		30
General	3	
Forestry and mining	3	
Forestry	4	
Mining	2	
Management and recreational access	16	
Landowner	2	
Opinion not clearly stated or unrelated		39
Total number of submissions		638

(Compiled from NSDNR 1995c)

The submissions were organized by Parks and Recreation Division into themes, including: comments on the public review process; management of candidate areas; completing the system and complimentary initiatives; and, comments on individual areas (NSDNR 1995c). Due to time constraints within this thesis research, the thematic summary was used to pre-select submissions for assessment relative to the ecological considerations discussed within this and the preceding chapter. Because the assessment was limited to these pre-selected submissions, the results represent the *minimum* number of submissions which express support for these ideas. Other submissions may also contain relevant comments, thus the *actual* numbers may be higher than indicated.

At least 43 percent of the submissions were identified as supporting completion of the systems plan and other complementary initiatives such as private stewardship and integrated planning and management. These submissions were reviewed for ideas such as the level of representation of natural regions, the habitat requirements of species, size and connectivity, and the need for integration of protected areas with broader regional or landscape planning and management. The numbers of submissions expressing support are assessed relative to categories and sub-categories which summarize these ideas and to the thematic organization developed by Parks and Recreation Division (Tables 3.2 and 3.3). Support for the various categories and sub-categories of ideas is shown to be distributed across the thematic organization developed by Parks and Recreation Division (Table 3.2).

At least 100 submissions explicitly call for satisfactory representation of all natural landscapes, implementation of future actions, and protection of at least 12 percent of land and water area. The terms "gap analysis" and "representation" are used in 37 submissions (Table 3.3).

At least 159 submissions (25 percent) support revision of selection criteria and protection of additional sites to include specific locations, special ecosystem types, wildlife habitat, smaller sites and those requiring restoration. Ninety-five submissions requested protection for 92 specific additional sites through-out the Province, including 17 coastal and marine locations. One respondent supports the plan but finds that there is "precious little in it about protecting our coasts or about the future protection of other crown land in N.S.. . . . This land belongs to all the people of N.S." (submission 530-BW, Lynne Perry, Mahone Bay). At least 53 submissions call for coastal and marine protection, "we cannot continue to avoid confronting this issue" (submission 510-WO, Tom Herman, Wolfville). Fifteen of these specifically use of the term "marine protected areas" (Table 3.3).

Table 3.2: Summary assessment of public comments regarding completion of the systems plan and complementary initiatives

Categories and Sub-categories of public comments	Overview	Gap analysis	Corridors	Private Steward-ship	Marine protected areas	Other initiatives	Forestry
Complete the System (generally):	27	7	-	1	-	7	-
• Specific reference to "gap analysis"	1	7	-	2	-	-	-
• Specific reference to "representation"	5	24	1	-	1	3	1
Continue with "Future actions"/"vision"/"goals"	13	-	1	1	-	2	1
Protect 12% of land base or more	30	2	-	1	-	3	-
Special ecosystems require greater protection:	2	6	-	1	-	1	-
• Rare, unique, ecological reserves, IBP sites	2	5	-	2	1	3	-
• Old growth forests	7	8	-	1	-	2	2
• Areas with rich soils	-	3	-	-	-	-	-
• Geologically significant areas	-	5	-	-	-	-	-
• Headwaters, floodplains, riparian zones, wetlands, estuaries, salt marshes	-	17	-	1	-	2	-
• Coastal areas and islands	-	38	-	-	2	2	-
• Marine/ocean/offshore areas (generally)	-	2	-	-	17	-	-
• Specific reference to "marine protected areas"	-	1	-	-	14	-	-
Revise criteria to include: • Smaller areas	4	15	-	1	-	-	-
• Areas in urban settings; historical/cultural areas; human modified areas; spiritual areas; areas with high ecotourism potential	-	22	-	-	3	1	-
• Areas assessed by NSDNR but not proposed as candidate protected areas	1	4	-	-	-	-	-
Include "restoration"	3	3	-	1	-	-	2
Specific additional areas proposed for protection : • Specific reference to sites other than those listed below	-	62	-	1	3	-	-
• Klusgap's/Kelly's Mountain	-	20	-	-	-	-	-
• Cape Split	-	9	-	1	-	-	-
• Sable Island	-	4	-	-	-	-	-
• Existing game sanctuaries	-	3	-	-	-	-	4

Include consideration of species' needs: • Specific reference to rare/endangered species	2	2	-	-	-	6	1
• General reference to wildlife habitat, large carnivores, forest interior, fish, game	5	3	1	-	1	9	18
Better adjacent land management is needed: • Generally	2	4	2	4	1	12	7
• Specific reference to : • "Buffer" areas	3	-	4	-	-	3	2
• "Fragmentation"; size/shape	5	5	1	1	1	5	1
• "Connectivity"/"consolidation"	1	8	5	3	1	1	2
• "Corridors"/"isolation"	3	-	15	2	-	3	2
• Corridors for "wildlife" needs	1	-	7	-	-	2	1
• "Riparian" corridors/ green-belts along waterways	1	1	2	1	-	3	5
• Specific corridor/consolidation site recommended	-	5	10	-	-	4	-
• "Greater ecosystem"/"Biosphere reserve"	1	-	1	-	-	6	-
Regional approach/landscape sustainability	10	1	-	1	-	14	-
Private land stewardship is required	5	19	4	39	-	7	1
Specific reference to 'conservation easements"; tax incentives; donations; bequests; land trusts; legislation	2	2	-	26	-	-	1
Improve land-use planning/management in Province; "Greening of the Planning Act"	4	2	1	3	-	19	7
Improve Crown land management (generally)	4	-	1	-	1	30	15
Integrated Resource Management; Integrate timber and wildlife managment	-	-	1	1	1	10	8
Public consultation for all land-use/management decisions (not just for protected areas)	-	-	-	-	-	12	1
Improve forestry managment /stewardship	4	3	2	3	-	6	38
Specific reference to "ecoforestry"	-	-	-	-	-	1	3
Specific concern with"clear cutting"	-	-	-	-	-	1	34
Over cutting; exceeding sustainable levels; rate of cutting; "we will run out of wood"	-	-	-	-	-	-	14
Mechanization/harvesters	-	-	-	-	-	-	6
Specific use of terms: "Devastating"	-	-	-	-	-	1	5

"Raping"; "Pillaging"; "Destroying"/"Destructive"	-	1	-	-	-	1	17
Timing is critical/ areas will be lost	9	7	1	-	-	1	4
Partnerships/ co-operation/multi-partner management	6	1	3	11	2	10	1
Long-term vision is needed	4	1	-	1	-	4	1
Long-term monitoring, research,data, indicators (funding)	1	-	-	-	-	4	-
Specific reference to "biodiversity"	5	2	-	1	1	4	2
Specific reference to "ecological integrity"/"ecosystem approach"/"evolutionary potential"	1	2	-	-	-	1	3
Need to foster protection/stewardship ethic	11	-	-	1	-	2	1
Specific reference to "wilderness" values	6	-	1	-	-	4	1
Total: Minimum* number of submissions with explicit support of ideas in categories and sub-categories within each organizational theme (Overview; etc.)	87	127	39	53	17	61	70
Total number of submissions assessed within each organizational theme (Overview; Gap analysis; etc.)	90	134	39	53	17	72	71

(Compiled from notes taken by the author of verbal presentations at 26 public meetings during public review phase in January and February of 1995; and, from a thematic summary of public comments which includes written submissions (NSDNR 1995c) .

Notes:

1. Column headings reflect thematic organization of submissions and comments by NSDNR (1995c), which include but are not limited to: *Overview; Gap analysis; Corridors; Private stewardship; Marine protected areas; Other initiatives; and, Forestry.*

2. Row headings reflect categories and sub-categories derived by author to summarize and quantify public comment regarding specific themes that cross the organizational framework utilized by NSDNR (1995c).

3. * Numbers in table cells indicate the *minimum* number of submissions which *explicitly* support the ideas expressed in the categories and sub-categories; actual support may be higher than explicit support; and, due to time constraints, *not all submissions were assessed for all categories and sub-categories*; notes taken prior to the development of the assessment framework and a thematic summary of public comments were utilized to focus the assessment on only those submissions identified as commenting on "Complementary Initiatives" and/or "Completing the System" by NSDNR (1995c).

Table 3.3: Assessment of minimum number of submissions with explicit support for ideas summarized in Categories and Sub-categories, such as "Completion of the System"

Categories and Sub-categories of public comments	Total per sub-category	Sub-total	Sub-total	Total per category	Total per categories group
Complete the systems plan (generally):	38		64	72	100
• Specific reference to "gap analysis"	8	37			
• Specific reference to "representation"	33				
Continue with future actions/vision	16				
Protect at least 12 % of land base	35				
Special ecosystems require greater protection:	10			83	159
• Rare, unique, ecological reserves, IBP sites	9				
• Old growth forests	19				
• Areas with rich soils	3				
• Geologically significant areas	5				
• Headwaters, floodplains, riparian zones, wetlands, estuaries, salt marshes	19				
• Coastal areas and Islands	41		53		
• Marine/ocean/offshore areas (generally)	18	19			
• Specific reference to "marine protected areas"	15				
Revise criteria to include: • Smaller areas	20	42		46	
• Areas in urban settings; historical/cultural/human modified areas; spiritual areas; ecotourism areas	26				
• Areas assessed by NSDNR but not proposed as candidate protected areas	5				
Include "restoration"	9				
Specific additional areas proposed for protection: • Recommend specific sites	64			95	
• Klusgap's/Kelly's Mountain	20				
• Cape Split	9				
• Sable Island	4				
• Existing game sanctuaries	7				
Include consideration of species' needs: • Specific reference to rare/endangered species	10			37	
• General reference to wildlife habitat, large carnivores, forest interior, fish, game	32				
Better adjacent land management: • Generally	28			75	89
• Specific reference to : • "Buffer" areas	9		65		
• "Fragmentation"; size/shape	15				
• "Connectivity"/"consolidation"	20	57			
• "Corridors"/"isolation"	19				
• Corridors for "wildlife"	9				
• "Riparian" corridors/ green-belts along waterways	12				
• Specific corridor/consolidation site recommended	19				
• "Greater ecosystem"/"Biosphere reserve"	5				
Regional approach/landscape sustainability	24				

Table 3.3: (continued)

Private land stewardship	63			68	
Specific reference to 'conservation easements"; tax incentives; donations; bequests; land trusts; legislation	27				
Improve land-use planning/management in Province; "Greening of the Planning Act"	32	62	69	74	100
Improve Crown land management (generally)	46				
Integrated Resource Management; Integrate timber and wildlife managment	19				
Public consultation for <u>all</u> land-use/management decisions (not just for protected areas)	12				
Improve forestry managment/stewardship	47	77		49	
Specific reference to "ecoforestry"	3				
Specific forestry concerns: • "Clear cutting"	35			59	
Over cutting; exceeding sustainable levels; rate of cutting; "we will run out of wood"	14				
Mechanization/harvesters	6				
Specific use of terms: "Devastating"	6				
"Raping"; "Pillaging"; "Destroying"/"Destructive"	18				
Timing is critical/ areas will be lost	21				
Partnerships/co-operation/multi-partner management	30				
Long-term vision is needed	11				
Long-term monitoring, research,data, indicators	5				
Specific reference to "biodiversity"	15			20	
Specific reference to "ecological integrity"/ "ecosystem approach"/"evolutionary potential"	6				
Need to foster protection/stewardship ethic	13			20	
Specific reference to "wilderness" values	9				
Total: Minimum number of submissions that expressed explicit support for ideas summarized within categories and sub-categories*					277

(Complied from notes taken by the author of verbal presentations at 26 public meetings during public review phase in January and February of 1995; and, from a thematic summary of public comments which includes written submissions (NSDNR 1995c) .

Note:

1. * Numbers in table cells indicate the *minimum* number of submissions which *explicitly* support the ideas expressed in the categories and sub-categories; actual support may be higher than explicit support; and, due to time constraints, *not all submissions were directly assessed for all categories and sub-categories*; notes taken prior to the development of the assessment framework and a thematic summary of public comments were utilized to focus the assessment on only those submissions identified as commenting on "Complementary Initiatives" and/or "Completing the System" by NSDNR (1995c).

Forty-two submissions make specific reference to unrepresented and under-represented natural landscapes and request greater protection (Table 3.4). "The protected areas plan goes a long way to helping us achieve protection but it should not be seen as the end, rather as the beginning of a new way of relating to our landscapes" (submission 453-CH, Eric Hundert, Dartmouth).

Table 3.4: Summary of number and location of additional areas proposed by public for *A Proposed Systems Plan for Parks and Protected Areas in Nova Scotia* (NSDNR 1994)

Site locations proposed for additional protected areas	Sub-total	Total
Terrestrial inland sites		33
Cape Breton Island	6	
Central and Northern Mainland Nova Scotia	19	
Western Nova Scotia	8	
Coastal and marine sites		17
Bay of Fundy	4	
South Shore	3	
Eastern Shore	5	
Cape Breton	5	
Natural landscapes or regions		42
Unrepresented natural landscapes dominated by Crown lands	13	
Unrepresented natural landscapes in coastal regions	6	
Under-represented coastal regions and islands	5	
Unrepresented natural landscapes dominated by privately-owned lands; and, Under-represented natural landscapes with additional Crown lands	14	
Areas for consolidation/connection of adjacent protected areas	4	
Total number of additional locations suggested for protected areas		92

(Compiled from NSDNR 1995d)

Eighty-three submissions call for the inclusion of special types of sites including ecological reserves, geologically significant, old growth, wetlands, headwaters, and coastal and marine: "the value of a salt marsh . . . is beyond any price" (submission 484-C, Richard Vine, Dartmouth). Forty-six submissions recommend the revision of selection criteria to include smaller areas, areas of historical or cultural value, areas within urban settings or with previous human disturbance, and potential for restoration (Table 3.3).

Sixty-eight submissions recognize the need to include private stewardship initiatives to complete the Plan and to work towards broader landscape sustainability. Twenty-seven of these explicitly refer to conservation easements, tax reform and other incentives. Twenty submissions express the need to foster a more environmentally responsible ethic; "if animal and plant habitat is to be saved in Nova Scotia, a human centered philosophy where economic gains are placed first in front of plant and animal well being must be abandoned" (submission 502-TR, Billy MacDonald, Scotsburn) (Table 3.3).

Seventy-seven submissions explicitly call for improvements in forestry management, with 59 of these expressing concerns regarding current forestry practices such as clear-cutting, over-harvesting, mechanical harvesters and wide-spread "devastation" and "destruction": ". . . tree harvesters trashing old forest wood with the ravenous hunger and ferocity of a junk yard dog with a fresh bone" (submission 589-L, Reginal Fuller, Baddeck). And, "they are mowing down our forests at an alarming rate" (submission 619-L, Peter Finley, Amherst). Further, some suggest that governments are responsible for "the reduction of fish and wildlife and the imminent devastation of our forests" (submission 224-YA, William Jack, Carlton).

At least 100 submissions support improvements in land planning and management through-out the Province, including "Greening of the Planning Act" (submission 197-C, Rick Peckham, Bedford), and integrated management of Crown lands. "N.S. should adopt a sustainable land use policy on its other crown lands" (submission 293-BA, Geoff May, Margaree Harbour). Greater public consultation is recommended regarding *all* types of land-use decisions, not just for protection: "all industrial, business and large recreational use must go through standing public consultation process on a provincial scale, with the feedback directly influencing the final decisions on these activities" (submission 537-BW, Jeff Amos, Bridgewater). "We also need to have open public debate regarding decisions being made about the exploitation of public lands" (submission 450-CH, Todd Keith, Halifax).

Better land-management adjacent to protected areas is requested within 89 submissions. Twenty-four of these explicitly recognize the need for a regional or landscape approach. Sixty-five submissions call for establishment of buffer zones and consideration of effects of fragmentation, size, shape and other landscape parameters, "before the Department of Highways runs more big roads through them" (submission 485-C, Gareth Harding, Halifax). Explicit reference to corridors, connectivity, or consolidation among protected areas is included within at least 57 of these submissions: "why not include some crown land between the most important candidate protected areas to create a little more continuity?" (submission 248-C, Kimberly Kelsey, Stellarton).

For example, at least six submissions specifically suggest connecting Waverley, Salmon River and Clattenburg Brook candidate protected areas with other lands (submissions 32, 80, 106, 406, 447, 546). Connectivity is also specifically suggested for:

1) Economy and Portapique River candidate protected areas; 2) Lake Rossignol, Tobeatic and Tidney River candidate protected areas and Kejimkujik National Park; 3) Cape Breton Highlands National Park and candidate protected areas in northern Cape Breton; and, 4) other areas such as Trout Lake, Tangier-Grand Lake, and those in the area of Liscombe (submissions 11, 126, 130, 169,132, 204, 293, 406, 420, 546) (Refer to Figure 3.1 for protected area locations).

These submissions and others recommend uninterrupted protected and semi-protected "wildland" or "wildlife" corridors to connect candidate protected areas and other protected areas for "free-flow" of species, both "wildlife' and "people", wherever possible through Crown lands and through private lands where necessary (submissions 10, 134, 130, 155, 259, 273, 293, 406, 412, 453, 527, 546, 585, 592, 645). Some of these submissions recognize that corridors need to be large, but suggest that they can include other land-use activities so long as connectivity and integrity are maintained through "landscape management" (155, 447, 527). At least one submission specifically recommends adoption of the "Wildlands Project Vision" for Nova Scotia, in order to protect fully-functioning ecosystems in large core reserves with compatible-use buffer zones and linkage corridors (submission 503-TR, David Orton, Saltsprings).

Several submissions also recognize that the proposed systems plan, in particular, and protected areas, in general, are central to a "sustainable landscape" and contribute toward maintaining "biodiversity". However, most "biodiversity" exists outside of protected areas or relies upon habitat beyond protected areas. The entire landscape must be better managed because protected areas in general, and the proposed systems plan, in particular, are only part of a larger plan or group of initiatives necessary to protect biodiversity (see for example, submissions 427, 450, and 510). At least one submission suggests that the Plan should set out a process for strengthening the legal framework for protecting biodiversity in N.S. and recommends establishing a "biodiversity law advisory committee" to develop thinking and policy approaches (submission 553-C, David Vander Zwaag, Halifax).

Others suggest that the candidate protected areas may be too small to meet biodiversity objectives and therefore will be inadequate without integrated resource management and land-use planning on adjacent lands (submissions 122, 131, 579). One submission states that deliberate effort must be made to protect larger carnivores or top predators and that such species may serve as indicators for ecosystem health (submission 412). Thirty-seven submissions explicitly recognize the need to incorporate species-level and wildlife considerations such as habitat needs into the systems plan (Table 3.3). Twenty submissions make specific use of the terms "biodiversity " or "ecological integrity", or refer to "evolutionary" potential. Eleven submissions express the need for a long-term vision, and five explicitly call for long-term research and monitoring, including the use of indicators and the need for funding for such research.

Submissions from both Kejimkujik and Cape Breton Highlands National Parks indicate that effective management of these parks requires consideration of the entire region and express interest in regional multi-partner management arrangements, including "Biosphere reserves" or "Greater ecosystems" (submissions 132, 302, and 230). Others explicitly support these ideas (see for example, submissions 420 and 204).

Thirty submissions recognize the need for multi-partnership initiatives and co-operative arrangements to complete the systems plan and to provide better management within protected areas, Crown lands, and the broader region. Twenty-one submissions suggest that the timing is critical: "we are about to see an unprecedented development of our coastline during the next 20 years. Any that can be protected now should be" (submission 406-C, David Cameron, Riverport). "There is no time to plead ignorance any more" (submission 548-BEW, Gareth Davidson, New Germany).

> . . . we have so little left in Nova Scotia that it is imperative that we set aside as much as possible now. . . . we are nickel and diming wild places to death. . . . when we grow up and learn to use our resources in a balanced way for the benefit of wild things and ourselves, then these plans [for protected areas] won't be needed. . . . Until then, they are. (submission 472-BW, Millie Evans, LaHave)

3.17 Discussion

Ecological considerations were included in the protected areas systems plan by the classification of natural landscapes and landscape ecosystems, the site selection processes and field reconnaissance. The process of selecting representative areas of natural landscapes is well supported by science, although significant gaps in representation remain. This posses a challenge for future protection of samples of these currently unrepresented or under-represented landscapes. Many of these landscapes are predominantly in privately held lands, many have been extensively converted through agriculture or forestry, and the Ministers responsible for the process have stated that no further Crown lands will be included in large, representative protected areas.

However, the systems plan also exhibits serious deficiencies in its lack of consideration of biotic guidelines at the species-population level. Ecological requirements of rare species, niche specialists, ungulates, spatially vulnerable, K-selected, range-edge or disjunct, or pollution-susceptible species have not been considered and are not incorporated in the description of future priorities or vision. As discussed in this and preceding chapters, protected area and biodiversity management theory increasingly calls for autecological and context specific studies relating to populations of focal-species and their habitat requirements for delineating landscape-level parameters and protected area boundaries. The lack of such considerations within the protected areas systems plan constitutes a serious deficiency and may threaten the persistence of the diverse entities and processes for which the plan was developed.

Only six of the proposed protected areas are larger than 10,000 hectares. Even the largest groups of protected areas (122,500 - 130,000 hectares) in Nova Scotia are probably not of sufficient size to maintain viable populations of native species with large area requirements, such as American moose, fisher, river otter, lynx, and cougar (Franklin 1980; Harris 1984; Leptich and Gilbert 1989; Hummel and Pettigrew 1991) (Table 3.5). Consolidated groupings of protected areas and other remaining natural areas on Crown lands into biodiversity management areas or grater ecosystems such as in the Tobeatic-Kejimkujik area and the northern Cape Breton Highlands area may encompass sufficient area to maintain viable populations of species such as American moose and American marten or lynx.

In the Tobeatic-Kejimkujik area, American moose may represent a potential focal-species. It is a large-bodied, space-demanding or wide-ranging species of ungulate, a major herbivore, and its population in the Tobeatic-Kejimkujik area is remnant of the native moose population in Nova Scotia, thus representing a special population. An estimate of the home-range requirements of American moose suggest that 125,000 hectares (MCA) are required to maintain a viable population over the short-term (Ne=50). For long-term viability, approximately 1,250,000 hectares may be required (Ne=500).

Tobeatic candidate protected area and Kejimkujik National Park together may provide adequate habitat area for short-term viability of populations of American moose, however a larger area is required to take into account disturbances such as fire that may render areas of habitat unsuitable for periods of time. Much larger area is probably required to maintain the viability of a single population of the remnant native American moose population over the longer term. Ideally, more than one population would be desired to safeguard against catastrophic events and disturbances such as disease.

In the northern Cape Breton Highlands area, isolated remnant populations of the native lynx and American marten remain. Home-range requirements for lynx are estimated to be higher than for American marten. Estimated minimum critical area for short-term population viability of lynx is estimated to be approximately 455,000 hectares (Ne=78) (Table 3.5), an area more than three times the size of Cape Breton Highlands National Park and Pollett's Cove-Aspy Fault candidate protected areas combined. Obviously larger areas will need to be managed for biodiversity objectives if even short-term viability of a remnant population of lynx is to be maintained. The long-term viability of a population of American marten (MCA=107,500 hectares for MVP-Ne=500) may be maintained within the area if other limiting factors are satisfied such as habitat quality. Again, a precautionary perspective would suggest that more than one viable population should be accommodated.

Current forms of land-use activities inside and outside of protected areas will have to be modified in order to maintain biodiversity as land-use pressures intensify. Species such as bobcat and black bear seem to adapt well to areas managed for objectives other than biodiversity. However, certain species such as American moose, American marten and lynx have specialized habitat or other resource requirements or are more sensitive to human activities and may not persist as land uses intensify and land cover changes both inside and outside of protected areas (Table 3.6). These species may be potential focal-species or species warranting special biodiversity management attention. A strategic approach for extending biodiversity management into the broader landscape would be to identify focal-species and define the habitat requirements for viable populations of the most demanding of these based on context specific studies.

Although the systems plan is clear in its ecological criteria for site selection, it seems that boundary delineation and the size of the protected areas primarily reflect pragmatic considerations of land tenure and land-resource commitments as well as existing conditions of naturalness and roadlessness. However, the protected areas systems plan does represent a significant step forward in parks and protected areas systems planning in Nova Scotia. Indeed, it represents a progressive approach for any land planning or resource management agency.

3.18 Summary conclusion

A Proposed Systems Plan for Parks and Protected Areas in Nova Scotia identifies 31 candidate protected areas selected primarily on the basis of representivity of natural landscapes (NSDNR 1994). This initiative is commendable, however, as acknowledged in the plan, "this system of protected areas alone will not ensure biodiversity" (NSDNR 1994, 4). Only 26 of the 77 natural landscape types identified are considered adequately represented (NSDNR 1994, 9, 14), leaving 51 natural landscapes unrepresented or under-represented. Even those that are considered adequately represented may contain only one protected area and exclude significant elements of biodiversity. Further, few if any of the areas are large or connected enough to maintain viable populations of native species.

Table 3.5: Estimated minimum critical area for viable populations of selected species

Selected mammal species	Individual home-range in hectares (ha)	MCA in hectares for Ne=50 (short-term mvp)	MCA in hectares for Ne=500 (long-term mvp)	MCA in hectares for Ne=other (short-term mvp)
Coyote	453	22,650	226,500	67,044 (Ne=148)
Red fox	62	3,100	31,000	9,176 (Ne=148)
American black bear	1,760	88,000	880,000	691,680 (Ne=393)
American marten^	215	10,750	107,500	50,000 (Ne=250x200 ha)
Fisher	1,610	80,500	805,000	402,500 (Ne=250)
American mink	52	2,600	26,000	13,000 (Ne=250)
River otter^	3,010	150,500	1,505,000	752,500 (Ne=250)
Eastern cougar	49,700	2,485,000	24,850,000	3,876,600 (Ne=78)
Lynx^	5,710	285,500	2,855,000	455,380 (Ne=78)
Bobcat	11,600	580,000	5,800,000	904,800 (Ne=78)
American moose^	2,500	125,000	1,250,000	

Sources: Harris 1984; Leptich and Gilbert 1989; Frankel and Soulé 1981; Hummel and Pettigrew 1991; NBDNRE 1995; Franklin 1980

Notes:
1. Selected mammal species primarily reflect species identified in Table 3.6.
2. ^ Symbol indicates species that may be in need of protected areas in N.S. because habitat is threatened by loss, conversion, degradation or fragmentation and/or population is threatened by direct exploitation, harassment or ecological interactions in N.S. (NSDNR 1996a; 1997b)
3. Individual home-range sizes are from Harris (1984, 86), with the exception of moose (Leptich and Gilbert 1989, 882). Home-range requirements for minimum viable populations were calculated by multiplying individual home-range sizes by minimum effective population (Ne) sizes of 50 breeding individuals for short-term survival and 500 for long-term survival (Franklin 1980).
4. Ne - *effective population size* - represents an "ideal" breeding population (Franklin 1980). Franklin's estimates are based on inbreeding considerations alone and for domestic species. Although they may provide a rough guideline, they have been criticised as being only of about the correct order of magnitude: minimum viable population size will be different for each species; the numbers probably should be significantly higher for most wild animals; and, the real or actual population size should be much higher because real populations are seldom ideal breeding populations.
5. Ne=50 (short-term mvp) and Ne=500 (long-term mvp) are from Franklin (1980); Ne=other (short-term mvp) figures are from Hummel and Pettigrewfor wolf, grizzly bear and cougar (1991, 148, 393, 78), and from NBDNRE for American marten (1995, 250). These mvp figures were applied to similar species within families (canids, black bear, mustelids, lynx and bobcat) but have not been determined scientifically nor referenced in scientific literature.
6. NBDNRE calculate the minimum viable population of American marten as 250 resident individuals; no time range for persistence is specified (1995, 6). They also suggest that 200 ha is required for each resident individual marten (1995, 10). These numbers lead to a calculation of approximately 50,000 ha of area required to support a minimum viable population of American marten in N.B..
7. Hummel and Pettigrew (1991, 173) suggest that short-term (50-100 years) minimum viable populations for cougars is 78, for grizzly bears is 393, and for wolves is 148; for long-term viability (1000 years) current genetic research suggests that these numbers should be increased by ten times. It may be that these numbers more accurately reflect viable population sizes for these and similar species such as lynx, black bear and possibly even coyote, than Franklin's (1980) generic estimate of Ne=50. Frankel and Soulé (1981, 129) estimate that the minimum critical area required to sustain a viable population of wolves is approximately 39,000-78,000km^2 (3,900,000-7,800,000 ha). It is not surprising that wolves have been extirpated from Nova Scotia, given these figures and the extent of land conversion.

Table 3.6: Species and characteristics which may suggest they require protected areas

Characteristics	**k-strategists:** a) long-lived b) habitat/dietary specialist c) low reproductive rates d) low rates of dispersal				**Summit predators**	**Species that concentrate spatially**	**Long distance migratory species**	**Large-bodied species**	**No. of characteristics met**
Mammal Species	a	b	c	d					
Arctic shrew									
Common shrew									
Smokey shrew									
Gaspé shrew		√							1
Long-tailed shrew		√							1
Water shrew									
Pygmy shrew									
Short-tailed shrew									
Star-nosed mole		√							1
Little brown bat			√			√			2
N. long-eared bat			√			√			2
Eastern pipistrelle			√			√			2
Silver-haired bat									
Red bat									
Hoary bat									
Coyote					√		√	√	3
Red fox					√				1
American black bear	√		√				√	√	4
Racoon									
American marten		√			√				2
Fisher					√		√		2
Ermine/Weasel					√				1
American mink					√				1
Striped skunk									
River otter					√		√		2
Eastern cougar	√		√		√		√	√	5
Lynx		√			√		√		3
Bobcat					√		√	√	3
White-tailed deer	√					√		√	3
Moose	√						√	√	3
Eastern chipmunk									
Woodchuck									
Am. red squirrel									
S. flying squirrel		√							1
N. flying squirrel									
American beaver									
Deer mouse									
White-footed mouse									
Red-backed vole									
S. bog lemming									
Muskrat									
Meadow vole									
Rock vole		√							1
Wood. jump. mouse									
Meadow. jp. mouse									
American porcupine			√						1
Snowshoe hare									

Source: Characteristics from Theberge (1993); responses from expert consensus (Refer to Tables 4.8.1 in Chapter 4) and Corbett (1997 pers. comm.)

The systems plan does not address viable populations and species-habitat distribution. However, it does consider landscape and ecosystem distribution, and includes relatively large, contiguous blocks of unroaded natural areas. It does not include allowances for ecological and evolutionary processes of change, such as responses to climate change. Connectivity is not maintained for immigration and dispersal across the landscape in response to environmental changes over time. The need for designating inviolable core areas and maintaining linkages, corridors and buffer areas is not recognized. Finally, while the systems plan attempts to include rare and unique species and ecosystems, it does not specifically address the needs of endangered, threatened or vulnerable species.

The sizes of the protected areas primarily reflect pragmatic considerations such as existing resource commitments (mining; forestry), land tenure (Crown land boundaries), and land cover (naturalness; unroaded). Area requirements of viable populations or patch dynamics such as disturbance and succession are not considered. This constitutes a serious limitation of the systems plan for protecting ecological processes and biological diversity, and should be incorporated into future initiatives such as private stewardship programs, regional landscape planning, partnership agreements, and integrated resource management.

As the proposed systems plan recognizes, biodiversity objectives must be integrated into broader landscape planning and management to make protected areas effective and maintain biodiversity. The province is currently developing an integrated resource management plan for Crown lands toward a vision of sustainability (NSDNR 1997c). A focal-species approach could provide critical information for incorporating species-population and landscape-level parameters into integrated resource management, ecologically sustainable landscape planning and other aspects of biodiversity management.

The identification of focal-species, or species warranting special biodiversity management attention, could help to focus biodiversity management priorities in Nova Scotia. Further research on these species could determine the critical habitat and other resource requirements for the most-demanding focal-species. These critical habitat requirements could define landscape-level parameters for biodiversity management, including monitoring and land-use planning. Because these landscape-level parameters would satisfy the habitat and resource requirements of the most-demanding focal-species, the requirements of many other species would be accommodated.

The challenge remains in identifying the most-appropriate suite of focal-species. This is especially true in Nova Scotia where the largest carnivores and most sensitive and space-demanding species have already been extirpated. The following chapter describes a framework and assessment process developed and tested to select focal-species in Nova Scotia. Potential focal-species are identified for mammal, reptile, amphibian and freshwater fish classes. Later chapters show how a focal-species approach can be utilized to select the most appropriate indicator species for monitoring measures of population dynamics and to define landscape-level parameters based on habitat and resource requirements of viable populations.

Chapter 4

A framework for identifying focal-species for biodiversity management

4.1 Introduction

As discussed in Chapter three, existing and proposed protected areas in Nova Scotia are not of sufficient size, number, connectivity or representivity to maintain current levels of native biodiversity. Even the largest groups of protected areas in Nova Scotia may not be large enough to maintain viable populations of native species with large area or home-range requirements (Refer to Table 3.5 in Chapter 3). Species such as American marten, lynx, and cougar are relatively sensitive to human activities and may not persist as land uses intensify. These and other species are potential focal-species for biodiversity management.

Although landscape-level approaches are necessary for maintaining biodiversity, there are few, if any, operational landscape parameters for planning, design or management. As previously discussed, a promising process described in the literature is to identify focal-species, and then determine viable population sizes and minimum critical areas for these species through population viability analyses, and autecological or biogeographical studies, incorporating allowances for the natural disturbance regime, patch dynamics and succession (Soulé and Simberloff 1986; Gilpin and Soulé 1986; Pickett et al. 1992; Noss 1995). Context specific considerations such as these could define landscape-level parameters relevant to the species and processes present (Lambeck 1997).

This chapter focuses on the issue of identifying focal-species, or species warranting special biodiversity management attention in Nova Scotia (Beazley 1997b). A process for identifying focal-species was developed and tested and is described. This represents the original or primary research component of the thesis. A framework or matrix including several variables and native species was developed and tested with participation from wildlife biologists and other experts through a Delphi survey method (Linstone and Turoff 1975). Results were assessed and are summarized within the text and presented in greater detail in the appendices (Volume 2, Appendices 3 to 9). Mammal, reptile and amphibian, and freshwater fish species warranting special biodiversity management attention in Nova Scotia are identified as potential focal-species. Further research and assessment is recommended to confirm the results and identify additional focal-species from within other classes of flora and fauna.

4.2 Context for identifying focal-species for Nova Scotia

4.2.1 Focal-species approaches in the literature

It is not feasible nor necessary to plan and manage for every species in biodiversity initiatives such as protected area design, landscape planning, research and monitoring. Focal-species are those which warrant special biodiversity management attention because they are: functionally important in the community; more prone than others to extirpation in landscapes utilized, disturbed or fragmented by humans; more demanding in their habitat requirements; and/or, more reliant upon protection areas or measures. Types of focal-species include vulnerable, keystone, indicator, flagship and umbrella species, and species with special populations such as those which are genetically unique (Tables 4.1 and 4.2) (Holbrook 1974; Hunter 1990; Noss 1990b; 1991a).

Biological and other characteristics have been described for identifying priority species for wildlife conservation in Florida (Millsap et al. 1990), for transboundary management in Algonquin Provincial Park (Theberge 1995), as well as those most vulnerable to climate change in Nova Scotia (Herman and Scott 1992; 1994) (Table 4.3). Theberge (1993) also described biological traits and behaviors that tend to characterize species which may require protected areas for continued persistence in landscapes increasingly modified by human activities (Table 4.2) (Refer also to Table 3.6 in Chapter 3). Characteristics which constitute appropriate indicator species for monitoring have also been described (Landres et al. 1988; Noss 1990b; 1995; Woodley 1993; 1996b) (Refer to Table 4.2 - Noss 1990b; and, to Chapter five, particularly Tables 5. 2, 5.3, 5.4 and 5.8). For the purposes of this study, focal-species types have been adapted from these sources, primarily from Hunter (1990) and Noss (1990b; 1991a), and are summarized in Table 4.1.

Table 4.1: Summary of types of focal-species for biodiversity management

1. Vulnerable or endangered species: rare species or species with small population size, genetic impoverishment, poor dispersal powers, wide-ranges or large area requirements, low fecundity, dependence on patchy or unpredictable resources, extreme variability in population density, or are persecuted or prone to extinction in human-dominated landscapes (may also be estimated by extent of decline since Euro-American settlement);

2. Keystone: pivotal species upon which a large part of a community depends;

3. Ecological indicator: species which signal the effects of perturbations on a number of other species with similar habitat requirements;

4. Flagship: popular, charismatic species that serve as symbols for conservation;

5. Umbrella: species with large area requirements which, if given sufficient habitat protection, will protect many other species; and,

6. Special populations: species for which the local population is a special gene pool.

Source: Compiled from Hunter 1990; and, Noss 1990b; 1991a

Table 4.2: Focal-species groups for biodiversity management attention

Hunter 1990	Noss 1990b; 1991a	Theberge 1993
Special species for biodiversity management or "feature-species management" (Holbrook 1974)	Overlapping classes of species deserving special emphasis, including intensive monitoring; species groups may be used to maintain the integrity of higher levels of biological organization	Types of species especially needing protected areas; classes of biological traits that make some species more vulnerable than others to human disturbance
1. Endangered species: rare and vulnerable species **2. Keystone species:** important prey, predator, symbiont, or competitor **2. Indicator species:** species with a narrow tolerance for environmental conditions, with specific habitat or habitat-feature requirements **3. Flagship species:** species that can galvanize public support; many are large, conspicuous animals with extensive home ranges and broad habitat needs **4. Special populations:** species where the population is a special gene pool	**1. Indicator species:** ***Ecological Indicators:*** species that signal the effects of perturbations on a number of other species with similar habitat requirements; ***Management Indicator species:*** - threatened and endangered species - species sensitive to intended management practices - game and commercial species - non-game species of special interest - ecological indicator species that suggest the effects of management practices on a broad set of species (Salwasser et al. 1983; Wilcove 1988) **2. Keystone species:** pivotal species upon which the diversity of a large part of the community depends; often dominant species at their trophic level; top predators **3. Umbrella and Flagship species:** ***Umbrella species***: species with large area requirements, which if given sufficient protected area will bring many other species under protection; large carnivores ***Flagship species:*** popular or charismatic species that serve as symbols and rallying points for major conservation initiatives (megavertebrates) **4. Vulnerable species:** species highly vulnerable to the impact of human civilization; endangered species. Traits that predispose species to decline in human-dominated landscapes are: - small population size; - a low level of genetic variation; - poor dispersal ability; - large area requirements; - low fecundity; - dependence on patchy or unpredictable resources; - a tendency to congregate in large groups; - long-distance migration; and - ground-nesting habits. (May also be estimated by the extent or rapidity of decline since human settlement.) ***Rarity*** is a good predictor of vulnerability but not all rare species are vulnerable to further decline, and rarity is a poor indicator of ecological importance.	**1. K-strategists:** long-lived, habitat specialists, with low rates of dispersal, and low reproductive rates (such as large mammals and large birds) **2. Summit predators:** species which feed at the top of the food chain; concentrate toxins (most vertebrate summit predators are also k-strategists) **3. Species that concentrate spatially:** (congregating waterfowl, caribou, musk-oxen) **4. Migratory birds** **5. Long-distance migratory mammals** (big-game species crossing park boundaries) **6. Large-bodied species** (generally low reproductive rates)

Table 4.3: Summary of variables for assessing species for priority conservation attention

Millsap et al. 1990	Herman and Scott 1992; 1994	Theberge 1995
Setting priorities for vertebrate species conservation in Florida	Assessing the vulnerability of vertebrate species to environmental change and to climatic change in N.S.	Identifying species in need of conservation attention
Biological variables: 1. population size 2. population trend 3. range size 4. distribution trend 5. population concentration 6. reproductive potential for recovery: a) average no. of young per female per year b) age at first reproduction 7. ecological specialization: a) dietary specialization b) reproductive specialization c) other specializations **Action variables:** 1. knowledge of distribution in Florida 2. knowledge of population trend in Florida 3. knowledge of Florida population limitations 4. ongoing management activities in Florida **Supplemental variables:** 1. systematic significance of the taxon 2. percentage of taxon's total range that occurs in Florida 3. trend in taxon's Florida population 4. period of occurrence in Florida 5. harvest of the taxon in Florida	**Variables for assessing general vulnerability to environment change (based on Millsap et al. 1990)** **Biological variables:** 1. population size 2. population trend 3. range size 4. distribution trend 5. population concentration 6. reproductive potential for recovery: a) ave. young/female/year; b) age at first reproduction 7. dietary specialization 8. reproductive specialization 9. habitat specialization **Action variables:** 1. knowledge of distribution in N.S. 2. knowledge of population trends in N.S. 3. knowledge of factors limiting populations in N.S. 4. present management activities in N.S. **Supplemental variables:** 1. systematic significance of the taxon 2. percentage of taxon's total range occuring in N.S. 3. harvest of taxon in N.S. **Variables for assessing climatic sensitivity** **1. Life history environments** Direct impacts of the following factors on food supply or access, dispersal mobility, habitat size or quality, exposure to predation, physiological stress and skewing of sex ratios: 2. reduced summer soil moisture 3. lower summer water table 4. reduced summer rainfall 5. lower summer stream flow rates 6. increased summer water-surface temperature 7. increased summer soil temperature 8. increased winter water-bottom temperature 9. reduced snow and ice cover 10. increased winter/spring flooding	**Status filter:** **1. species rare in park** **2. species declining in park or region** **3. regionally rare species** **4. provincially rare species** **5. nationally rare species** **Habitat filter:** **1. habitat specialists** **2. habitat specialists tied to those threatened by human use:** - regionally rare habitat - mature forests - wetlands - riparian zones - lake shores - coastal zones - habitats stressed by excessive resource extraction or pollution **Biological characteristics filter:** **1. low reproductive capability** **2. pollution susceptibility** **3. space demanding** (on a regional scale, either as having a large home range or migrating locally) **4. seasonally concentrating** **5. limited powers of dispersal** **6. range edge** **7. large bodied** **8. any species considered a resource by humans** (optional, depending on viewpoint, re: wildlife mismanagement) **Ecological Importance filter:** **1. summit predators** (all raptors, mustelids and canids) or important summit predators (that prey upon major herbivores or major ungulates, lagomorphs and rodents, either directly or from the top of a chain, and tempered by the extent to which they influence the size of prey populations) **2. keystone faunal species** (defined in various ways, normally as species important as food for many others) **3. species exerting a major impact on vegetation** (dominant ungulates, possibly lagomorph or rodents)

4.2.2 Systems for species status evaluations in Nova Scotia and Canada

A system for ranking species on the basis of their relative risk of extinction has also been recently developed and adapted for use in N.S. (Harper et al. 1996; Elderkin and Boates 1996) (Table 4.4). This system was first distributed at the national endangered species workshop held in June of 1996 in Toronto. The proposed system uses current data and knowledge to categorize species for the purpose of setting priorities for further assessments of potentially threatened or endangered species at the national level. It may also identify management priorities. The system is intended to be compatible to all jurisdictions. Regional rankings are first prepared by provincial and territorial agencies. The information is then compiled by the Canadian Endangered Species Conservation Committee (CESCC) to determine national ranks (Harper et al. 1996).

This system has since been adopted by Alberta, British Columbia and Nova Scotia (Elderkin 1998 pers. comm.). The Wildlife Division of NSDNR is currently using this system to rank bird, mammal, reptile and amphibian species in Nova Scotia (NSDNR 1996a; 1996b; 1997b; Elderkin and Boates 1996; and, Boates et al. 1997). Some preliminary results have been referenced within this thesis (Refer to Appendices 4.2 to 4.4). Further, the process, framework and information developed through the research for this thesis has contributed to the refinement of the provincial ranking system, as well as to discussions at the national level (Elderkin 1998 pers. comm.).

This national ranking system (Harper et al. 1996) consists of a small number of variables. The intention is to distill the multiple variables down to the most salient factors for indicating risk so that regional rankings can be completed in a timely and efficient manner. The focal-species framework developed for this thesis and described within this Chapter also serves to indicate the current rarity or population status of the species. However, the focal-species framework may also identify the factors contributing to species status by explicitly including variables which tend to characterize species as warranting special management attention (Refer to Table 4.5 for list of variables and to Appendix 2.5 for definitions). Identification of these factors is potentially important for setting management priorities and developing plans for preventing species from becoming at risk or for species recovery.

However, a focal-species framework which incorporates these various concepts into a systematic, criteria-based process for identifying species which warrant special biodiversity management attention has not been developed. Focal-species should be identified in the preliminary stages of biodiversity management so that research and other information-intensive processes can be focused on those species most warranting management attention. Priorities could be set for population viability analysis and other species-habitat relationship studies based on those species with the most pressing and demanding requirements. Such information is necessary to determine appropriate landscape-level approaches, based on scientifically defined parameters related to the particular species and biogeographic context in question.

Table 4.4: National system for ranking species on the basis of risk of extinction

Harper et al. 1996[1]; Elderkin and Boates 1996[2]
System for ranking species on the basis of their relative risk of extinction[1]; adapted for use in N.S.[2]

1. Population size
- the current estimate of the total number of mature individuals capable of reproduction

2. Population trend
- the change in the number of mature individuals over time

3. Distribution trend
- the change in the geographic distribution of the species over time

4. Geographic distribution
- the current area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of occurrence, excluding cases of vagrancy

5. Number of occurrences
- the estimated sites where the species currently persists

6. Threats to population
- the observed, inferred, or projected direct exploitation, harassment, or ecological interactions with predators, competitors, pathogens or parasites which may result in population declines

7. Threats to habitat
- the observed, inferred, or projected habitat alterations (loss, conversion, degradation, or fragmentation) which may result in population declines

Notes:
1. From a condensed version of a proposal for ranking species distributed at the national endangered species workshop held in Toronto, June 1996. These rankings may be used to identify species upon which to focus detailed assessment for potential designation as threatened or endangered. They may also help to identify management priorities to prevent species from declining to endangered levels (Harper et al. 1996).
2. A draft proposal for ranking species in Nova Scotia under the National Framework for Endangered Species Conservation has been adopted and revised from the National Framework Proposal (Harper et al. 1996) by Elderkin and Boates (1996).
3. Definitions of criteria are based on definitions used in the IUCN Red List Categories, CITES Criteria for Amendment of Appendices I and II (Res. Conf. 9.24) and the Natural Heritage Programs and Conservation Data Centres of the Nature Conservancy (Harper et al. 1996).

A focal-species framework could serve to integrate biodiversity policy and management objectives with ecological considerations at the species- and landscape levels, while serving to compile and present the information in a form that is accessible to decision-makers. Identification of a suite of focal-species could provide a co-ordinating focus for biodiversity objectives and programs across agencies, departments, levels of governments, non-government organizations, universities, land-owners and resource managers.

4.3 Methodology for a focal-species framework for Nova Scotia

A framework was developed and tested for identifying focal-species for biodiversity management in Nova Scotia. Such a framework is particularly useful in areas such as Nova Scotia where the most obvious types of focal-species, such as large carnivores, do not exist, have already been extirpated, or are of uncertain status. The framework integrates the factors and biological traits that characterize species as important in the community and/or vulnerable in landscapes disturbed or fragmented by human activities, particularly in Nova Scotia. Thirty-three variables were selected and grouped into 6 categories: 1) Rarity/population status; 2) Biological characteristics; 3) Habitat-related vulnerability; 4) Species of major ecological importance; 5) Human-impact factors; and, 6) Information status (Table 4.5). Matrices were developed for native terrestrial mammal, reptile and amphibian, and freshwater fish species (See Appendix 2.4). Birds were not assessed primarily because of time limitations and the large number of bird species in Nova Scotia. The matrix variables were reviewed by a local avifauna expert and considered to be applicable to bird species, with minor adjustment (McLaren 1996 pers. comm.).

The matrices, supplemental definitions, criteria and references, and an accompanying questionnaire about the focal-species framework were circulated to 32 wildlife biologists and managers, ecologists, and natural historians in government agencies and universities (See Appendix 2 for sample of matrices, questionnaire package and list of participants). A Delphi method was utilized because the process of selecting focal-species could benefit from subjective judgments on a collective basis; the various individuals with expertise had no history of adequate communication; time, cost and other logistical factors made effective face-to-face interactions unfeasible; and, potential future meetings or workshops could be made more effective by preliminary group communications. Delphi may be characterized as, "a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (Linstone and Turoff 1975, 3). It includes some feedback of individual contributions of information; assessment of the group judgment; opportunity for individuals to revise views; and a degree of anonymity for the individual responses (Table 4.6).

Table 4.5: Categories and variables used in matrices for selecting focal-species

Category	Variables
1. Rarity/ Population status	Nationally rare (COSEWIC) Small population in N.S. Population declining in N.S. Small number of occurrences in N.S. Small geographic range/distribution in N.S. Decline in range/distribution in N.S. Large percentage of range/distribution in N.S. Species existing at range edge in N.S. Genetically distinct form
2. Biological characteristics	Space-demanding/wide-ranging Population seasonally/daily concentrating Extremely variable in population density Limited dispersal power Low reproductivity or fecundity Large-bodied/largest member of feeding class Pollution susceptible/accumulator species
3. Habitat-related vulnerability	Dietary and reproductive specialization Habitat specialization Dependent upon provincially rare habitat Climatic sensitivity
4. Species of major ecological importance	Summit predator Species that occur at higher trophic levels Major vegetation influencer Keystone species
5. Human-impact factors	Legally harvested/killed in N.S. Population threatened by direct exploitation, harassment or ecological interactions in N.S. Habitat threatened by loss, conversion, degradation, or fragmentation in N.S. No management activities directed at taxon
6. Information status	Limited knowledge of distribution in N.S. Population trends not regularly monitored Factors limiting population in N.S. unknown No autecological studies in NS. No (meta) population viability analysis in N.S.

Notes:
1. Variables were selected from Theberge 1993; 1995; Noss 1990b; 1991a; Hunter 1990; Millsap et al. 1990; Herman and Scott 1992; 1994; Woodley 1993; Harris 1984; Harper et al. 1996
2. Variables differ slightly for freshwater fishes; see Appendix 2.4.2 and Table 4.8.4.1.
(Refer to Appendix 2.5 for further description and definition of variables)

Table 4.6: The Delphi method

The Delphi approach or method has been used in many applications and for at least three decades. It has been used for decision making, forecasting, conferencing, group value judgments and the systematic use of expert judgment in business, marketing, medicine, computer and information systems, education, planning, developing priorities, multi-disciplinary teams, and policy (See Worsham 1980 for a selected bibliography).

"in its design and use Delphi is more of an art than a science"
(Linstone and Turoff, 1975, 3)

Definition:

- Delphi may be characterized as "a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (Linstone and Turoff 1975, 3).

Components of a Delphi:

- some feedback of individual contributions of information and knowledge;
- some assessment of the group judgment or view;
- some opportunity for individuals to revise views; and,
- some degree of anonymity for the individual responses.

There are many different views on what are the "best" or "proper" procedures for accomplishing the various aspects of Delphi.

Properties of an application which lead to the use of Delphi:

- the problem does not lend itself to precise analytical techniques but can benefit from subjective judgments on a collective basis
- the individuals needed to contribute to the examination of a broad or complex problem have no history of adequate communication and may represent diverse backgrounds with respect to experience or expertise
- more individuals are needed than can effectively interact in a face-to-face exchange
- time and cost make frequent group meetings unfeasible
- the efficiency of face-to-face meetings can be increased by supplemental group communication process
- the heterogeneity of the participants must be preserved to assure validity of the results (i.e., avoidance of domination by quantity or by strength of personality)

Four phases of Delphi:

1. exploration of the subject
2. reach an understanding of how the group views the issue (agreement/disagreement areas; meanings of relative terms)
3. identify and evaluate underlying reasons for disagreement/differences
4. final evaluation: previously gathered information is initially analyzed and evaluations are fed back for consideration

Compiled from: Linstone and Turoff (1975); Worsham (1980)

The objectives of the process were: 1) to develop and test the framework for identifying focal-species for biodiversity management; 2) to initiate and involve local experts in a focal-species approach; 3) to determine the extent of current knowledge and expert consensus; 4) to collect, compile and provide information for decision-making; and, 5) to provide a preliminary identification of potential focal-species warranting further attention.

Nineteen responses were received, including: five from Parks Canada (Natural Resources Branch; Atlantic Regional Office; and, Kejimkujik and Cape Breton Highlands National Parks); six from Nova Scotia Department of Natural Resources (Wildlife Division, and Inland Fisheries); one from the Nova Scotia Museum of Natural History; one from New Brunswick Department of Natural Resources and Energy; and six from Dalhousie (Biology, Anatomy), Acadia (Biology), McGill (Redpath Museum), and Arizona State (West, Life Sciences) Universities and University of New Brunswick (Forestry) (Refer to Appendix 3.2 for List of Respondents).

Experts were self- and peer-defined as, "one who has considerable formal training; has published in academic, peer-reviewed or other journals; is recognized as an expert by his or her peers; and/or, has extensive and relatively recent field and/or management experience in the relevant taxonomic group in Nova Scotia" (Appendix 11.2). The responses were compiled, assessed, summarized and redistributed to the respondents for further comment (Refer to Appendix 10 for sample of Summary, including list of tables). Revised matrices were developed based on their comments, completed as far as possible with "consensus" information, and re-distributed to the respondents for their reference and use (Tables 4.8.1 to 4.8.4; Refer also to Appendix 3.6 for a composite list of variables).

4.4 Results

4.4.1 Assessment of the focal-species framework by respondents

Seventeen participants responded to the questionnaire component of the survey, however, not all respondents answered every question (Refer to Appendix 3.3 for compilation of responses). The main strengths of the focal-species framework were variously described by eleven respondents as, for example: a good general exercise to focus limited research and management resources; providing a means for prioritizing species; comprehensive and broad-based; incorporating professional judgment in a standardized manner; and, having value in educating participants about the approach and giving them input into its development. Two respondents described the matrices as presenting a good across-the-board comparison of species for decision-making (Appendix 3.3, question 5(b)).

The same eleven respondents variously identified the major weakness of the framework as the potential for inconsistency across species and variables due to: the relative nature the variables; the need for subjectivity and interpretation by various experts; and, the highly qualitative nature of the framework. Respondents noted that no one expert would know enough about all species and all variables, and that the current status of scientific data is insufficient to fill in the matrices in entirety. Redundancy or overlap in variables, and the lack of weighting of variables were other weaknesses identified by respondents (Appendix 3.3, question 5(c)).

Twelve out of fifteen respondents considered the variables to be generally appropriate, although five respondents suggested that clarification in definition is required (Appendix 3.3, question 1). Seven respondents identified the most important variables as: 1) Small population in N.S.; 2) Population threatened by direct exploitation, harassment or ecological interactions; and, 3)Habitat threatened by loss, conversion, degradation, or fragmentation in N.S. Every variable was considered to be among the most important by at least one respondent. Three respondents agreed that the least important variables are: 1) Large bodied/largest members of feeding class; 2) Climatic sensitivity; and, 3) Limited knowledge of distribution in N.S. Two respondents explicitly indicated that no variables should be deleted. Individual respondents suggested that variables be added for global and provincial status, niche specialization, reproductive success or offspring survivorship, disease susceptibility, and genetic fitness (Table 4.7) (Refer to: Appendix 3.3, questions 2, 3, 4, other comments, and general responses; and, Appendix 3.4, Assessment of variables by respondents).

Three respondents considered the process to be a learning experience or "fun". Four respondents indicated that they would prefer to complete the matrix together, "in a room", with other biologists and ecologists. Six respondents found the process to be intimidating, time-consuming, or unwieldy, with too many variables (Appendix 3.3, question 6 and general responses).

Regardless of these constructive criticisms, all 17 respondents who replied to the questionnaire indicated that they think the matrix process is a suitable way to identify focal-species and thus set priorities for planning and management attention. Respondents elaborated by stating, for example, that: it is "suitable as a first cut to set initial priorities"; overall, it is "a good way to analyze"; it represents "an attempt to input objectivity into a very subjective process"; "it is probably even more important in a political context than biologically"; and, it results in "useful information". One respondent stated that, "the

Table 4.7: Identification of most and least important variables by respondents

Categories	Variables (for mammal, reptile and amphibian, and freshwater fish species)	No. of times identified as Most Important*	No. of times identified as Least Important*
1. Rarity/ Population status	Nationally rare (COSEWIC)	5	2
	Small population in N.S.	7	1
	Population declining in N.S.	6	1
	Small no. of occurrences in N.S.	4	
	Small geographic range/distribution in N.S.	4	
	Decline in range/distribution in N.S.	5	
	Large percentage of range/distribution in N.S.	3	
	Species existing at range edge in N.S.	1	
	Genetically distinct form	2	1
2. Biological characteristics	Space-demanding/wide-ranging	4	1
	Population seasonally/daily concentrating	4	1
	Extremely variable in population density	5	2
	Limited dispersal power	6	2
	Low reproductivity or fecundity (mammals, reptiles and amphibians only)	6	1
	Large-bodied/largest member of feeding class (mammals, reptiles and amphibians only)	3	3
	Older-age at first reproduction (fish only)	2	
	Pollution susceptible/accumulator species	4	1
3. Habitat-related vulnerability	Dietary and reproductive specialization (mammals, reptiles and amphibians only)	3	1
	Habitat specialization (mammals, reptiles and amphibians only)	3	1
	Habitat/dietary/reproductive specialization (freshwater fishes only)	1	
	Sensitive to high annual variation in river/stream flow (freshwater fishes only)	2	
	Dependent upon unimpeded/unobstructed watercourse (freshwater fishes only)	1	
	Dependent upon provincially rare habitat	4	
	Climatic sensitivity	3	3
4. Species of major ecological importance	Summit predator	1	2
	Species that occur at higher trophic levels	1	2
	Major vegetation influencer (mammals, reptiles and amphibians only)	1	2
	Keystone species	3	2
5. Human-impact factors	Legally harvested or killed in N.S.	3	2
	Population threatened by direct exploitation, harassment or ecological interactions in N.S.	7	
	Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	7	
	No management activities directed at taxon	3	2
6. Information status	Limited knowledge of distribution in N.S.	2	3
	Pop. trends not regularly monitored in N.S.	2	2
	Factors limiting population in N.S. unknown	2	2
	No autecological studies in N.S.	2	2
	No (meta-) population viability analysis in N.S.	2	2

Table 4. 7: (continued)

Suggested variables to be added that are not easily included in existing variables
• Biological characteristics: - *Niche specialist* - *Genetic uniqueness / fitness / integrity* - *Offspring survivorship* - *Disease susceptibility*
• Global, provincial and regional status
• Habitat composition, scale and spatial pattern
• Use and value to humans (historic and current)
• Management category

1. Categories and variables selected from: Theberge 1993; 1995; Noss 1990b; 1991a; Hunter 1990; Millsap et al. 1990; Herman and Scott 1992; 1994; Woodley 1993; Harris 1984; Harper et al. 1996
2. Scores for most and least important variables are from expert responses to questionnaire

matrix provides a readily-digestible, visual summary of complex information for decision-making, allowing you to recognize patterns from the data" (Respondent no. 21) (Appendix 3.3, question 5(a), other comments, and general responses).

The identification of strengths and weaknesses and comments on the suite of variables indicate areas where the matrix may be simplified and/or made more rigorous. Further, responses indicate that there may be benefit and opportunity in conducting a workshop to present preliminary findings, discuss and reach further consensus, and work towards completing a revised framework for identifying focal-species.

4.4.2 Assessment of the extent of knowledge and consensus

4.4.2.1 Methodology

Respondents were also asked to complete matrices for mammals, reptiles and amphibians, and freshwater fishes native to Nova Scotia. These classes of species were chosen to test the utility of the framework for identifying vertebrate focal-species. The matrix format contains these species on one axis, and variables which characterize species as potential focal-species on the other axis (refer to Appendix 2.4 for matrix format). Respondents were asked to indicate the most appropriate response for each species relative to each variable. Response options included "yes" (√), "no" (x), "maybe" (m), "unknown to science" (?), and "I don't know" ( ).

The matrices were assessed in terms of the total number of responses indicated for each species, family and class (Appendix 5). The numbers of responses were calculated in order to determine the existing extent of scientific knowledge and consensus in expert judgment relative to each species, family, and class in terms of the variables which characterize potential focal-species. Composite matrices were compiled using only responses to each species and variable which represent a consensus in science and/or in expert opinion or judgment among the participants (refer to Tables 4.8.1 to 4.8.4 for composite matrices and to Appendix 4 for compilations of individual responses utilized to determine consensus). Determining and quantifying expert opinion or judgment is useful in areas such as biodiversity management where scientific knowledge or certainty does not currently exist but decisions must be made. Assessments were based on *average* numbers of responses as well as the number of *consensus* responses.

4.4.2.2 Summary of findings

Total response rate by class was highest for mammals and lowest for freshwater fishes (Table 4.9). Consensus responses rates by family were lowest for all families of freshwater fishes, especially minnows and carps, suckers, codfishes, and sticklebacks. The lowest consensus response rates for mammal families were for moles and bats; and the lowest response rates for herpetofaunal families were for turtles and snakes. Highest consensus response rates overall were for racoon, hare, and canids (Appendix 5.4).

The average consensus response rate by species was approximately 23 out of a total of 33 variables for both mammals and herpetofauna, ranging from a low of 18 responses for fisher and 19 responses for hoary bat, American marten, and northern ribbon snake, to a high of 30 responses for eastern chipmunk and deer mouse (Appendices 5.3.1 and 5.3.2). Average consensus response rates for freshwater fish species were generally lower, ranging from a low of nine responses for common shiner to a high of 23 responses for brook trout and 22 responses for Atlantic salmon (Appendix 5.3.3).

These figures indicate, for example, that less is known about freshwater fishes as a class than about mammals or herpetofauna, relative to the variables for identifying focal-species. Less is known about mole, bat, turtle and all freshwater fish families than about other families in Nova Scotia. Less is known in particular about common shiner, lake chub, fallfish, and fourspine and brook sticklebacks than about other mammal, herpetofaunal and freshwater fish species in Nova Scotia.

Table 4.8.1.1: Focal-species framework with consensus responses for mammal species

Category	Variable	Arctic shrew	Common/cinerous shrew	Smokey shrew	Gaspe shrew	Long-tailed/rock shrew	Water shrew	Pygmy shrew	Short-tailed shrew	Star-nosed mole
1. Rarity/ Population status	Nationally rare (COSEWIC)	X	X	X	√	X	X	X	X	X
	Small population in N.S.	X	X	X		√			X	X
	Population declining in N.S.	X	X	X	X	X	X	X	X	X
	Small number of occurrences in N.S.		X	X	√	√		√		
	Small geographic range/distribution in N.S.		X	X	√	√				
	Decline in range/distribution in N.S.	X	X	X	X	X	X	X	X	
	Large percent. of range/distribution in N.S.		X	X	√	X	X	X	X	X
	Species existing at range edge in N.S.		X	X			X	X	X	X
	Genetically distinct form	√	X	X	√	√	X	X	X	√
2. Biological character-istics	Space-demanding/wide-ranging	X	X	X	X	X	X	X	X	X
	Population seasonally/daily concentrating	X	X	X	X	X	X	X	X	X
	Extremely variable in population density		√						√	
	Limited dispersal power									
	Low reproductivity or fecundity	X	X	X	X	X	X	X	X	X
	Large-body/largest member of feed. class	X	X	X	X			X		
	Pollution susceptible/accumulator species						X			
3. Habitat-related vulnerability	Dietary and reproductive specialization		X	X					X	
	Habitat specialization		X		√	√		X		√
	Dependent upon provincially rare habitat		X		√		X	X	X	
	Climatic sensitivity	√						X		
4. Species of major ecological importance	Summit predator	X	X	X	X	X	X	X	X	X
	Species that occur at higher trophic levels	√	√	√	√	√	√	√	√	
	Major vegetation influencer	X	X	X	X	X	X	X	X	X
	Keystone species		√		X	X	X	X	X	X
5. Human-impact factors	Legally harvested/killed in N.S.	X	X	X	X	X	X	X	X	X
	Population threatened by direct exploitation, harassment or ecological interactions in N.S.	X	X		X		X	X	X	X
	Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.						X	X		
	No management directed at taxon	√	√	√		√	√	√	√	√
6. Information status	Limited knowledge of distribution in N.S.	√		√	√	√	√	√	√	√
	Population trends not regularly monitored	√	√	√	√	√	√	√	√	√
	Factors limiting pop. in N.S. unknown				√	√				
	No autecological studies in N.S.	√	√		√		√	√	√	√
	No (meta) pop. viability analysis in N.S.	√	√		√		√	√	√	√

Key: √ - affirmative response; X - negative response

Table 4.8.1.2: Focal-species framework with consensus responses for mammal species

Category	Variable	Little brown bat	Northern long-eared bat	Eastern pipistrelle	Silver-haired bat	Red bat	Hoary bat	Eastern cougar*	Lynx	Bobcat
1. Rarity/ Population status	Nationally rare (COSEWIC)	X	X	X	X	X	X	√	X	X
	Small population in N.S.	X		√	√	√		√	√	X
	Population declining in N.S.	X	X							X
	Small number of occurrences in N.S.	X	√	√	√	√	√		√	X
	Small geographic range/distribution in N.S.	X		√				X	√	X
	Decline in range/distribution in N.S.	X	X	X	X	X	X		√	
	Large percent. of range/distribution in N.S.	X	X	X	X	X	X		X	X
	Species existing at range edge in N.S.	X	X	√	√	√		√		√
	Genetically distinct form	X		X	√	X		X	X	X
2. Biological character-istics	Space-demanding/wide-ranging		X					√	√	√
	Population seasonally/daily concentrating	√	√	√		X	X	X	X	X
	Extremely variable in population density									
	Limited dispersal power	X	X	X	X	X	X	X	X	X
	Low reproductivity or fecundity	√	√	√				√	X	
	Large-body/largest member of feed. class	X	X	X	X			√	√	√
	Pollution susceptible/accumulator species							X	X	
3. Habitat-related vulnerability	Dietary and reproductive specialization									X
	Habitat specialization					X	X	X		X
	Dependent upon provincially rare habitat				X	X	X	X		X
	Climatic sensitivity	X				X	X	X	X	X
4. Species of major ecological importance	Summit predator	X	X	X	X	X	X	√	√	√
	Species that occur at higher trophic levels	√	√	√	√	√	√	√	√	√
	Major vegetation influencer	X	X	X	X	X	X	X	X	X
	Keystone species	X	X	X	X	X	X	X	X	X
5. Human-impact factors	Legally harvested/killed in N.S.	X	X	X	X	X	X	X	X	√
	N.S. Pop. threatened by direct exploitation, harassment or ecological interactions								√	
	Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		√		X	X	X		√	
	No management activity directed at taxon		X							
6. Information status	Limited knowledge of distribution in N.S.		√	√	√	√	√	√		
	Population trends not regularly monitored	√	√	√	√	√	√		√	
	Factors limiting pop. in N.S. unknown	X								
	No autecological studies in N.S.	√	√	√	√	√	√	√	√	√
	No (meta) pop. viability analysis in N.S.	√	√	√	√	√	√	√	√	√

Key: √ - affirmative response; X - negative response

* Eastern cougar status is uncertain; some credible sightings/tracks but no photos or specimens (Scott 1996)

Table 4.8.1.3: Focal-species framework with consensus responses for mammal species

Category	Variable	Coyote	Red fox	American black bear	Racoon	American marten	Fisher	Ermine/weasel	American mink	Striped skunk	River otter
1. Rarity/ Population status	Nationally rare (COSEWIC)	X	X	X	X	X	X	X	X	X	X
	Small population in N.S.	X	X		X	√	√	X	X	X	
	Population declining in N.S.	X	X	X	X			X	X	X	
	Small number of occurrences in N.S.	X	X	X	X			X	X	X	X
	Small geographic range/distrib. in N.S.	X	X	X	X	√	√	X	X	X	
	Decline in range/distribution in N.S.	X	X	X	X		√	X	X	X	
	Large percent. of range/distrib. in N.S.	X	X	X	X	X	X	X	X	X	X
	Species existing at range edge in N.S.	X	X	X	√	X	X	X	X	X	X
	Genetically distinct form	X	X	X	X			X	X	X	X
2. Biological character-istics	Space-demanding/wide-ranging	√	X	√	X	X	√	X	X	X	√
	Pop. seasonally/daily concentrating	X	X	X	X	X	X	X	X	X	X
	Extremely variable in pop. density				√		X		X		X
	Limited dispersal power	X	X	X	X	X	X	X	X	X	X
	Low reproductivity or fecundity	X	X	√	X	X	X	X	X	X	X
	Large-bodied/largest member of feeding class	√	X	√	X	X	X	X	X	X	X
	Pollution susceptible/accumulator sp.	X	X	X	X	X	X			X	
3. Habitat-related vulnerability	Dietary and reproductive specialization	X	X		X					X	
	Habitat specialization	X	X	X	X	√				X	
	Dependent upon prov. rare habitat	X	X	X	X			X	X	X	X
	Climatic sensitivity	X	X	X	X	X		X	X	X	X
4. Species of major ecological importance	Summit predator	√	√		X	√	√	√	√	X	√
	Sps. that occur at higher trophic levels		√			√	√	√	√		√
	Major vegetation influencer	X	X	X	X	X	X	X	X	X	X
	Keystone species	X	X	X	X	X	X	X	X	X	X
5. Human-impact factors	Legally harvested/killed in N.S.	√	√	√	√	X	X	√	√	X	√
	Population threatened by direct exploitation, harassment or ecological interactions in N.S.	X	X	X	X			X	X	X	√
	Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	X	X	X	X	√		X	X	X	
	No managementdirected at taxon										
6. Information status	Limited knowledge of distrib. in N.S.	X		X	X					X	
	Pop. trends not regularly monitored	X			X						
	Factors limiting pop. in N.S. unknown	X		X	X						
	No autecological studies in N.S.		√					√	√		√
	No (meta)pop. viability analysis in N.S.		√	√				√	√		

Key: √ - affirmative response; X - negative response

Table 4.8.1.4: Focal-species framework with consensus responses for mammal species

Category	Variable	White-tailed deer*	Moose/American moose	Eastern chipmunk	Woodchuck/groundhog	American red squirrel	Southern flying squirrel	Northern flying squirrel	American beaver	Deer mouse	White-footed mouse
1. Rarity/ Population status	Nationally rare (COSEWIC)	X	X	X	X	X	√	X	X	X	X
	Small population in N.S.	X		X	X	X	√	X	X	X	X
	Population declining in N.S.	X		X	X	X		X	X	X	X
	Small number of occurrences in N.S.	X	X	X	X	X	√	X	X	X	X
	Small geographic range/distrib. in N.S.	X	X	X	X	X		X	X	X	X
	Decline in range/distribution in N.S.	X		X	X	X		X	X	X	X
	Large percent. of range/distrib. in N.S.	X	X	X	X	X	X	X	X	X	X
	Species existing at range edge in N.S.	X	X	X	X	X	√	X	X	X	√
	Genetically distinct form	X	X	X	X	X		X	X	X	√
2. Biological character-istics	Space-demanding/wide-ranging		√	X	X	X	X	X	X	X	X
	Pop. seasonally/daily concentrating		X	X	X	X	X	X	X	X	X
	Extremely variable in pop. density			√		√			X	√	
	Limited dispersal power	X	X	X		X			X	X	
	Low reproductivity or fecundity			X	X	X	X	X	X	X	X
	Large-bodied/largest member of feeding class	√	√	X		X	X		X	X	
	Pollution susceptible/accumulator sps.	X	X						X		
3. Habitat-related vulnerability	Dietary and reproductive specialization	X		X	X	X	√			X	X
	Habitat specialization	X		X	X		X			X	X
	Dependent upon prov. rare habitat	X	X	X	X	X	X	X	X	X	X
	Climatic sensitivity	X	X	X	X	X		X	X	X	
4. Species of major ecological importance	Summit predator	X	X	X	X	X	X	X	X	X	X
	Sps. that occur at higher trophic levels	X	X	X	X	X	X	X	X	X	
	Major vegetation influencer	√	√	X	X	X	X	X	√	X	X
	Keystone species		X	X			X			√	
5. Human-impact factors	Legally harvested/killed in N.S.	√	√	X	X	√	X	X	√	X	X
	N.S. Pop. threatened by direct exploi-tation, harassment,ecological interact.			X	X	X	X	X	X	X	
	Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	X		X	X	X	X		X	X	
	No management directed at taxon	X	X	√	√					√	√
6. Information status	Limited knowledge of distrib. in N.S.	X						√			√
	Pop. trends not regularly monitored	X		√	√		√	√		√	√
	Factors limiting pop. in N.S. unknown	X							X		
	No autecological studies in N.S.			√		√	√	√		√	
	No (meta)pop. viability analysis in N.S.		√	√		√	√	√	√	√	

Key: √ - affirmative response; X - negative response
Note: * White-tailed deer reinvaded/reintroduced 1894-1910 (Scott 1996).

Table 4.8.1.5: Focal-species framework with consensus responses for mammal species

Category	Variable	Red-backed/Gapper's vole	Southern bog lemming	Muskrat	Meadow vole; Meadow/field mouse	Rock/yellow-nosed vole	Woodland jumping mouse	Meadow jumping mouse	American porcupine	Snowshoe/varying hare; rabbit
1. Rarity/ Population status	Nationally rare (COSEWIC)	X	X	X	X	X	X	X	X	X
	Small population in N.S.	X	X	X	X		X	X	X	X
	Population declining in N.S.	X	X	X	X	X	X	X	X	X
	Small number of occurrences in N.S.	X	X	X	X	√	X	X	X	X
	Small geographic range/distribution in N.S.	X		X	X					X
	Decline in range/distribution in N.S.	X	X	X	X		X	X	X	X
	Large percent. of range/distribution in N.S.	X	X	X	X	X	X	X	X	X
	Species existing at range edge in N.S.		X	X	X		X	X	X	X
	Genetically distinct form	X	X	√	X	√	√	X		X
2. Biological character-istics	Space-demanding/wide-ranging	X	X	X	X	X	X	X	X	X
	Population seasonally/daily concentrating	X	X	X	X	X	X	X	X	X
	Extremely variable in population density	√	√		√					√
	Limited dispersal power	X		X			X	X		X
	Low reproductivity or fecundity	X	X	X	X	X	X	X	√	X
	Large-body/largest member of feed. class	X					X	X		X
	Pollution susceptible/accumulator species		X		X				X	X
3. Habitat-related vulnerability	Dietary and reproductive specialization	X	X	X	X	X				X
	Habitat specialization	X			X	√	X	X	X	X
	Dependent upon provincially rare habitat	X		X	X	√	X	X	X	X
	Climatic sensitivity		X	X		X	X	X	X	X
4. Species of major ecological importance	Summit predator	X	X	X	X	X	X	X	X	X
	Species that occur at higher trophic levels	X	X	X	X	X	X		X	X
	Major vegetation influencer	X	X	X		X	X	X	√	√
	Keystone species	√			√	X				√
5. Human-impact factors	Legally harvested/killed in N.S.	X	X	√	X	X	X	X	X	√
	Population threatened by direct exploitation, harassment or ecological interactions in N.S.	X	X		X	X	X	X	X	
	Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	X			X	X	X	X	X	X
	No management directed at taxon	√	√		√			√	√	
6. Information status	Limited knowledge of distribution in N.S.		√							X
	Population trends not regularly monitored	√	√		√	√	√	√	√	
	Factors limiting pop. in N.S. unknown		√							
	No autecological studies in N.S.	√	√	√	√	√	√	√		√
	No (meta)pop. viability analysis in N.S.	√	√	√	√	√	√	√		√

Key: √ - affirmative response; X - negative response

Table 4.8.2: Focal-species framework with consensus responses for reptile species

Category	Variable	Snapping turtle	Wood turtle	Blanding's turtle	Eastern painted turtle	Maritime garter snake	Northern ribbon snake	Northern ringneck snake	Eastern smooth green snake	Northern redbelly snake
1. Rarity/ Population status	Nationally rare (COSEWIC)	X	√	√	X	X	X	X	X	X
	Small population in N.S.	X		√	X	X	√	X	X	X
	Population declining in N.S.	X		X	X	X	X	X	X	X
	Small number of occurrences in N.S.	X	X	√	X	X	√	X	X	X
	Small geographic range/distribution in N.S.	X		√	X	X	√	X	X	X
	Decline in range/distribution in N.S.	X		X	X	X	X	X	X	X
	Large percent. of range/distribution in N.S.	X	X	X	X	X	X	X	X	X
	Species existing at range edge in N.S.	√	√	√	√	X	√	X	X	X
	Genetically distinct form	√		√		X	√	√	X	X
2. Biological character-istics	Space-demanding/wide-ranging				X	X	X	X	X	X
	Population seasonally/daily concentrating				X					
	Extremely variable in population density	X	X	X						
	Limited dispersal power	X	√							
	Low reproductivity or fecundity		√	√	√	X	X		X	X
	Large-body/largest member of feed. class	√	X	X	X			X		X
	Pollution susceptible/accumulator species			√						
3. Habitat-related vulnerability	Dietary and reproductive specialization	X			X	X		√	√	√
	Habitat specialization	X			X	X	√	√	√	X
	Dependent upon provincially rare habitat	X	√			X				
	Climatic sensitivity		√	√	X	X		X	X	X
4. Species of major ecological importance	Summit predator	√	X	X					X	X
	Species that occur at higher trophic levels	√				√	√	√	√	
	Major vegetation influencer	X	X	X	X	X	X	X	X	X
	Keystone species	X	X	X		X				
5. Human-impact factors	Legally harvested/killed in N.S.	√	X	X	X	X	X	X	X	X
	Population threatened by direct exploitation, harassment or ecological interactions in N.S.		√	√	X	X	√	X	X	X
	Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		√	√	X	X	√	X	X	X
	No management directed at taxon			X	√	√		√	√	√
6. Information status	Limited knowledge of distribution in N.S.		√		√	√	√	√	√	√
	Population trends not regularly monitored	√	√		√	√	√	√	√	√
	Factors limiting pop. in N.S. unknown	X	X	X						
	No autecological studies in N.S.			X						
	No (meta)pop. viability analysis in N.S.		√	X						

Key: √ - affirmative response; X - negative response

Table 4.8.3: Focal-species framework with consensus responses for amphibians

Category	Variable	Eastern American toad	Northern spring peeper	Bullfrog	Green frog	Mink frog	Northern leopard frog	Pickerel frog	Wood frog	Yellow-spotted salamander	Blue-spotted salamander	Red-spotted newt	Red-backed salamander	Four-toed salamander
1. Rarity/ Population status	Nationally rare (COSEWIC)	X	X	X	X	X	X	X	X	X	X	X	X	X
	Small population in N.S.	X	X	X	X	X	X	X	X	X	X	X	X	
	Population declining in N.S.	X	X	X	X	X	X	X	X	X	X	X	X	X
	Small no.of occurrences in NS	X	X	X	X	X	X	X	X	X	√	X	X	√
	Small geographic range/distribution in N.S.	X	X	X	X	X	X	X	X	X		X	X	
	Decline in range/distrib.in N.S.	X	X	X	X	X	X	X	X	X	X	X	X	X
	Large percentage of range/distribution in N.S.	X	X	X	X	X	X	X	X	X	X	X	X	X
	Sps. existing at range edge in NS.	X	X	√	X	X	X	X	X	X	X	X	X	X
	Genetically distinct form	X	X	X	X	X	X	X	X	X	√	X	X	√
2. Biological character- istics	Space-demanding/wide-ranging	X	X	X	X	X	X	X	X	X	X	X	X	X
	Pop. seasonal/daily concentrating													X
	Extremely variable in pop. density						√							
	Limited dispersal power							√						
	Low reproductivity or fecundity	X	X	X	X	X	X	X	X	X	X	X		
	Large-bodied/largest member of feeding class		X	√								X	X	X
	Pollution susceptible/accumulator species		√	√	√	√	√	√	√	√	√	√	√	√
3. Habitat-related vulnera- bility	Dietary and reprod. specialization	X	X	X	X	X	X	X	X	X	X	√	√	√
	Habitat specialization	X	X	X	X		X		X	X	√	X	X	√
	Dependent on prov. rare habitat	X			X		X		X	X			X	
	Climatic sensitivity	X	X		√	X	√	√	X	X	X	√	√	X
4. Species of major ecological import.	Summit predator	X	X	X	X	X	X	X	X	X	X	X	X	X
	Sps. occur at higher trophic levels													
	Major vegetation influencer	X	X	X	X	X	X	X	X	X	X	X	X	X
	Keystone species	√	√	√	√	√	√	√	√				√	
5. Human-impact factors	Legally harvested/killed in N.S.	X	X	√	X	X	X	X	X	X	X	X	X	X
	Population threatened by direct exploitation, harassment or ecological interactions in N.S.										√			√
	Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.						X				√	√		√
	No management directed at taxon	√	√		√	√	√	√	√	√	√	√	√	
6. Infor- mation status	Limited knowledge of N.S. distrib.	√		√	√	√	√	√	√	√		√	√	√
	N.S. pop. trends not monitored	√	√	√	√	√	√	√	√	√	√	√	√	√
	Factors limiting NS. pop. unknown													√
	No autecological studies in N.S.	√	√	√	√	√	√	√	√	√	√	√	√	√
	No (meta) pop.via. analy. in N.S.	√	√	√	√	√	√	√	√	√				√

Key: √ - affirmative response; X - negative response

Table 4.8.4.1: Focal-species framework with consensus responses for freshwater fishes

Category	Variable	Sea lamprey	Atlantic sturgeon	American eel	Blueback herring	Gaspereau/alewife	American shad	Atlantic/Acadian whitefish	Lake whitefish	Atlantic salmon	Brook trout	Lake trout
1. Rarity/ Population status	Nationally rare (COSEWIC)	X	X	X	X	X	X	√	X	X	X	X
	Small population in N.S.	X	X	X		X	X	√	√		X	√
	Population declining in N.S.							√		√		
	Small no. of occurrences in N.S.	X	X	X		X	X	√	√		X	√
	Small geographic range/distrib. in N.S.	X	X	X		X	X	√	√		X	
	Decline in range/distrib. in N.S.									√		
	Large percent. of range/distrib. in N.S.	X	X	X	X	X	X	√	X	X	X	X
	Sps. existing at range edge in N.S.	X	X	X	√	X	X	√		X	X	
	Genetically distinct form	X	X	X	X	X	X	√	X	X	X	X
2. Biological character-istics	Space-demanding/wide-ranging	√	√	√	√	√	√	√		√	√	
	Pop. seasonal/daily concentrating	√	√		√		√	√		√	√	√
	Limited dispersal power	X	X	X	X		X		√	X	X	
	Older age at first reproduction		√		X		X			√		√
	Extremely variable in pop. density						√					
	Pollution susceptible/accumulator sp.									√	√	
3. Habitat-related vulnerability	Habitat/Diet./Repro. specialization	X		X	X	√	X		X	√	√	√
	Sensitive to high annual variation in river/stream flow			X			√			√	√	
	Dependent upon unimpeded/ unobstructed watercourses					√	√			√		
	Dependent upon prov. rare habitat											
	Climatic sensitivity											
4. Species of major eco. import.	Summit predator			X								
	Sp. that occur at higher trophic levels			√						√	√	√
	Keystone species				√	√	√			√		
5. Human-impact factors	Legally harvested/killed in N.S.	√	√	√	√	√	√	X	√	√	√	√
	N.S. Pop. threatened by direct exploitation, harassment, ecologic. interact.							√	√	√	√	
	Habitat threat. by loss, conversion, degradation, or fragmentation in N.S.							√	√	√	√	
	No management directed at taxon									X	X	
6. Information status	Limited knowledge of N.S. distrib.		√		√					X	X	√
	Pop. trends not reg. monitored										X	
	Factors limiting pop. N.S. unknown									X	X	
	No autecological studies in N.S.										X	
	No (meta) pop. viability analysis in NS.										X	

Key: √ - affirmative response; X - negative response

Table 4.8.4.2: Focal-species framework with consensus responses for freshwater fishes

Category	Variable	Rainbow smelt	Northern redbelly dace	Lake chub	Golden shiner	Common shiner	Blacknose shiner	Blacknose dace	Creek chub	Fallfish	Pearl dace	White sucker
1. Rarity/ Population status	Nationally rare (COSEWIC)	X	X	X	X	X	X	X	X	X	X	X
	Small population in N.S.	X	X		X		X		X	√		X
	Population declining in N.S.											
	Small no. of occurrences in N.S.		X		X		X	√	X	√		X
	Small geographic range/distrib. in N.S.				X		X	√	X	√	√	X
	Decline in range/distrib. in N.S.											
	Large percent. of range/distrib. in N.S.	X	X	X	X	X	X	X	X	X	X	X
	Sp. existing at range edge in N.S.	X	X	X			√	X	X		X	X
	Genetically distinct form	X	X	X	X	X	X	X	X	X	X	X
2. Biological character-istics	Space-demanding/wide-ranging	√	X			X	X	X	X	X	X	
	Pop. seasonal/daily concentrating	√	X	√		X	X		X		X	
	Limitied dispersal power	X	√	√	√	√	√	√	√	√	√	√
	Older age at first reproduction	X	X	X	X	X	X	X	X	X	X	
	Extremely variable in pop. density											
	Pollution susceptible/accumulator sp.											
3. Habitat-related vulnerability	Habitat/Diet./Repro. specialization	√	√	X	X		√	√			√	X
	Sensitive to high annual variation in river/stream flow											
	Dependent upon unimpeded/ unobstructed watercourses	√										
	Dependent upon prov. rare habitat											
	Climatic sensitivity											
4. Species of major eco. Import.	Summit predator	X										X
	Sp. that occur at higher trophic levels	√										
	Keystone species		√	√	√	√	√	√			√	
5. Human-impact factors	Legally harvested/killed in N.S.	√	√	√	√	√	√	√	√	√	√	√
	N.S. pop. threatened by direct exploitation, harassment, ecologic. interact.											
	Habitat threat. by loss, conversion, degradation, or fragmentation in N.S.											
	No managementdirected at taxon											
6. Information status	Limited knowledge of N.S. distrib.											
	Pop. trends not regularly monitored											
	Factors limiting N.S. pop. unknown											
	No autecological studies in N.S.											
	No (meta) pop. viability analysis in NS.											

Key: √ - affirmative response; X - negative response

Table 4.8.4.3: Focal-species framework with consensus responses for freshwater fishes

Category	Variable	Brown bullhead	Atlantic tomcod	Banded killifish	Mummichog	Fourspine stickleback	Brook stickleback	Threespine stickleback	Ninespine stickleback	White perch	Striped bass	Yellow perch
1. Rarity/ Population status	Nationally rare (COSEWIC)	X	X	X	X	X	X	X	X	X	X	X
	Small population in N.S.	X	X	X	X	X	√	X	X	X	X	X
	Population declining in N.S.											
	Small no. of occurrences in N.S.	X	X	X	X	X	√	X	X	X	X	X
	Small geographic range/distrib. in N.S.	X	X	X	X	X	√	X	X	X	X	X
	Decline in range/distrib. in N.S.											
	Large percent. of range/distrib. in N.S.	X	X	X	X		X	X	X	X	X	X
	Sps. existing at range edge in N.S.		X	X	X	X		X	X		X	
	Genetically distinct form	X	X	X	X	X	X	X	X	X	X	X
2. Biological character-istics	Space-demanding/wide-ranging	X		X	X						√	
	Pop. seasonal/daily concentrating	X		X						√	√	√
	Limitied dispersal power	√	X	√	X	X	√	X	X	X	X	√
	Older age at first reproduction	X				X	X	X	X	X		X
	Extremely variable in pop. density											
	Pollution susceptible/accumulator sp.	X	√									
3. Habitat-related vulnerability	Habitat/Diet./Repro. specialization	X	X	X	X	X	√	X	X	X	X	X
	Sensitive to high annual variation in river/stream flow											
	Dependent upon unimpeded/ unobstructed watercourses											
	Dependent upon prov. rare habitat											
	Climatic sensitivity											
4. Species of major eco.-import.	Summit predator	X		X					X			
	Sp. that occur at higher trophic levels									√	√	√
	Keystone species			√	√			√	√			√
5. Human-impact factors	Legally harvested/killed in N.S.	√	√	√	√	√	√	√	√	√	√	√
	N.S. pop. threatened by direct exploitation, harassment, ecologic. interact.											
	Habitat threat. by loss, conversion, degradation, or fragmentation in N.S.											
	No management directed at taxon											
6. Information status	Limited knowledge of N.S. distrib.											
	Pop. trends not regularly monitored											
	Factors limiting N.S. pop. unknown											
	No autecological studies in N.S.											
	No (meta)pop. viability analysis in N.S.											

Key: √ - affirmative response; X - negative response

Table 4.9: Total (affirmative and negative) response rate by class

Total response rate (affirmative and negative) as percentage of total number of cells from average and consensus responses by class		
Species group	**Average response rate**	**Consensus response rate**
Mammals	54%	72%
Reptiles and amphibians	48%	71%
Freshwater fishes	41%	39%

The variable categories with the highest consensus response rates were Rarity/population status and Species of major ecological importance for mammals and Rarity/population status for herpetofauna. The lowest response rates were in Information status and Habitat-related vulnerability for freshwater fishes (Table 4.10) (Appendix 6). These findings suggest that the ecological importance of mammal species, and the rarity or population status of mammal and herpetofaunal species are relatively well understood. However, less is known about, for example, the Habitat-related vulnerability of freshwater fishes in Nova Scotia.

Table 4.10: Percent response rate by class and category

Total response rate (affirmative and negative) as a percentage of total number of cells in each category by class from average and consensus responses												
Category	**1. Rarity/ population status**		**2. Biological characteristics**		**3. Habitat-related vulnerability**		**4. Species of major ecological importance**		**5. Human impact factors**		**6. Information status**	
Data source	**Ave.**	**Con.**	**Ave.**	**Con.**	**Ave.**	**Con.**	**Ave.**	**Con.**	**Ave.**	**Con.**	**Ave.**	**Con.**
Mammals	66.8	**85.**	54.9	67.2	56.3	62.2	69.9	**87.5**	40.4	67.	37.2	56.2
Reptiles and amphibians	50.4	**95.4**	30.5	45.5	63.1	**72.6**	36.0	65.8	50.9	69.3	45.6	62.7
Freshwater fishes	38.3	69	37.0	49.5	21.0	21.8	24.4	30.3	20.3	32.6	8.7	16.5

Notes:
1. Responses rates are total affirmative (√) and negative (x) responses as a percentage of the number of total cells.
2. Bold type indicates high rates of response (>70%)
3. Toned areas indicate low rates of response (<40%)

The matrices and assessment tables are useful for determining where information is most deficient or most complete, specific to individual species and variables. Species which appear to be relatively vulnerable and/or important and about which we know relatively little could constitute priority species for research; the variables could represent specific research questions for these species. Areas of agreement or disagreement in expert opinion or judgment can also indicate priority areas for research and monitoring. Deficiencies in knowledge and consensus reaffirm the need for management to be adaptive, in response to better information as it is acquired.

4.4.3 Survey of expertise relative to taxonomic groups in Nova Scotia

4.4.3.1 Methodology

Preliminary results from the assessments of the matrices regarding extent or level of knowledge spawned a separate but related study. This additional study was initiated in order to determine, in a different way, if the findings were indicative of the amount of knowledge or expertise relative to various taxonomic classes and orders in Nova Scotia. Surveys were distributed to a total of 132 potential experts in four separate mailings between November 5, 1996 and June 12, 1997, in a snowball-type method. Sixty-four surveys were completed and returned resulting in identification of a total of 158 potential experts identified by self and others. Of these, 62 experts were self-identified and approximately 94 were identified by others (Refer to Appendices 11.5 and 11.6 for quantitative compilation of results and additional notes regarding the methods of identification and assessment).

4.4.3.2 Summary of findings

A review of the responses shows that the numbers of self-identified experts by taxonomic order of mammals, reptiles and amphibians were lowest for bats, with no experts being self-identified, and for frogs, toads and salamanders, with only one expert being self-identified. The highest numbers of self-identified experts were for carnivores, rodents and turtles. Freshwater fishes were not assessed by order.

The total numbers of experts identified both by self and by others for orders were lowest for shrews and moles, toads, and salamanders, each with one expert identified, and bats, with two experts identified overall. The numbers were highest for carnivores, snakes, and turtles, each with seven experts identified, and even-toed ungulates (deer and moose), with six experts identified overall (Appendix 11.5).

The low numbers of experts identified for shrews and moles, toads and salamanders are reflected in the average number of total responses to the matrices for mole, shrew, toad and salamander families, as well as in consensus responses for moles (Compare Appendices 5.4 and 11.5). Low numbers of experts identified for bats are reflected in the consensus responses for bats, but not in the average responses. High numbers of experts identified for carnivores are reflected in both average and consensus responses to the matrices for families of carnivores, including canids, bears, racoon, mustelids and cats. High numbers of experts identified for even-toed ungulates, snakes and turtles are not reflected in either average or consensus responses to the matrices for these families.

The total numbers of experts identified by self and by others by taxonomic class were lowest for amphibians and highest for mammals (Table 4.11; Appendix 11.6). A relatively high number of experts were identified for fishes, in comparison with the numbers of responses received within the matrix survey approach. This is probably because a special request for identification of fish experts was issued after an extremely small sample resulted from the preliminary mailing; subsequent response rates by fish experts were relatively high. In general, the total number of experts identified by class reflects the distribution of the average response rates more closely than the consensus response rates to the matrices among classes (Compare Tables 4.9 and 4.11). An additional 79 experts were identified as general ecologists, biologists, or natural historians.

In hindsight, it would have been useful to have identified experts in Nova Scotia relative to taxonomic orders and classes prior to distributing the matrices to experts. However, recognition of the value of the broader identification of experts in this way arose only as a result of preliminary findings from the matrix survey process. The identification of experts and potential experts has been useful as an alternative indication of the relative expertise in Nova Scotia and represents a source of information for future studies, including future workshops or assessments for identification of focal species. The Nova Scotia Museum of Natural History also expressed support for the identification of "taxonomic-based expertise" as "a worthy project of considerable interest", and they look forward to a summary of the results (Wilson 1997 pers. comm.). A summary of the results will be distributed to participants as indicated in an accompanying letter (Appendix 11.3).

Table 4.11: Summary of numbers of identified experts by taxonomic class in Nova Scotia

Taxonomic Group	Number of self-identified experts	Number of experts identified by others	Total
Mammals	9	19	28
Amphibians	5	9	14
Reptiles	7	12	19
Freshwater fishes	11	8	19

(Compiled from survey of experts; Refer to Appendix 11, specifically Appendices 11.5 and 11.6, for numbers of experts relative to taxonomic orders and families)

4.4.4 Focal-species identification from questionnaire

In the questionnaire component of the focal-species survey process, respondents were asked to indicate those species which they believed to be the most significant or vulnerable species warranting special management attention. Species which were identified by five or more respondents are American marten, fisher, Eastern cougar, lynx, Blanding's turtle, wood turtle and northern ribbon snake (Table 4.12) (Appendix 3.3, question 7; Appendix 3.5) (Refer also to "Selected by experts" column in Table 4.14 for herpetofaunal species).

4.4.5 Focal-species identification from matrices

4.4.5.1 Methodology

The responses indicated within the mammal, reptile and amphibian, and freshwater fishes matrices were also assessed to identify potential focal-species. Assessments of the matrices were based on the number of affirmative (√) responses indicated for each species, family, and class (Appendices 7 and 8). Species which possess characteristics which constitute focal-species should receive higher rates of affirmative responses to the variables in the matrices. Respondents assessed each species relative to each variable for those with which he or she had some expertise; both scientific knowledge and best professional judgment were utilized (Appendix 4). Consensus responses were compiled onto composite matrices (Tables 4.8.1 to 4.8.4).

The number of affirmative responses were calculated from: 1) the average number of affirmative responses from all respondents (Appendix 7.2), and 2) the number of affirmative responses on the composite matrices derived from consensus responses (Appendix 7.3). Assessments included: 1) a simple number of affirmative responses, and 2) affirmative responses as a percentage of total (affirmative and negative) responses for

Table 4.12: Most vulnerable species as identified by Respondents on questionnaire

Species identified as most vulnerable by Respondents	No. of times identified	Major reason stated by Respondents for identifying species as most vulnerable
Mammals		
Gaspé Shrew	2	small isolated population, COSEWIC
Long-tailed Shrew	2	N.S.D.N.R. draft "YELLOW " status
Northern Long-eared Bat	2	
Eastern Pipistrelle	2	
Silver Haired Bat	2	
Red Bat	2	
Hoary Bat	3	habitat loss?; N.S.D.N.R. draft "YELLOW " status
American Marten	8	small isolated population, habitat requirements/loss; trapping; forestry; biological characteristics; top carnivore; N.S.D.N.R. draft "RED " status
Fisher	5	forestry - habitat loss; habitat requirements; over-trapping in 1800s; trapping; N.S.D.N.R. draft "YELLOW " status
Eastern Cougar	6	low numbers, totally extirpated? N.S.D.N.R. draft "RED " status
Lynx	8	small population, unlikely remaining on mainland; trapping by-catch; over harvesting; bobcat competition, habitat loss; N.S.D.N.R. draft "RED " status
American Moose (mainland population)	2	Very low numbers relative to the past - why?; high demand for use; major vegetation influencer
Southern Flying Squirrel	4	range edge; disjunct; N.S.D.N.R. draft "YELLOW " status
Southern Bog Lemming	1	small isolated population
Rock Vole	4	small isolated population, habitat sensitive N.S.D.N.R. draft "YELLOW " status
Reptiles and Amphibians		
Wood Turtle	6	rarity/population status; biological characteristics; habitat loss/degradation, human-impact: pet trade; N.S.D.N.R. draft "YELLOW " status
Blanding's Turtle	9	disjunct species; small population and territory; range edge, rarity/population status; biological characteristics; human-impact factors N.S.D.N.R. draft "RED " status
Northern Ribbon Snake	6	rarity, disjunct, rarity/population status; biological characteristics; human-impact factors; data ignorance - why so limited in range? N.S.D.N.R. draft "YELLOW " status
Eastern American Toad	1	all amphibians except bullfrog are vulnerable
Northern Spring Peeper	1	
Green Frog	1	
Mink Frog	1	
Northern Leopard Frog	1	
Pickerel Frog	1	
Wood Frog	1	

Table 4. 12 (continued)

Yellow-spotted Salamander	1	all amphibians except bullfrog are vulnerable
Blue-spotted Salamander	4	all amphibians except bullfrog are vulnerable; disjunct; N.S.D.N.R. draft "YELLOW" status
Red-spotted Newt	1	all amphibians except bullfrog are vulnerable
Red-backed Salamander	1	
Four-toed Salamander	4	all amphibians except bullfrog are vulnerable; rarity, disjunct, data ignorance, habitat; N.S.D.N.R. draft "YELLOW" status
Freshwater Fishes		
Atlantic Whitefish	3	low numbers, water quality?, dams, acid rain, introduced predator, habitat loss, lack of knowledge
Atlantic Salmon	1	over fishing; lack of fish ladders/passages

Toned areas indicate species identified most often as most vulnerable species by Respondents within the questionnaire (Refer to: Appendix 3.3, question 7; and, to Appendix 3.5).

each species, family and class (Appendix 7.3) (Refer also to "Affirmative response rate" columns in Table 4.14 for reptiles and amphibians). The percentage response rate was included in an attempt to even-out the effects of discrepancies in the current level or state of knowledge about various species and categories in Nova Scotia. Percentage response rates help to identify species which may receive a relatively lower simple number of affirmative responses primarily because respondents do not know enough about the species to make a response. It is important to distinguish these species from those who receive lower affirmative response rates because they do not reflect the criteria or variables and receive negative (x) responses. The affirmative response rate as a percentage of total responses makes this distinction more clear.

4.4.5.2 Summary of findings

Results from these various assessments differ slightly, but there are areas of significant agreement (Refer to Appendices 7.3.1 to 7.3.3, and to Table 4.14 for a comparison of affirmative response rates from various assessment types for reptile and amphibian species). Generally, the percentages of affirmative responses were higher for reptiles and amphibians than for mammals or freshwater fishes (Appendices 7.3.1 to 7.3.3). Over-all, the families with the highest affirmative response rates were: salmonids; semi-aquatic, pond and marsh turtles; lungless salamanders; and, cats (Appendix 7.4).

Eastern cougar, lynx, and eastern pipistrelle had the highest affirmative response rates for mammal species in every assessment of total affirmative response rate (Appendix 7.3.1). Gaspé shrew, long-tailed shrew, and silver-haired bat also consistently received high affirmative response rates. Wood turtle, Blanding's turtle, northern ribbon snake, and four-toed salamander consistently received the highest affirmative response rates of herpetofaunal species. Blue-spotted salamander and pickerel frog also had relatively high affirmative response rates (Appendix 7.3.2) (Refer also to toned cells in "Affirmative response rate columns of Table 4.14 for reptiles and amphibians). Freshwater fishes receiving consistently high affirmative response rates include Atlantic whitefish, lake whitefish, Atlantic salmon and lake trout. Blueback herring, brook trout and brook stickleback also received relatively high affirmative rates of response (Appendix 7.3.3).

Additional assessments were completed to determine which species received the highest affirmative response rates relative to the six categories of variables (Appendix 8) (Refer to Table 4.13 for reptile and amphibian species) (Refer also to "High affirmative response rate in several categories" column in Table 4.14 for reptile and amphibian species). The purpose of conducting this assessment was to give equal consideration to species which may be, for example, vulnerable because of their biological characteristics or habitat needs but do not have small populations at the present time. In a strict sense, an affirmative response in any category may indicate that the species is important in the community or potentially vulnerable. However, species which receive high affirmative response rates in several categories may be doubly-warranting of special management attention.

Eastern cougar consistently received the highest affirmative response rates in three to five categories, lynx in two to six categories, and eastern pipistrelle in two to five categories in assessments of mammal species. American marten, silver-haired bat, long-tailed shrew, river otter and bobcat had high affirmative response rates in two to four categories in every assessment. Arctic shrew, Gaspé shrew and fisher consistently had high affirmative response rates in two or more categories (Appendices 8.5.1 and 8.6.1).

Eleven herpetofauna species consistently received high affirmative response rates in two or more categories. Wood turtle received consistently high affirmative response rates in three to five categories, and four-toed salamander in four categories. Bullfrog and pickerel frog had high affirmative response rates in three to four categories. Blanding's turtle, northern ribbon snake, and northern leopard frog also received consistently high affirmative response rates in two or more categories (Appendices 8.5.2 and 8.6.2) (Refer also to toned cells in "High affirmative response rate in several categories" column in Table 4.14 for reptile and amphibian species).

Atlantic whitefish, lake whitefish, Atlantic salmon and lake trout consistently received the highest affirmative response rates in two or more categories in every assessment type (Appendices 8.5.3 and 8.6.3).

Table 4.13: Affirmative response rates by category and by data source and assessment type for reptile and amphibian species

Categories / Reptile and Amphibian Species	1. Rarity/ Population status				2. Biological characteristics				3. Habitat-related vulnerability				4. Species of major ecological importance				5. Human impact factors				6. Information status			
Data source and Assessment type	Average		Consensus		Average		Consensus		Average		Consensus		Average		Consensus		Average		Consensus		Average		Consensus	
Affirmative response rate	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Snapping turtle	1.6	30	2	22	3.	97	1	33	.1	4	0	0	2.	83	2	50	3.	75	1	100	2.1	81	1	50
Wood turtle	4.2	69	2	60	2.9	81	2	50	2.	100	2	100	0	0	0	0	3.2	82	2	67	2.3	100	3	100
Blanding's turtle	5.8	84	6	67	3.1	78	2	50	2.1	70	1	100	.4	44	0	0	2.	71	2	50	.9	45	0	0
Eastern painted turtle	1.8	50	1	13	1.2	60	1	25	0	0	0	0	0	0	0	0	1.6	70	1	25	2.2	92	2	100
Maritime garter snake	0	0	0	0	1.3	48	0	0	0	0	0	0	1.1	55	1	33	1.1	65	1	25	2.3	100	2	100
Northern ribbon snake	4.8	80	5	56	1.2	60	0	0	1	77	1	100	1	59	1	50	2.6	100	2	67	2.4	100	2	100
Northern ringneck snake	.8	13	1	11	1.3	62	0	0	2	65	2	67	1.1	65	1	50	1.1	85	1	25	2.5	100	2	100
E. smooth green snake	0	0	0	0	1.1	55	0	0	2	65	2	67	1	59	1	33	1.1	85	1	25	2.5	100	2	100
Northern redbelly snake	0	0	0	0	1.1	55	0	0	1	32	1	33	.9	53	0	0	1.1	85	1	25	2.5	100	2	100
Eastern American toad	0	0	0	0	1.4	64	0	0	0	0	0	0	1.3	68	1	33	1.4	88	1	50	2.7	100	4	100
Northern spring peeper	0	0	0	0	1.4	67	1	25	0	0	0	0	1.3	68	1	33	1.4	88	1	50	2.6	96	3	100
Bullfrog	1	19	1	11	2.4	80	2	50	0	0	0	0	1.3	72	1	33	2.2	92	1	100	2.8	100	4	100
Green frog	0	0	0	0	1.4	67	1	33	1	31	1	25	1.3	72	1	33	1.4	82	1	50	2.7	100	4	100
Mink frog	0	0	0	0	1.4	67	1	33	1	32	0	0	1.3	68	1	33	1.4	88	1	50	2.7	100	4	100
Northern leopard frog	0	0	0	0	2.4	80	2	50	1	31	1	25	1.3	68	1	33	2.	65	1	33	2.7	100	4	100
Pickerel frog	0	0	0	0	2.9	81	2	50	1.1	79	1	50	1.3	68	1	33	1.4	88	1	50	2.7	100	4	100
Wood frog	0	0	0	0	1.5	68	1	33	.1	3.1	0	0	1.3	68	1	33	1.4	82	1	50	2.7	100	4	100
Yellow-spot. salamander	0	0	0	0	.9	56	1	33	0	0	0	0	.4	40	0	0	1.4	82	1	50	2.7	100	4	100
Blue-spotted salamander	2.7	52	2	25	.9	56	1	33	1	46	1	33	.3	33	0	0	2.9	97	3	75	1.7	85	2	100
Red-spotted newt	0	0	0	0	.6	43	1	25	2	65	2	67	.4	40	0	0	2.1	91	2	67	2.6	100	3	100
Red-backed salamander	0	0	0	0	.9	56	1	33	2	63	2	50	1.3	68	1	33	1.4	82	1	50	2.6	100	3	100
Four-toed salamander	2.3	54	2	29	.8	53	1	25	2.1	66	2	67	.3	33	0	0	2.7	90	2	67	3.4	97	5	100

Notes:
Bold type indicates 5 highest affirmative response rates for each category, data source (average and consensus) and assessment type (simple number or percentage);
Toned areas indicate species and categories where high affirmative responses rates were obtained with every data source and type of assessment within each category .
(Refer to Appendices 8.5.1 and 8.5.3 for mammal and freshwater fish assessments.)

Table 4.14: Affirmative response rates by data source and assessment type

Assessment Type	Identified by experts in survey	Affirmative response rate				Number of categories in which the species scored within 5 highest affirmative response rates			
Data source		Average		Consensus		Average		Consensus	
Reptiles & Amphibians		#	%	#	%	#	%	#	%^
Snapping turtle		11.8	57.6	7	31.8	3	2	2	2
Wood turtle	6	15	77.7	11	55	4	4	4	5
Blanding's turtle	9	14.3	71.8	11	45.8	3	3	3	3
Eastern painted turtle		7	56.5	5	22.7				1
Maritime garter snake		5.6	32.6	4	16.7		1	1	2
Northern ribbon snake	6	13	83.3	11	57.9	2	4	3	5
N. ringneck snake		8.6	52.1	7	31.8	1	1	2	3
E. smooth grn. snake		7.5	48.1	6	26.1	1	1	2	3
N. redbelly snake		6.4	43.2	4	17.4		1		1
E. American toad	1	6.1	39.1	6	25	2	2	2	2
N. spring peeper	1	6	37	6	25	1	1	1	2
Bullfrog		9.1	53.8	9	39	3	4	3	4
Green frog	1	7.2	43.9	8	32	2	2	2	2
Mink frog	1	7.2	44.4	7	30.4	2	2	2	2
Northern leopard frog	1	8.9	47.6	9	33.3	3	3	3	3
Pickerel frog	1	8.9	58.9	9	37.5	3	4	3	3
Wood frog	1	6.3	38.2	7	28	2	2	2	2
Yellow-spotted salamander	1	4.6	39.3	6	25	1	1	1	1
Blue-spotted salamander	4	8.8	62.4	9	41	2	2	2	3
Red-spotted newt	1	7.2	57.6	8	33.3	1	2	2	3
Red-backed salamander	1	7.5	57.7	8	33	2	2	2	2
Four-toed salamander	4	11.2	70.4	12	50	4	4	4	4

Notes:
Bold type indicates species with the ten highest rates of affirmative responses; toned areas indicate species with the five highest rates of affirmative responses.

4.5 Summary conclusion

The value of doing the multiple assessments is that patterns and consistencies are revealed, along with some differences. For example, several species consistently received high total affirmative response rates overall as well as in several categories, including Eastern cougar, lynx, eastern pipistrelle, wood turtle, four-toed salamander, Atlantic salmon and lake trout (Appendix 9.2) (Table 4.15) (Refer also to Table 4.14 for reptile and amphibian species). Species with consistently high scores overall possess relatively higher numbers of characteristics, however, a large number of those may be within a single category such as Rarity/Population status. Species which receive high scores in several categories may be more vulnerable in terms of, for example, both rarity/population status and biological traits, as well as more functionally important, more demanding in their habitat requirements, and/or more threatened, and thus warrant further consideration. Species which receive consistently high scores in every type of assessment are potentially important focal-species, warranting priority biodiversity management attention. (Refer to Table 4.15 for a preliminary summary of potential mammal, reptile and amphibian, and freshwater fish focal-species).

Table 4.15: Potential mammal, reptile and amphibian, and freshwater fish focal-species

<table>
<tr><th>Mammals</th><th>Reptiles and Amphibians</th><th>Freshwater fishes</th></tr>
<tr><td>Eastern cougar
Lynx
Eastern pipistrelle</td><td>Wood turtle
Four-toed salamander</td><td>Atlantic salmon
Lake trout</td></tr>
<tr><td rowspan="2">Gaspé shrew</td><td rowspan="2">Blanding's turtle
Northern ribbon snake</td><td>Atlantic whitefish</td></tr>
<tr><td>Blueback herring</td></tr>
<tr><td>Long-tailed shrew
Silver-haired bat</td><td>Blue-spotted salamander</td><td>Lake whitefish</td></tr>
<tr><td>Arctic shrew
American marten</td><td rowspan="2">Bullfrog
Pickerel frog
Northern leopard frog</td><td>Brook trout</td></tr>
<tr><td>Fisher</td><td>Atlantic sturgeon
Rainbow smelt</td></tr>
</table>

1. Table cells represent a rough cluster analysis of potential focal-species within each taxonomic class based on consistency of high affirmative response rates in all assessments, in order of higher (top) to lower (bottom) consistent affirmative response rates.
2. Species within each table cell are listed in order of appearance on species lists used throughout the thesis; relative scores of species within each cell are similar.

The differences that appear among assessment results for the same species may arise from a limited number of consensus responses for variables or species where individual or average response rates were relatively high. Some potential focal-species could receive low scores in simple number assessments simply because not enough is known about them. Species that have high affirmative response rates in some assessments but not in others could be examined more closely to determine if the difference is a residual effect of lack of knowledge or consensus.

Five species that consistently received the highest affirmative response rates are also listed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 1996): Gaspé shrew, eastern cougar, wood turtle, Blanding's turtle and Atlantic whitefish. Twelve mammal, reptile and amphibian species which received consistently high affirmative response rates were also identified as species of concern in a preliminary listing process in Nova Scotia (1996a; 1997b): lynx, Gaspé shrew, long-tailed shrew, eastern pipistrelle, silver-haired bat, American marten, fisher, wood turtle, Blanding's turtle, northern ribbon snake, blue-spotted salamander, and four-toed salamander (Refer to Appendix 1.2 for species status). Freshwater fishes in Nova Scotia have not been ranked by NSDNR.

Although rarity and population status constitute one category of variables in the matrix process, these characteristics alone are not enough to explain the higher affirmative response rates that these species receive across the range of 33 variables. These species are at risk because of their small populations, biological traits, habitat-related vulnerability and other characteristics which are represented by the variables. The focal-species framework serves to identify those factors and traits which may characterize species as vulnerable or potentially vulnerable or warranting special biodiversity management attention.

Species with consistently high affirmative response rates that do not appear on other lists of species of concern are: Arctic shrew, bullfrog, pickerel frog, northern leopard frog, Atlantic salmon, lake trout, lake whitefish, blueback herring, brook trout, Atlantic sturgeon and rainbow smelt. The value of the focal-species framework may be in its potential for identifying species such as these that may require special management attention to prevent them from becoming at risk.

It is important to note that the potential focal-species identified in this chapter do not constitute the full suite of focal-species required for biodiversity management, nor do they necessarily represent the highest priority focal-species. Other taxonomic classes, such as birds, invertebrates and plants, need to be considered. The primary aim of the process was to test the framework, and to identify, in a preliminary way, potential focal-species for those classes of vertebrates assessed. Refinement of the framework, the variables and their definitions, along with additional data and consensus in expert judgment or opinion are necessary to make the process more rigorous. Further, identification of focal-populations of species in particular regions of the Province is also recommended. Such an assessment could take into account regionally-specific variability in species or population status and biogeographic or habitat-related context.

A focal-species framework integrates biodiversity policy and management objectives with ecological considerations at the species- and landscape levels, while serving to compile and present information in a form that is accessible and useful to decision-makers. Identification of a suite of focal-species could provide a co-ordinating focus for biodiversity objectives and programs across government and non-governmental agencies, universities, land-owners and resource managers. The focal-species approach and data set developed through the research described in this chapter could be adapted, for example, to identify a potential suite of indicator species for monitoring biodiversity in Nova Scotia. Such an approach was developed and tested for mammal, reptile and amphibian and freshwater fish species in Kejimkujik National Park and is described in the following chapter.

Chapter 5

A focal-species framework for selecting indicator species

5.1 Introduction

The previous chapter described a framework for selecting focal-species. Potential focal-species for biodiversity management in Nova Scotia were identified. These species represent priority species for biodiversity management at a provincial level. Identification of focal-species or focal-populations at the regional level would also be useful for biodiversity management, and may be more accurate by taking regional variation in population and habitat status and biogeographic context into account.

This chapter examines the concepts of indicator species and focal-species, and the potential utility of focal-indicator species as part of a larger composite suite of indicators of ecological integrity at the regional level (Beazley 1997c). The focal-species approach may be adapted to provide a useful framework for selecting indicator species. Indicator species are sometimes considered in a narrow sense such as described for ecological indicator species (Refer to Table 4.3). For broader monitoring objectives such as biodiversity a range of indicator species types is required; in this sense indicator species are similar to focal-species and their identification could benefit from a focal-species approach.

While indicator species and focal-species may be similar in many respects, they are not identical. Focal-species include ecological indicator species but they also include other species that may not be good indicators because of, for example: characteristics which make them difficult to monitor such as low numbers or evasive behaviors; sensitivity to monitoring; or, ineffectiveness in showing early or typical responses to stresses. Suites of indicator species also include species of which individuals or populations are not necessarily in need of special management attention but that, for example: indicate effects of stress on a broad range of species; are sensitive to management practices, such as game species; and, successfully invading exotic species.

Groups of focal-species and indicator species may display considerable overlap in species composition. However, variation is likely to occur as a result of differences in emphasis that reflect the separate but related objectives of monitoring and maintaining biodiversity.

A focal-species framework for identifying potential indicator species for monitoring biodiversity in Kejimkujik National Park is described. The objective is to identifying indicator species for monitoring population-dynamics as measures of biodiversity. These indicator species or populations may also serve to define landscape-level measures for biodiversity monitoring such as habitat loss and fragmentation.

The framework was developed and tested using variables and consensus responses from the focal-species approach described in Chapter four. Variables characterizing focal-species were integrated with criteria for selecting different types of indicator species. A matrix process was utilized to identify potential mammal, reptile and amphibian, and freshwater fish indicator species for biodiversity monitoring at Kejimkujik National Park. Preliminary assessment results are presented and species which warrant further consideration as potential indicator species are identified. The potential utility, limitations and benefits of the focal-species approach and framework for identifying indicator species is discussed.

5.2 Monitoring ecological integrity and transboundary phenomena

Protected areas play a critical role in maintaining biodiversity; protected areas as life-supporting systems are essential components of the larger landscape. It is important that ecological integrity of protected areas be maintained, therefore monitoring for ecological integrity and biodiversity objectives is a key part of ecosystem management. Major objectives have been defined for maintenance of ecological integrity, including: 1) representation of all native ecosystem types; 2) maintenance of key processes (geomorphological, hydrological, ecological, biological, and evolutionary) within normal ranges of variation (including speciation, natural disturbances, species migration and dispersal); 3) maintenance of viable populations of native species in natural patterns of abundance and distribution (identify species most sensitive to human activities, keystone, umbrella species); and 4) encouragement of compatible human uses (Noss 1992b; 1995; Grumbine 1994b; Woodley 1994; 1996a; 1996b). These objectives cannot be met within protected areas alone. They represent transboundary phenomena.

To define an area capable of retaining ecological integrity over time, the structures and processes that represent key ecological considerations for protected area design need to be incorporated. Guidelines for delineating ecologically sound boundaries (Theberge 1989) and ideas from conservation biology regarding identification of focal-species, minimum viable population size, minimum critical habitat area, and patch dynamics represent the same structures and processes that are the subjects of ecological integrity objectives. It is not possible to understand and define all structures and processes; it is necessary to determine and focus on the most significant. Based on the objectives of ecological integrity, maintenance of sufficient areas for key processes and viable populations of focal-species is critical; these objectives are transboundary.

5.3 Kejimkujik National Park context

The ecological integrity that Kejimkujik National Park currently experiences is supported or supplemented by the relatively natural surrounding regional landscape matrix. However, the surrounding land tenure is quite diverse, including many small private holdings which for the most part reflect areas that are no longer in a natural state, and larger private holdings, including lumber and pulp and paper industries, and provincial crown land, much of which is subject to forestry and mining commitments and leases. The remaining natural landscape could significantly change in the future, and indeed is already changing at a rapid pace, potentially jeopardizing the ecological integrity of Kejimkujik National Park and the broader region.

Part of the Provincial Crown or public land has been proposed as a wilderness protected area: the Tobeatic. Combined, Kejimkujik National Park zones I and II and the Tobeatic Wilderness Protected Area represent approximately 130,000 hectares of protected area. These areas could best be managed for ecological and other considerations if they are managed together, as a unit. However, even when combined the area is small in comparison with estimates of home-range requirements for viable populations of species with relatively large area requirements such as American moose (MVP Ne=50: 125,000 hectares) and fisher (MVP Ne=50: 80,500 hectares) (Refer to Table 3.5).

These figures represent area-requirements for short-term (50 to 100 years) viability; area-requirements for long-term (1000 years) viability are increased by about one order of magnitude or ten times. Further, these figures are based on an effective or ideal breeding population (Ne) of 50 individuals. Estimates for American marten suggest a more realistic short-term viable population for wild populations would be approximately 250 individuals. For fisher, such a population size would raise the minimum critical area to approximately 402,500 hectares. Such areas are much larger than Kejimkujik National Park and Tobeatic candidate protected area combined and do not incorporate patch dynamics or natural disturbance regimes.

5.4 Indicator species

> An indicator species is an organism whose characteristics (e.g., presence or absence, population density, dispersion, reproductive success) are used as an index of ecological attributes that are too difficult, inconvenient or expensive to otherwise measure .
> (Landres et al. 1988 in Woodley 1993)

The use of indicator species to monitor or assess environmental conditions is a firmly established tradition, however it has encountered many conceptual and procedural problems. Criticisms of the traditional concept and use of indicator species are valid and recommend the use of indicators as part of a comprehensive strategy of risk analysis that focuses on key habitats as well as species (Landres et al. 1988 in Noss 1990b and in Woodley 1993). Recent frameworks for ecological or biodiversity monitoring consider multiple levels of organization (regional landscape; community-ecosystem; population-species; and, genetic), and compositional, structural, and functional aspects (Noss 1990b; 1995; Woodley 1993). They also include selection criteria for different categories of indicator species that consider vulnerable, keystone, and umbrella species as well as ecological indicator species (Noss 1990b; Woodley 1993; 1996b).

The term "indicator species" has often been used in a generic or ambiguous way. Operational definitions are quite varied depending upon the characteristics of the phenomenon they are meant to indicate. Consequently, indicator species are discussed at a variety of ecological and conceptual or management levels, ranging from specific localized stresses to ecological integrity or biodiversity. Indicator species may also be one group of focal-species for management (Refer to Table 4.3) (Holbrook 1974 in Hunter 1990; Hunter 1990; Noss 1990b; 1991a). These focal-species groups can be used to focus biodiversity management at the species-population level in order to maintain integrity at the ecosystem level (Noss 1991a). For biodiversity or ecosystem management, each focal-species group should be considered in selecting the most suitable species for detailed monitoring and assessment; a species that falls into several groups would warrant extra attention.

Species-level indicators are important in their own right, to monitor population dynamic measures such as mortality, natality, immigration, emigration, population viability, and habitat and other requirements of individuals and viable populations of sensitive and important species. They are also important for defining and meaningfully interpreting landscape-level measures such as patch size and shape, edge, connectivity and others described by landscape ecology, and human induced stresses such as habitat loss and fragmentation. Species-level indicators also represent key transboundary structures and processes such as: critical and supplemental habitat, home ranges, and migration and dispersal routes; and, speciation and evolution, because species cross boundaries now and will in the future, particularly, for example, in response to climate and other environmental changes, and demographic, catastrophic and stochastic events that lead to species extinction and extirpation.

5.5 Approaches utilizing indicator species

A proposed *Scheme for ecological monitoring in national parks and protected areas* is based on a two-tiered approach: 1) to assess known threats; and 2) to monitor a suite of indicators to assess overall ecosystem integrity (Woodley 1996b). When choosing a biological indicator for a specific stress, it is important to ensure the response prediction model for the specific stress has been developed and the relationships are as clear as possible. No single biological indicator or indicator species has been found that will provide all the information necessary to reflect the behavior of an ecological system.

Ideal indicator species should be: sufficiently sensitive to the particular stressor to provide an early warning of change; easy and cost-effective to measure, collect, assay, and/or calculate; able to differentiate between natural cycles or trends and those induced by anthropogenic stress; a population that will not be harmed by sampling for assay purposes; and, one which will not die out easily as stress progresses, but show response tiers (Cook 1976, Sheehan 1984, Munn 1988 in Noss 1990b; Woodley 1993). Ideal indicator species will rarely be found, but these factors should be involved in indicator species selection (Woodley 1993). Good examples are the use of spotted salamander reproduction and tree ring widths as biological indicators of effects of acid precipitation (Portnoy 1990 and Munn 1988 in Woodley 1993).

Indicator species may also be used to evaluate the effects of management practices. Species types to consider as management indicator species may include: 1) threatened and endangered species; 2) species sensitive to intended management practices; 3) game and commercial species; 4) non-game species of special interest; and 5) ecological indicator species that suggest the effects of management practices on a broad set of species (Salwasser et al. 1983 and Wilcove 1988 in Noss 1991a; Noss 1990b).

Using a suite of indicators to assess overall ecosystem integrity poses a significant challenge, especially in choosing the most appropriate indicators. An overall strategy must integrate indicators and measures at various scales and levels of organization. Woodley's (1994) *Framework for assessing ecological integrity* in national parks and protected areas consists of three major spheres: 1) biodiversity; 2) ecosystem function;

and, 3) stressors. Key measures for monitoring ecological integrity within the biodiversity sphere include "species richness" (changes in species richness, and numbers and extent of exotics) and "population dynamics" (mortality/natality rates of indicator species; immigration/emigration of indicator species; and, population viability of indicator species) (Woodley 1994; 1996b).

These measures are derived from conservation biology (Table 5.1). Population viability analyses include estimations of minimum viable population size and minimum critical area required to sustain the focal-population over time, and are based on species-specific population dynamics such as mortality and natality and emigration and immigration rates. Woodley's species-population measures of biodiversity reflect these recommendations from conservation biology. Noss also outlines a range of measures for assessing and monitoring biodiversity at the species-population level (1990b; 1995). Assessment at the species-population level is important in and of itself, however it also provides necessary information for assessment and monitoring at the community-ecosystem and regional landscape levels. Variables at the landscape level such as connectivity and fragmentation cannot be meaningfully interpreted without reference to the requirements of particular species or suites of species. The challenge remains to select the most appropriate indicator species for defining and monitoring these measures.

Table 5.1: Monitoring measures recommended by conservation biology

1. **Population dynamics of selected species:** information required to determine population viability and minimum viable population size; specifically, an accurate measure of recruitment to the population, and an estimate of total population size; at the individual level, reproductive rates of selected indicator species;

2. **Minimum viable population (MVP) sizes of selected species:** species should include top predators, rare species, and large body size organisms (Theberge 1990 pers. comm. in Woodley 1996b); MVP to be determined by population viability analysis using knowledge of population dynamics; measures should be taken of birth and death rates for each distinct population of the selected species; and,

3. **Minimum area requirements of selected species:** especially for those with large territories, rare species or species with sparse distribution; calculation of minimum critical area should be done without regard to park boundaries.

(Source: Woodley 1993; 1996b)

5.6 Selecting indicator species

There are many considerations in using and selecting indicator species (Table 5.2). The primary consideration is the purpose of the assessment and monitoring. Goals and objectives must be clearly defined. What is to be monitored and why? This question is fundamental to the selection of appropriate indicators. The purpose of selecting indicator species for Kejimkujik National Park is primarily to assess change, such as changes in population structure and health (Munro 1997 pers. comm.). This chapter will focus on selecting indicators for assessing and monitoring biodiversity at the species-population level. This is consistent with the use of indicators and measures of biodiversity, particularly population dynamics, for assessing ecological integrity as described by Woodley (1996b).

Table 5.2: Considerations for the use of indicator species

1. Goals must be clearly defined, including criteria to be used to determine when those goals have been achieved;

2. Selection of indicators depends on formulating specific questions relevant to management or policy that are to be answered through the monitoring process;

3. Indicators should be used only when necessary and appropriate (when direct measures can not or should not be made);

4. Indicator species should be chosen using criteria that are unambiguously defined, and assumptions should be clearly stated;

5. The biology of selected species should be known in as much detail as possible;

6. Sources of subjectivity should be listed wherever possible;

7. Assessment design, methods of data collection and statistical analysis should be submitted to external peer review;

8. Research should be directed toward developing an overall monitoring and assessment strategy that accounts for the natural variability in population attributes and that incorporates concepts from landscape ecology; and,

9. Indicators for the level of organization one wishes to monitor may be selected from levels at, above or below that level. For example, to monitor at the species-population level, one might chose indicators from the landscape level (corridors for dispersal), population level (size, fecundity, sex ratios), level of individuals (physiological parameters), or genetic level (heterozygosity).

(Sources: Landres et al. 1988 in Woodley 1993; Noss 1990b)

Criteria for identifying indicator species vary depending on the phenomenon to be assessed. Selection criteria for categories of indicator species for assessing ecological integrity have been compiled by Woodley (Table 5.3). These criteria are used as the basis of the proposed framework for identifying indicators species described below. The framework assesses various species for their suitability as indicator species for population dynamic measures of biological integrity at the species-population level. The proposed framework integrates and attempts to operationalize Woodley's selection criteria for different categories of indicator species and a *Scheme for ecological monitoring in national parks and protected areas* (Woodley 1996b).

Table 5.3: Selection criteria for different categories of indicator species*

1. Species vulnerable to identified indirect or distant threats such as acid precipitation or climatic shifts;
2. Species vulnerable to identifiable direct or local threats such as disturbance from visitor use;
3. Rare species of all kinds (with defensible definitions of rarity: COSEWIC, rare in natural region, or rare in park);
4. Dominant species such as summit predators or keystone species;
5. Old-growth or non-disturbance species;
6. K-selected species such as extreme habitat specialists or species with low fecundity or low capability for compensatory recruitment;
7. Species with large body size;
8. Exotic or non-native species that are successfully living and reproducing in a given ecosystem;
9. Accumulator species or those that have a tendency to accumulate toxins

(Source: Woodley 1993; 1996b)
Note: * Selection criteria should be applied for each broad ecosystem type in a monitoring and assessment program

5.7 Methodology: A framework for identifying indicator species

A framework for identifying indicator species is proposed which integrates a focal-species approach (Hunter 1990; Noss 1990b; Beazley 1997b) with criteria for selecting indicator species for population dynamics and viability measures of biodiversity (Woodley 1996b). Woodley's selection criteria for different categories of indicator species are defined and supplemented by sub-criteria (Table 5.4). Interpretation and judgment have been exercised in choosing appropriate sub-criteria to reflect Woodley's intent or meaning. Some criteria may require further definition and refinement in order to identify the most appropriate species, such as keystone, *k*-selected, and non-disturbance species. Critical review is required, with subsequent revision or refinement.

Woodley's first two criteria, 1) "Species vulnerable to identified indirect or distant threats", and 2) "Species vulnerable to identifiable direct or local threats" are somewhat ambiguous (1993; 1996b). It is not clear whether the criteria refer to vulnerability *per se*, such as resulting from biological traits or habitat requirements which make them susceptible to the threats (vulnerable species), or to particular sensitivity to the specific threat such that it may signal the effects of perturbations (ecological indicator species). For this reason, both aspects are explicitly incorporated into the proposed range of selection criteria and the identification matrix, under vulnerable species and ecological indicator species criteria.

Table 5.4: Categories and variables for selecting indicator species for monitoring

1. Vulnerable species:

1.1 Endangered, threatened and vulnerable species / Rare species of all kinds:*

1.1.1- Internationally rare (IUCN; WWF; TNC)
1.1.2- Nationally rare (COSEWIC)
1.1.3- Provincial Species of Concern (NSDNR):
- at risk of extinction (NSDNR- Red)
- particularly sensitive to human activities or natural events (NSDNR-Yellow)

1.1.4- Rare in Park or region
1.1.5- Genetically rare/distinct or impoverished
1.1.6- Small population size (NSDNR)
1.1.7- Small number of occurrences (NSDNR)
1.1.8- Small geographic distribution (NSDNR)

1.2 Species vulnerable to indirect or distant threats: *

1.2.1- Sensitive to acid precipitation or climate change*
1.2.2- Pollution susceptible, accumulator or tendency to accumulate toxins*

1.3 Species vulnerable to local or direct threats:*

1.3.1- Species which concentrate spatially
1.3.2- Decline in range/distribution (NSDNR)
1.3.3- Decline in population size (NSDNR)
1.3.4- Population threatened by direct exploitation, harassment or interactions (NSDNR)
1.3.5- Habitat threatened by loss, conversion, degradation, or fragmentation (NSDNR)

1.4 Biological characteristic-related vulnerability:

1.4.1-*K*-selected species such as extreme habitat specialists or species with low fecundity or low capability for compensatory recruitment *
1.4.2- Relatively large body size*
1.4.3- Limited powers of dispersal
1.4.4- Large area requirements / wide-ranging
1.4.5- Extremely variable in population density

1.5 Old-growth or non-disturbance species*

2. Keystone or dominant species :*

2.1 Important prey; 2.2 Summit predator; 2.3 Major herbivore/Pivotal species in the community

3. Ecological indicator species:

3.1 Stress-related indicator species:

3.1.1- Sensitive to stresses: Acid precipitation or climate change; Pollution susceptible, accumulator or tendency to accumulate toxins; Non-disturbance or old-growth dependent*
3.1.2- Species that indicate effects of stress on a broad set of species

3.2 Management-related indicator species:

3.2.1- Sensitive to intended management practices; Game species; Non-game species of special interest; Species that indicate effects of management practices on a broad set of species

3.3 Exotic, non-native or invading r-strategist/generalist/opportunistic species successfully living and reproducing in a given ecosystem*

4. Flagship and Umbrella species:

4.1 Popular or charismatic species; 4.2 Large-area requirements/wide-ranging

5. Special Populations: 5.1 Population is a special gene pool

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Sources: Holbrook 1974; Hunter 1990; Noss 1990b, 1991a; Millsap et al. 1990; Theberge 1993, 1995; NSDNR 1996a; Woodley 1993, 1996b; Herman and Scott 1992; 1994; Harper et al. 1996; Elderkin and Boates 1996)
* Asterisk indicates Woodley's selection criteria for different categories of indicator species (1993; 1996b).
Note: Criteria vary slightly for freshwater fishes

The criteria are organized into a matrix which is structured by categories of focal-species types (Tables 5.5.1, 5.5.2, and 5.5.3). Each focal-species type should be considered in selecting the most suitable indicator species for biodiversity or ecological integrity monitoring. The selection criteria, sub-categories and matrix are presented in the spirit of demonstrating the potential utility of a focal-species approach and data set in identifying indicator species for monitoring biodiversity at the species-population level. The criteria and data set are demonstrated and tested in the matrix format utilizing native species existing or possibly existing in Kejimkujik National Park.

Considerations used to identify species fulfilling each criterion could be incorporated into the matrix and comprise a more-detailed level of sub-criteria for identification or information purposes. Alternatively the information could be recorded or attached in memo fields. This information could be used for management planning.

Sources of information used to complete the matrix include expert consensus from ecologists, biologists and wildlife managers (Refer to Tables 4.8.1 to 4.8.4 in Chapter 4), and provincial wildlife agency and Nova Scotia Museum of Natural History documents (NBDNRE 1997; NSDNR 1996a; Scott 1996). Park specific information was obtained from Kejimkujik National Park (Drysdale 1986; Underwood 1997 pers. comm.). Further information from these sources and others could be utilized to identify potential indicator species for Cape Breton Highlands National Park and other protected areas.

5.8 Assessment and interpretation of results

The information compiled within the matrix framework was assessed in four different ways (Refer to Table 5.6). The total number of criteria satisfied by each species was calculated as: 1) a simple number; and, 2) a percentage of the total number of known or consensus responses. The purpose of calculating the number of criteria satisfied as a percentage of total responses was to compensate for or take into account the varying levels of knowledge about different species. A third type of assessment counted the number of sub-categories that each species fulfilled (level 1.1, 1.2, 1.3, etc.). This assessment is considered to be informative because it compensates for a possible scoring bias towards species which satisfy several criteria within one sub-category but not in other sub-categories. Some sub-categories, such as 1.1 Endangered, threatened and vulnerable species/rare species of all kinds, contain more criteria than others, thereby resulting in an inherent bias in the weighting among sub-categories and categories.

Table 5.5.1: Focal-species selection framework for indicator species in Kejimkujik National Park - Mammals

Species group	1. Vulnerable species																					2. Keystone/ Dominant			3. Ecological Indicator			4. Flagship/ Umbrella		5. Special
Criteria / Native Mammals (existing/possibly existing in Park)	1.1 Endangered, threatened, vulnerable/ rare species of all kinds								1.2 Vulnerable to indirect or distant thr.		1.3 Species vulnerable to local or direct threat					1.4 Biological characteristic-related vulnerability					1.5 Old-growth/ non-disturbance	2.1	2.2	2.3	3.1	3.2	3.3	4.1 Flagship	4.2 Umbrella	population
	1	2	3	4	5	6	7	8	1	2	1	2	3	4	5	1	2	3	4	5										
Arctic shrew*	X	X	X		√	X			√		X	X	X	X			X		X				X	X	√		X		X	√
Common shrew	X	X	X	X	X	X	X	X			X	X	X	X			X		X	√	X	√	X	X			X		X	
Smokey shrew	X	X	X	√	X	X	X	X			X	X	X				X		X				X	X			X		X	
Water shrew	X	X	X		X					X	X	X	X	X	X				X		X	X	X	X			X		X	
Pygmy shrew	X	X	X		X		√	√	X		X	X	X	X	X		X		X		X	X	X	X			X		X	
Short-tailed shrew	X	X	X		X	X					X	X	X	X					X	√	X	X	X	X			X		X	
Star-nosed mole	X	X	X	X	√	X					X		X	X		√			X			X	X	X			X		X	√
Little brown bat	X	X	X	X	X	X	X	X	X		√	X	X			√	X	X				X	X	X			X			
N. long-eared bat	X	X	√	X			√				√	X	X		√	√	X	X	X			X	X	X			X		X	
Eastern pipistrelle	X	X	√	√	X	√	√	√			√	X				√	X	X				X	X	X			X			
Silver-haired bat*	X	X	√	√	√	√	√					X			X		X	X			X	X	X	X			X			√
Red bat*	X	X	√	√	X	√	√		X		X	X			X			X			X	X	X	X			X			
Hoary bat*	X	X	√	√			√		X		X	X			X			X			X	X	X	X			X			
Coyote*	X	X	X		X	X	X	X	X	X	X	X	X	X	X		√	X	√		X	X	√	X	X	√	√		√	
Red fox	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	√	X	X	√	X		X	
Am. black bear	X	X	X	X	X		X	X	X	X	X	X	X	X	X	√	√	X	√			X		X		√	X	√	√	
Racoon	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	√	X	X	X	X	X	√	X		X	
American marten*	X	X	√	√		√		√	X	X	X				√	√	X	X	X			X	√	X		√		√	X	√
Fisher*	X	X	√	√		√		√		X	X	√					X	X	√	X		X	√	X		√		√	√	√
Ermine/Weasel	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X		X	X	√	X		√	X		X	
American mink	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	√	X		√	X		X	
Striped skunk*	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X		X		X	
River otter	X	X	X	X	X		X		X		X			√			X	X	√	X	X	X	√	X		√	X	√	√	
Eastern cougar*	X	√	√		X	√		X	X	X	X					√	√	X	√		X	X	√	X	X		X	√	√	
Lynx*	X	X	√		X	√	√	√	X	X	X	√		√	√	√	√	X	√			X	√	X	X		X	√	√	
Bobcat	X	X	X	X	X	X	X	X	X		X		X				√	X	√		X	X	√	X		√	X	√	√	
White-tailed deer*	X	X	X	X	X	X	X	X	X	X		X	X		X	√	√	X			X		X	√	X	√	√	√		
American moose*	X	X	X	√			X	X	X	X	X					√	√	X	√		X	X	X	√	X	√	X	√	√	√
Eastern chipmunk	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	√	X	X	X	X			X		X	

Table 5.5.1 (continued)

Species group	1. Vulnerable species																					2. Keystone/ Dominant			3. Ecological Indicator			4. Flagship/ Umbrella		5. Special
Criteria Native Mammals (existing/possibly existing in Park)	1.1 Endangered, threatened, vulnerable/ rare species of all kinds								1.2 Vulnerable to indirect or distant thr.		1.3 Species vulnerable to local or direct threat					1.4 Biological characteristic-related vulnerability					1.5 Old-growth/ non-disturbance	2. 1	2. 2	2. 3	3. 1	3. 2	3. 3	4.1 Flagship	4.2 Umbrella	population
	1	2	3	4	5	6	7	8	1	2	1	2	3	4	5	1	2	3	4	5										
Woodchuck	X	X	X	√	X	X	X	X	X		X	X	X	X	X				X		X		X	X			X		X	
Am. red squirrel	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	√			X	X		√	X		X	
S. flying squirrel	X	√	√	√	√	√	√				X			X	X	√	X		X			X	X	X		√	X	√	X	√
N. flying squirrel	X	X	X	X	X	X	X	X	X		X	X	X	X					X				X	X			X		X	
American beaver	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	√	X	√	X	√	X	√	X	
Deer mouse	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	√	X	√	X	X			X		X	
White-footed mouse	X	X	X	X	√	X	X	X			X	X	X						X		X		X	X			X		X	√
Red-backed vole	X	X	X	X	X	X	X	X			X	X	X	X	X		X	X	X	√	X	√	X	X			X		X	
S. bog lemming	X	X	X	*	X	X	X		X	X	X	X	X	X					X	√			X	X	X		X		X	
Muskrat	X	X	X	X	√	X	X	X	X		X	X	X					X	X		X		X	X		√	X		X	√
Meadow vole	X	X	X	X	X	X	X	X		X	X	X	X	X	X				X	√	X	√	X	X			X		X	
Wood. jump. mouse	X	X	X	X	√	X	X		X		X	X	X	X	X		X	X	X		X		X	X			X		X	√
Mead. jump. mouse	X	X	X	X	X	X	X		X		X	X	X	X	X		X	X	X		X		X	X			X		X	
American porcupine	X	X	X	X		X	X		X	X	X	X	X	X	X	√			X				X	√			X	√	X	
Snowshoe hare	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	√	X	√	X	√	X	√	X		X	

Notes:

1. * Coyote has invaded N.S. (probably prehistorically present); American marten, fisher and white-tailed deer were extirpated and re-introduced/re-invaded (Scott 1996). Eastern cougar status is uncertain - probably extirpated; lynx is extremely rare on mainland - probably extirpated (Scott 1996). American moose in this case refers to a localized remnant population of indigenous moose. Presence of arctic shrew, silver-haired bat, red bat, hoary bat and striped skunk uncertain/unconfirmed (Drysdale 1986; Underwood 1997 pers. comm.); these species may not exist in Kejimkujik N.P.
2. Criteria include Selection criteria for different categories of indicator species (Woodley 1993; 1996b), and are organized according to focus-species groups (Noss 1990b; 1991a; Hunter 1990). Considerations used to identify species fulfilling each criterion could be incorporated into the table and comprise a more-detailed level of sub-criteria for information purposes. Alternatively the information could be recorded or attached in memo fields.
3. Sources of information used to complete the matrix include consensus from experts (Refer to Table 4.8.1 in Chapter 4), park specific information from Kejimkujik National Park (Drysdale 1986; Underwood 1997 pers. comm.), and draft provincial wildlife agency and other documents (NBDNRE 1997; NSDNR 1996a; Groombridge 1993; COSEWIC 1996).
4. Old growth or non-disturbance species includes Dependent upon provincially rare habitat
5. Flagship species: subjective opinion of K. Beazley
6. Toned areas indicate sub-categories (1.1, 1.2, 1.3, etc.) considered fulfilled by various species.

Table 5.5.2: Focal-species selection framework for indicator species in Kejimkujik National Park - Reptiles and Amphibians

Species group	1. Vulnerable species																					2. Keystone/ Dominant			3. Ecological Indicator			4. Flagship/ Umbrella		5. Special population
Criteria: Native Reptiles and Amphibians (existing/possibly existing in Park)	1.1 Endangered, threatened, vulnerable/ Rare species of all kinds								1.2 Vulnerable to indirect or distant thr.		1.3 Species vulnerable to local or direct threat					1.4 Biological characteristic-related vulnerability					1.5 Old-growth/ non-disturbance*	1	2	3	1	2	3*	4.1 Flagship	4.2 Umbrella	
	1	2	3	4	5	6	7	8	1	2	1	2	3	4	5	1	2	3	4	5										
Snapping turtle	X	X	X	X	√	X	X	X	√	√	√	X	X	√		X	√	X	√	X	X	X	√	X	√	√			√	
Blanding's turtle	X	√	√	√	√	√	√	√	√	√	√	X	X	√	√	√	X		√	X	√	X	X	X	√	√		√	√	√
E. painted turtle	X	X	X	X		X	X	X	X		X	X	X	X	X	√	X		X			X		X					X	
M. garter snake	X	X	X	X	X	X	X	X	X			X	X	X	X	X			X		X	X		X					X	X
N. ribbon snake	X	X	√	√	√	√	√	√	X			X	X	√	√		X		X		√	X		X	√				X	
N. ringneck snake	X	X	X	X	√	X	X	X	X			X	X	X	X	√			X			X		X					X	
E. smooth green sn.	X	X	X	X	X	X	X	X	X			X	X	X	X	√			X			X	X	X					X	X
N. redbelly snake	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X		X			X	X	X					X	X
E. American toad	X	X	X	X	X	X	X	X	X			X	X			X			X		X	√	X	X					X	X
N. spring peeper	X	X	X	X	X	X	X	X	X	√		X	X			X	X		X			√	X	X	√				X	X
Bullfrog	X	X	X	X	X	X	X	X	X	√		X	X			X	√		X			√	X	X	√	√			X	X
Green frog	X	X	X	X	X	X	X	X	√	√		X	X			X			X			√	X	X	√				X	X
Mink frog	X	X	X	X	X	X	X	X	X	√		X	X			X			X			√	X	X	√				X	X
N. leopard frog	X	X	X	X	X	X	X	X	√	√		X	X		X	X			X	√	X	√	X	X	√				X	X
Pickerel frog	X	X	X	X	X	X	X	X	√	√		X	X			X		√	X			√	X	X	√				X	X
Wood frog	X	X	X	X	X	X	X	X	X	√		X	X			X			X		X	√	X	X	√				X	X
Yel.-spot. salamand.	X	X	X	X	X	X	X	X	√	√		X	X			X			X		X		X	X	√				X	X
Blue-spot. salama.	X	X	√	√	√	X	√	√	√	√		X	X	√	√	X			X		√		X	X	√				X	
Red-spotted newt	X	X	X	X	X	X	X	X	√	√		X	X		√	X	X		X				X	X	√				X	X
Red-back. salaman.	X	X	X	X	X	X	X	X	√	√		X	X			X	X		X		X	√	X	X	√				X	X
Four-toed salama.*	X	X	√		√	X	√	√	X	√	X	X	X	√	√	√	X		X		√		X	X	√				X	

Sources: Groombridge 1993; COSEWIC 1996; NSDNR 1996a; Drysdale 1986; Herman 1997 pers. comm.; Underwood 1997 pers. comm.; expert consensus (Refer to Tables 4.8.2 and 4.8.3 in Chapter 4)

Note:Sub-criteria for reptiles and amphibians vary slightly from Table 5.4

1.4.1 - Includes Dietary/reproductive/habitat specialization

1.5- Includes Dependent upon provincially rare habitat

3.3 - Exotic species: N/A: Table includes only those species native to N.S.

4.1 - Flagship species: Subjective opinion of K. Beazley

Four-toed salamander*: status in Kejimkujik N.P. uncertain/unknown

Table 5.5.3: Focal-species selection framework for indicator species in Kejimkujik National Park - Freshwater fishes

Species group	1. Vulnerable species																					2. Keystone/ Dominant	3. Ecological Indicator			4. Flagship/ Umbrella		5. Special population
Criteria Native Freshwater fishes (existing/possibly existing in Park)	1.1 Endangered, threatened, vulnerable/ Rare species of all kinds								1.2 Vulnerable to indirect or distant thr.		1.3 Species vulnerable to local or direct threat					1.4 Biological characteristic-related vulnerability					1.5 Non-disturbance/ unobstructed					4.1 Flagship	4.2 Umbrella	
	1	2	3	4	5	6	7	8	1	2	1	2	3	4	5	1	2	3	4	5			1	2	3			
American eel	X	X		X	X	X	X	X	X		X			X	X	X	√	X	√	X			X	√	X		√	X
Lake whitefish	X	X			X	√	√	√	X		X			√	√	X	√	√	√	X			X	√			√	X
Brook trout	X	X		X	X	X	X	X	√	√	√			√		√	X	X	√	X	√		√	√	X	√	√	X
Golden shiner	X	X		X	X	X	X	X	X		√					X	X	√	√		X	√	X		X		√	X
Creek chub	X	X			X	X	X	X	√		X						X	√	X				√		X		X	X
White sucker	X	X		X	X	X	X	X	√	X	√				X	X	X	√	X			√	√	√	X		X	X
Brown bullhead	X	X		X	X	X	X	X	X	X	X				X	X	X	√	X	X	X		X	√	X		X	X
Banded killifish	X	X		X	X	X	X	X			X				X	X	X	√	X	X	X	√	X		X		X	X
Ninespn. stickleback	X	X			X	X	X	X			X					X	X	X	X	X		√	X		X		X	X
White perch	X	X		X	X	X	X	X	√	√	√		X	X	X	X	X	X	X	√	√		√	√	X		X	X
Yellow perch	X	X		X	X	X	X	X	X		√			X	X	X	X	√	√	X	X	√	X	√	X		√	X

Sources: Groombridge 1993; COSEWIC 1996; Drysdale 1986; Underwood 1997 pers. comm.; expert consensus (Refer to Table 4.8.4 in Chapter 4)

Note:Sub-criteria vary for freshwater fishes:

1.1.3 - NSDNR designations not yet determined
1.2.1 - Includes Sensitivity to high annual variation in river/stream flow and temperature
1.4.1 - Includes Dietary/reproductive/habitat specialization
1.4.2 - Includes Older age at first reproduction
1.5.1- Includes Dependent upon provincially rare habitat
1.5.2- Includes Dependent upon unimpeded/unobstructed watercourse
3.3 - Exotic species: N/A: This table includes only those species native to N.S., with the possible exception of lake whitefish which has been introduced to Kejimkujik N.P.
4.1 - Flagship species: Subjective opinion of K. Beazley

Table 5.6: Summary of assessments for potential indicator species for Kejimkujik N.P.

Highest rankings in total number of criteria satisfied (total no. of √)	**Highest rankings in criteria satisfied (√) as a percentage of total responses** (√ and X)	**Highest rankings in number of sub-categories of focal-species types satisfied** (1.1, 1.2, 1.3, etc.)	**Highest rankings in number of focal-species types satisfied** (Vulnerable; Keystone; Ecological indicator; Flagship/Umbrella; Special population)
Mammals			
Lynx (13) **Fisher (11)**	**Fisher (55)** **Lynx (54)**	**Fisher (8)** **American marten (7)** **American moose (7)**	**Fisher (5)** **American marten (5)** **American moose (5)**
American marten (10) **S. flying squirrel (10)**	**American marten (48)** **S. flying squirrel (48)**	River otter (6) **Lynx (6)**	Coyote (4) River otter (4) Bobcat (4) White-tailed deer (4) **S. flying squirrel (4)**
Eastern cougar (9) **American moose (9)**	**Eastern cougar (43)** Eastern pipistrelle (41) **American moose (39)** Silver-haired bat (35)	Coyote (5) **Eastern cougar (5)** Bobcat (5) White-tailed deer (5) **S. flying squirrel (5)**	Arctic shrew (3) American black bear (3) **Eastern cougar (3)** **Lynx (3)** American beaver (3) Muskrat (3) American porcupine (3) Snowshoe hare (3)
Reptiles and Amphibians			
Blanding's turtle (21)	**Blanding's turtle (72)**	**Blanding's turtle (10)** **Snapping turtle (8)**	**Blanding's turtle (4)** **Snapping turtle (4)**
Bl.-spt. salamander (12) **Snapping turtle (11)** N. ribbon snake (10) Four-td. salamander (10)	Bl.-spt. salamander (55) N. ribbon snake (50) Four-td salamander (45) **Snapping turtle (42)**	Four-td. salamander (6) Bullfrog (5) Bl.-spot. salamander (5)	N. spring peeper (3) Bullfrog (3) Green frog (3) Mink frog (3) N. leopard frog (3) Pickerel frog (3) Wood frog (3) Red-bck. salamander (3)
Freshwater Fishes			
Brook trout (11)	**Lake whitefish (53)**	**Brook trout (8)**	Yellow perch (4)
Lake whitefish (10)	**Brook trout (48)**	White sucker (6) White perch (6) **Lake whitefish (5)** Yellow perch (5)	American eel (3) **Lake whitefish (3)** **Brook trout (3)** Golden shiner (3) White sucker (3)

Notes:
1. Numbers in brackets ( ) indicate scores: number or percentage of criteria, sub-categories or focal-species types satisfied.
2. Horizontal lines between groups of species indicate a rough cluster analysis of relative scoring.
3. Bold type indicates species receiving relatively high scores in every assessment.

A fourth and final assessment was done to determine the number of focal-species groups represented by each species (vulnerable, keystone/dominant, ecological indicator, flagship/umbrella, and special population). This assessment is important because the first three types of assessments, based on number and percentage of criteria and sub-categories satisfied, generally favour or result in higher scores being received by vulnerable species because this category contains a higher number of criteria and sub-categories. However, vulnerable species are just one of five types of focal-species or species warranting special management attention, including monitoring.

It is important to note that not all criteria and sub-criteria could be assessed for all species due to deficiencies or lack of expert consensus in the data set, partially arising from the current status of knowledge of species and distributions in Nova Scotia. Additional information regarding, for example, population susceptibility, sensitivity to acidification, accumulator species, and non-native species is required to complete the matrix and provide a consistent level of information across criteria and across species.

Many criteria, such as large-bodied, large area requirements, non-disturbance species, and dietary, reproductive, and habitat specialization need to be interpreted in a relative sense. Refinements in these and other definitions could also improve the consistency of the matrix process. It may take some experimentation to determine how strictly to apply the criteria in order to produce an optimum suite of potential indicator species. Further, it is likely to require several tests of the definitions, sub-criteria and matrix format to develop the most effective process for identifying the most appropriate indicator species.

The various assessment results are interpreted and recommendations are made regarding species with the most potential as indicator species for monitoring biodiversity at Kejimkujik National Park. Several species fulfill several criteria and represent more than one type of focal-species. Many species fulfill at least one criteria. Only four mammal and two reptile species existing or possibly existing in Kejimkujik National Park fulfill no criteria (water shrew, striped skunk, northern flying squirrel, meadow jumping mouse, Maritime garter snake, and northern redbelly snake). All freshwater fish species fulfill at least one criterion. Results are summarized in Table 5.6 and are further discussed on a class basis.

5.8.1 Mammals

Mammal species that receive high scores in all four types of assessments are fisher, lynx, American marten, southern flying squirrel, eastern cougar and American moose. These species are generally more vulnerable than the others and represent at least three types of focal-species. When the number of criteria satisfied by the species is calculated as a percentage of total responses, eastern pipistrelle and silver-haired bat also receive high scores. This reflects a relative vulnerability coupled with a lack of knowledge about these species and their status; uncertainty or lack of data may be a factor in keeping these species from receiving higher scores in the other assessments. Only three species represent every type of focal-species: American marten, fisher and American moose. Other species that represent three or more types of focal-species are coyote, river otter, bobcat, Arctic shrew, American black bear, white-tailed deer, American beaver, muskrat, American porcupine and snowshoe hare.

Eastern cougar is not a suitable indicator species given arguments over its status; it is probably extirpated from Nova Scotia. Lynx may not be a suitable indicator species in mainland Nova Scotia because of their extremely low numbers and probable extirpation from the mainland; a small localized population persists in the highlands of Cape Breton Island. Any remaining individuals or populations of these species on the mainland would not be easy or cost-effective to assess, and may be further harmed by assessment. However, the identification of these extirpated or vulnerable species through the matrix framework process does support the position that focal-species warrant special management attention. It may also confirm or substantiate the choice of criteria and utility of the framework process for identifying focal-species and potential indicator species.

Although American moose populations may be considered relatively healthy in some parts of Nova Scotia and elsewhere, the local Kejimkujik-Tobeatic population is the only remaining and recovering population of the original indigenous herd. American moose and white-tailed deer are also potentially important indicator species because of the particular ecological requirements of ungulates (Theberge 1989) and their role as major herbivores. American marten, fisher and white-tailed deer were all extirpated from Nova Scotia and were re-introduced or re-invaded with varying degrees of success. Status and health of the re-introduced American marten population in the Park and region is uncertain. The presence of Arctic shrew and silver-haired bat within the Park is also uncertain.

Eighteen mammal species fulfill at least one criterion in the ecological indicator species category. Coyote may be a potentially useful and interesting indicator species because it represents three types of focal-species, including ecological indicator species, and is a successful, recently invading or re-invading species. Non-native species were generally excluded from the mammal species list, however coyote was assessed because there is evidence that coyote was historically present in New Brunswick and probably existed previously in Nova Scotia (Scott 1996). Further, the wolf has been extirpated from Nova Scotia and the coyote may be considered to be fulfilling the role of summit predator.

Based on an overall interpretation of the assessment results, potential mammal indicator species with the highest overall scores for Kejimkujik National Park include: American marten, fisher, American moose, coyote, river otter, bobcat, white-tailed deer and southern flying squirrel. Other species that warrant further consideration are lynx, eastern pipistrelle and silver-haired bat, due to their uncertain status and potential vulnerability. American black bear may also warrant further consideration because it is a relatively common, large-bodied species, representing three focal-species types. Arctic shrew, muskrat, American beaver, American porcupine and snowshoe hare may also warrant further consideration as species which represent three focal-species types.

5.8.2 Reptiles and Amphibians

Blanding's turtle and snapping turtle receive high scores in every assessment type, fulfilling a relatively large number and percentage of criteria as well as several sub-categories, and representing four types of focal-species. Northern ribbon snake, blue-spotted salamander and four-toed salamander fulfill several criteria and sub-categories therefore warranting further consideration as indicator species due to their potential vulnerability. Northern spring peeper and all frogs represent three focal-species groups, along with red-backed salamander. Bullfrog in particular may represent a useful indicator species for frogs because it represents five sub-categories whereas other frog species represent three or four sub-categories. All frog species are vulnerable to indirect or distant threat, and represent important prey and stress-related ecological indicator species. Bullfrog, northern leopard frog and pickerel frog also possess biological characteristics related to vulnerability. However, bullfrog also represents a management-related indicator species because it is legally harvested in Nova Scotia, thus potentially influenced by management practices.

As a result of these assessments it would appear that Blanding's turtle and snapping turtle warrant further consideration as potential indicator species along with northern ribbon snake, blue-spotted salamander and four-toed salamander. The status or occurrence of four-toed salamander in Kejimkujik National Park is uncertain at present, therefore some initial survey work may be warranted. Northern spring peeper and all frogs generally warrant further consideration, however bullfrog in particular may represent a useful indicator species for frogs.

5.8.3 Freshwater fishes

Brook trout and lake whitefish receive high scores in every assessment type, thus indicating a relative vulnerability and potential to represent various sub-categories and types of focal-species groups. Lake whitefish may not be considered an appropriate indicator species for Kejimkujik National Park because it was introduced to the Park. However, it was assessed because of uncertainty regarding its origin in Nova Scotia (Gilhen 1974). Yellow perch represented the highest number of focal-species groups (four) for freshwater fishes, however it did not satisfy a relatively high number or percentage of criteria overall. This would indicate that yellow perch has several characteristics which make it suitable as a potential indicator species although it is not particularly vulnerable at the present time in this area. Other species that are not particularly vulnerable but which represent three focal-species groups are American eel, golden shiner, white sucker and white perch.

Generally, yellow perch, brook trout and lake whitefish warrant further consideration as potential indicator species because they represent a relatively large number of focal-species types and/or relative vulnerability. American eel, golden shiner and white sucker may warrant further consideration because they represent three types of focal-species. White perch may also deserve some attention because it satisfies a relatively high number of sub-categories.

5.9 Linking indicator species to landscape measures

Ecological integrity and biodiversity monitoring should include measures at various levels of organization including species and ecosystems, and should focus on those structures and processes most threatened by stresses. Landscape-level measures are important in assessing threats such as habitat loss and fragmentation. However, landscape measures need to incorporate the processes or limitations that most threaten each focal- or indicator species (Lambeck 1997).

Monitoring and research priorities could be identified as population- and landscape-level measures defined in reference to the needs of focal- or indicator species. These species function as indicators of landscape-level stresses such as habitat loss and fragmentation. Thus, a focal-species approach provides a potentially useful way to address transboundary and other sustainable landscape planning issues.

5.10 Summary conclusions

Methods for selecting indicator species are evolving along with definitions of monitoring goals. Integration of a focal-species approach with selection criteria for indicator species is possible in an assessment framework such as the one described. The framework appears to be useful for identifying potential mammal, reptile and amphibian and freshwater fish indicator species for monitoring population dynamics measures of biodiversity at the species-population level. These measures include natality/ mortality, emigration/immigration, and population viability of indicator species. A focal-species approach is compatible with *A scheme for ecological monitoring in national parks and protected areas*, including selection criteria for different categories of indicator species and a framework for assessing ecological integrity (Woodley 1996b). The focal-species framework and data set could be adapted for use elsewhere, such as in Cape Breton Highlands and other national parks, provincial parks and protected areas in Nova Scotia and elsewhere, and more generally for regional ecological integrity and biodiversity management or integrated resource management.

Priority species warranting special consideration as potential indicator species are: fisher, American marten, American moose, Blanding's turtle, snapping turtle, yellow perch and brook trout. Several other species warrant further consideration, including, but not limited to, coyote, river otter, bobcat, white-tailed deer, southern flying squirrel, northern spring peeper, bullfrog, and lake whitefish. Eastern cougar and lynx also receive high scores in all assessments, however, they are not recommended as potential indicator species because they are probably extirpated from the Park and from the mainland of Nova Scotia. Atlantic salmon probably would also have received high scores however the species has been confirmed as extirpated from the Park, along with gaspereau/alewife, and therefore was not assessed. Species of uncertain status or unconfirmed presence in Kejimkujik National Park warranting further consideration are Arctic shrew, silver-haired bat, and four-toed salamander. Other species with relatively high scores include eastern pipistrelle, American black bear, muskrat, snowshoe hare, northern ribbon snake, blue-spotted salamander, American eel, golden shiner, white sucker, and white perch (Table 5.7).

Many species fulfill several criteria and represent more than one type of focal-species. Few species fulfill no criteria. This may provide some justification for being more rigorous in application of the criteria in order to limit the number of potential indicator species. However, all potential indicator species need to be reviewed in terms of other selection considerations such as cost-effectiveness and ability of the population to withstand assessment; this additional assessment is likely to limit the potential number of indicator species (Table 5.8).

Critical review and refinement of the criteria, definitions and the process of assessment are required. Additional data and knowledge are also required to improve reliability and consistency across species and criteria. Extension and adaptation of the process and criteria to identify potential bird, invertebrate and plant indicator species is also necessary to round out the suite of indicator species.

Table 5.7: Species warranting further consideration as potential indicator species in Kejimkujik National Park.

Mammals	Reptiles and Amphibians	Freshwater fishes
Fisher American marten American moose	Blanding's turtle Snapping turtle	Yellow perch Brook trout
Coyote River otter Bobcat White-tailed deer Southern flying squirrel	Northern spring peeper All frog species, or bullfrog (as a potential indicator species for frogs)	Lake whitefish*
Lynx* Eastern pipistrelle Silver-haired bat* American black bear Arctic shrew* Muskrat Snowshoe hare	Northern ribbon snake Blue-spotted salamander Four-toed salamander*	American eel Golden shiner White sucker White perch

Notes:
1. Species indicated by asterisk (*) are of uncertain status in Kejimkujik National Park
2. Groups of species delineated by table cells represent a rough cluster analysis based on interpretation of combined relative scores in the various assessments of number and percentage of criteria and sub-categories satisfied and number of focal-species groups represented by each species

There are several benefits of a focal-species approach. It provides a focus for research, monitoring and management with limited resources, as well as for broad goals such as maintaining ecological integrity or biodiversity. It provides an immediate focus within a longer term and broader regional context, and for partnerships and co-operative arrangements with adjacent landowners and other agencies in terms that are relatively easily understood. Focal-species may also serve as a multiple-species umbrella for conservation initiatives at the landscape-level such as defining critical habitat for species with the most demanding requirements (Lambeck 1997). They may also provide a focus for interpretive programs and education, as well as for broader social marketing of ecosystem and species preservation and habitat conservation.

The approach integrates science, management and policy in a way that is operational at national, regional and local park levels. It is also strategic in that it is issue and goal driven; it is responsive and appropriate for adaptive management; and, it is contextual in that it may be adapted to particular regional, historical and biogeographical situations. However, a focal-species approach to monitoring biodiversity at the species-population level represents only one aspect of a monitoring and management program which should include a suite of indicators and measures at various levels. Landscape measures represent one other level of considerations.

Biodiversity management decisions at the landscape-level may benefit from species-population level information. For example, landscape characteristics such as habitat size and quantity can only be meaningfully assessed relative to the needs of the individuals and populations of the species which utilize that habitat or comprise that landscape. As previously discussed, focal-species represent those species warranting special biodiversity management attention. If those focal-species with the most demanding habitat, resource and management requirements can be identified, the landscape-level parameters that accommodate these requirements may be defined. If the habitat and resource requirements of these most-demanding focal-species are met, then many other species may also be protected.

Table 5.8: Other considerations for selecting indicator species

1. Sufficiently sensitive to provide an early warning of change;
2. Distributed over a broad geographical range;
3. Capable of providing a continuous assessment over a wide range of stresses;
4. Relatively independent of sample size;
5. Easy and cost-effective to measure, collect, assay, and/or calculate;
6. Population will not be harmed by sampling for assay purposes;
7. Population will not die out easily as stress progresses, but show response tiers;
8. Able to differentiate between natural cycles or trends and those induced by anthropogenic stress; and,
9. Relevant to ecologically significant phenomena.

(Sources: Cook 1976, Sheehan 1984, Munn 1988 in Noss 1990b; Woodley 1993)

The following chapter discusses the potential for linking a focal-species approach to landscape-level considerations. Frameworks for categorizing the various factors which limit focal-species are developed, tested and assessed for their utility in identifying focal-species with the most-demanding habitat or resource requirements. Mammal, reptile, amphibian, and freshwater fish species with the most demanding landscape-level requirements are identified in a preliminary way for the Kejimkujik National Park region and for the province.

Chapter 6

Linking focal-species to the landscape

6.1 Introduction

In the preceding chapters, focal-species have been identified at the provincial level as well as at the regional level as indicator species in the Kejimkujik National Park area. Focal-species warrant special biodiversity management attention. A focal-species approach is appropriate for identifying indicator species for monitoring population dynamics at a regional level. Linking these focal-species or populations to their habitat or landscape-level requirements could provide useful information for biodiversity management such as monitoring, transboundary management, land-use planning and recovery plans for endangered species. This would serve to integrate species-population level considerations with landscape and regional levels.

Habitat loss and fragmentation are the primary causes of species and population extirpations in the temperate zone (Harris 1984; Hunter 1990). Species with large area requirements, limited dispersal abilities, specialized habitat requirements, and low fecundity are probably more negatively affected than others by habitat loss and fragmentation. Over-harvesting of species, including hunting, is the second major threat to species (Hunter 1990). Ecological integrity and biodiversity planning and management initiatives, including research and monitoring, should focus on those species, ecosystems and processes most threatened by these stresses. Current emphasis on ecosystem protection and landscape-level approaches are important in responding to these landscape-level threats. However, landscapes and ecosystems have meaning only in terms of the particular species and processes present.

This chapter describes the links between species-population and landscape-level considerations generally, and for the focal-species identified in the previous chapters. The status of the information linking species to habitat is not sufficient to make specific decisions about the character, extent and distribution of critical habitat for species in Nova Scotia. However, frameworks are developed and assessed for characterizing these requirements for the focal-species based on their most demanding requirements. Assessments are conducted for focal-species identified in Nova Scotia as well as in the region of Kejimkujik National Park. Focal-species are also categorized according to the landscape-level factors limiting their populations as suggested by Lambeck (1997). Assessments are compared and conclusions are drawn regarding the utility of the approaches and potential linkages between focal-species and the landscape-level.

Priorities are identified for further autecological studies and population viability analysis relative to specific focal-species and their particular habitat or resource requirements in the Kejimkujik National Park area and in Nova Scotia. American moose is identified as one focal-species which is considered to be limited by landscape-level factors. Home-range requirements of American moose are discussed and the need for further research and monitoring is demonstrated. Additional regional-scale assessments are recommended to identify focal-species populations and their specific habitat and resource-limitations in other areas of Nova Scotia, in order to accommodate regional variation.

6.2 Methodology for linking focal-species to the landscape-level

Two sets of frameworks are developed and assessed for focal-species in Nova Scotia. The first set of frameworks and assessments utilizes categories and variables from the focal-species framework developed in Chapter four. The second set integrates these variables with a process recently developed by Lambeck (1997). Various assessments are conducted in the spirit of experimentation and discovery within these two sets of frameworks. The objective is to test their utility and the consistency or variability of the results in order to determine which frameworks are most useful and to identify focal-species related to various categories of limiting factors at a landscape-level.

The two sets of frameworks and assessments are first discussed separately, and then comparisons are made between the sets and among all of the assessments and results. Potential focal-species warranting special biodiversity management attention at the landscape-level are identified from comparisons of the results.

6.3 Assessments utilizing categories and variables from the focal-species framework

6.3.1 Methodology

Two frameworks and assessments were completed using the categories, variables and consensus responses from the focal-species framework developed in Chapter 4. For the first framework, six key variables with direct relevance to landscape-level considerations were selected (Refer to column headings in Table 6.1). Two of these are related to threats to populations and habitats; the other four are biological characteristics related to habitat requirements: space-demanding/wide-ranging; limited-dispersal power; habitat specialization; and, dependent upon provincially rare habitat. For freshwater fishes, the variable dependent upon provincially rare habitat is substituted with dependent upon unobstructed/ unimpeded water course (Table 6.1).

All species existing in Nova Scotia were assessed relative to these variables, utilizing the consensus responses provided in Tables 4.8.1.1 to 4.8.4.3 in Chapter four. Revised status evaluations for mammal species were also incorporated (NSDNR 1997b).

The second assessment examines species considered vulnerable or potentially vulnerable at both the provincial level and within the Kejimkujik National Park region. These species are assessed relative to categories of variables from the focal-species framework that are habitat-related at the landscape scale. Focal-species with high scores in the categories of biological characteristics, habitat-related vulnerability, human-impact factors and information status are identified (Tables 6.2.1 and 6.2.2). Preliminary conclusions are drawn regarding the requirements of various focal-species for management attention relative to the various categories.

6.3.2 Results

6.3.2.1 Results from assessment utilizing variables categorized as threats or requirements

From the first assessment (Table 6.1) it appears that mammal species with threats to populations and habitats tend to be those that are space-demanding/wide-ranging, that have specialized habitat, dietary and reproductive requirements, or that are dependent upon provincially rare habitat. All of the mammal species identified with these six variables were previously identified as focal-species, warranting special management attention, with the exception of coyote, American black bear and bobcat. Although space-demanding and wide-ranging, coyote, American black bear and bobcat are not considered to be at risk or vulnerable at this time. These species require relatively large areas but have persisted with relative success in the presence of humans and other species, perhaps at least partially because they are habitat or dietary generalists. In contrast, fisher, river otter, lynx and American moose are considered to be experiencing threats to populations or habitats, as well as being space-demanding or wide-ranging. These may represent priority species for management attention at the landscape level.

Little brown bat and northern long-eared bat populations and habitats are considered to be threatened particularly because winter populations congregate in a small number of communal hibernacula, making entire populations vulnerable to human activity (NSDNR 1997b). American marten are also threatened, and have specialized habitat requirements. Other mammal species also have specialized habitat requirements or dependence upon provincially rare habitat. The extent of habitat specialization highlights the need to consider each habitat or patch type when managing or planning at the landscape level (Table 6.1).

Table 6.1: Assessment based on habitat threats and requirements utilizing variables from the focal-species framework for species in Nova Scotia

Threats		Requirements/limitations			
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Habitat threatened by loss, conversion, degradation, fragmentation in N.S.	Space-demanding/ wide-ranging	Limited dispersal power	Habitat/ dietary and/or reproductive specialization	Dependent upon provincially rare habitat, or unobstructed/ unimpeded watercourse
Mammals					
Arctic shrew Little brown bat N. long-ear. bat E. pipistrelle A. marten Fisher River otter Lynx A. moose	Arctic shrew Little brown bat N. long-ear. bat A. marten Fisher Lynx A. moose	Coyote A. black bear Fisher River otter Eastern cougar Lynx Bobcat A. moose		Gaspé shrew Long-tail. shrew Star-nose. mole A. marten S. flying squirrel Rock vole	Gaspé shrew Rock vole
Reptiles and Amphibians					
Wood turtle Blanding's turtle N. ribbon snake Bl.-s. salamand. Fr.-t. salamand.	Wood turtle Blanding's turtle N. ribbon snake Bl.-s. salamand. Red-spot. newt Fr.-t. salamand.		Wood turtle Pickerel frog	N ribbon snake N. ring. snake E. s. gr. snake N. redbl. snake Bl.-s. salamand. Red-spot. newt R.-b. salamand. Fr.-t. salamand.	Wood turtle
Freshwater fishes					
Atl. whitefish Lake whitefish Atlantic salmon Brook trout	Atl. whitefish Lake whitefish Atlantic salmon Brook trout	Sea lamprey Atl. sturgeon American eel Bluebk. herring Gaspereau/Ale. American shad Atl. whitefish Atlantic salmon Brook trout Rainbow smelt Striped bass	Lake whitefish N. redbell. dace Lake chub Golden shiner Common shiner Blknose. shiner Blacknose dace Creek chub Fallfish Pearl dace White sucker Brown bullhead Banded killifish Brk. stickleback Yellow perch	Gaspereau/Ale. Atlantic salmon Brook trout Lake trout Rainbow smelt N. redbell. dace Blknose. shiner Blacknose dace Pearl dace Brk. stickleback	Gaspereau/Ale. American shad Atlantic salmon Rainbow smelt

Sources: Expert consensus (Tables 4.8.1.1 to 4.8.4.3) and NSDNR 1997b

Notes:

1. Information from NSDNR (1997b) relates specifically to threats to populations and habitats for mammal species only; this information represents new information compiled and drafted after the expert survey and consensus phase of this research; species listed under threats to populations and to habitats received scores of A, B, A or B, B or C, or, B & C by NSDNR (1997b). Eastern cougar was not evaluated by NSDNR; status is uncertain/evaluation deferred pending status report by F.W. Scott.

Reptile and amphibian species with threatened populations and habitats seem to be mostly those with specialized habitat, dietary and reproductive requirements or dependence on provincially rare habitat. No reptile or amphibian species are considered to be space-demanding or wide-ranging. At least five species with threats to populations and habitats have specialized habitat, dietary and/or reproductive requirements, including: wood turtle, northern ribbon snake, blue-spotted salamander, red-spotted newt, and four-toed salamander. Wood turtle is also considered to be limited in dispersal ability and dependent upon provincially rare habitat (Table 6.1). These species may represent priority focal-species for landscape level considerations.

Freshwater fishes with threatened populations and habitats are mainly those which are considered to be space-demanding or wide-ranging, including: Atlantic whitefish, Atlantic salmon and brook trout (Table 6.1). Atlantic salmon and brook trout also are considered to have specialized habitat, dietary or reproductive requirements. Atlantic salmon are also dependent upon unimpeded/unobstructed watercourses. These species may represent priority species for defining landscape-level parameters related to lakes, rivers and streams and other aspects of the aquatic environment. Populations and habitats of lake whitefish are also considered to be threatened, and limited in dispersal ability. However lake whitefish was probably introduced to Nova Scotia and may be considered to be of less priority than native species. Many freshwater fish species are considered to have limited dispersal abilities (especially minnows and carps, suckers and catfishes) and/or special habitat, diet or reproduction requirements, however are not considered to be threatened.

6.3.2.2 Results from assessments utilizing categories from focal-species framework

Provincial level results

The second assessment was based on the categories of variables developed in the focal-species framework in Chapter four (Table 6.2.1). Results are similar to those in the previous assessment which indicates that the categories reflect the key variables. However, interpretation of the results is slightly more difficult because several variables are included within the categories. Assessments based on the key variables seem to be easier to interpret and possibly more precise and informative for management decision-making. Further, the original category headings do not accurately reflect the relevance of the variables and have been slightly reworded to improve clarity.

As in the previous assessment, mammal species such as bats, fisher, river otter, eastern cougar, lynx and American moose that display biological-spatial characteristics, such as space-demanding/wide-ranging, are also those experiencing impacts upon their populations and habitats (Table 6.2.1). Arctic shrew, bats and American marten have specialized habitat, dietary, or reproductive requirements and are experiencing threats to their populations and habitats. These groups of species again appear to be indicated as priority species for landscape-level management. A lack of information on the distribution and limiting factors of bats, river otter, lynx, and American moose, combined with their potential vulnerability, suggests that these species may warrant additional landscape-level monitoring and research.

Reptile and amphibian species also exhibit similar results in this second assessment. Wood turtle, Blanding's turtle, northern ribbon snake, pickerel frog, and all salamander species, with the exception of yellow-spotted salamander, appear to warrant priority attention at the landscape-level (Table 6.2.1). Populations and habitats of these species are threatened, and they are considered to have biological-spatial characteristics such as limited dispersal power as well as specialized habitat, dietary or reproductive requirements. Further, a lack of information about distribution and limiting factors is indicated for most of these species, with the exception of snapping turtle and Blanding's turtle. Blanding's turtle and pickerel frog may appear as priority species in this assessment and not in the pervious assessment because they satisfy variables other than the key ones within the larger categories, such as climatic or pollution sensitivities or lack of management activities.

Additional freshwater fishes are indicated as experiencing impacts such as threats to populations and habitats in this second assessment. This is again probably a result of the inclusion of variables other than the key ones within the larger categories, such as legally harvested or killed in Nova Scotia, or no management activities directed at taxon. These variables do not necessarily indicate a threat to populations or habitats. Most of the species identified in the impact factors category, with the exception of Atlantic whitefish, lake whitefish, Atlantic salmon, and brook trout, may not be considered to be experiencing threats at this time, or even necessarily in the future, so long as legal harvesting and population and habitat status is monitored and well managed. Harvested species such as Atlantic sturgeon, blueback herring, gaspereau/alewife, American shad, lake trout, rainbow smelt and blacknose dace are potential species for monitoring attention at the landscape-level because of their biological-spatial characteristics, and specialized habitat, dietary or reproductive requirements. Atlantic whitefish, lake whitefish, Atlantic salmon, and brook trout remain priority species for landscape-level considerations (Table 6.2.1).

Table 6.2.1: Assessment based on habitat-related categories from the focal-species framework for vulnerable or potentially vulnerable species in Nova Scotia

Biological-spatial characteristics Space-demanding/ wide-ranging; spatially concentrating; limited dispersal ability	**Habitat-related specialization** Habitat/dietary/ reproduct. specialization; rare habitat; unimpeded/unobstructed watercourse	**Impact factors** Threatened populations or habitats (exploitation, ecological interaction; loss, conversion, degradation, fragmentation)	**Information status** Limited knowledge of distribution; limiting factors unknown; no regular monitoring
Mammals			
Little brown bat Northern long-eared bat Eastern pipistrelle Silver-haired bat Fisher River otter Eastern cougar Lynx Bobcat American moose	Arctic shrew Gaspé shrew Long-tailed shrew Little brown bat Northern long-eared bat Eastern pipistrelle Silver-haired bat American marten Fisher Lynx Southern flying squirrel Rock vole	Arctic shrew Long-tailed shrew Little brown bat Northern long-eared bat Eastern pipistrelle American marten Fisher River otter Eastern cougar Lynx Bobcat American moose	Arctic shrew Gaspé shrew Long-tailed shrew Northern long-eared bat Eastern pipistrelle Silver-haired bat Red bat Hoary bat River otter Eastern cougar Lynx Bobcat American moose Southern flying squirrel Rock vole
Reptiles and Amphibians			
Snapping turtle Wood turtle Blanding's turtle Northern ribbon snake Bullfrog Northern leopard frog Pikerel frog	Wood turtle Blanding's turtle Northern ribbon snake Pikerel frog Blue-spotted salamander Red-spotted newt Red-backed salamander Four-toed salamander	Snapping turtle Wood turtle Blanding's turtle Northern ribbon snake Bullfrog Pickerel frog Blue-spotted salamander Red-spotted newt Red-backed salamander Four-toed salamander	Wood turtle Northern ribbon snake Bullfrog Northern leopard frog Pikerel frog Blue-spotted salamander Red-spotted newt Red-backed salamander Four-toed salamander
Freshwater fishes			
Atlantic sturgeon Blueback herring Gaspereau/Alewife American shad Atlantic whitefish Lake whitefish Atlantic salmon Brook trout Lake trout Rainbow smelt	Gaspereau/Alewife American shad Atlantic salmon Brook trout Lake trout Rainbow smelt Blacknose dace	Atlantic sturgeon Blueback herring Gaspereau/Alewife American shad Atlantic whitefish Lake whitefish Atlantic salmon Brook trout Lake trout Rainbow smelt Blacknose dace Brook stickleback	Atlantic sturgeon Blueback herring Lake trout

Source: Appendices 9.3.2.3 and 9.3.3.3; and Appendices 8.5.1 to 8.5.3

Notes:

1. Species include only focal-species identified through assessments of expert survey responses with the exception of little brown bat and American moose added as a result of subsequent information (NSDNR 1997b; Nette 1997 pers. comm.).
2. Species listed are focal-species with the highest affirmative response rates within the relevant categories (categories 2,3,5 and 6) from Appendices 8.5.1 to 8.5.3.

Table 6.2.2: Assessment based on habitat-related categories from the focal-species framework for vulnerable or potentially vulnerable species in Kejimkujik Natonal Park

Biological-spatial characteristics Space-demanding/ wide-ranging; spatially concentrating; limited dispersal ability	**Habitat-related specialization** Habitat/dietary/ reproduct. specialization; rare habitat; unimpeded/unobstructed watercourse	**Impact factors** Threatened populations or habitats (exploitation, ecological interaction; loss, conversion, degradation, fragmentation)	**Information status** Limited knowledge of distribution; limiting factors unknown; no regular monitoring
Mammals			
Little brown bat Northern long-eared bat Eastern pipistrelle Silver-haired bat* Coyote American black bear Fisher River otter Eastern cougar* Lynx* Bobcat American moose	Arctic shrew* Star-nosed mole Little brown bat Northern long-eared bat Eastern pipistrelle Silver-haired bat* American marten Fisher River otter Lynx* Southern flying squirrel	Star-nosed mole Little brown bat Northern long-eared bat Eastern pipistrelle American marten Fisher River otter Eastern cougar* Lynx* Bobcat American moose	Arctic shrew* Northern long-eared bat Eastern pipistrelle Silver-haired bat* Red bat* Hoary bat* Star-nosed mole River otter Eastern cougar* Lynx* Bobcat American moose Southern flying squirrel
Reptiles and Amphibians			
Snapping turtle Blanding's turtle Bullfrog Northern leopard frog Pikerel frog	Blanding's turtle Northern ribbon snake Northern ringneck snake E. smooth green snake Pikerel frog Blue-spotted salamander Red-spotted newt Red-backed salamander Four-toed salamander*	Snapping turtle Blanding's turtle Northern ribbon snake Bullfrog Blue-spotted salamander Red-spotted newt Four-toed salamander*	Northern ribbon snake Northern ringneck snake E. smooth green snake Northern spring peeper Bullfrog Green frog Mink frog Northern leopard frog Pikerel frog Wood frog Yellow-spot. salamander Blue-spotted salamander Red-spotted newt Red-backed salamander Four-toed salamander*
Freshwater fishes			
Lake whitefish* Brook trout White sucker Yellow perch	Brook trout	Lake whitefish* Brook trout Golden shiner Creek chub White sucker Brown bullhead Banded killifish White perch Yellow perch	American eel Golden shiner Creek chub White sucker Brown bullhead Banded killifish

Source: Tables 5.5.1 to 5.5.3; and Appendices 8.5.1 to 8.5.3

Notes: 1. * Species status uncertain or unconfirmed in Kejimkujik National Park

2. Species include only focal-species for the Kejimkujik National Park region, identified from Tables 5.5.1 to 5.5.3, category 1: Vulnerable species (sub-categories 1.1 to 1.5) and Tables 6.3.1 to 6.3.3. Focal-species include all those identified in these tables with the exception of those that received no affirmative responses to variables, or affirmative responses only for variable 4.4: extremely variable in population density.

3. Species listed are focal-species with the highest affirmative response rates within the relevant categories (categories 2,3,5 and 6) from Appendices 8.5.1 to 8.5.3.

4. * Lake whitefish is introduced in the Kejimkujik National Park region (Drysdale 1986); it is included here to be consistent with the provincial level assessments; origin status of lake whitefish in the province is uncertain, however there is growing evidence that it is introduced (Gilhen 1974; Hebda 1997 pers. comm.).

Regional level results: Kejimkujik National Park

Slight differences between provincial-level results and those at the regional level in the Kejimkujik National Park area are exhibited (Compare Tables 6.2.1 and 6.2.2). These differences are to be expected and reflect regionally specific differences in species composition, population status, genetic variability, habitat distribution and threats. For example, species such as Gaspé shrew, long-tailed shrew, wood turtle, Atlantic sturgeon, blueback herring, Atlantic whitefish, and Atlantic salmon do not exist in the Kejimkujik National Park region. It is also increasingly apparent that lynx and eastern cougar no longer exist in the region, however these species have been included within these assessments because of uncertainty regarding their status and to be consistent with earlier assessments. Remnant indigenous populations of American marten and lynx remain in Cape Breton Island, and a remnant population of the indigenous American moose herd remains only in the Kejimkujik National Park region. Blanding's turtle is also found only in the Kejimkujik National Park region.

Mammal species such as little brown bat, northern long-eared bat, eastern pipistrelle, fisher, river otter, and American moose exhibit biological-spatial factors which characterize them as potentially vulnerable, and are experiencing impacts such as threats to populations and habitats (Table 6.2.2). These species represent potential priority species for landscape-level management attention. Five of these species also have specialized habitat requirements, including bats, fisher and river otter. Northern long-eared bat, eastern pipistrelle, river otter and America moose may also be potentially vulnerable because of information status factors. More distribution and population and habitat status information is needed regarding bats in general.

Snapping turtle, Blanding's turtle, and bullfrog are also potentially limited by biological-spatial factors and are experiencing impacts on their habitats and populations. Other species such as northern ribbon snake, blue-spotted salamander, red-spotted newt and four-toed salamander have specialized habitat requirements and are experiencing threats to habitats and/or populations (Table 6.2.2). More habitat and population status information is required for frogs and salamanders in general. The presence of four-toed salamander in Kejimkujik National Park is unconfirmed.

Brook trout, white sucker and yellow perch are potentially limited by biological-spatial factors and are experiencing impacts upon populations and habitats (Table 6.2.2). Brook trout also has specialized habitat requirements.

These species may represent priority species for landscape-level attention in the Kejimkujik National Park region. Further information and research at the population and local-regional levels is required to verify the results, which are largely based upon provincial and species-level information. Population-level assessments may more accurately identify management priorities at the regional scale.

6.4 Integrating focal-species variables with Lambeck's process

6.4.1 What is Lambeck's process?

Lambeck's recently developed process is essentially a way of identifying focal-species to comprise a multi-species umbrella for defining landscape attributes (1997). Lambeck's objective is compatible with the approach developed within this thesis. Landscape and ecosystem-level parameters need to be defined in terms of the species and processes characteristic of the particular region. For example, habitat requirements of the most area- or resource-demanding species must be understood and accommodated within the ecosystem and landscape-level parameters (Lambeck 1997). The process appears to have merit and warrant exploration in terms of its potential integration with the focal-species approach and framework.

The first step in linking focal-species to landscape-level parameters is to determine the process or limitation that most threatens each species at risk, such as habitat loss or fragmentation, or exotic species invasion. Lambeck (1997) suggests that each species could then be grouped according to the type of threat (Table 6.3).

Table 6.3: Type-of-threat groupings for focal-species

Process/Management species:

- process-limited (predation, competition, fire, grazing, disease)

Structural/Reconstruction species:

- area-limited (related to patch-size; surrogate for resource limited where resource limitation is not a specific or obvious one);
- dispersal-limited (patches are too far apart/unconnected);
- resource-limited (seasonal, life-stage or other specific shortage of carrying capacity)

Compiled from Lambeck 1997

It is then necessary to identify the focal-species most sensitive to each type of threat in order to define the acceptable level of the threat. Because the most demanding species are selected, a landscape designed and managed to meet their needs will encompass the needs of other species for each relevant landscape parameter. This represents a multi-species umbrella (Lambeck 1997).

6.4.2 Integration of the focal-species framework with Lambeck's process

Variables from the focal-species framework, including the framework for identifying indicator species, were integrated with Lambeck's (1997) process for grouping species according to threat (Table 6.4). Vulnerable species were assigned to variables and categories that distinguish between those that could persist in the landscape if it were managed differently and those that are limited by habitat size and configuration in the landscape (Tables 6.5.1 to 6.5.3).

Species that could persist in the landscape with different management practices are considered to be process limited (Lambeck 1997). Variables from the focal-species framework that relate to this category could include: population threatened by direct exploitation, harassment or ecological interactions in N.S.; sensitive to acid precipitation or climate change; pollution susceptible/accumulator species; and , for fishes, sensitive to high annual variation in river/stream flow.

Species that are limited by habitat size and configuration in current landscapes are those that are considered to require habitat reconstruction (Lambeck 1997). These species are categorized as area-limited, dispersal-limited, or resource-limited (Lambeck 1997). Area-limited species are those which may be limited because patches of appropriate habitat are too small to support a functional social group, or, as a minimum, a breeding pair. Variables from the focal-species framework which may be related to this category include: space-demanding/wide-ranging (with an emphasis on the space-demanding aspect because wide-ranging may be better considered as dispersal-limited); population seasonally/daily concentrating, or species which concentrate spatially; dietary and reproductive specialization; habitat specialization; dependent upon provincially rare habitat; habitat threatened by loss, conversion, degradation or fragmentation in N.S.; old-growth or non-disturbance species; and, for fishes, sensitive to high annual variation in river/stream flow.

Dispersal-limited species are those for which suitable habitat patches are beyond the distance over which individuals can move or separated by inhospitable areas which prohibit movement. Variables which may relate to this category include: space-demanding/wide-ranging (with emphasis on the wide-ranging because space-demanding may be better characterized as area-limited); limited dispersal power; habitat threatened by loss, conversion, degradation or fragmentation in N.S. (with emphasis on fragmentation); and, for fishes, dependent upon unimpeded/unobstructed watercourse.

Resource-limited species are those for which the number of individuals that a region can support is determined by the carrying capacity at the time of lowest resource availability. In other words, these species are limited by a resource bottleneck that if supplemented could result in a positive population response. Variables from the focal-species framework which characterize resource-limited species may include: dietary and reproductive specialization; habitat specialization; population seasonally/daily concentrating; and extremely variable in population density (Table 6.4).

All species considered vulnerable, potentially vulnerable or of uncertain vulnerability should be allocated to at least one category of process-limited, area-limited, dispersal-limited, or resource limited. Species within each category may then be ranked according to their sensitivity to the threat. Area-limited species are those with the greatest area requirements for each patch type, and their needs could define the minimum patch sizes. Dispersal-limited species are those with the greatest requirements for wide corridors or with the least ability to move along corridors, and their needs could define the width and length of corridors for each patch type. However, it is not likely possible to determine corridor parameters with much confidence at present because dispersal is among the least understood aspects of the ecology of most species (Lambeck 1997). Resource-limited species are those for which critical resources can be identified and shown to limit the carrying capacity of the area. The resource needs of the least abundant consumer must be met; this species becomes the defining one for that resource (Lambeck 1997). In the assessment conducted here, this category is essentially comprised of variables which may characterize certain species as potentially resource-limited. In this assessment, critical resources have not been identified and shown to limit the carrying capacity of the area.

Once species have been categorized, they may be ranked according to their vulnerability to the threats. The most vulnerable or demanding species constitute a suite of focal-species for defining landscape-scale structures and processes for management attention such as biodiversity monitoring, landscape planning, and integrated resource management. This step of the process has been conducted within this thesis in a very preliminary way because of time and information limitations.

The variables from the focal-species framework do not all relate directly to Lambeck's categorizes of limiting factors. These variables were not selected or defined with Lambeck's recently developed process in mind. For example, information was not collected regarding particular resource-limitations for various species, and species were not assessed relative to particular patch or habitat types within this thesis due to information, time and other constraints. These aspects represent limitations in the work. However, the variables and information that have been selected and integrated may serve to illustrate in a conceptual and experimental way how Lambeck's (1997) process may be adapted and applied to link focal-species with landscape-level considerations. These variables and data are sufficiently relevant to integrate into an assessment framework and provide preliminary results (Table 6.4).

Table 6.4: Framework and variables for identifying species as requiring landscape process/management responses (process-limited species) and landscape structure/ reconstruction responses (area-limited, dispersal-limited, and resource-limited species)

<u>Landscape Process: management responses required</u>

1. Process limited species:

1.1 Population threatened by direct exploitation, harassment or ecological interactions
1.2 Sensitive to acid precipitation or climate change
1.3 Pollution susceptible/accumulator species
1.4 Sensitive to high annual variation in river/stream flow (freshwater fishes only)

<u>Landscape Structure: reconstruction responses required</u>

2. Area-limited species:

2.1 Space-demanding/wide-ranging
2.2 Population seasonally/daily concentrating, or species which concentrate spatially
2.3 Dietary and reproductive specialization
2.4 Habitat specialization
2.5 Dependent upon provincially rare habitat
2.6 Habitat threatened by loss, conversion, degradation or fragmentation in N.S.
2.7 Old-growth or Non-disturbance species
2.8 Sensitive to high annual variation in river/stream flow (freshwater fishes only)

3. Dispersal-limited species:

3.1 Space-demanding/wide-ranging
3.2 Limited dispersal power
3.3 Habitat threatened by loss, conversion, degradation or fragmentation in N.S.
3.4 Dependent upon unimpeded/unobstructed watercourse (freshwater fishes only)

4. Resource-limited species:

4.1 Dietary and reproductive specialization
4.2 Habitat specialization
4.3 Population seasonally/daily concentrating
4.4 Extremely variable in population density

Heading categories are derived from Lambeck (1997); variables are derived from the focal-species framework developed within this thesis.

6.4.3 Methodology

Species considered vulnerable, potentially vulnerable or of uncertain status in Kejimkujik National Park were assessed relative to the categories and variables described above and summarized in Table 6.4. In total, 65 mammal, reptile, amphibian and freshwater fish species were identified by referring to the focal-species framework for selecting indicator species (Refer to Tables 5.5.1 to 5.5.3, column 1: Vulnerable species, in Chapter 5). Tables 6.5.1 to 6.5.3 represent the assessment of these species relative to variables from the focal-species framework which have been integrated with Lambeck's categories of limiting factors. Responses were primarily derived from the consensus tables presented in Chapter four (Refer to Tables 4.8.1 to 4.8.4). However, additional regionally or Park-specific information was incorporated (Drysdale 1986; Underwood 1997 pers. comm.), along with recent information from provincial species status evaluations for mammals (NSDNR 1997b).

From this framework and the responses provided, focal-species may be categorized as process-, area-, dispersal-, or resource-limited. Table 6.6 summarizes the results of the assessment, identifying each species that received an affirmative (√) response in each category as well as the number of variables satisfied.

Table 6.7 represents a summary of the results of a secondary assessment of the information contained within Tables 6.5.1 to 6.5.3. This secondary assessment was completed to minimize the amount of redundancy and provide a more focused list of species for priority attention. For this secondary assessment, variables were reduced to the most salient ones as shown in Table 6.8.

Assessments were also completed for freshwater fishes that do not occur in Kejimkujik National Park. These assessments were conducted because the range of freshwater fish species that exists in Kejimkujik National Park is relatively small in comparison with the range of vulnerable or potentially vulnerable freshwater fishes in Nova Scotia. Freshwater fish distribution is extremely variable by region, with the number of freshwater fish species decreasing significantly with increasing distance form the Chignecto peninsula (Davis and Browne 1996). This assessment of freshwater fishes that do not exist in Kejimkujik National Park facilitates comparisons among assessment types and results.

Table 6.5.1: Framework integrating variables from focal-species framework with Lambeck's process for vulnerable species existing in Kejimkujik National Park - Mammals

	Management				Structure/Reconstruction															
	1. Process-limited				2. Area-limited								3. Dispersal-limited				4. Resource-limited			
Mammals	.1	.2	.3	.4	.1	.2	.3	.4	.5	.6	.7	.8	.1	.2	.3	.4	.1	.2	.3	.4
Arctic shrew*	√	√			x	x							x						x	
Common shrew	x				x	x	x	x	x	x	x		x		x		x	x	x	√
Smokey shrew	x				x	x	x			x			x		x		x		x	
Pygmy shrew	?	x			x	x		x	x	x	x		x		x			x	x	
Short-tail. shrew	x				x	x	x		x	x	x		x		x		x		x	√
Star-nose. mole	x				x	x		√		x			x		x			√	x	
Little brown bat	√	x				√				√				x	√				√	
N. long-ear. bat	√				x	√				√			x	x	√				√	
E. pipistrelle	√					√				?				x	?				√	
Silver-hair. bat*	?								x	?	x			x	?					
Red bat*	?	x				x		x	x	?	x			x	?			x	x	
Hoary bat*	?	x				x		x	x	?	x			x	?			x	x	
Coyote	x	x	x		√	x	x	x	x	x	x		√	x	x		x	x	x	
Am. black bear	x	x	x		√	x		x	x	x			√	x	x			x	x	
Racoon	x	x	x		x	x	x	x	x	x	x		x	x	x		x	x	x	√
Am. marten	√	x	x		x	x		√		√			x	x	√			√	x	
Fisher	√		x		√	x				√			√	x	√				x	x
River otter	√	x			√	x			x		x		√	x					x	x
East. cougar *		x	x		√	x		x	x		x		√	x				x	x	
Lynx	√	x	x		√	x				√			√	x	√				x	
Bobcat	x	x			√	x	x	x	x	x	x		√	x	x		x	x	x	
White-tail. deer	x	x	x				x	x	x	x	x			x	x		x	x		
Am. moose	√	x	x		√	x			x	√	x		√	x	√				x	
E. chipmunk	x	x			x	x	x	x	x	x	x		x	x	x		x	x	x	√
Woodchuck	x	x			x	x	x	x	x	x	x		x		x		x	x	x	
Am. red squirrel	x	x			x	x	x		x	x			x	x	x		x		x	√
S. flying squirrel	x				x	x	√	x	x	x			x		x		√	x	x	
Deer mouse	x	x			x	x	x	x	x	x	x		x	x	x		x	x	x	√
Wh-foot. mouse	x				x	x	x	x	x	x	x		x		x		x	x	x	
Rd-backed vole	x				x	x	x	x	x	x	x		x	x	x		x	x	x	√
S. bog lemming	x	x	x		x	x	x			x			x		x		x		x	√
Muskrat	x	x			x	x	x		x	x	x		x	x	x		x		x	
Meadow vole	x		x		x	x	x	x	x	x	x		x		x		x	x	x	√
Wd. jmp. mouse	x	x			x	x		x	x	x	x		x	x	x			x	x	
A. porcupine	x	x	x		x	x		x	x	x			x		x			x	x	
Snowshoe hare	x	x	x		x	x	x	x	x	x	x		x	x	x		x	x	x	√

Sources: Expert concensus (Tables 4.8.1.1 to 4.8.1.5); NSDNR 1997b; Drysdale 1986; Underwood 1997 pers. comm.)

Notes: 1. Refer to Table 6.4 to reference variables to variable numbers or key.

1. * Species presence uncertain/unconfirmed in Park (Drysdale 1986; Underwood 1997 pers. comm.)

2. Ten species are considered potentially vulnerable only because of the biological characteristic, Extremely variable in population density (Refer to Table 5.5.1). These species are: common shrew, short-tailed shrew, racoon, eastern chipmunk, American red squirrel, deer mouse, red-backed vole, southern bog lemming, meadow vole, and snowshoe hare. These species are common and are not considered vulnerable, however they may be potentially vulnerable due to possible resource limitations or other factors related to extreme variability.

3. Toned variables 1.4, 2.8, and 3.4 apply only to freshwater fishes.

Table 6.5.2: Framework integrating variables from focal-species framework with Lambeck's process for vulnerable species existing in Kejimkujik National Park - Reptiles and Amphibians

Reptiles and Amphibians	Management				Structure/Reconstruction															
	1. Process-limited				2. Area-limited								3. Dispersal-limited				4. Resource-limited			
	.1	.2	.3	.4	.1	.2	.3	.4	.5	.6	.7	.8	.1	.2	.3	.4	.1	.2	.3	.4
Snapping turtle	√	√	√		√	√	x	x	x		x		√	x			x	x	√	x
Blanding's turtle	√	√	√		√	√	√	√		√	√		√		√		√	√	√	x
E. painted turtle	x	x			x	x	x	x		x			x		x		x	x	x	
N. ribbon snake	√	x			x			√		√	√		x		√			√		
North. ringneck snake	x	x			x		√	√		x			x		x		√	√		
East. smooth green snake	x	x			x		√	√		x			x		x		√	√		
Northern spring peeper		x	√		x		x	x					x				x	x		
Bullfrog		x	√		x		x	x					x				x	x		
Green frog		√	√		x		x	x	x				x				x	x		
Mink frog		x	√		x		x						x				x			
N. leopard frog		√	√		x		x	x	x	x	x		x		x		x	x		√
Pickerel frog		√	√		x		x						x	√			x			
Wood frog		x	√		x		x	x	x		x		x				x	x		
Yellow-spotted salamander		√	√		x		x	x	x		x		x				x	x		
Blue-spotted salamander	√	√	√		x		x	√		√	√		x		√		x	√		
Red-spotted newt		√	√		x		√	x		√			x		√		√	x		
Red-backed salamander		√	√		x		√	x	x		x		x				√	x		
Four-toed salamander*	√	x	√		x	x	√	√		√	√		x		√		√	√	x	

Sources: Expert consensus (Refer to Tables 4.8.2 and 4.8.3); Drysdale 1986; Herman 1997 pers. comm.; Underwood 1997 pers. comm.

Notes:

1. * Presence uncertain/unconfirmed in Park (Drysdale 1986; Underwood 1997 pers. comm.)
2. Toned variables 1.4, 2.8, and 3.4 apply only to freshwater fishes.
3. Refer to Table 6.4 to reference variables to variable numbers or key.

Table 6.5.3: Framework integrating variables from focal-species framework with Lambeck's process for vulnerable species existing in Kejimkujik National Park - Freshwater fishes

	Management				Structure/Reconstruction													
Freshwater fishes	1. Process-limited				2. Area-limited							3. Dispersal-limited				4. Resource-limited		
	.1	.2	.3	.4	.1	.2	.3/.4	.5	.6	.7	.8	.1	.2	.3	.4	.1/.2	.3	.4
American eel	x	x		x	√	x	x		x		x	√	x	x		x	x	x
Lake whitefish*	√	x			√	x	x		√			√	√	√		x	x	x
Brook trout	√	√	√	√	√	√	√				√	√	x		√	√	√	x
Golden shiner		x			√	√	x					√	√		x	x	√	
Creek chub		√			x	x						x	√				x	
White sucker		√	x		x	√	x		x			x	√	x		x	√	
Brown bullhead		x	x		x	x	x		x			x	√	x	x	x	x	x
Banded killifish					x	x	x		x			x	√	x	x	x	x	x
White perch	x	√	√		x	√	x		x			x	x	x	√	x	√	√
Yellow perch	x	x			√	√	x		x			√	√	x	x	x	√	x

Sources: Expert consensus (Refer to Table 4.8.4); Drysdale 1986; Underwood 1997 pers. comm.; Hutchings 1997 pers. comm.

Notes:

1. * Lake whitefish is introduced in Kejimkujik National Park
2. Refer to Table 6.4 to reference variables to variable numbers or key

Table 6.5.4: Framework integrating variables from focal-species framework with Lambeck's process for vulnerable species - Freshwater fishes that do not occur in Kejimkujik National Park

	Management				Structure/Reconstruction													
Freshwater fishes	1. Process-limited				2. Area-limited							3. Dispersal-limited				4. Resource-limited		
	.1	.2	.3	.4	.1	.2	.3/.4	.5	.6	.7	.8	.1	.2	.3	.4	.1/.2	.3	.4
Atlantic sturgeon				√	√	√	x				√	√	x		√	x	√	x
Blueback herring				√	√	√	x				√	√	x		√	x	√	√
Atlantic whitefish	√			x	√	√	x		√		x	√	√	√	x	x	√	x
Atlantic salmon	√	√	√	√	√	√	√		√		√	√	x	√	√	√	√	
Lake trout					√	√	√					√	√			√	√	x
Rainbow smelt		√		√	√	√	√				√	√	x		√	√	√	√

Sources: Expert consensus (Refer to Table 5.8.4); Hutchings 1997 pers. comm.

Note: Refer to Table 6.4 to reference variables with variable numbers or key

Table 6.6: Summary of preliminary assessment for species in Kejimkujik National Park

<table>
<tr><th>Management response</th><th colspan="3">Structure/Reconstruction response</th></tr>
<tr><th>Process-limited</th><th>Area-limited</th><th>Dispersal-limited</th><th>Resource-limited</th></tr>
<tr><td colspan="4">Mammals</td></tr>
<tr><td>Arctic shrew* (2)</td><td>Little brown bat (2)
North. long-eared bat (2)
American marten (2)
Fisher (2)
Lynx *(2)
American moose (2)</td><td>Fisher (2)
Lynx *(2)
American moose (2)</td><td rowspan="2">Common shrew (1)
Short-tailed shrew (1)
Star-nosed mole (1)
Little brown bat (1)
North. long-eared bat (1)
Eastern pipistrelle (1)
Racoon (1)
American marten (1)
Eastern chipmunk (1)
American red squirrel (1)
South. flying squirrel (1)
Deer mouse (1)
Red-backed vole (1)
South. bog lemming (1)
Meadow vole (1)
Snowshoe hare (1)</td></tr>
<tr><td>Little brown bat (1)
North. long-eared bat (1)
Eastern pipistrelle (1)
American marten (1)
Fisher (1)
River otter (1)
Lynx *(1)
American moose (1)</td><td>Star-nosed mole (1)
Eastern pipistrelle (1)
Coyote (1)
American black bear (1)
River otter (1)
Eastern cougar* (1)
Bobcat (1)
South. flying squirrel (1)</td><td>Little brown bat (1)
N. long-eared bat (1)
Coyote (1)
American black bear (1)
American marten (1)
River otter (1)
Eastern cougar *(1)
Bobcat (1)</td></tr>
<tr><td colspan="4">Reptiles and Amphibians</td></tr>
<tr><td rowspan="3">Snapping turtle (3)
Blanding's turtle (3)
Pickerel frog (3)
Blue-spt. salamander (3)</td><td>Blanding's turtle (6)</td><td></td><td></td></tr>
<tr><td>Four-toe. salamander*(4)</td><td></td><td></td></tr>
<tr><td>North. ribbon snake (3)
Blue-spt. salamander (3)</td><td></td><td>Blanding's turtle (3)</td></tr>
<tr><td>Green frog (2)
N. leopard frog (2)
Yw.-spot. salamander (2)
Red-spotted newt (2)
Red-bck. salamander (2)
Four-toe. salamander*(2)</td><td>Snapping turtle (2)
Nrth. ringneck snake (2)
E. smooth grn. snake (2)
Red-spotted newt (2)</td><td>Blanding's turtle (2)</td><td>Nrth. ringneck snake (2)
E. smooth grn. snake (2)
Four-toe. salamander*(2)</td></tr>
<tr><td>North. ribbon snake (1)
North spring peeper (1)
Bullfrog (1)
Mink frog (1)
Wood frog (1)</td><td>Red-bck. salamander (1)</td><td>Snapping turtle (1)
N. ribbon snake (1)
Pickerel frog (1)
Blue-spt. salamander (1)
Red-spotted newt (1)
Four-toe. salamander*(1)</td><td>Snapping turtle (1)
North. ribbon snake (1)
North. leopard frog (1)
Blue-spt. salamander (1)
Red-spotted newt (1)
Red-bck. salamander (1)</td></tr>
<tr><td colspan="4">Freshwater fishes
(Vulnerable in Kejimkujik National Park)</td></tr>
<tr><td>Brook trout (4)</td><td>Brook trout (4)</td><td>Lake whitefish* (3)</td><td></td></tr>
<tr><td>White perch (2)</td><td>Golden shiner (2)
Yellow perch (2)</td><td>Brook trout (2)
Golden shiner (2)
Yellow perch (2)</td><td>Brook trout (2)
White perch (2)</td></tr>
<tr><td>Lake whitefish* (1)
Creek chub (1)
White sucker (1)</td><td>American eel (1)
Lake whitefish* (1)
White sucker (1)
White perch (1)</td><td>American eel (1)
Creek chub (1)
White sucker (1)
Brown bullhead (1)
Banded killifish (1)
White perch (1)</td><td>Golden shiner (1)
White sucker (1)
Yellow perch (1)</td></tr>
</table>

Notes:
1. Summary of assessments from Tables 6.5.1 to 6.5.3
2. * Presence in Park uncertain /unconfirmed (Drysdale 1986; Underwood 1997 pers. comm.)

Table 6.6: (Continued) Freshwater fishes not found in Kejimkujik National Park

Freshwater fishes (Vulnerable in N.S. but not existing in Kejimkujik National Park)			
Atlantic salmon (4)	Atlantic salmon (5)	Atlantic whitefish(3) Atlantic salmon (3)	Rainbow smelt (3)
Rainbow smelt (2)	Rainbow smelt (4)	Atlantic sturgeon (2) Blueback herring (2) Lake trout (2) Rainbow smelt (2)	Blueback herring (2) Atlantic salmon (2) Lake trout (2)
Atlantic sturgeon (1) Blueback herring (1) Atlantic whitefish (1)	Atlantic sturgeon (3) Blueback herring (3) Atlantic whitefish (3) Lake trout (3)		Atlantic sturgeon(1) Atlantic whitefish (1)

Note: Summary of assessment from Table 6.5.4

Table 6.7: Summary of secondary assessment in Kejimkujik National Park region

Management response	Structure/Reconstruction response		
Process-limited	**Area-limited**	**Dispersal-limited**	**Resource-limited**
Mammals			
Arctic shrew* (2) Little brown bat (1) North. long-eared bat (1) Eastern pipistrelle (1) American marten (1) Fisher (1) River otter (1) Lynx *(1) American moose (1)	Fisher (2) Lynx *(2) American moose (2)	Fisher (2) Lynx *(2) American moose (2)	Star-nosed mole (1) American marten (1) South. flying squirrel (1)
	Little brown bat (2) North. long-eared bat (2) American marten (2)	Little brown bat (1) North. long-eared bat (1) American marten (1)	
	Coyote (1) American black bear (1) River otter (1) Eastern cougar* (1) Bobcat (1)	Coyote (1) American black bear (1) River otter (1) Eastern cougar* (1) Bobcat (1)	
Reptiles and Amphibians			
Snapping turtle (3) Blanding's turtle (3) North. ribbon snake (1) Blue-spt. salamander (3) Four-toe. salamander*(2)	Blanding's turtle (6)	Blanding's turtle (2)	Blanding's turtle (3) Nrth. ringneck snake (2) E. smooth grn. snake (2) Four-toe. salamander*(2)
	Blue-spt. salamander (3) Red-spotted newt (2) Four-toe. salamander*(4)	Blue-spt. salamander (1) Red-spotted newt (1) Four-toe. salamander*(1)	North. ribbon snake (1) Blue-spt. salamander (1) Red-spotted newt (1) Red-bck. salamander (1)
	Snapping turtle (2)	Pickerel frog (1)	
		Snapping turtle (1)	
Freshwater fishes (Vulnerable in Kejimkujik National Park)			
Brook trout (4)	Lake whitefish* (1)	Lake whitefish* (3)	Brook trout (2)
Lake whitefish* (1)	American eel (1) Brook trout (4) Golden shiner (2) Yellow perch (2)	Brook trout (2)	
		Golden shiner (2) Yellow perch (2)	
		Creek chub (1) White sucker (1) Brown bullhead (1) Banded killifish (1)	
		American eel (1) White perch (1)	
Freshwater fishes (Vulnerable in N.S. but not existing in Kejimkujik National Park)			
Atlantic salmon (4)	Atlantic whitefish (3) Atlantic salmon (5)	Atlantic whitefish(3) Atlantic salmon (3)	Atlantic salmon (2) Lake trout (2) Rainbow smelt (3)
Atlantic whitefish (1)	Atlantic sturgeon (3) Blueback herring (3) Lake trout (3) Rainbow smelt (4)	Lake trout (2)	
Atlantic sturgeon (1) Blueback herring (1) Rainbow smelt (2)		Atlantic sturgeon (2) Blueback herring (2) Rainbow smelt (2)	

Notes:
1. * Presence of species uncertain/unconfirmed in Kejimkujik National Park
2. Summary of secondary assessments from Tables 6.5.1 to 6.5.4, utilizing only those most salient variables summarized in Table 6.8

Table 6.8: Most salient variables for secondary assessment

1. Process-limited species:

1.1 Population threatened by direct exploitation, harassment or ecological interactions

2. Area-limited species:

2.1 Space-demanding/wide-ranging
2.6 Habitat threatened by loss, conversion, degradation or fragmentation in N.S.

3. Dispersal-limited species:

3.1 Space-demanding/wide-ranging
3.2 Limited dispersal power
3.3 Habitat threatened by loss, conversion, degradation or fragmentation in N.S.

4. Resource-limited species:

4.1 Dietary and reproductive specialization
4.2 Habitat specialization

For both the initial and secondary assessments (Tables 6.6 and 6.7), table cells within columns represent a rough cluster analysis. Species in table cells near the top of the columns received affirmative responses to a higher number of variables than those species in the table cells which are below. For example, in Table 6.6, Blanding's turtle received an affirmative response to six variables within the area-limited category, whereas red-backed salamander received only one affirmative response. In Table 6.7, fisher, lynx and American moose are considered to be space-demanding/wide-ranging, as well as requiring habitat which is considered to be threatened by loss, conversion, degradation or fragmentation in Nova Scotia. Although one affirmative response may be sufficient to warrant management attention, more than one affirmative response may indicate a priority species, a particularly challenging management situation, or the need for a multiple-response.

6.4.4 Results

6.4.4.1 Mammals existing in Kejimkujik National Park and region

Thirty-seven vulnerable or potentially vulnerable mammal species existing or possibly existing in Kejimkujik National Park were assessed (Tables 6.5.1, 6.6 and 6.7). Nine mammal species may be considered to be process-limited. Populations of species such as Arctic shrew, little brown bat, northern long-eared bat, eastern pipistrelle, American marten, fisher, river otter, lynx and American moose may be at least partially limited by direct exploitation, harassment or ecological interaction in Nova Scotia (Tables 6.6. and 6.7). For example, populations of American marten and fisher may be limited by accidental capture by trappers and illegal kill, as well as interspecific competition with each other and with other predators. Lynx may also be limited by competition with coyote and bobcat, and accidental trapping and illegal kill as well as unpredictable snowshoe hare cycles. American moose may be limited by interspecific competition with white-tailed deer, a high rate of usually fatal infection by the brainworm *Parelaphostrongylus tenuis*, and increases in illegal kill due to increased road access. Little brown bat, northern long-eared bat and eastern pipistrelle congregate in hibernacula in a small number of caves and abandoned mines, thus whole populations are particularly vulnerable to human disturbance (NSDNR 1997b).

Eleven mammal species may be area-limited (Table 6.7). Populations of species such as fisher and American moose may be limited by their requirements for large-areas and wide-ranges, combined with threats to their habitat by loss, conversion, degradation and fragmentation in Nova Scotia. Other species such as little brown bat, northern long-eared bat, and American marten may also be limited by loss, conversion, degradation, and fragmentation of their more localized and/or specialized habitats. Species such as coyote, American black bear and bobcat also require large areas and wide ranges, however their habitats do not appear to be threatened at present, probably because they tend to adapt to and persist in areas modified by human activities. Although these species are not currently considered to be at risk, their large area requirements may make them vulnerable to area-limitations in the future. River otter require relatively large areas, and their populations may be threatened. Star-nosed mole, eastern pipistrelle and southern flying squirrel may also be considered area-limited due to special habitat, dietary or reproductive requirements, or spatial concentration of populations (Table 6.6). Eastern cougar and lynx are also area-limited but have probably been extirpated from the region.

These same eleven species also appear to be dispersal-limited (Table 6.7). This reflects the use of similar variables such as space-demanding/wide-ranging and habitat threatened by loss, conversion, degradation and fragmentation in Nova Scotia, coupled with the factor that no mammal species are to considered to have limited dispersal power. A distinction between area-limited and dispersal-limited mammal species may be made with further research to determine those species with limited dispersal abilities, and to differentiate between requirements for large areas, wide ranges, or dispersal, and perhaps between impacts of habitat loss or degradation and habitat fragmentation. In the initial assessments star-nosed mole, eastern pipistrelle and southern flying squirrel were also identified (Table 6.6).

In the initial assessment, sixteen species are identified as satisfying variables which may characterize them as being potentially resource-limited (Table 6.6). Thirteen of these species satisfy the sole characteristic of being extremely variable in population density, and are not considered to be particularly vulnerable at the present time. These species have therefore been excluded from the secondary assessment, however it is important to note that they may be potentially vulnerable to resource-limits in the future. Star-nosed mole, American marten and southern flying squirrel may be resource-limited at the present time because of specialized habitat, dietary and/or reproductive requirements (Table 6.7).

American marten is identified within all four categories of limiting factors (Tables 6.6 and 6.7). Little brown bat, northern long-eared bat, fisher, river otter, lynx, and American moose are identified within three limitation categories. Populations of these species may be process-limited, area-limited, and dispersal limited, and may represent priorities for landscape-level management attention. Little brown bat and northern long-eared bat may also be potentially resource-limited (Table 6.6).

Nine mammal species which are considered vulnerable or potentially vulnerable do not receive any affirmative response to the variables in any of the categories (Table 6.5.1). The reasons for this are probably at least threefold. First, at least four of these species are considered potentially vulnerable because they are genetically distinct, including woodchuck, white-footed mouse, muskrat, and woodland-jumping mouse (Refer to Table 5.5.1 in Chapter 5). However, these species are not uncommon nor currently considered to be at risk in Nova Scotia; neither are they considered to be process-, area-, dispersal-, or resource-limited by the data sources or variables utilized in the assessments. The characteristic of being genetically distinct suggests, at least intuitively, that individuals of these species may possess limited dispersal power.

Secondly, at least three of these species, silver-haired bat, red bat and hoary bat, are considered vulnerable or potentially vulnerable primarily because of our lack of knowledge or understanding of their status, distribution and biology in Nova Scotia (NSDNR 1997b). These species receive relatively few affirmative responses to variables which characterize them as limited by any specific factor. However, they may represent priorities for research.

Finally, at least three species, smokey shrew, pygmy shrew, and silver-haired bat, are considered potentially vulnerable because they may be rare in the park or region and/or exist in a small number of occurrences or small geographic range or distribution in Nova Scotia. It is not known why these species are limited in the Kejimkujik National Park region or in Nova Scotia, or even if this limited status is accurate. However, their populations and habitats are generally not considered to be threatened in Nova Scotia. As such it is difficult to assign an affirmative response to particular variables and categories related to the cause of any limitation. It is possible that causal factors are any one or a combination of ecological interactions such as interspecific competition, inadequate amounts or connectivity of appropriate habitat, or other specific resource- limitations.

Although these species of uncertain status and limitation are not assigned to any category nor included within the summary tables, they warrant management attention particularly to increase our understanding of their distribution, status and ecology.

Mammal species which do not occur in Kejimkujik National Park but which are identified as potential focal-species (Refer to Table 4.15 in Chapter 4) could be assessed to identify landscape-level limitations in other areas of Nova Scotia. For example, Gaspé shrew and long-tailed shrew were identified as potential focal-species in Chapter 4. Both species have small numbers of occurrences in Nova Scotia as well as special habitat requirements. It may be surmised that these species, although currently not considered at risk, may be potentially limited by all categories of limitation factors. Their populations may be vulnerable to ecological interactions or processes such as fire or climatic change because of the small number of occurrences as well as the specialized habitat requirements (process-limited). Habitats for these species may be limited and dispersal power may be limited because of their specialized habitat requirements and habitat fragmentation or isolation. In this sense, habitat specialization may result in area- or dispersal-limitations, as well as increased potential for resource-limitations.

6.4.4.2 Reptiles and amphibians in Kejimkujik National Park and region

Eighteen reptiles and amphibians considered to be vulnerable or potentially vulnerable in Kejimkujik National Park were assessed (Table 6.5.2). Fifteen species are identified as potentially process-limited in the initial assessment (Table 6.6). However, in the secondary assessment only snapping turtle, Blanding's turtle, northern ribbon snake, blue-spotted salamander, and four-toed salamander were identified (Table 6.7). Populations of these five species are currently considered to be threatened by direct exploitation, harassment or ecological interactions in Nova Scotia (Table 6.5.2). For example, in Kejimkujik National Park, populations of Blanding's turtles may be at least partially limited by egg predation by racoons. Other species, including bullfrog and northern leopard frog, may also be process-limited because of their sensitivity to pollution and to acid precipitation or climatic change (Tables 6.5.2 and 6.6).

Nine reptile and amphibian species were identified as potentially area-limited in the initial assessment (Table 6.6). In the secondary assessment only four species are identified (Table 6.7). Blanding's turtle is identified because it is relatively space-demanding and wide-ranging, and its habitat is considered to be threatened by loss, conversion, degradation or fragmentation in Nova Scotia (Table 6.5.2). Habitat for blue-spotted salamander, red-spotted newt and four-toed salamander is also considered to be threatened by loss, conversion, degradation, and fragmentation, thus populations of these species may be area-limited. Snapping turtle may be another potentially area-limited species because individuals are relatively space-demanding or wide-ranging (Table 6.7). However, other species such as northern ribbon snake may be potentially area-limited due to specialized dietary, reproductive or habitat requirements (Table 6.6).

A similar suite of species to the area-limited ones is identified as dispersal-limited, again because of the lack of distinction between space-demanding and wide-ranging, as well as between habitat loss, conversion or degradation and habitat fragmentation. These include Blanding's turtle, snapping turtle, and blue-spotted, red-spotted, and four-toed salamander. However, pickerel frog is also identified as dispersal-limited because individuals are considered to have limited dispersal abilities (Table 6.7). Species which are identified as potentially area-limited but not as dispersal-limited include northern ringneck snake, eastern smooth green snake, and red-backed salamander (Table 6.6).

In the initial assessment, ten reptile and amphibian species are identified as having characteristics which may put them at risk of becoming potentially resource-limited, although no specific resource limitations were identified (Table 6.6). Blanding's turtle, northern ringneck snake, eastern smooth green snake and four-toed salamander may be potentially resource-limited because of their specialized requirements for both habitat and diet and/or reproduction. Northern ribbon snake, blue-spotted salamander, red-spotted newt, and red-backed salamander may also be resource-limited because of their specialized requirements for either habitat or diet and/or reproduction (Table 6.7). Northern leopard frog may also be potentially vulnerable to resource-limitations because of variability in population density (Table 6.6).

Blanding's turtle, northern ribbon snake, blue-spotted salamander and four-toed salamander are identified in every category of limitation in the initial assessment (Table 6.6). Populations of these species may be limited by process, area, dispersal and resource factors. Snapping turtle and red-spotted newt are identified in three categories of limitations. All frog and salamander species existing or possibly existing in Kejimkujik National Park are vulnerable to process-limitations, primarily related to sensitivity to pollution, acidification and/or climatic changes. However, all species of salamanders except yellow-spotted salamander also appear to be limited by area and dispersal factors as well as being potentially vulnerable to resource-limitations because of their specialized habitat, dietary or reproductive requirements (Table 6.6).

Even in the more restrictive secondary assessment, Blanding's turtle, blue-spotted salamander and four-toed salamander are identified in every limitation category (Table 6.7). Snapping turtle and red-spotted newt are identified in three limitation categories. Northern ribbon snake is potentially limited by both process and resource limitations. These species may represent priorities for landscape-level management attention.

Reptile and amphibian species which do not occur in Kejimkujik National Park but which were identified as potential focal-species should be assessed to identify landscape-level limitations for management attention elsewhere in Nova Scotia (Refer to Table 4.15 in Chapter 4). For example, wood turtle may be considered process-limited because populations are threatened by direct exploitation, harassment or ecological interactions in Nova Scotia. Populations are also area-limited in that they are dependent upon provincially rare habitat, and that habitat is considered to be threatened by loss, conversion, degradation, or fragmentation. Further, wood turtle populations may be dispersal-limited through both the limited dispersal powers of individuals and the loss and fragmentation of its habitat. The wood turtle may also be resource-limited, although no specific resource limitations have been identified within this thesis.

6.4.4.3 Freshwater fishes in Kejimkujik National Park and region

Ten freshwater fish species considered to be vulnerable or potentially vulnerable in the Kejimkujik National Park area were assessed to identify limiting factors at the landscape-level (Table 6.5.3). Five species may be process-limited (Table 6.6). Populations of lake whitefish and brook trout may be threatened by direct exploitation, harassment or ecological interactions in Nova Scotia (Table 6.7). Brook trout are also considered to be sensitive to high annual variation in river or stream flow. Creek chub, white sucker and white perch may also be potentially process-limited because they are considered to be sensitive to pollution, acidification and/or climatic changes (Table 6.6).

Seven freshwater fishes may be area-limited (Table 6.6). American eel, lake whitefish, brook trout, golden shiner and yellow perch are considered to be space-demanding or wide-ranging (Table 6.7). In addition, habitat of lake whitefish may be threatened by loss, conversion, degradation or fragmentation in Nova Scotia.

Freshwater fishes considered to be vulnerable or potentially vulnerable in Kejimkujik National Park appear to be primarily limited by dispersal related factors. All ten species are identified as dispersal-limited in both the initial and secondary assessments (Tables 6.6 and 6.7). Seven species may have limited dispersal powers, including lake whitefish, golden shiner, creek chub, white sucker, brown bullhead, banded killifish, and yellow perch. Brook trout and white perch are considered to be dependent upon unimpeded or unobstructed watercourses. American eel may also be considered vulnerable to potential dispersal-limitations in the future because of their requirements to range widely.

Five species may be considered to be resource-limited (Table 6.6). Brook trout has specialized habitat, diet and/or reproduction requirements, however specific resources which may be limited have not been identified (Table 6.7). Golden shiner, white sucker, white perch and yellow perch may also be potentially vulnerable to resource-limitations due to the characteristics of their populations as being seasonally or daily concentrating and/or extremely variable in population density (Table 6.6).

Brook trout is identified in every category of limitation type in both the initial and secondary assessments (Tables 6.6 and 6.7). Brook trout may be limited by processes, area, dispersal, and resources, and may represent a priority species for landscape-level management attention in the Kejimkujik National Park region. White sucker and white perch may also be potentially limited by all categories of limitation factors. Golden shiner and yellow perch may be limited by three categories of factors, including area-limited, dispersal-limited and resource-limited (Table 6.7).

6.4.4.4 Freshwater fishes that do not occur in Kejimkujik National Park

Several freshwater fishes that do not occur in Kejimkujik National Park were identified as potential focal-species (Refer to Table 4.15 in Chapter 4). These species include Atlantic salmon, lake trout, Atlantic whitefish, blueback herring, Atlantic sturgeon, and rainbow smelt. These species were also assessed to identify the types of landscape-level limitations for management attention within Nova Scotia (Tables 6.5.4, 6.6, and 6.7). All of these six species, with the possible exception of Lake trout, may be limited by all four categories of limitation factors. Thus they may all represent important species for landscape-level management attention.

Five species may be process-limited (Table 6.6). Atlantic whitefish and Atlantic salmon populations are considered to be threatened by direct exploitation, harassment or ecological interactions in Nova Scotia (Tables 6.5.4 and 6.7). Atlantic salmon may also be sensitive to annual variation in river or stream flow, along with Atlantic sturgeon, blueback herring and rainbow smelt. Lake trout does not appear to be process-limited, but this could be primarily related to lack of knowledge or consensus regarding threats to population, and sensitivity to pollution, acidification and climatic changes (Table 6.5.4).

All six species may be area-limited, primarily because they are considered to be space-demanding or wide-ranging (Tables 6.6 and 6.7). Atlantic whitefish and Atlantic salmon are also dependent upon habitat which may be threatened by loss, conversion, degradation or fragmentation in Nova Scotia (Table 6.5.4).

All six species may also be dispersal-limited, partially because they are considered to be space-demanding or wide-ranging, but also because of additional factors (Tables 6.6 and 6.7). Atlantic whitefish and lake trout are considered to possess limited dispersal powers. Atlantic whitefish and Atlantic salmon are also dependent upon habitats which may be threatened by fragmentation. Atlantic salmon is also dependent upon unimpeded or unobstructed watercourses, as are Atlantic sturgeon, blueback herring and rainbow smelt (Table 6.5.4).

Atlantic salmon, lake trout, and rainbow smelt may also be resource-limited because of their specialized habitat, dietary or reproduction requirements (Tables 6.6 and 6.7). Atlantic sturgeon, blueback herring and lake whitefish may also be potentially limited by resource availability at certain times because populations are considered to be seasonally or daily concentrating. Although specific resource limitations have not been identified, these populations may potentially be limited by resource availability at times of highest population concentrations.

6.5 Comparison of assessments and assessment results

6.5.1 Comparison of assessment frameworks

Assessments were conducted at provincial and regional levels for vulnerable or potentially vulnerable species in Nova Scotia and the Kejimkujik National Park region. These assessments utilized various combinations of variables and categories developed within this thesis for the focal-species framework, including integration with a process developed by Lambeck (1997). The assessment frameworks differ in category headings and organization of variables, however they are related and comparable, although not without some difficulty (Table 6.9). There is a certain amount of overlap of variables among categories, and categories differ among assessments. Table 6.9 provides a summary of categories and variables for the different assessments.

For example, the variable space-demanding/wide-ranging is a separate category in Table 6.1, where as it is contained within the category biological-spatial characteristics in Tables 6.2.1 and 6.2.2. It is also related to the area-limited categories in Tables 6.5.1 to 6.5.4, 6.6, and 6.7). Habitat-related specialization, which includes specialized habitat, dietary, or reproductive requirements in Tables 6.2.1 and 6.2.2, may also be related to resource-limitations, but also to area- or dispersal-limitations in Tables 6.5.1, 6.5.2, 6.6. and 6.7. This factor or characteristic also illustrates the need to examine each habitat or patch type and particular resource requirements for potential limitations. The term Human-impact factors was changed to Impact factors because the category includes variables such as threats to population and to habitat which do not differentiate between human and non-human causes. However, the variables in the Impact factors category in Tables 6.2.1 and 6.2.2 generally may be related to process-limitations in Tables 6.5.1 to 6.5.4, 6.6, and 6.7, which include ecological interactions such as interspecific competition, and exploitation such as over-harvesting or illegal kill (Table 6.9).

The differences in terminology among assessments is a result of the attempt to remain consistent with the variables and categories used in the focal-species framework while integrating them with Lambeck's process (1997). Determining which variables to relate to the categories of process-, area-, dispersal-, or resource-limitations, requires subjective judgment because certain variables may be related to more than one category. The rationale for completing many assessment types is to test the various combinations of variables and categories within the assessment frameworks.

For example, results are generally the same among the various assessments regarding mammal species. However, within reptiles and amphibians, less species tend to be identified in the space-demanding variable in Table 6.1 than in the parallel category area-limited category in Tables 6.5.1 to 6.5.4, 6.6 and 6.7. This is because the area-limited category in Tables 6.5.1 to 6.5.4, 6.6 and 6.7 includes additional related variables such as habitat threatened by loss, conversion, degradation and fragmentation. For freshwater fishes, differences arise between the categories related to dispersal arise because the category dispersal-limited in Tables 6.5.1 to 6.5.4, 6.6, and 6.7 includes those that are wide-ranging, limited dispersal power and dependent upon unimpeded/ unobstructed watercourses. In Tables 6.2.1 and 6.2.2, variables related to dispersal such as limited dispersal power and dependent upon unimpeded/unobstructed watercourse are split within the two categories of biological-spatial characteristics and habitat-related specialization. In Table 6.1, limited dispersal power and dependent upon unimpeded/ unobstructed watercourses are separate categories.

The major difficulty seems to be that although some characteristics or requirements of species or populations may be known, in many cases it is not known whether these are the limiting factors to the species or population in Nova Scotia. For example, are vulnerable populations of individuals with limited dispersal power actually dispersal-limited? Or is their limitation actually a result of a resource limitation, which, if not specifically identified, should be characterized as an area limitation, which Lambeck (1997) suggests should act as a surrogate for unknown resource-limitations?

Table 6.9: Comparison of categories and variables from focal-species framework with those integrated with Lambeck's process

Table 6.1	Tables 6.2.1 and 6.2.2	Tables 6.5.1 to 6.5.4 and Table 6.6	Table 6.7
Threats	**Impact factors**	**Process-limited**	**Process limited**
Population threatened by direct exploitation, harassment or ecological interactions	Population threatened by direct exploitation, harassment or ecological interactions	Population threatened by direct exploitation, harassment or ecological interactions	Population threatened by direct exploitation, harassment or ecological interactions
Habitat threatened by loss, conversion, degradation or fragmentation in N.S.	Habitat threatened by loss, conversion, degradation or fragmentation in N.S.	Sensitive to acid precipitation or climate change	
	No management activities directed at taxon	Pollution susceptible/accumulator species	
	Legally harvested/killed in N.S.	Sensitive to high annual variation in river/stream flow (freshwater fishes only)	
Requirements:	**Biological-spatial characteristics**	**Area-limited**	**Area-limited**
Space-demanding/wide-ranging	Space-demanding/wide-ranging	Space-demanding/wide-ranging	Space-demanding/wide-ranging
	Population seasonally/daily concentrating, or species which concentrate spatially	Population seasonally/daily concentrating, or species which concentrate spatially	
	Extremely variable in population density	Dietary and reproductive specialization	
Limited dispersal power	Limited dispersal power	Habitat specialization	
	Low reproductivity or fecundity	Dependent upon provincially rare habitat	
	Large-bodied/largest member of feeding class	Habitat threatened by loss, conversion, degradation or fragmentation in N.S.	Habitat threat. by loss, conversion, degradation, fragmentation
	Pollution susceptible/accumulator species	Old-growth or Non-disturbance species	
	Habitat-related specialization	Sensitive to high annual variation in river/stream flow (freshwater fishes only)	
Habitat, dietary and reproductive specialization	Dietary and reproductive specialization Habitat specialization	**Dispersal-limited**	**Dispersal-limited**
Depend. upon prov. rare habitat	Dependent upon provincially rare habitat	Space-demanding/wide-ranging	Space-demanding/wide-ranging
	Climatic sensitivity	Limited dispersal power	Limited dispersal power
	Sensitive to high annual variation in river/stream flow (freshwater fishes only)	Habitat threatened by loss, conversion, degradation or fragmentation in N.S.	Habitat threat. by loss, conversion, degradation, fragmentation
Dependent upon unimpeded /unobstructed watercourse	Dependent upon unimpeded /unobstructed watercourse (freshwater fishes only)	Dependent upon unimpeded /unobstructed watercourse (freshwater fishes only)	Dependent upon unimpeded/ unobstructed watercourse
	Information status	**Resource-limited**	**Resource-limited**
	Limited kowledge of distribution in N.S.	Dietary and reproductive specialization	Dietary and reproductive specialization
	Population trends not regularly monitored		
	Factors limiting population in N.S. unknown	Habitat specialization	Habitat specialization
	No autecolohical studies in N.S.	Population seasonally/daily concentrating	
	No (meta) pop. viability analysis in N.S.	Extremely variable in population density	

A second difficulty is that even if the factors limiting a population are known, it is not always easy to distinguish whether these factors are process-, area-, dispersal-, or resource-limitations. For example, are wide-ranging species which are limited by landscape factors considered to be area-limited or dispersal-limited? Information about the extent of habitat loss or fragmentation, as well as the impacts on the particular species, is required to make the distinction. Although individuals of certain species may be biologically capable of ranging widely, specific habitat requirements may prohibit their movements. In this sense, should all vulnerable species with special habitat, dietary or reproductive requirements be considered dispersal-limited? Or are they primarily area-limited or resource-limited? Finally, many of these limiting factors could also be considered to be process-limiting because almost all the limiting factors to vulnerable species in Nova Scotia are related to management practices of one sort or another, including resource management and landscape planning, and could be alleviated through management practices which incorporate ecological considerations.

In general, similar results were obtained among the various assessments. Some assessments generated longer lists of species within particular categories or variables. Multiple variable categories enabled a rough cluster analysis which may serve to rank species as more resource-demanding than others. However, single variable assessments preserve the ability to link individual species with specific limiting factors or characteristics such as space-demanding/wide-ranging, or limited dispersal powers. Single variable assessments result in lists of all species identified with each factor. Multiple variable categories generate even longer lists of species satisfying the various factors, which is then shortened by selecting only those species identified with a number of factors. Although this may help to prioritize or identify species satisfying several factors, key species which are linked with only one or a few of the most salient factors may be missed.

It may be beneficial to conduct both single variable and multiple variable types of assessments. Generally, these assessments are supportive of each other, and the identification of certain species through both types of assessments may highlight focal-species or species warranting special management attention at the landscape level. No single assessment framework appears to be better than the others. All contain inherent difficulties, primarily related to definition of categories and uncertainty regarding the information required to identify, for example, dispersal- or area-limitations.

The most salient factors for defining landscape-level limitations and for integrating with Lambeck's framework may be those summarized in Table 6.10. These salient factors are similar to but slightly more rigorously defined than those utilized in the secondary assessment as summarized in Table 6.8.

Table 6.10: Salient factors for integration with Lambeck's framework

1. Process-limited:

1.1 Population threatened by direct exploitation, harassment or ecological interactions in N.S.

2. Area-limited:

2.1 Space-demanding/wide-ranging
2.2 Habitat threatened by loss, conversion, degradation or fragmentation in N.S.
2.3 Habitat specialization
2.4 Dietary and reproductive specialization (when no other limiting factor is known or no specific resource limitations can be identified)
2.5 Sensitive to high annual variation in river/stream flow (freshwater fishes only)

3. Dispersal-limited:

3.1 Limited powers of dispersal
(Wide-ranging species may also come into consideration here, especially in combination with habitat specialization or habitat threatened by loss, conversion, degradation or fragmentation)
3.2 Dependent upon unimpeded/unobstructed water course (freshwater fishes only)

4. Resource-limited:

4.1 Dietary and/or reproductive specialization (when specific resource limitations are known

6.5.2 Comparison of results

As previously mentioned, similar results were obtained among the various assessments. Tables 6.11 and 6.12 synthesize the results of all the assessments at provincial and regional levels. In Nova Scotia, area- and dispersal-limited species include fisher, lynx, American moose, wood turtle, Blanding's turtle, northern ribbon snake, pickerel frog, Atlantic whitefish, Atlantic salmon and brook trout. In Kejimkujik National Park and region, area- and dispersal-limited species include fisher, American moose, Blanding's turtle, snapping turtle, brook trout, and yellow perch. These and additional species other categories of limiting factors warrant landscape-level biodiversity management attention (Tables 6.11 and 6.12).

The species identified within these tables tend to represent the highest common denominator in that they include only those species that were identified in every assessment type in the related variable or category. As a result, certain key species may be missed. However, the identified species represent species that warrant special management attention relative to specific limiting-factor categories. Additional thought, information, and research is necessary to refine the assessment framework and to link these species with specific habitat parameters at the landscape level.

6.6 Identifying focal-species within categories

In theory, the next step in this process is to rank the species within each limitation category according to relative sensitivity to the threat or according to the species with the most demanding requirements for that limiting factor. The previous summaries of assessment results in Tables 6.6, 6.7, 6.11, and 6.12 may represent a preliminary attempt at this ranking through rough cluster analyses. However, further and more detailed information is required to identify the species with the greatest requirements or sensitivities within each limitation category, both in general and in reference to each specific habitat or patch type.

It is critical to conduct assessments linking species to landscapes for each particular patch type because, for example, the area requirements of populations of species requiring old-growth forest habitat is not relevant to considerations of area requirements of wetland species. Protecting sufficient habitat area for American marten does not necessarily protect the area requirements of Blanding's turtle. Similarly, managing the process-limitations of American moose, such as interspecific competition with white-tailed deer or illegal kill, will not necessarily protect communal hibernacula in caves and abandoned mines from human activities which threaten populations of little brown bat, northern long-eared bat and eastern pipistrelle.

Further research is required to better understand the range of processes which limit specific populations within particular biogeographical regions. The habitat and resource requirements of vulnerable or focal-populations within each region need to be better understood. Assessments should be completed within each habitat or patch type for the vulnerable or potentially vulnerable species that utilize that habitat type. Research and monitoring programs could be developed to study focal-populations relative to limitation factors within each habitat patch type, in order to determine the most resource-demanding species and their needs These species could then be utilized to define landscape-level parameters relative to their needs. The first step is to determine which species are the most resource demanding within each patch type and limitation category, and then to determine more precisely what those needs are for a viable population. Research and monitoring studies regarding focal-populations and landscape limitations should be conducted as part of biodiversity management and could be integrated with existing monitoring polices, frameworks and programs in national parks, such as at Kejimkujik and Cape Breton Highlands National Parks.

Table 6.11: Focal-species for landscape management-reconstruction assessment in Nova Scotia

Management response	Structure/Reconstruction response		
Process-limited	**Area-limited**	**Dispersal-limited**	**Resource-limited**
Mammals			
Arctic shrew Little brown bat Northern long-eared bat Eastern pipistrelle American marten Fisher River otter Lynx American moose	Fisher Lynx American moose	Fisher Lynx American moose	Gaspé shrew Long-tailed shrew American marten Southern flying squirrel Rock vole
	Little brown bat Northern long-eared bat Eastern cougar *	Little brown bat Northern long-eared bat American marten *	
Reptiles and Amphibians			
Wood turtle Blanding's turtle Northern ribbon snake Blue-spotted salamander Four-toed salamander	Wood turtle Blanding's turtle Northern ribbon snake Pickerel frog	Wood turtle Pickerel frog	Wood turtle Northern ribbon snake Blue-spotted salamander Four-toed salamander
		Blanding's turtle Northern ribbon snake	
Freshwater fishes			
Atlantic whitefish Atlantic salmon Brook trout	Atlantic whitefish Atlantic salmon Brook trout	Lake whitefish Brook trout	Atlantic salmon Brook trout Lake trout Rainbow smelt Gaspereau/Alewife Blacknose dace
Atlantic sturgeon Blueback herring Lake whitefish Lake trout Rainbow smelt	Atlantic sturgeon Blueback herring Rainbow smelt	Atlantic whitefish Atlantic salmon	
	Lake trout Lake whitefish	Atlantic sturgeon Blueback herring Lake trout Rainbow smelt	

Note:
1. * Coyote, American black bear and bobcat are also potentially area-limited and dispersal-limited because of their space-demanding/wide-ranging characteristics, however they have been omitted from this list because they are not considered to be at risk at the present time and their populations and habitats are not considered to be threatened. Lynx and eastern cougar are probably extirpated on mainland Nova Scotia but a small remnant population of lynx remains in Cape Breton Island.
2. Lake whitefish may have been introduced to Nova Scotia.

6.6.1 Potential focal-species within categories for Kejimkujik National Park and region

Generally, priority species for further process-limited research and assessment in Kejimkujik National Park may include: little brown bat, northern long-eared bat, eastern pipistrelle, American marten, fisher, river otter and American moose; snapping turtle, Blanding's turtle, northern ribbon snake, blue-spotted salamander and four-toed salamander; and, brook trout (Table 6.12).

Potential area-limited and dispersal-limited species for further assessment in Kejimkujik National Park may include: little brown bat, northern long-eared bat, American marten, fisher, river otter and American moose; snapping turtle, Blanding's turtle and pickerel frog; and, brook trout and yellow perch.

Priority species for resource-limited research and assessment may include: American marten and southern flying squirrel; Blanding's turtle, northern ringneck snake, eastern smooth green snake and four-toed salamander; and, brook trout.

Table 6.12: Focal-species for landscape management-reconstruction assessment in the Kejimkujik National Park region

Management response	Structure/Reconstruction response		
Process-limited	**Area-limited**	**Dispersal-limited**	**Resource-limited**
	Mammals		
Little brown bat Northern long-eared bat Eastern pipistrelle American marten Fisher River otter American moose	Fisher American moose	Fisher American moose	Star-nosed mole American marten Southern flying squirrel
	Little brown bat Northern long-eared bat American marten	Little brown bat Northern long-eared bat	
	River otter *	River otter *	
	Reptiles and Amphibians		
Snapping turtle Blanding's turtle Northern ribbon snake Blue-spotted salamander Four-toed salamander*	Blanding's turtle	Blanding's turtle	Blanding's turtle Northern ringneck snake E. smooth green snake Four-toed salamander*
	Snapping turtle	Pickerel frog	
		Snapping turtle	Northern ribbon snake Blue-spotted salamander Red-spotted newt Red-backed salamander
	Freshwater fishes		
Brook trout	Brook trout Yellow perch	Brook trout	Brook trout
		Yellow perch	
		White sucker	

Note:
1. * Coyote, American black bear and bobcat are also potentially area-limited and dispersal-limited because of their space-demanding/wide-ranging characteristics, however they have been omitted from this list because they are not considered to be at risk at the present time and their populations and habitats are not considered to be threatened. Lynx and eastern cougar have also been omitted from this list because it is unlikely that individuals remain in the region or on mainland Nova Scotia.
2. Lake whitefish may be process-limited, area-limited and dispersal-limited, however it has been omitted from this list because it is considered to be an introduced species to Kejimkujik National Park and region.
3. Presence of four-toed salamander uncertain/unconfirmed in Kejimkujik National Park

6.6.2 Potential focal-species within categories for Nova Scotia

Generally, priority species for further process-limited research and assessment in Nova Scotia may include: Arctic shrew, little brown bat, northern long-eared bat, eastern pipistrelle, American marten, fisher, river otter, lynx, and American moose; wood turtle, Blanding's turtle, northern ribbon snake, blue-spotted salamander, and four-toed salamander; and, Atlantic whitefish, Atlantic salmon, and brook trout (Table 6.12).

Potential area-limited and dispersal-limited species for further assessment at the provincial level may include: fisher, lynx, and American moose; wood turtle, Blanding's turtle, northern ribbon snake and pickerel frog; and, Atlantic whitefish, Atlantic salmon, and, brook trout.

Priority species for resource-limited research and assessment may include: Gaspé shrew, long-tailed shrew, American marten, southern flying squirrel and rock vole; wood turtle, northern ribbon snake, blue-spotted salamander, and four-toed salamander; and, Atlantic salmon, brook trout and lake trout.

6.7 Further regional assessments for species existing in other areas of the province

These species and others could also be further assessed relative to specific biogeographic regions, habitat patch types, and populations existing outside of Kejimkujik National Park. Certain mammal species such as Arctic shrew, Gaspé shrew, long-tailed shrew, silver-haired bat, American marten, eastern cougar, and lynx could represent priority species for additional assessments because of regionally specific circumstances, status and distribution.

For example, Arctic shrew, Gaspé shrew, long-tailed shrew, and lynx are among the species that do not or may not exist in Kejimkujik National Park. Although lynx was included in the assessment for Kejimkujik National Park and region to be consistent with other assessments within the thesis, it is becoming increasingly accepted that lynx has been extirpated on the mainland but continues to persist in small, geographically isolated, remnant populations on Cape Breton Island, although threatened by interspecific competition, habitat loss and fragmentation and other factors. American marten populations in Kejimkujik National Park and area were reintroduced in the 1980s, however, a small remnant of a native population persists on Cape Breton Island, although threatened by geographical isolation, habitat loss and fragmentation and other processes. Eastern cougar represents a special case in that its status on both the mainland and Cape Breton Island is uncertain, although it is suspected that it has been extirpated; its status evaluation by NSDNR has been deferred pending a status report by F.W. Scott (NSDNR 1997b). Although these species may not warrant further research and assessment in the Kejimkujik National Park area for these various reasons, they may represent priority species for further research and assessment in other regions, particularly on Cape Breton Island.

In contrast, the American moose population in Kejimkujik National Park region represents a remnant of the native moose population, whereas American moose in Cape Breton Highlands were reintroduced from Alberta in 1947 by Parks Canada and are not considered to be at risk (Pulsifer and Nette 1995; Aikenhead 1997; NSDNR 1997b). Similarly, fisher were reintroduced to the province around 1947-48 and 1963-66; while current occurrences in the Kejimkujik National Park area are widely scattered, populations in the eastern counties of the mainland are considered to be relatively secure (NSDNR 1997b). Whereas the American moose and fisher may represent priority species for further research in Kejimkujik National Park, they may not warrant further special biodiversity management attention in other regions of the province.

Blanding's turtle does not exist in areas of Nova Scotia outside of the southwestern portion of the province. Northern ribbon snake is known only in Queens and Lunenburg counties in Nova Scotia (NSDOEd., no date). Although these species may represent priority species for further assessment in Kejimkujik National Park, further research may not be warranted elsewhere in the province. Snapping turtle probably does not exist in Cape Breton Island outside of a few isolated individuals believed to be released captive turtles. Northern ringneck snake is rare in the northern portions of the mainland and Cape Breton Island (NSDOEd., no date). Snapping turtle and northern ringneck snake may warrant further assessment in areas of the mainland other than Kejimkujik National Park, but are probably not of concern in Cape Breton.

However, wood turtle is identified as a vulnerable or potentially vulnerable species in Nova Scotia, although it does not exist in Kejimkujik National Park or region. Wood turtle is considered to be most common in the northeastern portion of the mainland and in southwestern Cape Breton Island (NSDOEd., no date). Wood turtle may represent a priority species for further research and assessment to determine its limitation factors in those areas. Frogs and salamanders generally require further research and assessment throughout the province, particularly: bullfrog, pickerel frog, and northern leopard frog; and, blue-spotted salamander, and four-toed salamander.

Brook trout, golden shiner and yellow perch are species existing within Kejimkujik National Park that may warrant further research and assessment in other parts of the province. Lake whitefish is considered to have been introduced into Kejimkujik National Park, although its origin within the province as a whole has been debated or uncertain. It appears that lake whitefish may have been introduced to the province (Davis and Browne 1996), and as such may not warrant special attention afforded native species. It was assessed within this thesis because of the uncertainty related to its origin at the beginning of this research.

As previously discussed, several vulnerable or potentially vulnerable freshwater fishes exist in Nova Scotia that do not exist in Kejimkujik National Park. Species such as Atlantic sturgeon, blueback herring, Atlantic whitefish, Atlantic salmon, lake trout and rainbow smelt may represent priority species for further assessment in various regions of the province to identify limiting factors relative to specific populations and biogeographic areas.

6.8 American moose: Linking area-limited species with landscape parameters

Considering mammal species alone, and making broad generalizations about home-range or area requirements, without reference to specific habitat or patch types, some observations may be made. For example, of the vulnerable or potentially vulnerable species existing or possibly existing in Kejimkujik National Park, fisher, river otter, eastern cougar, lynx and American moose have the largest home-range area requirements (Refer to Table 3.5 for estimated home-range sizes). Of these species, the two species with the largest area-requirements, eastern cougar and lynx, are considered to be extirpated or probably extirpated from the mainland or from the province. Fisher was likely extirpated throughout the mainland prior to 1930, and was later reintroduced. American moose was extirpated throughout the province with the exception of a small remnant population in the Kejimkujik region, and was later reintroduced.

Factors other than habitat loss and fragmentation likely played a role in the extirpation of these species, including process-limited factors such as interspecific competition and hunting and trapping. However, river otter and American moose remain as potentially the most vulnerable native populations with large-area requirements in the Kejimkujik National Park region.

While river otter is not considered to be vulnerable at this time, American moose is being increasingly considered to be at risk. Habitat loss and fragmentation, primarily through extensive forest harvesting, is considered to be one of the key factors (Pulsifer and Nette 1995). Habitat loss and fragmentation are also important factors in an indirect way. Loss, conversion, degradation or fragmentation of optimum habitat for American moose often results in improved access and habitat for white-tailed deer. This results in increased interspecific competition among American moose and white-tailed deer and higher rates of infection by the brain worm, *Parelaphostrongylus tenuis*, which is usually fatal for moose but not for deer. *P. tenuis* may be the limiting factor for recovery of American moose where moose and deer range overlap (Telfer 1967; Pulsifer and Nette 1995; NSDNR 1997b).

Mean summer home-range and habitat use of an individual American moose, *Alces alces*, in northern Maine has been calculated by Leptich and Gilbert as approximately 25 km^2, or 2500 hectares (1989, 882). Summer home-range and habitat use was determined by tracking and examining 13 radio-collared moose from May to August during 1984 and 1985. Findings were determined to be consistent with other studies of American moose home-ranges in Maine. Individual home-range sizes varied between 2 km^2 (200 hectares) and 60 km^2 (6000 hectares), with part of the variability being due to special movements associated with aquatic habitats. Moose normally found close to a lake had smaller home ranges (Leptich and Gilbert 1989, 882). No difference was found between home-range sizes of males and females; home-range boundaries of different individuals were shown to overlap; and, fidelity to summer home-ranges was indicated.

Home range was defined as "that area normally traversed by an organism for food collecting, breeding, and rearing young" (Burt 1943, as cited in Leptich and Gilbert 1989, 880). Moose populations in different areas vary from sedentary with a single home range to migratory with distinct seasonal home ranges. Moose in Maine are largely sedentary with winter ranges within or adjacent to summer ranges (LeResche 1974, Dunn 1976, and Crossley and Gilbert 1983 as cited in Leptich and Gilbert 1989).

The mean summer home-range and habitat use area calculated by Leptich and Gilbert (1989) is the figure used to estimate home-range and minimum critical area requirements for viable populations of American moose in Chapter 3 (Refer to Table 3.5). It is assumed that American moose home-range behavior and size is similar in Nova Scotia to that in Maine; Nova Scotia and Maine are in similar biogeographic regions. It is necessary to utilize findings from comparable regions because information specific to home-range and habitat use in Nova Scotia does not exist.

Home-range area requirements for a short-term viable population of American moose (Ne=50) was estimated to be 125,000 hectares (50x2500ha). Allowances for overlap in home-range boundaries of different individuals as observed by Leptich and Gilbert (1989) were not included in the calculation. As previously discussed, Kejimkujik National Park and Tobeatic candidate protected areas combined may provide the estimated home-range area requirements of a short-term viable population of American moose. Long-term viability would require a much greater area, probably by as much as ten times or about one order of magnitude. Further, this does not include allowances for natural disturbances or redundancy.

However, these estimates are not based on field studies of home-range requirements of populations. Viable population sizes are not known and are merely estimates derived from in-breeding considerations for domestic species (Franklin 1980). Population viability and home-range requirements will vary with specific populations and habitat or biogeographic characteristics. Further study of area- and dispersal-requirements and habitat of American moose in the Kejimkujik-Tobeatic region is warranted. Research related to American moose and white-tailed deer interactions is also warranted to provide information for addressing the potential process-limitation related to the brainworm *P. tenuis*.

Habitat and populations of American moose are considered to be threatened by loss, fragmentation, conversion, degradation and exploitation or ecological interactions. American moose has also been identified as area- and dispersal-limited at both the provincial and Kejimkujik National Park regional levels through the assessments within this chapter (Tables 6.11 and 6.12). Further, the American moose population in southwestern Nova Scotia represents a special value for biodiversity in that it is the last remnant of the native American moose population in Nova Scotia.

No focused moose survey program has been conducted to assess the status of populations on the mainland since the closing of the mainland moose hunting season in 1982 (Pulsifer and Nette 1995). An informal aerial survey flown in the winter of 1993 over a 400 km^2 portion of the Tobeatic region indicated the possibility of a relatively large herd for that area. However, the results were accompanied by a caution regarding the interpretation of these results because the moose were sighted in a relatively small area which may be part of a much larger region (7283 km^2) previously identified and designated as of low moose density by Telfer (1968, in Pulsifer and Nette 1995, 213-14). Subsequent informal aerial surveys of this same area have not located a comparable number of moose (Pulsifer and Nette 1995).

NSDNR is increasingly concerned about mainland American moose populations and the remnant native American moose population in the Kejimkujik-Tobeatic area in particular (Nette 1997 pers. comm.). Tony Nette, wildlife biologist in charge of American moose and other big game management for NSDNR, has been quoted as stating that, "the species is in greatly reduced numbers; their numbers are so low, any loss is a serious loss" (Aikenhead 1997, 23). As a result of this concern, NSDNR is conducting a survey of American moose in the Tobeatic Wildlife Management Area near Kejimkujik National Park. Ten adult moose will be radio-collared and helicopter surveys will be conducted to track habitat use over one or two years (Nette 1997 pers. comm.; Aikenhead 1997).

Kejimkujik National Park has identified transboundary issues including species migration and habitat as a key priority in the draft *Ecosystem Conservation Plan* (Drysdale 1997b pers. comm.). American moose has been suggested as a potential species for research and monitoring related to transboundary issues, partly as a result of the research presented within this thesis, but primarily as a result of the American moose study being conducted by NSDNR (Drysdale 1997b pers. comm.). Further information regarding American moose population and habitat status would contribute to Kejimkujik National Park's ecosystem management goals related to ecological integrity and biodiversity, particularly regarding transboundary phenomenon.

This survey of winter home-range is of particular interest as a complement to the summer home-range information determined for northern Maine. Further, it may be useful for identifying limiting factors such as area and dispersal for American moose. American moose is an important species for this type of wildlife-habitat relationship study because the species may generally be considered a focal-species and a useful indicator species at the population level. It can also inform landscape-level parameters because it is may be represent a priority area-limited population.

In the Kejimkujik-Tobeatic area, it is important to study the American moose for these reasons, but also because the population is a vulnerable remnant of the native moose population. As a focal-species, a greater understanding of American moose home-ranges could help define population and landscape-level parameters for protected area planning and management issues, as well as broader integrated resource management and land use planning.

American moose could provide a focus for research and monitoring, as well as education and interpretation, and co-operative and partnership arrangements. Understanding and communicating home-range requirements for viable populations of the last remaining remnants of the native American moose herd in Nova Scotia could provide an easily understood and compelling rationalization in support of transboundary biodiversity management initiatives such as a greater ecosystem or biosphere reserve.

6.9 Summary conclusions

Habitat loss and fragmentation are the primary causes of species and population extirpations in the temperate zone (Harris 1984; Hunter 1990). Landscape-level approaches and considerations are required to address this aspect of biodiversity management. However, landscape-level parameters have no meaning for biodiversity management outside of the requirements of the species, populations and processes that comprise that landscape.

The majority of losses to biodiversity in the temperate zone occur at the population level (Daily and Ehrlich 1997-1998). In order to maintain biodiversity in Nova Scotia, populations of native species must be protected or enhanced. Focal-species can provide a focus for biodiversity management efforts at the species-population level by identifying those species most in need of biodiversity management attention. If the focal-species with the most demanding habitat and resource requirements can be identified, then they may serve as a multi-species umbrella (Lambeck 1997).

By defining the habitat and resource needs of the most demanding focal-species and populations, landscape-level biodiversity management decisions can be meaningfully considered. Landscape-level parameters such as habitat size, shape, connectivity, and quality can be defined and accommodated within the broader landscape. Biodiversity management area boundaries may be drawn. If the landscape satisfies the habitat requirements of the most resource and habitat demanding species, the needs of many other species will also be accommodated.

Frameworks for identifying the most resource and habitat demanding species were developed, tested and assessed. Variables from the focal-species framework were integrated with Lambeck's (1997) process for identifying species for defining landscape attributes. The various results from these assessments were summarized and compared and preliminary conclusions were drawn regarding potential focal-species warranting biodiversity management attention at the landscape level. Focal-species were categorized according to threat or limiting factors. Preliminary cluster analysis provide tentative indications of species with the most-demanding resource or habitat requirements within each threat or limitation category. Assessments were conducted at both the regional and provincial levels.

A synthesis of all of these assessments and considerations suggest that all of the frameworks produce similar results, outside of differences resulting from regional variations. Lambeck's (1997) process of linking focal-species with limiting factors is useful as a conceptual framework. However difficulties were experienced in attempting to define or identify the various factors which might comprise the categories, thus making it operational. Development of a suitable framework is a challenge because factors or variables may apply to more than one limitation category. Further, the most appropriate category to which any particular limiting factor might belong is not always apparent. More rigorous definition of categories and variables, as well as information regarding specific populations, habitats and landscapes, is required to refine the framework.

However, based on the assessments that were completed, certain recommendations may be made. For example, overlap and duplication of variables among the limiting-factor categories should be minimized. The most suitable framework would contain only the most salient factors for defining the limiting-factor category.

The list of categories and variables summarized within Table 6.10 represents the most salient factors selected from the focal-species framework, integrated with Lambeck's limitation categories. Further thought and experimentation may be required to refine the framework.

The various frameworks that were tested were found to be useful for identifying focal-species related to limiting-factor categories. Similar results were obtained among the assessments. Preliminary identification of potential focal-species may be made at both the provincial and regional levels. Tables 6.11 and 6.12 summarize the regional and provincial synthesis of results.

Certain focal-species were identified by both the provincial and Kejimkujik National Park region assessments. These species may represent priority species for landscape-level biodiversity management. Process-limited species include: little brown bat, northern long-eared bat, eastern pipistrelle, American marten, fisher, river otter and American moose; Blanding's turtle, northern ribbon snake, blue-spotted salamander and four-toed salamander; and brook trout.

Area- and dispersal-limited species identified at both regional and provincial levels were the same with the exception of pickerel frog which is not considered to be area-limited. Species which are both area- and dispersal-limited include fisher, American moose, little brown bat, northern long-eared bat, Blanding's turtle and brook trout.

Species which may be resource-limited at both provincial and regional levels include: American marten, southern flying squirrel, northern ribbon snake, blue-spotted salamander, four-toed salamander and brook trout. Resource-limited factors are the most difficult to identify relative to specific species and resources. These species are primarily species that have specialized habitat and resource requirements. They could perhaps be more appropriately considered area-limited, as a surrogate of undefined or potential resource limitations.

Comparisons of provincial-level assessments with other regional assessments would produce different results. For example, Gaspé shrew, lynx, wood turtle, Atlantic whitefish and Atlantic salmon were identified in the provincial assessment and would be identified in regional assessments in areas where they occur. For this reason, these species are incorporated into a summary list of potential focal-species warranting landscape management or reconstruction attention at both regional and provincial levels in Nova Scotia (Table 6.13). Eastern cougar is also included although its status in Nova Scotia is uncertain.

Table 6.13: Focal-species for landscape management-reconstruction assessment at both provincial and regional levels in Nova Scotia

Management response	Structure/Reconstruction response		
Process-limited	**Area-limited**	**Dispersal-limited**	**Resource-limited**
Mammals			
Little brown bat North. long-eared bat Eastern pipistrelle American marten Fisher River otter Eastern cougar* Lynx American moose	Little brown bat North. long-eared bat Fisher Eastern cougar* Lynx American moose	Little brown bat North. long-eared bat American marten Fisher Lynx American moose	Gaspé shrew Long-tailed shrew American marten South. flying squirrel Rock vole
Reptiles and Amphibians			
Blanding's turtle Northern ribbon snake Blue-spot. salamander Four-toed salamander	Wood turtle Blanding's turtle	Wood turtle Pickerel frog Blanding's turtle	Wood turtle Northern ribbon snake Blue-spot. salamander Four-toed salamander
Freshwater fishes			
Brook trout Atlantic whitefish Atlantic salmon	Atlantic whitefish Atlantic salmon Brook trout	Brook trout Atlantic whitefish Atlantic salmon	Atlantic salmon Brook trout

Note: Eastern cougar has been included although its status in Nova Scotia is uncertain

Populations of wood turtle, Atlantic salmon, and brook trout are identified as limited by all four categories of factors. Little brown bat, northern long-eared bat, American marten, fisher, lynx and American moose, Blanding's turtle, and Atlantic whitefish are identified within three categories of limiting factors. These species may require a combination of management responses and landscape reconstruction responses such as habitat and corridor protection, enhancement and restoration.

Although these species have been identified with a category of limiting factors, it was not possible to identify the most demanding species within each category because of information and time limitations. Additional research is necessary to identify the limiting factors related to each of these species, as well as the requirements of populations of these species in relation to the limiting factors. Greater autecological information on species-habitat relationships in the specific biogeographical context is required. The species identified above may represent priorities for such research. The limiting factors and the variables which define those factors may provide guidance as to the specific landscape-level or habitat information required for each species. In this way, research and monitoring could be strategically oriented towards specific biodiversity objectives.

However, it is also possible to make some broad generalizations about area-limited species based on home-range calculations alone. Many factors other than home-range size contribute to area-limitations, such as supply, quality or configurations of habitat. However, generally speaking, species with large range sizes may be more likely than other species to be area-limited.

The most-demanding area-limited species, excluding freshwater fishes, based on estimated home-range areas alone are fisher, eastern cougar, lynx and American moose. Eastern cougar has the largest area requirement by far (Refer to Table 3.5 in Chapter 3). This is likely a contributing factor in its probable extirpation from Nova Scotia.

Lynx has the second largest home-range requirement, and has essentially been extirpated from the mainland. A small remnant population exists in the Cape Breton Highlands. Protection of the lynx in Nova Scotia will require protection and enhancement of habitat in the Cape Breton Highlands, in the order of 455,000 hectares for a short-term minimum viable population (Ne=78) (Refer to Table 3.5 in Chapter 5). This is more than three times the size of the largest group of protected areas, Cape Breton Highlands National Park and Pollett's Cove/Aspy Fault.

American moose requires 125,000 hectares of habitat for a short term minimum viable population (Ne=50). American moose probably represents the most-demanding area-limited species on the mainland, in light of the extirpation of lynx, eastern cougar, wolf and woodland caribou. Habitat area-requirements of viable populations of American moose probably represent the landscape parameter for minimum habitat size to maintain biodiversity in mainland Nova Scotia. This minimum parameter remains to be defined. Considerations other than home-range estimates must be incorporated, such as viable population size, natural and other disturbance regimes and the biogeographical context. Long-term viability will require even larger areas.

Further assessments are required to identify the most resource-demanding focal-species in various regions of the province. Regional-level assessments are recommended in order to consider context specific factors related to population and habitat status. Landscape-level parameters need to be defined relative to the populations and processes that comprise the landscape within the particular context.

The final chapter attempts to synthesize the discoveries described within the thesis. Recommendations are made regarding the focal-species approach and its application at both provincial and regional levels. Conclusions are drawn regarding its potential for integration with other applications such as selecting indicators and making linkages to the landscape level. Its necessity for biodiversity management in Nova Scotia and elsewhere in the temperate region is reaffirmed.

Chapter 7

Conclusion: Synthesis

7.1 Introduction

The preceding chapters have described, developed, and assessed a number of factors related to managing for biodiversity in Nova Scotia with a focus on protected areas and the species-population level. A rationale for maintaining biodiversity was described, and major changes to biodiversity along with the main causes of losses have been identified. The literature on ecological considerations for protected area design and maintenance of biodiversity has been examined for application to biodiversity management in Nova Scotia. The necessity of including species-population level information in protected area and broader landscape management and planning was established. It has been argued that the identification of focal-species, or those most warranting of special biodiversity management attention, can serve to focus priorities for biodiversity management.

An approach for identifying the most appropriate suite of focal-species for Nova Scotia was developed, tested and assessed, with participation from experts through a Delphi survey method. The focal-species approach and Delphi survey constitute the primary research components of the research. The approach was found to be useful and potential focal-species were identified for Nova Scotia.

The focal-species approach was adapted and applied at the regional level to identify indicator species for monitoring population-level dynamics as a measure of biodiversity at Kejimkujik National Park. The approach was found to be applicable and useful and potential indicator species were identified.

The approach was then applied to develop and test frameworks for linking focal-species or populations with landscape-level parameters. Assessments were conducted for the Kejimkujik National Park region as well as for Nova Scotia. The focal-species or populations with the most-demanding habitat and resource requirements were tentatively identified. Additional, regionally specific information was found to be required to confirm the most appropriate suite of habitat-limited focal-species and to define specific landscape level parameters.

This concluding chapter summarizes and attempts to synthesize these results. The biodiversity context and need for a focal-species approach is reviewed. The focal-species approach, its application, results and limitations are assessed. The potential value of the approach for integrating species-population and landscape-level considerations for biodiversity management is described. Directions for further research are recommended.

7.2 Biodiversity context in Nova Scotia

Nova Scotia has evolved over 600 million years since its origin in the late Precambrian era. Major events such as continental collision and rifting, glaciation, fire, and re-colonization and distribution of biological life have resulted in a geologically and biologically diverse province. The peninsular land mass functions essentially as an island, offering limited opportunity for migration or dispersal into or out of the province. Sufficient areas of land and water to support viable populations of native species need to be protected within Nova Scotia to maintain current levels of native biological diversity.

Species and populations which previously existed in Nova Scotia such as wolf and woodland caribou have been lost. At least thirty-five species found or once found in Nova Scotia are threatened (COSEWIC 1993 as cited in NSDNR 1994). Several species are considered to be at risk or particularly sensitive to human activities or natural events (Elderkin and Boates 1996; NSDNR 1996a; 1997b).

These and other changes in Nova Scotia represent losses in native biodiversity at all levels, including landscape, community, ecosystem, species, population and genes. These losses primarily result from human activities which convert and fragment habitat, allow over-exploitation and harassment, favor competing species, and interfere with natural processes such as fire. If current levels of native biodiversity are to be maintained or enhanced, land use and other management practices will have to take ecological considerations into account. Protected areas and other biodiversity management areas have important roles to play within ecologically sustainable landscapes.

7.3 The necessity for a focal-species approach to biodiversity management

The conservation biology literature promotes an approach for protected area planning and management toward protecting biological diversity at the species-population level. It calls for the identification of key, target or focal-species to guide protected area design. The premise is that size, area and other landscape or habitat-related parameters can not be determined without reference to the requirements of the particular populations which are the object of protection, or which occupy the ecosystems which are to be the object of protection. Ecological integrity of ecosystems requires the maintenance of viable populations of native species over time as part of the products and processes of ecological communities and of evolution.

The process described in the literature is to identify focal-species, and determine minimum viable population (MVP) sizes and minimum critical area (MCA) for these species through population viability analysis. Population viability analysis involve the calculation of MVP and MCA for particular populations of species within their specific biogeographical context, including considerations of the natural processes such as disturbance and succession which constitute the patch dynamics of the landscape. Identifying the appropriate focal-species is a critical first step.

The ecological considerations incorporated into this approach reflect the processes for maintaining biodiversity, however, it is likely that very large areas will be required. These large areas are not likely to be encompassed entirely by protected areas. Broader landscapes, beyond protected areas, will need to be managed towards maintaining viable populations and other natural processes if biodiversity is to be maintained. A landscape approach is necessary. However, landscapes designed to maintain biodiversity will need to take into account or be based upon the habitat and other resource requirements of focal-species. Focal-species represent those which warrant special biodiversity management attention such as vulnerable or sensitive species and those with large or specialized habitat requirements.

Current landscape approaches for protected area and broader integrated resource management tend to rely primarily on the criteria of representivity for site selection and delineation. Representation of typical landscapes is an important objective for protecting community, ecosystem or landscape-level biodiversity, and represents a coarse-filter approach. However, it is not the only objective necessary to protect biodiversity. Ecological integrity objectives must also be met. These may represent a fine-filter layer of considerations and include processes such as population viability.

Current protected area planning initiatives in Canada primarily reflect coarse-filter, representivity objectives. Ecological integrity objectives are called for in the management of these areas. Areas selected on the bases of representivity generally will not be able to be managed for ecological integrity objectives without broader regional landscape co-operation. The processes which comprise ecological integrity and which are necessary to maintain the values for which the protected areas were established transcend protected area boundaries. Viability of populations of species have not been considered in protected area design, but have become a required component of management within the objective of maintaining ecological integrity.

The wilderness protected areas proposed in Nova Scotia's parks and protected area strategy are not large or connected enough nor located in appropriate habitat type to maintain minimum critical habitat for viable populations of some species, especially those which are wide-ranging or have large spatial area or specialized habitat, dietary or reproductive requirements. As shown in Chapter Three, there is public support for incorporation of broader ecological considerations into protected area and larger regional planning in Nova Scotia. There is public recognition of the need for more and larger protected areas, greater connectivity and linkages, and integrated land and resource planning and management at the landscape scale in order to protect biodiversity values.

The next step in protected area design and management and broader landscape planning for the maintenance of biodiversity requires the consideration of phenomenon at the species-population level. An autecological approach is necessary to provide information for landscape-level management and planning based on the needs of viable populations of specific focal-species in the particular biogeographical context.

7.4 Identifying focal-species in Nova Scotia

A framework was developed and tested and found to be useful for identifying focal-species and indicator species and making linkages to landscape-level considerations. Development and application of the focal-species approach to various aspects of biodiversity management in Nova Scotia represents the original or primary research component of this thesis. The research is considered to represent an important contribution to the field (Noss 1997 pers. comm.; Soulé 1997 pers. comm.; Elderkin 1998 pers. comm.).

Information for identifying focal-species at the provincial level was obtained through expert consensus utilizing a Delphi survey approach. Potential focal-species, representing priority species for special biodiversity management attention in Nova Scotia were identified. The focal-species were tentatively identified as "potential" because certain limitations in the framework and the process are recognized. For example, additional information and greater consensus is required and probably obtainable with further research and expert participation.

Additional refinement of the variables and categories could result in a more rigorous or accurate assessment. Recommended refinements include: more precise definitions of the variables; reorganization of the variables into categories which reflect various types of focal-species or types of factors which limit population viability; the addition or deletion of certain variables; and the possible weighting of variables to reflect relative importance. A revised composite list of categories and variables for identifying focal-species is provided in Appendix 3.6.

Greater opportunity to take regional variation into account could be incorporated into the process, such as by conducting assessments at regional rather than provincial scales and focusing on populations rather species. In this sense, it is recommended that focal-populations be identified, rather than focal-species.

Potential focal-species of mammals include but are not limited to: eastern cougar, lynx, eastern pipistrelle, Gaspé shrew, long-tailed shrew, silver-haired bat, Arctic shrew, American marten and fisher. These species received consistently high assessments in each assessment type and probably represent priority species for biodiversity management attention. It is likely that American moose could be added to this list in light of recently acquired information and new concerns about their status in Nova Scotia (NSDNR 1997b; Nette 1997 pers. comm.).

Potential focal-species of reptile and amphibian species include wood turtle, four-toed salamander, Blanding's turtle, blue-spotted salamander, bullfrog, pickerel frog and northern leopard frog. Focal-species of freshwater fishes include Atlantic salmon, lake trout, Atlantic whitefish, blueback herring, brook trout, Atlantic sturgeon and rainbow smelt.

Five potential focal-species are also listed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 1996): Gaspé shrew, eastern cougar, wood turtle, Blanding's turtle and Atlantic whitefish. This may indicate that the focal-species framework does serve to identify species which warrant special biodiversity management attention. This is not considered to be a tautological effect; national endangerment and population status constitute only one category of variables. This factor alone is not sufficient to result in the identification of endangered species as focal-species.

Potential focal-species that do not appear on other lists of species of concern are: Arctic shrew, bullfrog, pickerel frog, northern leopard frog, Atlantic salmon, lake trout, lake whitefish, blueback herring, brook trout, Atlantic sturgeon and rainbow smelt. The value of the focal-species framework may be in its potential for identifying species such as these that may require special management attention to prevent them from becoming at risk.

7.5 A regional approach: identifying focal-indicator-species

The need for a regional or population-level approach was recognized in testing the focal-species approach at the provincial level. Regional differences were discovered through the process of attempting to assign single responses to variables at species and provincial levels. Regional differences were apparent in, for example, species composition, status of species and populations, genetic importance or uniqueness of populations, availability of habitat types, and threats to habitat and populations. Regional differences were most apparent between Cape Breton Island and mainland Nova Scotia, for example, in populations of lynx, American marten, and American moose. However differences also exist among areas of the mainland such as between southwestern and eastern Nova Scotia regarding fisher populations, and between southwestern Nova Scotia and the Cobequids regarding American moose populations.

The focal-species approach was adapted and applied at a regional level to mammal, reptile and amphibian and freshwater fish species existing in Kejimkujik National Park. The focal-species approach was found to be compatible with Woodley's (1996b) criteria for selecting indicator species. Indicator species differ from focal-species in that additional consideration is given to factors such as the ability to indicate effects of stress on a broad set of species, sensitivity to intended management practices, and successfully invading exotic species.

A framework for identifying focal-indicator-species was developed by integrating a focal-species approach with Woodley's criteria for selecting indicator species. The framework was found to be useful for identifying the most appropriate indicator species for monitoring population dynamics such as population viability as a measure of biodiversity at the species-population level.

Focal-species or populations represent those that warrant special management attention because they are vulnerable, functionally important, have large or special habitat requirements, or other factors which limit the ability of their populations to persist over time. These characteristics, when integrated with other considerations for the selection of indicator species, represent the best range of variables for selecting species for monitoring population dynamics for the purposes of biodiversity management. For these same reasons, focal-species may also serve to define parameters for monitoring habitat loss and fragmentation and other measures of threats to biodiversity at the landscape-level. Parameters for landscape measures could be defined by the specific habitat and resource requirements of the most demanding focal-indicator-species.

Potential indicator species for monitoring biodiversity measures at the species-population level and defining landscape parameters include fisher, American marten, American moose, Blanding's turtle, snapping turtle, yellow perch and brook trout. Other species warranting consideration as potentially important indicator species include: coyote, river otter, white-tailed deer, southern flying squirrel, northern spring peeper, and bullfrog. Lynx and eastern cougar were also identified but are considered to be extirpated from the region. Coyote is a potential indicator species because it is a top carnivore, wide-ranging, and a successfully invading species. White-tailed deer is identified as a potential indicator species partly because it is a game species, and may be considered a successfully invading species, with potential implications for vegetation and American moose.

7.6 Linking focal-species to the landscape-level

A framework for linking focal-species to the landscape was developed and integrated with an approach described by Lambeck (1997). The framework was tested for focal-species identified at both provincial and regional levels. Assessments were conducted utilizing variables and categories from the focal-species framework. Additional assessments were completed integrating these variables with Lambeck's approach. The results were similar, indicating that the approaches are compatible and that variables such as space-demanding/wide-ranging may be utilized to link focal-species with landscape-level parameters. While the approach appears to hold promise, further information is required regarding regionally specific species-habitat relationships and habitat quality, extent and distribution, in order to make the results more rigorous and to provide specific information for landscape-level decision making.

Focal-species of mammals, reptiles, amphibians and freshwater fishes were categorized according to factors limiting their populations such as spatial area of habitat, dispersal, specific dietary or other resources, or exploitation or ecological interactions. These factors may be generally categorized as either threats or requirements or, according to Lambeck's (1997) framework, as process-, area-, dispersal-, or resource-limitations. It may be useful to group the variables and limitations into categories which distinguish between: 1) threats, such as threats to habitats and populations; and, 2) requirements, such as area or special habitat, dietary or other requirements related to biological characteristics, behavior or habitat requirements. These categories may be easier to conceptualize or operationalize than, for example, Lambeck's management or process category of limitation types which, though not easily understood, essentially refer to process or management related threats to focal-species. However, all limitation factors, including both process or management and structural or reconstruction factors, represent threats to focal-species. Identifying threats is compatible with provincial and national frameworks for identifying species at risk (Harper et al. 1996; Elderkin and Boates 1996), as well as Woodley's (1996b) framework for monitoring ecological integrity and guidelines for selecting indicator species.

Identification of the most demanding focal-species within each category was hindered by a lack of specific information. Further research is required to define categories and identify specific limiting factors related to particular populations of species, however some preliminary conclusions can be drawn.

Focal-species in the Kejimkujik National Park region that may be primarily limited by management or processes such as exploitation or interspecific competition include: little brown bat, northern long-eared bat, eastern pipistrelle, American marten, fisher, river otter, and American moose; snapping turtle, Blanding's turtle, northern ribbon snake, blue-spotted salamander, and four-toed salamander; and, brook trout. These species primarily require management responses such as limits on exploitation or predation control such as protection of Blanding's turtle nesting sites.

Focal-species primarily limited by the spatial area of habitat or by dispersal factors such as isolation, limited dispersal powers, or dependence upon unobstructed watercourses include: little brown bat, northern long-eared bat, American marten, fisher, river otter, and American moose; snapping turtle, Blanding's turtle, pickerel frog, blue-spotted salamander, red-spotted newt, and four-toed salamander; and, American eel, brook trout, golden shiner, white perch and yellow perch. These species require management responses at the landscape-level such as increased protection or enhancement of suitable habitat, maintenance or reconstruction of corridors for dispersal, or removal of obstructions across waterways.

Focal-species primarily limited by specific resource shortages or bottlenecks may include: American marten and southern flying squirrel; Blanding's turtle, northern ringneck snake, eastern smooth green snake, and four-toed salamander; and, brook trout. These species require management responses such as resource enhancement or supplementation at periods of low availability, or recovery of special habitat characteristics or patch types. Resource-limited species were particularly difficult to identify with the information available; further assessment is required. Discretion is required because all focal-species at both the provincial and regional level may potentially be considered resource-limited as well as process-limited.

These focal-species warrant special biodiversity management attention and are limited by landscape-level factors. They may represent the focal-species that are most limited by these landscape-level factors. Therefore, they may also serve as a multi-species umbrella for protecting other less-demanding species. These species represent a useful suite of focal-species for defining landscape-level parameters relative to their needs, such as home-range size and configuration, corridors or connectivity, habitat loss, fragmentation and conversion, and patch types. Before this can be reliably accomplished further information is required regarding species-habitat relationships in particular regions. These species represent priorities for further management attention including autecological field research and monitoring of population-landscape interactions.

Other provincial-level focal-species that do not exist in Kejimkujik National Park region warrant further assessment to identify the categories of factors limiting their populations in various regions. These species include Arctic shrew, Gaspé shrew, long-tailed shrew, lynx, wood turtle, Atlantic sturgeon, blueback herring, Atlantic whitefish, Atlantic salmon, lake trout and rainbow smelt.

7.7 Synthesis: The final analysis

In the final analysis, the thesis essentially recommends a landscape approach, but one which is informed by focal-species. Landscape parameters have no meaning outside of the requirements of the species or populations and processes which constitute those landscapes. Further, the approach serves to integrate and synthesize population, species and landscape levels with larger and smaller scale research, inventory and monitoring programs as recommended for reliable long-term landscape scale studies (Stohlgren et al. 1995). Through the course of the research and assessment it has become apparent that the focal-species approach is probably more accurately conceived as a focal-population approach. It is important to recognize this distinction in level and make assessments and decisions that reflect regional variability in both species and habitats.

For example, the American moose and American marten have genetically distinct populations within Nova Scotia including both remnants of native populations and reintroduced populations. Remnants of native populations may be considered more important to native biodiversity, representing genetically distinct populations from those in other jurisdictions. These distinctions and others related to population status and threats are difficult to incorporate into responses on a species-level.

Similar difficulties are evident in making assessments at the provincial scale. Regional differences in populations, biogeographic context and extent and character of threats make responses to certain variables at a provincial level very difficult. For example, fisher, lynx, wood turtle, Atlantic salmon and populations of other species display different patterns of occurrence, distribution, and population and habitat status in various areas of the province, particularly between Cape Breton Island and the mainland, and between eastern and western portions of the mainland. Provincial-level decisions about species can only be responsibly made by considering the sum of regional and population-based assessments. Provincial and species level assessments are probably more defensible if regional differences are explicitly included and recorded rather than implicitly or intuitively considered.

With these limitations clearly stated as provisos, there are none the less certain species that are identified as focal-species, as focal-indicator-species, and as limited by landscape-level factors at both provincial and regional scales through every type of assessment (Tables 7.1 and 7.2). These species are priority focal-species at both species and population levels and provincial and regional scales, and may define landscape-level parameters, thus potentially serving as multi-species umbrellas for maintaining biodiversity. These species include American marten, fisher, American moose, Blanding's turtle, northern ribbon snake, blue-spotted salamander, four-toed salamander, and brook trout. Lynx should also be included within this list; it was not recommended as an indicator-species at Kejimkujik National Park solely because of its small numbers and possible extirpation. American moose has been added in consideration of updated information regarding its potential vulnerability or uncertainty regarding its status in southwestern Nova Scotia (Nette 1997 pers. comm.; NSDNR 1997b).

Other important focal-species which do not occur in Kejimkujik National Park should also be added to this list, including wood turtle, Atlantic salmon, Atlantic whitefish, lake trout, blueback herring and perhaps Atlantic sturgeon and rainbow smelt. If eastern cougar remains in Nova Scotia, it should also be considered a priority focal-species. Again, its low population status, like that of the lynx, indicates that the range of variables selected to indicate potential focal-species, or species warranting special management attention, do represent factors which may result in vulnerability.

Many species of frogs and bats may also be potential focal-species or indicator species. Their relatively lower scores in many assessments may be a factor of lack of information. However, eastern pipistrelle, silver-haired bat, northern long-eared bat, little brown bat, bullfrog, northern spring peeper, northern leopard frog and pickerel frog were identified in several assessments, along with Arctic shrew, Gaspé shrew, long-tailed shrew, river otter and southern flying squirrel.

There is a great deal of uncertainty regarding species and population status, species-habitat relationships, distribution, and threats in Nova Scotia. This emphasizes the value of expert opinion and best judgment, particularly with consensus, for decision-making in the absence of scientific certainty or facts. Ecosystems may be too complex for certainty in any situation. Adaptive and active management, a new type of experimental and research-oriented management with controls, monitoring, and adaptation in response to changes and new information, is recommended by this uncertainty (MacNab 1983; Walters and Holling 1990; Arcese and Sinclair 1997).

Table 7.1: Comparison of results from focal-species assessments in Chapters 4, 5, and 6

Provincial-level focal-species; Kejimkujik National Park focal-indicator-species; Focal-species requiring landscape management or reconstruction at Provincial scale and at Kejimkujik National Park regional scale

Provincial-scale focal-species	Kejimkujik region focal-indicator-species	Provincial-scale landscape-limited focal-species	Kejimkujik region landscape-limited focal-species
Mammals			
Eastern cougar* Lynx Eastern pipistrelle Gaspé shrew	Fisher American marten American moose	Little brown bat Northern long-eared bat American marten Fisher Eastern cougar* Lynx American moose	Little brown bat Northern long-eared bat American marten Fisher River otter Eastern cougar* Lynx* American moose
Long-tailed shrew Silver-haired bat Arctic shrew American marten Fisher American moose*	Coyote River otter Bobcat White-tailed deer Southern flying squirrel		
Reptiles and Amphibians			
Wood turtle Four-toed salamander Blanding's turtle Northern ribbon snake	Blanding's turtle Snapping turtle	Wood turtle Blanding's turtle Northern ribbon snake Pickerel frog Blue-spotted salamander Four-toed salamander	Blanding's turtle Snapping turtle Northern ribbon snake Blue-spotted salamander Four-toed salamander*
Bullfrog Northern leopard frog Pickerel frog Blue-spotted salamander	Northern spring peeper All frogs, esp. bullfrog Northern ribbon snake Blue-spotted salamander Four-toed salamander*		
Freshwater fishes			
Atlantic salmon Lake trout Atlantic whitefish Blueback herring	Brook trout Yellow perch	Atlantic whitefish Atlantic salmon Brook trout	Brook trout
Brook trout Atlantic sturgeon Rainbow smelt	American eel Golden shiner White sucker White perch	Lake trout Atlantic sturgeon Blueback herring Rainbow smelt	Yellow perch

Source: Tables 4.15; 5.7; 6.11 and 6.12

Notes:

1. *Eastern cougar is included even though status is uncertain (NSDNR 1997b; status report pending by F.W. Scott); Lynx is included in Kejimkujik National Park assessment although probably extirpated from mainland N.S., however lynx was not recommended as an indicator species for Kejimkujik because of low numbers/possible extirpation; American moose has been added to the list of focal-species in N.S. for this assessment because of recent information regarding its potential vulnerability/uncertainty in N.S. (Nette 1997 pers. comm; NSDNR 1997b). Status of four-toed salamander in the Kejimkujik region is also uncertain (Drysdale 1986; Underwood 1997 pers. comm.) Wood turtle does not appear in Kejimkujik region assessments because it does not occur in that area.
2. * Lake whitefish has been omitted because it is introduced in the Kejimkujik National Park region (Drysdale 1986); origin status of lake whitefish in the province has been considered uncertain, however there is growing evidence that it is introduced (Gilhen 1974; Hebda 1997 pers. comm.); The Nova Scotia Museum recently described it as introduced to the province (Davis and Browne 1996).

Table 7.2: Priority focal-species from every assessment type - Chapters 4, 5 and 6

Mammals	Reptiles and Amphibians	Freshwater fishes
American marten Fisher American moose	Blanding's turtle Northern ribbon snake Blue-spotted salamander Four-toed salamander	Brook trout
Lynx Eastern cougar	Wood turtle	Atlantic whitefish Blueback herring Atlantic salmon Lake trout
Eastern pipistrelle Silver-haired bat Northern long-eared bat Little brown bat Arctic shrew Gaspé shrew Long-tailed shrew River otter Southern flying squirrel	Bullfrog Northern spring peeper Northern leopard frog Pickerel frog	Atlantic sturgeon Rainbow smelt

Uncertainty should not be a deterrent to action towards maintenance of biodiversity and ecological integrity. Management approaches should be strategic, or goal and policy driven, towards biodiversity objectives, then monitored for new information and evidence of its effects. New information should be shared with other agencies in a spirit of co-operation towards this broad biodiversity management goal which extends beyond institutional boundaries (Gauthier 1995). Decisions should be precautionary or conservative, recognizing the uncertainty, and should standards should be placed well above minimums such as in population viability and critical area considerations.

The process of determining consensus may sometimes present a considerable challenge. However, the Delphi survey method and focal-species matrix framework seemed to work well for bringing together individuals in a way that allowed individual responses, feedback, opportunity for revisions of views, and sharing of the results. The matrix framework allowed consideration of highly subjective or relative responses to a wide-range of species and variables in a systematic way, thus incorporating some objectivity, and enabling quantification of a qualitative assessment. The process was also a two-way learning method towards development of a focal-species approach and data base through a shared effort.

Further, the process was useful and valuable for clearly identifying specific areas of consensus and lack of consensus. Areas of consensus represent areas of greater certainty, and areas of lack of consensus indicates areas of greatest uncertainty. This information is valuable in itself for management related to information status and research. Species-populations which show a combined lack of consensus and vulnerability may be identified as priority species for further research and management attention, such as fisher, bats, northern ribbon snake and most freshwater fishes. Species exhibiting a combination of vulnerability and certainty regarding specific threats indicate areas for management action and close monitoring.

The focal-species approach at a provincial scale is similar to a listing process or species status evaluation currently being developed at provincial and national levels (Harper et al 1996; Elderkin and Boates 1996). However, it includes species that are not considered currently at risk, but are potentially vulnerable because of biological characteristics, habitat requirements or other factors. It also summarizes information which might indicate why particular species are at risk or potentially vulnerable, and identify the primary factors that lead to species becoming at risk. This information is useful for management such as in developing recovery plans, or proactive biodiversity management responses such as research and monitoring, and protected area and broader land use planning.

A important finding is that a population-level, regional-scale approach is necessary to take into account regional and population variation across the province. The focal-indicator-species assessment that was applied at the regional level in Kejimkujik National Park was found to be more specific in response to regional and population-level variations such as population and habitat status. Population-regional-level assessments are recommended for all regions of the province, particularly in Cape Breton highlands national park region where remnant American marten and lynx populations persist.

Approaches for linking focal-species to the landscape-level require further information in order to define specific landscape-level parameters. American moose was identified as a potential focal-species with large area requirements. Available American moose habitat information was summarized however further research to define home-range requirements in the Kejimkujik-Tobeatic region is recommended.

The value of linking focal-species to landscape-level considerations has been demonstrated. Landscape parameters could be defined relative to the needs of the most-demanding resident populations. These parameters could provide meaningful information for defining biodiversity monitoring measures such as habitat loss and fragmentation. It could also provide useful information, such as area, connectivity, and other habitat requirements at the landscape-level for broader land-use decision making and protected area planning for maintaining viable populations of native species over time. Further research linking focal-populations with landscape parameters is recommended, particularly for defining measures such as habitat size and shape, or loss and fragmentation for biodiversity monitoring. Such information could be particularly useful for focusing transboundary management issues around protected areas.

Additional discussion, improved information, and greater consensus is needed to make the focal-species or focal-population identification process more rigorous or to increase the level of certainty. A workshop process which builds on the work to date would no doubt improve the level of consensus. It would allow individual experts greater opportunity to compare, discuss and perhaps revise or supplement their responses in consultation with other experts. This process would probably be more successful if completed at two levels: one level dealing with factors that remain essentially constant across the province; and, a second level addressing factors that vary across the province by region and by species and population.

In summary, the utility of the focal-species approach has been demonstrated. It is useful for identifying focal-species for biodiversity management, as indicator species for monitoring population dynamics, as well as for defining landscape-level parameters such as size, shape, distribution, and quality of critical habitat for focal-species. Focal-species can provide a multi-species umbrella for protected area design and biodiversity management, including monitoring. The approach should be extended beyond protected areas to broader regional and provincial scale planning and management, including integrated resource management and land-use planning.

An important limitation to acknowledge is that the approach described and tested within the thesis explicitly addresses only mammals, reptiles, amphibian and freshwater fish species native to Nova Scotia. A suite of focal-species should also include plants, birds, and invertebrates. For example, butterflies may be the best single group of animals to use as indicators of ecological health, showing dramatic responses to changes in land cover and management practices. Avifauna also serve as indicators of change, with populations largely in decline due to habitat loss (Daily and Ehrlich 1997-98). However, a landscape designed to meet the requirements of mammals, reptiles and amphibians and freshwater fishes with large spatial requirements, special habitat needs, and sensitivities to human activities will go a long way towards protecting populations of species in other classes.

More information on ecological processes such as disturbances and succession is required and should be incorporated into habitat requirement considerations for focal-species. Enough area should be protected such that habitat needs will be met while natural processes of disturbance and succession such as fire and insect population cycles continue. Obviously large areas will be required. Thus biodiversity management must be extended into the broader landscape if current levels of native biodiversity are to be maintained.

Focal-species and populations can provide a focus for a wide range of biodiversity management objectives and activities. Inter-agency partnerships and co-operation may be facilitated by a common goal. Limited financial and other resources may be directed toward priorities defined by focal-species or populations and their habitat requirements. This may be useful for developing research and monitoring programs, ecosystem conservation plans, integrated resource management plans, policies, and other biodiversity management decisions. The approach itself represents an integration of science and management. It operationalizes biodiversity management policies, goals and objectives in a way that is strategic and context specific.

Focal-species or populations may also provide a useful and appealing focus for educational and interpretive programs and broader social marketing in support of biodiversity objectives. The approach represents an easily understood connection from species and populations to habitats and landscapes, and identifies a range of species, some charismatic, for special attention. These focal-species may also provide a compelling focus or rationale within which to seek co-operation among private and corporate owners and managers of lands adjacent to protected areas or biodiversity management zones, particularly for addressing transboundary objectives.

Perhaps focal-species can be a reminder that we share a finite land and water resource with many other creatures and processes in this place we call home. Although this habitat is finite in space, focal-species may help us to realize the potential infinity of biodiversity and evolution through time.

Afterword

Integration

In closing, and throughout this work,
a familiar refrain has accompanied me, serving as a touchstone.

I realize that this touchstone has been a constant companion throughout my life,
resurfacing at this time.
I recognize it as an early indication of my passion and my life's work.

My first recollection of it is as a young child, hearing it sung and singing along
in a small, sun-filled church, on the first day that I walked to church on my own
and walked straight up to the front pew.

It was spring, the birds were singing,
and the words and my wonder and awe at the beauty of spring and the songs of the birds
and the sunshine all came together
in a kind of synchronisity that can only be described as joy.

All things bright and beautiful,
all creatures great and small,
all things wise and wonderful,
the lord god made them all.

This is why I do this work; where I get the will.
I have found my work.
And at the risk of sounding religious,
although I do consider myself a spiritual person,
it is the work of god.

But it is *for* the creatures, great and small.

Thank you to my parents for letting me walk alone.

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A Focal-Species Approach to Biodiversity Management in Nova Scotia

Volume 2

Appendices

by

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List of abbreviations

BWG	Biodiversity Working Group
CCFM	Canadian Council of Forest Ministers
CEAC	Canadian Environmental Advisory Council
CCEA	Canadian Council on Ecological Areas
CESCC	Canadian Endangered Species Conservation Committee
CITES	Convention on International Trade in Endangered Species
COSEWIC	Committee On the Status of Endangered Wildlife In Canada
EC	Environment Canada
IBP	International Biological Programme
IUCN	International Union for the Conservation of Nature and Natural Resources
MAB	Man and the Biosphere Programme
MCA	Minimum critical area
MDA	Minimum dynamic area
MVP	Minimum viable population
NBDNRE	New Brunswick Department of Natural Resources and Energy
NCC	Nature Conservancy Canada
Ne	Effective or ideal breeding population size
NFSC	National Forest Strategy Coalition
NSDFA	Nova Scotia Department of Fisheries and Aquaculture
NSDLF	Nova Scotia Department of Lands and Forests
NSDNR	Nova Scotia Department of Natural Resources
NSDOD	Nova Scotia Department of Development
NSDOE	Nova Scotia Department of Environment
NSDOEd	Nova Scotia Department of Education
NSRTEE	Nova Scotia Round Table on Environment and Economy
PVA	Population viability analysis
TNC	The Nature Conservancy (United States)
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Environment and Society Conservation Organization
WCED	World Commission on Environment and Development
WMI-LAIG	Whitehorse Mining Initiative-Land Access Issues Group
WMI-LCA	Whitehorse Mining Initiative-Leadership Council Agreement
WWF	World Wildlife Fund Canada

Appendix 1: List of Species and Species Status

Table 1.1: List of Species

Scientific Name	Common Name
Class mammalia	
Order Insectivora (Shrews, Moles)	
Family Soricidae (Shrews)	
Sorex arcticus	Arctic Shrew (Black-backed Shrew)
Sorex cinerus	Common Shrew (Masked/Cinerous Shrew)
Sorex fumeus	Smokey Shrew
Sorex gaspensis	Gaspé Shrew
Sorex dispar	Long-tailed Shrew (Rock Shrew)
Sorex palustris	Water Shrew
Sorex hoyi	Pygmy Shrew
Blarina brevicauda	Short-tailed Shrew
Family Talpidae (Moles)	
Condylura cristata	Star-nosed Mole
Order Chiroptera (Bats)	
Family Vespertilionidae (Plain-nosed Bats)	
Myotis lucifugus	Little Brown Bat
Myotis septentrionalis	Northern Long-eared Bat
Pipistrellus subflavus	Eastern Pipistrelle
Lasionycteris noctivagans	Silver-haired Bat
Lasiurus borealis	Red Bat
Lasiurus cinereus	Hoary Bat
Order Carnivora (Carnivores)	
Family Canidae (Wolves, Dogs, Foxes)	
Canis lupus	Wolf (Grey Wolf, Timber Wolf)
Canis latrans	Coyote
Vulpes vulpes	Red Fox
Family Ursidae (Bears)	
Ursus americanus	American Black Bear
Family Procyonidae (Racoons)	
Procyon lotor	Racoon
Family Mustelidae (Weasels, Otters, Skunks)	
Martes americana	American Marten
Martes pennanti	Fisher
Mustela erminea	Ermine (Weasel)
Mustela vison	American Mink
Mustela macrodon	Sea Mink
Mephitis mephitis	Striped Skunk
Lontra canadensis	River Otter
Family Felidae (Cats)	
Felis concolor	Eastern Cougar (Mountain Lion)
Lynx lynx	Lynx
Lynx rufus	Bobcat

Table 1.1: List of Species (continued)

Order Artiodactyla (Even-toed Ungulates)	
Family Cervidae (Deer, Moose)	
Rangifer tarandus *Odocoileus virginianus* *Alces alces*	Woodland Caribou White-tailed Deer Moose (American Moose)
Order Rodentia (Rodents)	
Family Sciuridae (Squirrels, Marmots)	
Tamius striatus *Marmota monax* *Tamiasciurus hudsonicus* *Glaucomys volans* *Claucomys sabrinus*	Eastern Chipmunk Woodchuck (Groudhog) American Red Squirrel Southern Flying Squirrel Northern Flying Squirrel
Family Catoridae (Beavers)	
Castor canadensis	American Beaver
Family Cricetidae (New World Rats and Mice)	
Peromyscus maniculatus *Peromyscus leucopus*	Deer Mouse White-footed Mouse
Family Arvicolidae (Voles, Lemmings)	
Clethrionomys gapperi *Synaptomys cooperi* *Ondatra zibethicus* *Microtus pennsylvanicus* *Microtus chrotorrhinus*	(Gapper's) Red-backed Vole Southern Bog Lemming Muskrat Meadow Vole (Meadow Mouse, Field Mouse) Rock Vole (Yellow-nosed Vole)
Family Zapodidae (Jumping Mice)	
Napaeozapus insignis *Zapus hudsonius*	Woodland Jumping Mouse Meadow Jumping Mouse
Family Erethizontidae (New World Porcupines)	
Erethizon dorsatum	American Porcupine
Order Lagomorpha (Hares, Rabbits)	
Family Leporidae (Hares, Rabbits)	
Lepus americanus	Snowshoe Hare (Varying Hare, Rabbit)
Class Reptilia	
Order Testudines	
Family Chelydridae (Snapping Turtles)	
Chelydra serpentina serpentina	Common Snapping Turtle
Family Emydidae (Semiaquatic, Pond and Marsh Turtles)	
Clemmys insculpta *Emydoidea blandingi* *Chrysemys picta picta*	Wood Turtle Blanding's Turtle Eastern Painted Turtle

Table 1.1: List of Species (continued)

Order Serpentes	
Family Colubridae (Typical Snakes)	
Thamnophis sirtalis pallidula	Maritime Garter Snake
T. sauritissseptentrionalis	Northern Ribbon Snake
Diadophus punctatus edwardsi	Northern Ringneck Snake
Opheodrys vernalis vernalis	Eastern Smooth Green Snake
Storia occipitomaculata occipitomaculata	Northern Redbelly Snake
Class Amphibia	
Order Anura	
Family Bufonidae (Toads)	
Bufo americanus americanus	Eastern American Toad
Family Hylidae (Tree Frogs)	
Hyla crucifer crucifer	Northern Spring Peeper
Family Ranidae (Typical Frogs)	
Rana catesbeiana	Bullfrog
Rana clamitans melonata	Green Frog
Rana septentrionalis	Mink Frog
Rana pipiens	Northern Leopard Frog
Rana palustris	Pickerel Frog
Rana sylvatica	Wood Frog
Order Caudata	
Family Ambystomatidae (Mole Salamanders)	
Ambystoma maculatum	Yellow-spotted Salamander
Ambystoma laterale	Blue-spotted Salamander
Family Salamandridae (Newts)	
Notophthalmus viridescens viridescens	Red-spotted Newt
Family Plethodontidae (Lungless Salamanders)	
Plethodon cinereus	Eastern Redback Salamander
Hemidactylium scutatum	Four-toed Salamander
Class Cephalaspidomorphi	
Order Petromyzontiformes	
Family Petromyzontidae (Lampreys)	
Petromyzon marinus	Sea Lamprey
Class Actinopterygii	
Order Acipenseriformes	
Family Acipenseridae (Sturgeons)	
Acipenser oxyahynchus	Atlantic Sturgeon

Table 1.1: List of Species (continued)

Order	
Family Anguillidae (Freshwater Eels)	
Anguilla rostrata	American Eel
Order Clupeiformes	
Family Clupeidae (Herrings)	
Alosa aestivalis	Blueback Herring
Alosa pseudoharengus	Gaspereau, Alewife
Alosa sapidissima	American Shad
Order salmoniformes	
Family Salmonidae (Trouts)	
Coregonus canadensis	Atlantic/Acadian Whitefish
Coregonus clupeaformis	Lake Whitefish
Salmo Gairdneri	Rainbow Trout
Salmo salar	Atlantic Salmon
Salvelinus fontinalis	Brook Trout
Salvelinus namaycush	Lake Trout
Family Osmeridae (Smelts)	
Osmerus mordax	Rainbow Smelt
Order Cypriniformes	
Family Cyprinidae (Minnows and Carps)	
Chrosomus eos	Northern Redbelly Dace
Couesius plumbeus	Lake Chub
Notemigonus crysoleucas	Golden Shiner
Notropis cornutus	Common Shiner
Notropis heterolepis	Blacknose Shiner
Rhinichthys atratulus	Blacknose Dace
Semotilus atromaculatus	Creek Chub
Semotilus corporalis	Fallfish
Semotilus margarita	Pearl Dace
Family Catostomidae (Suckers)	
Catostomus commersoni	White Sucker
Order Siluriformes	
Family Ictaluridae (Freshwater Catfishes)	
Ictalurus nebulosus	Brown Bullhead
Order	
Family Gadidae (Codfishes)	
Microgadus tomocod	Atlantic Tomcod
Order Cyprinodontiformes	
Family Cyprinodontidae (Killifishes)	
Fundulus diaphanus	Banded Killifish
Fundulus heteroclitus	Mummichog

Table 1.1: List of Species (continued)

Order Gasterosteiformes	
Family Gasterosteidae (Sticklebacks)	
Apeltes quadracus	Fourspine Stickleback
Culaea inconstans	Brook Stickleback
Gasterosteus aculeatus	Threespine Stickleback
Pungitius pungitius	Ninespine Stickleback
Order Perciformes	
Family Percichthyidae (Temperate Basses)	
Morone americana	White Perch
Morone saxatilis	Striped Bass
Family Percidae (Perches)	
Perca flavescens	Yellow Perch

Compiled from: Scott (1996); NSDOEd (no date); Gilhen (1974); Groombridge (1993)
Note: Introduced and extralimital species are generally not included.

Table 1.2: Species Status

Scientific Name	Common Name	Status (Groombridge 1993; Scott 1996; NSDOEd. no date; COSEWIC 1996)	Draft Species at risk category * (NSDNR 1996a; 1997b)
Mammals			
Sorex arcticus	Arctic Shrew (Black-backed Shrew)	Locally common; Mainland only; ssp. *maritimensis* is disjunct and may be distinct species	Green
S. cinerus	Common Shrew (Masked /Cinerous Shrew)	Common	Green
S. fumeus	Smokey Shrew	Common	Green
S. gaspensis	Gaspé Shrew	Vulnerable (COSEWIC); rare and very local: C.B. Highlands; disjunct	Yellow
S.dispar	Long-tailed Shrew (Rock Shrew)	Rare and very local: Wentworth Valley;disjunct	Yellow
S. palustris	Water Shrew	Uncommon and local	Green
S. hoyi	Pygmy Shrew	Uncommon and very local	Green
Blarina brevicauda	Short-tailed Shrew	Common	Green
Condylura cristata	Star-nosed Mole	Locally common	Green
Myotis lucifugus	Little Brown Bat	Common	Yellow
M. septentrionalis	Northern Long-eared Bat	Uncommon	Yellow
Pipistrellus subflavus	Eastern Pipistrelle	Rare; West mainland only	Yellow
Lasionycteris noctivagans	Silver-haired Bat	One record: Kejimkujik N.P.	Yellow
Lasiurus borealis	Red Bat	Rare	Yellow
L. cinereus	Hoary Bat	Uncommon	Yellow
Canis lupus	Wolf (Grey Wolf, Timber Wolf)	Extirpated in N.S. (COSEWIC); Globally vulnerable (IUCN)	
C.latrans	Coyote	Common; invaded; probably prehistorically present	Green
Vulpes vulpes	Red Fox	Common	Green
Ursus americanus	American Black Bear	Common	Green
Procyon lotor	Racoon	Common on mainland; invading C.B. Island	Green
Martes americana	American Marten	Remnant pop. in C.B.H.N.P.; extirpated on mainland; reintroduced in Kejimkujik N.P.	Red
M. pennanti	Fisher	Extirpated; reintroduced in SW and NE mainland	Yellow
Mustela erminea	Ermine (Weasel)	Common	Green
M. vison	American Mink	Common	Green
M. macrodon	Sea Mink	Extinct (COSEWIC)	Green
M. mephitis	Striped Skunk	Common; Mainland only	Green
Lontra canadensis	River Otter	Common	Green
Felis concolor	Eastern Cougar (Mountain Lion)	Endangered (COSEWIC); status not certain	Status evaluation deferred

Table 1.2: Species Status (continued)

Lynx lynx	Lynx	Extremely rare on mainland; fairly common on C.B.Island	Red
L. rufus	Bobcat	Common; Mainland only	Green
Rangifer tarandus	Woodland Caribou	Extirpated (COSEWIC)	
Odocoileus virginianus	White-tailed Deer	Reinvaded/introduced; Common	Green
Alces alces	Moose (American Moose)	Common; Exirpated and reintroduced on C.B.Island	Red
Tamius striatus	Eastern Chipmunk	Common	Green
Marmota monax	Woodchuck (Groudhog)	Common on mainland; invading C.B.Island	Green
Tamiasciurus hudsonicus	American Red Squirrel	Common	Green
Glaucomys volans	Southern Flying Squirrel	Vulnerable (COSEWIC); disjunct; two small populations: Kejimkujik N.P. and Gaspereau Valley	Yellow
G. sabrinus	Northern Flying Squirrel	Common	Green
Castor canadensis	American Beaver	Common	Green
Peromyscus maniculatus	Deer Mouse	Uncommon and local in W. mainland	Green
Peromyscus leucopus	White-footed Mouse	Disjunct; Common in SW.N.S, very local in central - E.N.S., absent in NW.N.S./C.B. Island	Green
Clethrionomys gapperi	(Gapper's) Red-backed Vole	Common	Green
Synaptomys cooperi	Southern Bog Lemming	Uncommon and very local; fairly common and local in C.B.Highlands	Green
Ondatra zibethicus	Muskrat	Common	Green
Microtus pennsylvanicus	Meadow Vole (Meadow Mouse, Field Mouse)	Common	Green
M. chrotorrhinus	Rock Vole (Yellow-nosed Vole)	Disjunct; locally common in C.B.Highlands periphery	Green
Napaeozapus insignis	Woodland Jumping Mouse	Common	Green
Zapus hudsonius	Meadow Jumping Mouse	Locally common	Green
Erethizon dorsatum	American Porcupine	Common on mainland; may be invading C.B.Island	Green
Lepus americanus	Snowshoe Hare (Varying Hare, Rabbit)	Common	Green

Table 1.2: Species Status (continued)

Reptiles			
Chelydra serpentina serpentina	Common Snapping Turtle	Most common in SW. mainland; 3 reports in C.B. (released captives)	Green
Clemmys insculpta	Wood Turtle	Most common in NE. mainland and SW. C.B.Island; Vulnerable (COSEWIC)	Yellow
Emydoidea blandingi	Blanding's Turtle	One small, isolated population in Kejimkujik N.P.; Threatened (COSEWIC)	Red
Chrysemys picta picta	Eastern Painted Turtle	Common in SW.N.S.; becoming less common in NE.	Green
Thamnophis sirtalis pallidula	Maritime Garter Snake	Common	Green
T. sauritis septentrionalis	Northern Ribbon Snake	Queens / Lunenburg Co.s only	Yellow
Diadophus punctatus edwardsi	Northern Ringneck Snake	Most common in SW. and E. mainladn; reports from N.N.S. and C.B.Island are rare	Green
Opheodrys vernalis vernalis	Eastern Smooth Green Snake	Widespread	Green
Storia occipitomaculata occipitomaculata	Northern Redbelly Snake	Widespread	Green
Amphibians			
Bufo americanus americanus	Eastern American Toad	Common	Green
Hyla crucifer crucifer	Northern Spring Peeper		Green
Rana catesbeiana	Bullfrog		Green
R. clamitans melonata	Green Frog		Green
R. septentrionalis	Mink Frog		Green
R. pipiens	Northern Leopard Frog		Green
R. palustris	Pickerel Frog		Green
R. sylvatica	Wood Frog		Green
Ambystoma maculatum	Yellow-spotted Salamander		Green
A. laterale	Blue-spotted Salamander	N. N.S., Queens Co., and C.B.	Yellow
Notophthalmus viridescens viridescens	Red-spotted Newt		Green
Plethodon cinereus	Eastern Redback Salamander		Green
Hemidactylium scutatum	Four-toed Salamander	Least common species	Yellow

Table 1.2: Species Status (continued)

Freshwater Fishes			
Petromyzon marinus	Sea Lamprey		
Acipenser oxyahynchus	Atlantic Sturgeon		
Anguilla rostrata	American Eel		
Alosa aestivalis	Blueback Herring		
A. pseudoharengus	Gaspereau, Alewife		
A. sapidissima	American Shad		
Coregonus canadensis	Atlantic/Acadian Whitefish	Endangered; Great Lakes (COSEWIC; IUCN)	
C. clupeaformis	Lake Whitefish		
Salmo Gairdneri	Rainbow Trout		
S. salar	Atlantic Salmon		
Salvelinus fontinalis	Brook Trout		
S. namaycush	Lake Trout		
Osmerus mordax	Rainbow Smelt		
Esox niger	Chain Pickerel		
Chrosomus eos	Northern Redbelly Dace		
Couesius plumbeus	Lake Chub		
Notemigonus crysoleucas	Golden Shiner		
Notropis cornutus	Common Shiner		
N. heterolepis	Blacknose Shiner		
Rhinichthys atratulus	Blacknose Dace		
Semotilus atromaculatus	Creek Chub		
S. corporalis	Fallfish		
S. margarita	Pearl Dace		
Catostomus commersoni	White Sucker		
Ictalurus nebulosus	Brown Bullhead		
Microgadus tomocod	Atlantic Tomcod		
Fundulus diaphanus	Banded Killifish		
F. heteroclitus	Mummichog		
Apeltes quadracus	Fourspine Stickleback		
Culaea inconstans	Brook Stickleback		
Gasterosteus aculeatus	Threespine Stickleback		
Pungitius pungitius	Ninespine Stickleback		
Morone americana	White Perch		
M. saxatilis	Striped Bass		

Micropterus dolomieui	Smallmouth Bass		
Perca flavescens	Yellow Perch		

Compiled from: Scott (1996); NSDOEd (no date); Gilhen (1974); Groombridge (IUCN) (1993), COSEWIC/WWF (1996); NSDNR (1996a; 1997b).

Notes:
1. Introduced and extralimital species are generally not included.
2. Freshwater fish status in Nova Scotia has not been ranked (NSDNR 1996a).
3. "Red" status applies to any species known to be, or believed to be, at risk. "Yellow" status applies to any species known to be, or believed to be, particularly sensitive to human activities or natural events. "Green" status applies to any species known to be, or believed to be, not at risk. ("Risk", in this case, refers to imminent risk of extinction or extirpation) (NSDNR 1996a).
4. *Revised mammal status has recently been completed (NSDNR 1997b) and has resulted in changes in status for some mammal species from an earlier draft status evaluation (NSDNR 1996a). The earlier draft status evaluation was used by some respondents in their responses to the questionnaire and to identify species they considered to be vulnerable (Refer to Appendices 3.3 an 3.5 and Table 4.11). These earlier responses and NSDNR (1996a) were used to determine consensus responses and are reflected in the assessment of responses and the results. Reptile and Amphibian status based on draft evaluation (NSDNR 1996a); revised evaluation in progress. Freshwater fishes have not been evaluated.
5. Status evaluation for Eastern cougar has been deferred due to its uncertain status in N.S.. A status report is in preparation by F.W. Scott (NSDNR 1997b).
6. Abbreviations: C. B. - Cape Breton; C.B.H. - Cape Breton Highlands; C.B.H.N.P. - Cape Breton Highlands National Park; N.P. National Park; E. - Eastern; N. - Northern; NE. - Northeastern; SW. - Southwestern; W - Western; N.S. - Nova Scotia; Co. - County.

Appendix 2: Matrix and Questionnaire and List of participants

2.1 List of contents

- 2.2 Cover letter
- 2.3 Abstract
- 2.4 Matrices
- 2.5 Definitions
- 2.6 Questionnaire
- 2.7 List of participants

2.2 Sample cover letter:

November 11, 1996

Attention:

Dear ;

Thank you for agreeing to take part in my Ph.D. research, and for your kind assistance to date. Your contribution is greatly appreciated. As a participant, you will receive a summary of the results.

Enclosed is a preliminary abstract, a list of definitions and references, a matrix for identifying species vulnerable to extirpation in human-altered landscapes in N.S., and a questionnaire. The enclosed matrices are for native mammal, amphibian and reptile, and freshwater fish species.

I would request that you fill out the matrices to the best of your professional ability. I recognize that the task is a highly qualitative one requiring best-professional judgement. The intent is that species be evaluated **relative to each other** within the group. This is especially important to bear in mind in those instances where precise definitions may not be provided, such as in determining those species most space-demanding / wide-ranging, those with the most limited dispersal power, or those with the most significant habitat specialization. If you prefer to use a definition other than the ones provided, please note your revision or addition.

Please complete the matrix for those variables and species in which you possess some professional competence, including those that require educated "guesses". Responses may include: *affirmative, negative, maybe, unknown*, and *beyond area of individual or personal expertise* (refer to legend on matrix sheet). Change any existing responses or definitions with which you disagree. I request that you use a pen or pencil which contrasts in colour with the black ink already used (red, green, blue). You are welcome to circulate the matrix to others to complete, either separately or in collaboration with yourself.

I would appreciate it if you would also take the time at the end to complete the accompanying questionnaire about your experience of completing the matrices. I would suggest that you retain the matrices until you have completed all that pertain to your area of expertise. It may be helpful to you to refer to the matrices when completing the questionnaire. Please return the completed matrices and questionnaire to me, along with any changed definitions, within two weeks of receipt of the final matrix.

Should you have any questions, please do not hesitate to contact me.

Sincerely,

Karen Beazley

2.3 Sample of abstract submitted with matrix/questionnaire package

Identifying priority species for habitat conservation in Nova Scotia

Beyond protected areas and endangered species

Karen Beazley - Interdisciplinary Ph.D. Programme, Dalhousie University, Halifax, N.S.

Abstract

Parks and protected areas alone will not protect present levels of ecological integrity or native biological diversity. Critical habitat for viable populations of significant species will not be contained within protected area boundaries. Sufficient habitat needs to be accommodated within the broader landscape.

It is not desirable nor possible to consider the habitat requirements of every species - some are more vulnerable to extirpation in human-altered landscapes than others. A matrix is developed, based on previous work by others, to identify the most sensitive, significant or priority species for habitat conservation attention. Variables are grouped under categories of rarity/population status, biological characteristics, habitat sensitivity, ecological importance, human-impact factors, and information status. The matrix is being tested on various experts in Nova Scotia to: 1) assess the utility of the matrix process and suitability of the variables selected; 2) identify gaps in the information base; 3) work toward expert consensus; and, 4) provide a preliminary identification of significant mammal, amphibian and reptile, bird, and freshwater fish species for habitat conservation attention in N.S.

The identification process may be useful for setting priorities for research and for habitat conservation. It may provide information for broader landscape planning and management and for addressing transboundary phenomenon around protected areas. It may also provide a common focus for experts and others across agencies through participation, consensus and co-operation.

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2.4 Matrices included with matrix/questionnaire package as distributed to participants:

2.4.1 Mammal Species: Matrix for identifying species vulnerable to extirpation in human-altered landscapes in Nova Scotia (overleaf)

2.4.2 Reptile and Amphibian Species: Matrix for identifying species vulnerable to extirpation in human-altered landscapes in Nova Scotia (second overleaf)

2.4.3 Freshwater Fishes: Matrix for identifying species vulnerable to extirpation in human-altered landscapes in Nova Scotia (third overleaf)

Matrix for identifying species vulnerable to extirpation in human-altered landscapes in Nova Scotia

Native terrestrial vertebrate species existing in Nova Scotia	1. Rarity/ PopulationStatus									2. Biological Characteristics							3. Habitat Related Vulnera-bility				4. Species of Major Ecological Importance				5. Human - Impact Factors				6. Information Status				
Mammals (Introduced, extra-limital, extinct, and extirpated species are not included) (By order and family)	Nationally rare (COSEWIC, 1996)	Small population in N.S.	Population declining in N.S.	Small number of occurrences in N.S.	Small geographic range/distribution in N.S.	Decline in range/distribution in N.S.	Large percentage of range/distribution in N.S.	Species existing at range edge in N.S.	Genetically distinct form	Space-demanding / wide-ranging	Population seasonally/daily concentrating	Extremely variable in population density	Limited dispersal power	Low reproductivity / low fecundity	Large-bodied (largest members of feeding class)	Pollution susceptible / accumulator species	Dietary and reproductive specialization	Habitat specialization	Dependant upon provincially rare habitat	Climatic sensitivity	Summit predator	Species that occur at higher trophic levels	Major vegetation influencer	Keystone species	Legally harvested or killed in N.S.	Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	No management activities directed at taxon	Limited knowledge of distribution in N.S.	Population trends not regularly monitored in N.S.	Factors limiting population in N.S. unknown	No autecological studies in N.S.	No (meta-) population viability analysis in N.S.
Arctic shrew (*Black-backed shrew*)	X				✓		✓	✓	✓	X	X			X				✓		✓	X	✓	X					✓	✓	✓			
Common shrew (*Masked shrew, Cinerous shrew*)	X	X		X	X		X	X		X	X			X			X	X	X		X	✓	X	✓				✓		✓			
Smokey shrew	X						X	X		X	X			X			X			✓	X	✓	X					✓	✓	✓			
Gaspé shrew	✓	✓		✓	✓		✓	✓	✓	X	X			X			✓	✓			X	✓	X	X					✓	✓	✓		
Long-tailed shrew (*Rock shrew*)	X	✓		✓	✓				✓	X	X			X			✓	✓			X	✓	X	X				✓	✓	✓	✓		
Water shrew	X			✓	✓		X	X	X	X	X		X	X	X	X	✓	✓			X	✓	X					✓	✓	✓			
Pygmy shrew	X			✓	✓		X	X		X	X			X							X	✓	X					✓	✓	✓			
Short-tailed shrew	X						X	X		X	X			X			X	✓	X	✓	X	✓	X	X				✓	✓	✓			
Star-nosed mole	X				✓		X	X	✓	X	X			X			✓	✓			X	✓	X	X				✓	✓	✓			
Little brown bat	X	X		X	X		X	X	X	X	✓			✓			✓	✓			X		X	X	✓	✓	✓		✓	✓			
Northern long-eared bat	X	✓		✓	✓		X	X	✓	X	✓			✓			✓	.			X		X	X	✓	✓	✓		✓	✓			
Eastern pipistrelle	X	✓		✓	✓		X	✓	X	X	✓			✓			✓	✓			X		X	X	✓	✓	✓	✓	✓	✓			
Silver-haired bat	X	✓	✓	✓	✓		X	✓	✓	X	✓			✓			✓	✓			X		X	X	✓	✓		✓	✓	✓			
Red bat	X	✓	✓	✓	✓		X	✓	X	X	X			X			✓				X		X	X	✓	✓		✓	✓	✓			
Hoary bat	X	✓	✓	✓	✓		X	✓	✓	X	X			X			✓				X		X	X	✓	✓		✓	✓	✓			
Coyote*	X					X	X		X	✓	X			X	✓		X	X	X		✓	✓	X	X	✓			✓					
Red fox	X	X		X	X		X	X	X	X	X			X			X	X	X		✓	✓	X	X	✓								
American black bear	X	✓		X	X		X	X	X	✓	X			✓	✓		X	X	X		✓	✓		X	✓								
Racoon	X	X	X	X	X		X	✓	X	X	X			X			X	X	X			✓	X	X	✓			✓					
American marten	X	✓	✓	✓	✓	✓	X	X	✓	X	X		X	X	X	X	✓	✓			✓	✓	X	X	✓	✓	✓		✓	✓			
Fisher	X	✓	✓		✓	✓	X	X	✓	✓	X		X	X	X	X	✓	✓			✓	✓	X	X	✓	✓			✓	✓			
Ermine (*Weasel*)	X	X		X	X		X	X	X	X	X			X			✓	✓	X		✓	✓	X	X	✓			✓	✓	✓			
American mink	X	X		X	X		X	X	X	X	X			X			✓	✓	X		✓	✓	X	X	✓								
Striped skunk	X	X		X	X		X	X	X	X	X			X			X	X	X			✓	X	X	✓			✓		✓			
River otter	X	✓	✓	✓	✓		X	X	X	✓	X			X			✓	✓	X		✓	✓	X	X	✓	✓	✓		✓				
Eastern cougar (*Mountain lion*)***	✓	✓	✓	✓		✓	X	✓	X	✓	X		X	✓	✓		✓				✓	✓	X	X		✓	✓	✓	✓	✓			
Lynx	X	✓	✓	✓	✓	✓	X		X	✓	X		X	X	✓	X	✓	✓			✓	✓	X	X	✓	✓	✓		✓	✓			
Bobcat	X	X		X		✓	X	✓	X	✓	X		X		✓		X	X			✓	✓	X	X	✓				✓				
White-tailed deer***	X	X		X	X		X	X	X	✓	✓		X	✓	✓	X					X		✓		✓								
Moose (*American moose*)	X	✓				✓	X	X	X	✓	X		X	✓	✓	X		✓			X		✓	X	✓								
Eastern chipmunk	X	X		X	X		X	X	X	X	X			X			X	X	X		X		X					✓	✓	✓			
Woodchuck (*Groudhog*)	X	X		X	X		X	X	X	X	X			X			X	X	X		X		X		✓			✓		✓			
American red squirrel	X	X		X	X		X	X	X	X	X			X			X	✓			X		X		✓			✓		✓			
Southern flying squirrel	✓	✓	✓	✓	✓	✓			✓	X				X			✓	X	X		X		X	X					✓	✓			
Northern flying squirrel	X	X		X	X		X	X		X	X			X			✓	✓	X		X		X						✓	✓			
American beaver	X	X		X	X		X	X	X	X	X		X	X	X			✓	X		X				✓								
Deer mouse	X	X		X	X		X	X	X	X	X			X			X	X	X		X		X	✓				✓		✓			
White-footed mouse	X	X		X	X		X	✓	✓	X	X			X			X	X	X		X		X					✓	✓	✓			
Red-backed vole (*Gapper's*)	X	X		X	X					X	X			X			X	X	X	✓	X		X	✓				✓		✓			
Southern bog lemming	X				✓		X	X	✓	X	X		X	X	X			✓			X		X					✓	✓	✓	✓		
Muskrat	X	X		X	X		X	X	✓	X	X			X			X	✓	X		X		X		✓								
Meadow vole (*Meadow mouse, Field mouse*)	X	X		X	X		X	X		X	X			X			X	X	X	✓	X		X	✓				✓		✓			
Rock vole (*Yellow-nosed vole*)	X	✓		✓	✓	✓	X		✓	X	X			X				✓			X		X	X				✓	✓	✓	✓		
Woodland jumping mouse	X	X			✓		X	X	✓	X	X			X			✓		X		X		X							✓			
Meadow jumping mouse	X	X			✓		X	X	X	X	X			X			✓	X	X		X		X					✓		✓			
American porcupine	X	X			✓		X	X	✓	X	X			✓			✓	X	X		X				✓			✓		✓			
Snowshoe hare (*Varying hare, rabbit*)	X	X		X	X	.	X	X	X	X	X	✓	X	X	X	X			X		X		✓	✓	✓								

(Sources: Column headings adapted and compiled from Millsap, et.al., 1990; Herman and Scott, 1992; 1994; Woodley, 1993; Theberge, 1995; Elderkin and Boates, 1996. List of species compiled from Scott, 1991 (3rd revision April 1996). Responses compiled from Peterson, 1966; Banfield, 1974; Harris, 1964; NBDNRE, 1991;1992; Herman and Scott, 1992; 1994; Theberge, 1995; Elderkin and Boates, 1996; and, Scott, 1991 (3rd revision April 1996)).

Response key: Affirmative (✓); Negative (X); Maybe (M); Unkown (?); Beyond area of individual or personal expertise ( )

2.4.1 Mammal Species: Matrix for identifying species vulnerable to extirpation in human-altered landscapes in Nova Scotia

Name: ______________________ Date: ______________________

Matrix for identifying species vulnerable to extirpation in human-altered landscapes in Nova Scotia

Native terrestrial vertebrate species existing in Nova Scotia	1. Rarity/ PopulationStatus									2. Biological Characteristics							3. Habitat Related Vulnerability				4. Species of Major Ecological Importance				5. Human - Impact Factors				6. Information Status				
Reptiles and Amphibians (Introduced, extra-limital, extinct, and extirpated species are not included) (By order and family)	Nationally rare (COSEWIC, 1996)	Small population in N.S.	Population declining in N.S.	Small number of occurrences in N.S.	Small geographic range/distribution in N.S.	Decline in range/distribution in N.S.	Large percentage of range/distribution in N.S.	Species existing at range edge in N.S.	Genetically distinct form	Space-demanding / wide-ranging	Population seasonally/daily concentrating	Extremely variable in population density	Limited dispersal power	Low reproductivity / low fecundity	Large-bodied (largest members of feeding class)	Pollution susceptible / accumulator species	Dietary and reproductive specialization	Habitat specialization	Dependant upon provincially rare habitat	Climatic sensitivity	Summit predator	Species that occur at higher trophic levels	Major vegetation influencer	Keystone species	Legally harvested or killed in N.S.	Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	No management activities directed at taxon	Limited knowledge of distribution in N.S.	Population trends not regularly monitored in N.S.	Factors limiting population in N.S. unknown	No autecological studies in N.S.	No (meta-) population viability analysis in N.S.
Snapping turtle		X		X			X	✓	✓					✓	✓		X	X			✓	✓			✓	✓	✓	✓	✓	✓			
Wood turtle	✓	✓		X	✓		X		✓				✓	✓		✓		✓		✓					✓	✓	✓	✓	✓	✓			
Blanding's Turtle	✓	✓		✓	✓		X	✓	✓				✓	✓		✓	X	✓		✓						✓	✓			✓			
Eastern painted turtle							X	✓	✓					✓			X	X							✓			✓	✓	✓			
Maritime garter snake		X		X	X		X	X			✓						X	X		X		✓						✓	✓	✓			
Northern ribbon snake		✓		✓	✓		X	✓	✓		✓							✓				✓				✓	✓	✓	✓	✓			
Northern ringneck snake		X		X	X		X	X	✓		✓						✓	✓		X		✓						✓	✓	✓			
Eastern smooth green snake		X		X	X		X	X			✓						✓	✓		X		✓						✓	✓	✓			
Northern redbelly snake		X		X	X		X				✓						✓	X		X		✓						✓	✓	✓			
Eastern American toad		X		X	X		X	X			✓						X	X						✓				✓	✓	✓			
Northern spring peeper		X		X	X		X	X			✓						X	X		X				✓				✓	✓	✓			
Bullfrog		X		X	X		X	✓			✓				✓		X	X						✓	✓			✓	✓	✓			
Green frog		X		X	X		X	X			✓						X	X		✓				✓				✓	✓	✓			
Mink frog		X		X	X		X	X			✓						X	✓		X				✓				✓	✓	✓			
Northern leopard frog		X		X	X		X	X			✓	✓					X	X		✓				✓	✓		X	✓	✓	✓			
Pickarel frog				X	X		X	✓			✓		✓			✓				✓				✓				✓	✓	✓			
Wood frog		X		X	X		X	X			✓						X	X		X				✓				✓	✓	✓			
Yellow-spotted salamander							X	X										X		X								✓	✓	✓			
Blue-spotted salamander				✓	✓		X	X	✓		.							✓		X					.	✓	✓	✓		✓			
Red-spotted newt							X	X									✓	X		✓						✓	✓	✓	✓	✓			
Red-backed salamander							X	X									✓	X		✓				✓			.·	✓	✓	✓			
Four-toed salamander					✓		X	X	✓								✓	✓		X						✓	✓	✓	✓	✓	✓		

(Sources: Column headings adapted and compiled from Millsap, et.al., 1990; Herman and Scott, 1992; 1994; Woodley, 1993; Theberge, 1995; Elderkin and Boates, 1996. List of species compiled from Gilhen, 1984; Nova Scotia Museum, Department of Education, Info). Responses compiled from Gilhen, 1984; Cook, 1984; Herman and Scott, 1992; 1994; Theberge, 1995; Elderkin and Boates, 1996).

Response key: Affirmative (✓); Negative (X); Maybe (M); Unkown (?); Beyond area of individual or personal expertise ( )

2.4.2 Reptile and Amphibian Species: Matrix for identifying species vulnerable to extirpation in human- altered landscapes in Nova Scotia

Name: ______________________ Date: ______________

Matrix for identifying species vulnerable to extirpation in human-altered landscapes in Nova Scotia

Native terrestrial vertebrate species existing in Nova Scotia	1. Rarity/ PopulationStatus									2. Biological Characteristics						3. Habitat Related Vulnerability					4. Species of Major Ecological Importance			5. Human - Impact Factors				6. Information Status				
Freshwater Fishes (Introduced, extra-limital, extinct, and extirpated species are not included) (By order and family)	Nationally rare (COSEWIC, 1996)	Small population in N.S.	Population declining in N.S.	Small number of occurrences in N.S.	Small geographic range/distribution in N.S.	Decline in range/distribution in N.S.	Large percentage of range/distribution in N.S.	Species existing at range edge in N.S.	Genetically distinct form	Space-demanding / wide-ranging	Population seasonally/daily concentrating	Limited dispersal power	Older age at first reproduction	Extremely variable in population density	Pollution susceptible / accumulator species	Habitat / Dietary / Reproductive Specialization	Sensitive to high annual variation in river/stream flow	Dependent upon unimpeded/unobstructed watercourses	Dependent upon provincially rare habitat	Climatic sensitivity	Summit predator	Species that occur at higher trophic levels	Keystone species	Legally harvested or killed in N.S.	Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	No management activities directed at taxon	Limited knowledge of distribution in N.S.	Population trends not regularly monitored in N.S.	Factors limiting population in N.S. unknown	No autecological studies in N.S.	No (meta-) population viability analysis in N.S.
Sea lamprey		X		X	X		X	X	X	✓	✓	X				X								✓								
Atlantic sturgeon		X		X	X		X	X	X	✓	✓	X	✓											✓								
American eel		X		X	X		X	X	X	✓		X	.			X								✓								
Blueback herring							X	✓	X	✓		X	X			X							✓	✓				✓				
Gaspereau		X		X	X		X	X	X	✓	✓	X	X			✓		✓					✓	✓								
American shad		X		X	X		X	X	X	✓		X	X			X		✓					✓	✓								
Atlantic whitefish	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓							✓							✓	✓						
Lake whitefish		✓		✓	✓		X		X			✓				X								✓	✓	✓						
Atlantic salmon						✓	X	X	X	✓	✓	X			✓	✓		✓					✓	✓	✓	✓						
Brook trout				X	X		X	X	X	✓	✓	X				✓						✓		✓	✓							
Lake trout							X		X		✓		✓			✓						✓		✓				✓				
Rainbow smelt		X					X	X	X	✓	✓	X	X			✓						✓		✓								
Northern redbelly dace		X		X			X	X	X	X	X	✓	X			✓							✓	✓								
Lake chub							X	X	X		✓	✓	X			X							✓	✓								
Golden shiner		X		X	X		X		X			✓	X			X							✓	✓								
Common shiner							X		X	X	X	✓	X										✓	✓								
Blacknose shiner		X		X	X		X	✓	X	X	X	✓	X			✓							✓	✓								
Blacknose dace				✓	✓		X	X	X	X		✓	X			✓							✓									
Creek chub		X		X	X		X	X	X	X	X	✓	X											✓								
Fallfish		✓		✓	✓		X		X	X		✓	X																			
Pearl dace					✓		X	X	X	X	X	✓	X			✓							✓									
White sucker		X		X	X		X	X	X			✓				X								✓								
Brown Bullhead		X		X	X		X		X	X	X	✓	X		X	X								✓								
Atlantic tomcod		X		X	X		X	X	X			X			✓	X								✓								
Banded killifish		X		X	X		X	X	X	X	X	✓				X							✓	✓								
Mummichog		X		X	X		X	X	X	X		X				X							✓	✓								
Fourspine stickleback		X		X	X			X	X			X	X			X																
Brook stickleback		✓		✓	✓		X		X			✓	X			✓																
Threespine stickleback		X		X	X		X	X	X			X	X			X							✓									
Ninespine stickleback		X		X	X		X	X	X			X	X			X							✓									
White perch		X		X	X		X		X		✓	X	X			X								✓								
Striped bass		X		X	X		X	X	X	✓	✓	X				X						✓		✓								
Yellow perch		X		X	X		X		X		✓	✓	X			X							✓	✓								

(Sources: Column headings adapted and compiled from Millsap, et.al., 1990; Herman and Scott, 1992; 1994; Woodley, 1993; Theberge, 1995; Noss, 1995; Elderkin and Boates, 1996; Hutchings, 1996, pers. comm. List of species compiled from Gilhen, 1974.
Responses compiled from Livingstone, 1951; Scott, 1955; Scott and Crossman, 1973; Gilhen, 1974).

Response key: Affirmative (✓); Negative (X); Maybe (M); Unkown (?); Variable not applicable to taxon (n/a); Beyond area of individual or personal expertise ( )

2.4.3 Freshwater Fishes: Matrix for identifying species vulnerable to extirpation in human-altered landscapes in Nova Scotia

2.5 Definitions and references provided to experts with matrix/questionnaire package:

Definitions

1. Rarity/Population Status

Nationally rare: Species listed by COSEWIC or others as endangered, threatened, vulnerable or rare.

Small population in N.S.: Total number of mature individuals capable of repoduction in N.S. estimated to be below 3000, or unknown but expected to be small (Score >/= 7 in Herman and Scott 1992; or rating scale A-B in Elderkin and Boates 1996; Gilhen 1984; 1974).

Population declining in N.S.: Known or suspected decline in number of individuals over last 20 years or three generations (which ever is longer), or presently stable but former serious decline in N.S. (Score >/=6 in Herman and Scott 1992; or rating scale A-B in Elderkin and Boates 1996).

Small number of occurrences in N.S.: Estimated sites where the species currently persists in N.S. is </=20 (Rating scale A-B in Elderkin and Boates 1996; Gilhen 1984; 1974).

Small geographic range/distribution in N.S.: Size of area within N.S. over which taxon is distributed when most seasonally restricted is </=2000km^2 (Score >/=7 in Herman and Scott 1992) or area of occurrence in N.S. is </= 10% of N.S. (Rating scale A-B in Elderkin and Boates 1996; Gilhen 1984; 1974).

Decline in range/distribution in N.S.: Area occupied by taxon in N.S. has declined by 25% or more since European settlement (Score >/=5 in Herman and Scott 1992), or has declined by 20% or more in the last 20 years or six generations, whichever is longer (Rating scale A-B in Elderkin and Boates 1996).

Large percentage of range/distribution in N.S.: Greater than 25% of the taxon's total geographic range or distribution occurs in N.S. (Score >/= 4 in Herman and Scott 1992; Peterson 1966; Banfield 1974; Gilhen 1984; Cook 1984; Scott 1954; Scott and Crossman 1973).

Species existing at range edge in N.S.: Species are existing at the limit of their total geographic range or distribution in N.S. (Peterson 1966; Banfield 1974; Gilhen 1984; Cook,1984; Scott 1954; Scott and Crossman 1973).

Genetically distinct form: Monotypic family, genus or species, or disjunct population below the species level (Score >/= 1 in Herman and Scott 1992; Peterson,1966; Banfield 1974; Scott 1996; Gilhen 1984; Cook 1984; Scott 1954; Scott and Crossman 1973).

2. Biological Characteristics

Space-demanding/wide-ranging: (On a regional scale.) Greater than 1000 ha home-range or territory or migrating locally, or anadromous, catadromous, or marine fish existing in freshwater (Harris 1984; Banfield 1974; Theberge 1995; Gilhen 1974; Scott 1954; Scott and Crossman 1973).

Population seasonally/daily concentrating: Majority of the individuals in the population concentrate or aggregate seasonally or daily (hibernacula, wintering yards; spawning grounds) at </= 25 locations in N.S. (score >/= 6 in Herman and Scott 1992; Theberge 1995; Peterson 1966; Banfield 1974; Gilhen 1984; Scott and Crossman 1973).

Extremely variable in population density: Populations experience dramatic fluxuations in size/density on a periodic basis (Noss 1995; Peterson 1996; Banfield 1974; Gilhen 1984; Cook 1984).

Limited dispersal power: Limited physical or inherent biological ability to disperse (emmigrate; immigrate), such as species with small home-range diameters, and small vertebrates that refuse to cross roads or other relatively narrow swaths of unsuitable habitat, or freshwater fishes with low tolerance for salt water (Theberge 1995; Noss 1995; Harris 1984; Peterson 1996; Banfield 1974; Gilhen 1984; Cook 1984; Gilhen 1974: Scott 1954; Scott and Crossman 1973).

Low reproductivity / low fecundity: Older age (>2 years) at female's first reproduction and limited number of young per female per year (<2 offspring), or fish >5 years old at first reproduction (Score of >/=5 in Herman and Scott 1992; Theberge 1995; Peterson 1966; Banfield 1974; Cook 1984; Scott and Crossman,1973).

Large-bodied (largest members of feeding class): Average adult weight of larger sex (usually male) ranging 8-10kg or more, or largest members of their feeding class (Theberge 1995; Banfield 1974; Cook1984).

Pollution susceptible (accumulator species): Taxon tends to accumulate toxins in tissue or genetic alterations; or taxon with low tolerance to pollution in habitat environment (particularly aquatic) (Theberge 1995; Woodley 1993; Scott 1954; Scott and Crossman 1973).

3. Habitat-related vulnerability

Dietary and reproductive specialization: Dietary specializations, including specialization in foraging space, or prey type, size or behavior, and/or reproductive specialization, including specialized requirements for breeding sites and/or conditions for rearing young (Score >/=2 in Herman and Scott 1992; Gilhen 1984; Cook 1984; Gilhen 1974; Scott 1954; Scott and Crossman 1973).

Habitat specialization: Other specializations which increase a taxon's vulnerability to changes in the environment such as narrow pH, temperature, turbidity /sedimentation, moisture or dissolved oxygen tolerances, dependence on patchy or unpredictable resources, special habitat structure or physiography, such as talus formations or mature forest, or specialized retreats or hibernacula (Score >/=2 in Herman and Scott 1992; Theberge 1995; Gilhen 1984; Cook 1984; Gilhen 1974; Scott 1954; Scott and Crossman 1973).

Dependent upon provincially rare habitat: Dependent upon special habitat structure or physiography which currently exists in small and isolated patches in Nova Scotia (<2% of the area in Nova Scotia).

Climatic sensitivity: Relative vulnerability of the species to changes in climate as determined by variables such as number of life history environments, direct impacts of changes in summer moisture, water table, rainfall, streamflow, water-surface temperature, and soil temperature, and winter water-bottom temperature, snow and ice cover and winter/spring flooding (Score >10 in Herman and Scott 1992; Gilhen 1984); or relative sensitivity to habitat changes or weather extremes related to climate change.

4. Species of major ecological importance

Summit predators: Raptors, mustelids, canids (Theberge 1995; Scott 1991; 1996; Peterson 1966; Banfield 1974; Gilhen 1984).

Species that occur at higher trophic levels: Carnivores, insectivores (Harris 1984; Scott 1991; 1996; Peterson 1966; Banfield 1974; Gilhen 1984; Cook 1984; Gilhen 1974; Scott 1954; Scott and Crossman 1973).

Major vegetation influencer: Dominant ungulates, possibly lagomorphs or rodents (Theberge 1995; Peterson 1966; Banfield 1974)

Keystone species: Important as food for many other species, or pivitol species on which the diversity of a large part of the community depends (Theberge 1995; Noss 1995; Peterson 1966; Banfield 1974; Gilhen 1984; Gilhen 1974; Scott 1954; Scott and Crossman 1973).

5. Human-impact factors

Legally harvested or killed in N.S.: Taxon which is harvested in N.S. without legal protection, under regulation, or by accidental take or killing of nuisance animals (Score >/=2 in Herman and Scott 1992; Elderkin, pers. comm. 1996; Gilhen 1984; 1974; Scott 1954; Scott and Crossman 1973).

Population threatened by direct exploitation, harassment or ecological interactions in N.S.: Moderate or extreme threats to population from direct exploitation, harassment, or ecological interactions with predators, competitors, pathogens or parasites which result in population declines (Rating scale A-B in Elderkin and Boates 1996; Gilhen 1984; 1974; Scott 1954; Scott and Crossman 1973).

Habitat threatented by loss, conversion, degradation, or fragmentation in N.S.: Moderate or extreme threats to habitat through habitat alterations (loss, conversion, degradation, or fragmentation) which may result in population declines (Rating scale A-B in Elderkin and Boates, 1996; Gilhen 1984; 1974; Scott 1954; Scott and Crossman 1973).

No management activities directed at taxon: No management activities are directed entirely or primarily at the taxon (Score of 10 in Herman and Scott 1992).

6. Information status

Limited knowledge of distribution in N.S.: Knowledge of distribution in N.S. is extrapolated from a few locations or from general range maps, or broad range limits or habitat associations are known but local occurences cannot be predicted accurately (Score of >/=5 in Herman and Scott 1992; Gilhen 1984; 1974; Scott 1954; Scott and Crossman 1973).

Population trends not regularly monitored in N.S.: Knowledge of population trends in N.S. not currently monitored, monitored locally intermitently, or monitored intermittently at the provincial-level or regularly at the local-level (Score >/=5 in Herman and Scott 1992; Gilhen 1984).

Factors limiting population in N.S. unknown: Knowledge of factors affecting population size and distribution in N.S., including inferences from non-N.S. populations, are unknown or unsubstantiated (Score of 10 in Herman and Scott 1992; Gilhen 1984).

No autecological studies in N.S.: No existing known or published autecological studies on the taxon conducted in N.S.

No (meta-) population viability analysis in N.S.: No existing known or published population or meta-population viability analysis on the taxon conducted in N.S.

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2.6 Sample of questionnaire sent to experts in matrix/questionnaire package:

Questionnaire

Name:______________________________ Date:______________________________

Please complete the questionnaire after you have filled-in the four matrices for mammals, amphibians and reptiles, and freshwater fish, or those aspects which pertain to your particular expertise.

Please comment on your experience of completing the matrix:

1. Do you think that the variables are appropriate? Workable?

2. Which variables do you consider to be the most important?

3. Which variables do you think could be deleted or are least important?

4. Can you think of variables that should be added? Why?

5. (a) Do you think that the matrix process is a suitable way to identify species vulnerable to extirpation in human-altered landscapes and, thus, set priorities for planning and management attention? Why? Why not?

(b) What are the strengths of the process?

(c) What are the weaknesses of the process?

6. What are your thoughts about the process of completing the matrix? What was your experience?

7. Based on the excerise of completing the matrix <u>and</u> your best professional judgement, which species would you identify as being the most vulnerable to extirpation in human-altered landscapes in Nova Scotia? What are the major reasons or variables? (List to a maximum of ten.)

Species	**Major reason for identification**
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

8. Other comments:

Thank you for your participation!

2.7 List of Participants:

Drysdale, Clifford, Park Ecologist Underwood, John, Park Warden Kejimkujik National Park P.O. Box 236, Maitland Bridge, N.S. B0T 1B0 (902) 682-2798; (902) 682-2707	Boates, Dr. Sherman Nova Scotia Department of Natural Resources Wildlife Division, 136 Exhibition St., Kentville, N.S. B4N 4E5 (902) 679-6091
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Corbett, Gary Parks Canada, Canadian Heritage Historic Properties, Upper Water Street Halifax, N.S. B3J 1S9 (902) 426-3432	MacDonald, Peter Nova Scotia Department of Natural Resources Wildlife Division, P.O. Box 99 Tusket, N.S. B0W 3M0 (902) 648-3536
Woodley, Dr. Stephen Parks Canada, Natural Resources Branch 25 Eddy St., Hull, P.Q. K1A 0M5 (819) 994-2446	Bancroft, Bob Nova Scotia Department of Fisheries Inland Fisheries, P.O. Box 700 Pictou, N.S. B0K 1H0 (902) 485-702
Herman, Prof. Tom Acadia University Wolfville, N.S. B0P 1X0 (902) 585-1469	Adams, Nancy, Management Biologist Nova Scotia Department of Fisheries and Aquaculture, P.O. Box 700 Pictou, N.S. B0K 1H0

Bondrup-Nielsen, Prof. Soren Biology Department Acadia University Wolfville, N.S. B0P 1X0 (902) 585-1424	Gilhen, John Nova Scotia Museum of Natural History 1747 Summer St., Halifax, N.S. B3H 3A6 (902) 424-7370
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Freedman, Prof. Bill Biology Department Dalhousie University Halifax, N.S. (902) 494-3737	Beaudette, Dan New Brunswick Department of Natural Resources and Energy, Fish and Wildlife P.O. Box 6000, Fredericton, N.B. E3B 5H1, (506) 453-2440
Hutchings, Dr. Jeff Biology Department Dalhousie University Halifax, N.S. (902) 494-2687	Sullivan, Mike New Brunswick Department of Natural Resources and Energy, Fish and Wildlife P.O. Box 6000, Fredericton, N.B. E3B 5H1, (506) 453-2440
Leonard, Dr. Marty Biology Department Dalhousie University Halifax, N.S. (902) 494-2158	Forbes, Dr. Graham Faculty of Forestry University of New Brunswick Fredericton, N.B. E3B 6C2 (506)453-4929
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Lowcock, Les c/o David Green Redpath Museum, McGill University 859 Sherbrooke St. W. Montreal, P.Q. H3A 2K6	Theberge, Prof. John Faculty of Environmental Studies School of Urban and Regional Planning University of Waterloo Waterloo, Ont., N2L 3G1 (519) 885-1211
Pough, Prof. F. Harvey Department of Life Sciences Arizona State University, West PO Box 37100, Phoenix, AZ. U.S.A. 85069-7100 (602) 543-6048	

Appendix 3
Summary of questionnaire responses

Appendix 3 summarizes the comments participants provided in response to the questions asked in the questionnaire; they do not include information derived from the matrices. Responses to the matrices are summarized in Appendices 4 through 9. A summary of responses to the questionnaire and matrices is provided in Chapter 4. Contents of Appendix 3 are listed below.

3.1 List of contents:

- 3.2 List of respondents
- 3.3 Compilation of questionnaire responses
- 3.4 Most and least important variables and variables to be added as identified by respondents
- 3.5 Most vulnerable species as identified by respondents on questionnaire
- 3.6 Composite list of categories and variables for identifying focal-species

<u>Appendix 3.2: List of respondents</u>

1. Bancroft, Bob, Nova Scotia Department of Fisheries, Inland Waters
2. Beach, Harry, Parks Canada, Atlantic Region
3. Beaudette, Dan, New Brunswick Department of Natural Resources and Energy
4. Boates, Dr. Sherman, Nova Scotia Department of Natural Resources, Wildlife Division
5. Bondrup-Nielsen, Prof. Soren, Acadia University, Biology Department
6. Bridgland, James, Parks Canada, Cape Breton Highlands National Park
7. Corbett, Gary, Parks Canada, Atlantic Region
8. Duke, Tony, Nova Scotia Department of Natural Resources, Wildlife Division
9. Elderkin, Mark, Nova Scotia Department of Natural Resources, Wildlife Division
10. Forbes, Dr. Graham, University of New Brunswick, Department of Forestry
11. Herman, Prof. Tom, Acadia University, Biology Department
12. Hutchings, Dr. Jeff, Dalhousie University, Biology Department
13. MacDonald, Peter, Nova Scotia Department of Natural Resources, Wildlife Division
14. Nette, Tony, Nova Scotia Department of Natural Resources, Wildlife Division
15. Oullett, Martin, Redpath Museum, McGill University
16. Pough, Prof. Harvey, University of Arizona, West, Department of Life Scinces
17. Scott, Fred, Acadia University, Biology Department
18. Theberge, Prof. John, University of Waterloo, Faculty of Environmental Studies
19. Underwood, John, Parks Canada, Kejimkujik National Park
20. Wassersug, Prof. Richard, Dalhousie University, Anatomy Department
21. Woodley, Dr. Stephen, Parks Canada, Natural Resources Branch

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Note: Respondents are listed in alphabetical order. <u>The numbers adjacent to each name **do not** represent **Respondent** numbers **refered to in the texts and in the tables**</u>. Respondents were assigned numbers relative to the chronological sequence in which their responses were received. Respondent numbers have been utilized in the text and in the tables to retain some degree of anonimity for individual responses.

Appendix 3.3: Compilation of questionnaire responses

Note: All comments are direct quotes from questionnaires except points of clarification contained within brackets [ ].

1. Do you think that the variables are appropriate? workable?

Probably as appropriate and workable as any. (Respondent 1)

Yes. Nationally rare - I would give more value to Endangered Species than to just vulnerable species - Matrix non distinctive. If you √ shrews for higher trophic level you also must do bats.
2. Large bodied - feeding class (family?) - this definition is too complicated - feeding class - shrews/bats/moles all different but small . Generally yes! (Respondent 2)

In most cases yes. Dietary + reproductive special - - should have been separated, i.e. bear dietary generalist but repro. specialists. Also moose were difficult because we have an overabundance on C.B. Highlands but population threatened (?) on mainland. (Respondent 3)

Appropriate - yes. Workable - no. (Respondent 4)

Appropriate for what? For your thesis title - they may be workable if a group of people work together on the matrix and agree on what the terms mean. Working alone it is difficult to know what you mean. (Respondent 5)

Depending on the target. There are a lot of variables and they require considerable knowledge / information to fill them all in well. Nobody has all the information so all the creatures will not be filled in the same. (Respondent 6)

Generally. Often ranges are less than clear for many spp. (Respondent 7)

Yes. I think you have a good range of variables. (Respondent 8)

[Cribbed from letter: see section - General Comments] The relevancy of your variables depends in part on the use to which you (or others) will put the matrix. Some variables will give you a predictable list, while others may provide some new insight. For example, the qualities of being nationally endangered, at the edge of one's range, or rare in NS are reasonable predictors of vulnerability, but the relationships are tautological in nature and little new is gained with these. (Respondent 9)

Yes - obvious choices but all dependent on data quality and quantity (i.e., shrews and bats are not as well known as others, therefore how do you weight priorities when ignorance is deserving of more attention? (Respondent 10)

[Re: Amphibians and reptiles] Yes. If about nothing is known in category 6 (Information status) how can we trust the information in the first category (Rarity/Population status)?
All the references are very general and old, and not based on very intensive studies . . . except maybe for the Blanding's Turtle. (Respondent 14)

Some are subjective, but that's probably unavoidable. (Respondent 16)

Several are ambiguous and lack precision in definition. For example, descriptions such as "older", "extremely variable", "dependent upon" needed to be tightened up. (Respondent 18)

Generally variables are appropriate and workable but need some clarification regarding definitions to make them work better. Many things are rolled into one variable in some cases; you can break down or keep track of the factors with a "memo field". For example:

- "Rarity and Population Status" category, it would be better to focus on provincial then go to local and national and global status from there. Concentrate on the surrounding context, for example, with national, look at status in New Brunswick, P.E.I., and Nfld.; for global, look to status in Maine, New Hampshire, and Massachusetts. You need to incorporate global status because species that are common in N.S. may not exist elsewhere, or may be endangered everywhere else, such as coastal plain species or Gaspé or Long-tailed shrew.

- Regarding "Nationally rare", COSEWIC can be a useful focus but COSEWIC listing is influenced by politics and preferences, etc., therefore, for example, species are missing from the list, species are there because of expert preferences or biases in the research interest, and certain geographic areas are better covered. Look also to IUCN's "Red Book", and the Nature Conservancy's listings.

- In categories "Low reproductivity/fecundity" and "large body size", why not use three categories, i.e, small, medium and large? Is the characterization meant to be absolute (i.e., bigger than a certain size) or relative? It is more useful to look at the largest species in the taxonomic or functional group.

- "Keystone species" - the term can be used both generically and specifically. Specific keystones in a strict sense are still being debated and are not always or well known; an example is the lobster/sea urchin situation. The generic use refers to species that are important in the community, for example, but this is not an ecological "technically correct" use of the term. You could address this simply by not using the term "keystone" and use a different term such as "functionally important species".

- Human impact factors - Under population and habitat threats you are rolling several things into one or two categories. For example, the difference between fragmentation and loss is significant in terms of management responses. This problem might be dealt with by having a "memo field" in which to keep track of the various and specific types of threats and references, etc.

- No management activities directed at Taxon - What do you mean by management? It means a lot of different things to different people. List in point form what you mean by management, i.e: monitoring (by just looking, or by taking some, with harvest or other use, i.e., for science); modifying fragmentation patterns (i.e., reconnectivity for marten habitat); in relative or absolute terms; strict protection of wilderness, or management of working land for marten habitat. How is this variable used? Is it to indicate that there is more likely to be information available? or protection available?

- Rather than speaking of "Legally harvested", are you referring to everything that is "used" ("used" in the large sense, i.e., for tourism, trapping, science). Are they "used" or are they legally used? Or are you looking for whether the use is sustainable? For example, perhaps you should have a management category.

- Population trend not regularly monitored: what do you mean by regularly, and by monitored? There is an implicit thought in this variable that monitoring is essential, or that, philosophically, "monitoring is good", therefore, it is "not good" if it is not monitored. Sometimes monitoring has negative impacts or is carried out in association with or through other activities, such as trapping. Therefore, for information purposes alone, you might want to ask, is it monitored? (Respondent 20)

Workable, Yes. Appropriateness has to be addressed on the basis of management requirements for species, and relative to scale, for example, geographic scale or land base, or biological management scale. I'm not sure that, for example, at the genetic level of scale that the available or known information is adequate for a decision base. Even in reference to the geographical scale, for everything that is known there is much more that is not known; you need to make tremendous assumptions. The question is whether or not these assumptions are tenable or responsible given the expectations of the public regarding the quality of information upon which we base decisions.

In general terms, to develop a process like this depends very much on how it is going to be used. It is very important that variables are chosen, and the value of the variable be determined, according to management requirements. Also, a variable can be used on a single species basis, but is more valuable relative to other species in its taxonomic or family group, for example, overall quality might be good for the group. The value of the variables depends on the quality or type of information, for example, we know a lot about the lynx, therefore, there is a powerful bang with the results. But, with climate warming, data is controversial and projecting effects of changes is not possible with any degree of confidence. Regarding the actual suite of variables, by and large there is a multivariate colinearity in them that would negate their use individually. They are not unrelated; they are somewhat redundant, interrelated and dependent upon one another. You need to ask the question: which are the most robust and lead to the best answer. (Respondent 21)

2. Which variables do you consider to be the most important?

1b, 1d, 1e, 2c
[small population in Park/region;
small number of occurrences in Park/region;
small geographic range/distribution in region;
limited dispersal power] (Respondent 1)

1a,b,e,g, 2e,g, 3b,c, 4d, 5b,c
[Nationally rare (COSEWIC);
Small population in N.S.;
Small geographic range/distribution in N.S.;
Large percentage of range/distribution in N.S.;
Low reproductivity/low fecundity;
Pollution susceptible/accumulator species;
Habitat specialization;
Dependent upon provincially rare habitat;
Keystone species;
Population threatened by direct exploitation, harassment or ecological interaction in N.S.;
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.] (Respondent 2)

Population declining in N.S.;
Decline in range/distribution in N.S. .
All! (Respondent 3)

Autecological info (#6)
[Limited knowledge of distribution in N.S.;
Population trends not regularly monitored in N.S.;
Factors limiting population in N.S. unknown;
No autecological studies in N.S.;
No (meta-)population viability analysis in N.S.] (Respondent 4)

Rarity (Respondent 5)

cannot answer - changes from species to species
1. rate of decline
2. biological characteristics (Respondent 6)

That varies by species considered.
Population parameters;
Habitat vulnerability;
Human impact factors (Respondent 7)

For priority:
Small population;
Genetically distinct form;
Nationally rare

For management planning:
Limited dispersal power;
Low fecundity;
Keystone species (Respondent 10)

[Cribbed from letter: see section - General Comments] The biological characteristics (block 2) provide useful variables, especially those relating to high space demands, high variability in population parameters, and limited dispersal ability. . . .
Dietary or habitat specialization (Block 3) is useful but should be associated with particular dietary items and (or) habitat types, and be complemented with assessments of current abundance and expected future trends in these items. . . .
The section on ecological importance (block 4) is interesting, and the variables are of considerable use to selecting species as indicator or "important" species. . . .
The most important variables are . . . those that address habitat - composition, scale and spatial pattern. (Respondent 9)

For amphibians and reptiles: Category 1, which depends on category 6; Category 2; Category 5 (Respondent 14)

For amphibians and reptiles: Habitat and life history; Human effects (Respondent 16)

Age at first reproduction;
Variability in density;
Sensitivity to variation in water flow (Respondent 18)

This depends; what is your main purpose? to identify vulnerable species or "species of concern" priorities? In your title there is the term "human-altered" ; why is this even used? It seems to imply that there are pristine areas that are not to be considered. Regarding the word "extirpation" - it connotes a crises situation; they are on the verge of disappearing. The wording of the title should reflect the purpose, which must be "preventative" rather than focused on the sensational or crises, for example, that the species is about to disappear, which is suggested by the term "extirpation". The concern is as much for a 50% decline in a common or widespread species (anticipating the possible future list of "red" species) as for a more rare species (for example, in N.S., those species at the northern limit of their range, where we would be fighting a losing battle with trying to stop a normal biological change. Rarity or small population is less important than a decline in population or range and distribution. You also need to think about how to define decline (% over time).

Regarding clarification of the purpose, it would be useful to classify population problems as to the "degree" of the problem, i.e., big problem or main problem rather than minimal problems. For example, a serious problem would be a decline in population of 20% over 5 years. The definition of a "serious" problem relates to the function or purpose of what you are trying to achieve. For example, you want to be able to use the information to both identify problems and address problems. I see the term tautological in some other comments - you are using the information to identify problems and promote a way of dealing with the problems. You can address the problems by identifying five main problems or risk factors or threats to mammals in N.S.: a mix of biological and human factors. For example, big, furry, scary, "use" species go extinct in N.S.; therefore you may be able to identify 5 or 6 categories of critters that may be subject to similar problems.

You have two types of variables, those that are quantitative and those that are qualitative. I think the most important variables are Population decline and Decline in range and distribution; these are quantitative. These are population status variables and are different from rarity, and should have priority or more weight over "rarity", which is a natural thing and could be good; as you know there are several different types of rarity. Threats to the population and to habitat are also important variables. In the qualitative realm, important variables are something affecting reproductive ability - poor reproductive success, and something reflecting genetic factors or problems (for example, there might be a bottleneck) (Respondent 20)

The most important variables are the seven ... (NSDNR) have hit on [1. Population size; 2. Population Trend; 3. Distribution trend; 4. Geographic distribution; 5. Number of occurrences; 6. Threats to population; 7. Threats to habitat.]. They are the best because they are robust. By robust I mean flexible enough for weighting to allow a wide-range of individuals to come to the table and understand the rationale and participate. Biologically they are tried and tested nationally and internationally (by the IUCN and the Nature Conservancy, both in U.S. and in Canada).

As far as your other fields, some, for example, COSEWIC, are interesting. But I'm not sure that COSEWIC is the best measure to affect a decision because provincial priorities are not necessarily aligned with national ones. In fact, COSEWIC does not necessarily reflect national priorities.

"Percentage of range/distribution in N.S." is a valuable measure within a more quantitative approach. However, I would want to tie-up the factor that this species is "endemic to N.S.", with "large percentage of range in N.S.".

"Species at range edge in N.S." is good but should be in a qualifying memo field, as information, but not necessarily used for ranking.

"Genetically distinct form" is the same - good for information but not for ranking. Also, you need to tie-in this information with the source for reference; there is a need to tighten up the standards for genetic information; it is very plastic. Information needs to be more empirical, such as more DNA analysis, and needs to be qualified in a memo-field.

Your other factors are very useful for a bunch of reasons, but a vast number of them are not as useful for an evaluation system of status or system for setting provincial priorities. These are more for use within a status detailed evaluation for those species identified as threatened or "red". For example, biological characteristics are related to why it is endangered in the first place, therefore it is good to include them in the recovery planning process.

1."Geographic distribution" and 2."No. of occurrences" are very powerful landscape measures. 3. "Threats to Population" and 4. "Threats to habitat" are very important also. 5. global status or Nature Conservancy value is also important. These five factors have nested within them the biological characteristics. For example, Threats to population and to habitat have those biological and habitat related vulnerabilities included in that they are why some species are threatened and others aren't . That is why these 5 factors are given more weight in determining "red" status. For determining "yellow" status, additional factors are include, for example, species have at least one other factor with "A" rating (Respondent 21)

3. Which variables do you think could be deleted or are least important?

1a (COSEWIC) [Nationally rare (COSEWIC)] (Respondent 1)

2c,f especially 2c; 2d not well suited to our mammal species; 5a,d
[2c -Extremely variable in population density (especially);
2f - Large bodied (largest members of feeding class);
2d - Limited dispersal power; (not well suited to our mammal species)
5a - Legally harvested or killed in N.S.;
5d - No management activities directed at taxon] (Respondent 2)

? - because don't know how you intend to use info. (Respondent 3)

National rarity (Respondent 4)

Information status
[Limited knowledge of distribution in N.S.;
Population trends not regularly monitored in N.S.;
Factors limiting population in N.S. unknown;
No autecological studies in N.S.;
No (meta-)population viability analysis in N.S.] (Respondent 6)

Keystone and genetically distinct are somewhat arguable.
Climatic sensitivity - change to climatic change sensitivity? (Respondent 7)

Knowledge of distribution in N.S. is very subjective - one never has enough - this will give you an answer but attributing meaning will be difficult. (Respondent 8)

None - need as many as you have (Respondent 10)

For amphibians and reptiles: Summit predators; species that occur at higher trophic levels; major vegetation influencer; and, large-bodied (Largest member of feeding class) (Respondent 14)

For amphibians and reptiles: Population characteristics - for amphibians they vary from year to year (Respondent 16)

Climatic sensitivity - How do you quantify this? (Respondent 18)

None need to be deleted; I have no clear idea of which are least important. (Respondent 20)

Waive this question: all factors other than the ones previously mentioned as important (Respondent 21)

4. Can you think of variables that should be added? Why?

Possibly - susceptibility to predation by domestic and feral cats? Have noted impacts here on flying squirrels and jumping mice. (Respondent 1)

Perhaps info. on use and value to humans in categories, past and present: economic, aesthetic, recreational, tourism, subsistence. (Respondent 3)

Yes. The study needs a more rigorous way of defining expertise. (Respondent 4)

Whether the species is native or introduced. (Respondent 5)

Under biological characteristics:
1. niche specialists - e.g., cavity nesters;
2. negative interaction with humans - i.e., nests on beaches (Respondent 6)

Introduced predators affecting species;
Irreversible land use practices;
Is species effectively doomed - even if management efforts were directed? (Respondent 7)

No (Respondent 8)

[Cribbed from letter] Dietary or habitat specialization should be associated with particular dietary items and (or) habitat types, and be complemented with assessments of current abundance and expected future trends in these items. ...
I consider vulnerability to be most relevant for species when considered over their entire range, rather than within a single jurisdiction. ... The most important variables are therefore those that address habitat - composition, scale and spatial pattern. (Respondent 9)

Regional rarity in Maritime;
Meta-population assessment (Respondent 10)

For amphibians and reptiles:
- Provincial status: endangered, threatened, vulnerable or rare (law - provincial equivalent to COSEWIC. For example, a species nationally rare can be very common in N.S;
- Offspring survivorship: mass reproducers (frogs/toads) vs reptiles;
- Disease susceptible: more and more important (Respondent 14)

- Global status
- neighboring jurisdiction status;
- reproductive success;
- genetic issues, i.e., how diverse or unique something is genetically; or, how genetically diverse // it's genetic integrity (Respondent 20)

- Nature Conservancy's global ranks (Value of 1-5, with 5 being demonstrably secure and 1 being globally threatened)
- IUCN information (Respondent 21)

5. (a) Do you think that the matrix process is a suitable way to identify species vulnerable to extirpation in human-altered landscapes and, thus, set priorities for planning and management attention? Why? Why not?

It is suitable for "first cut" to set initial priorities. Obvious extension would be GIS study of habitat requirements for potential spp.. (Respondent 1)

Some variables are too subjective: If we stuck to 1, 2a,e,g, 3b,c, 4d, 5b,c that would highlight all species of concern.
[1. rarity/population status;
2a. Space-demanding/wide-ranging;
e. Low reproductivity/low fecundity;
g. Pollution susceptible/accumulator species;
3b. Habitat specialization;
c. Dependent upon provincially rare habitat;
4d. Keystone species;
5b. Population threatened by direct exploitation, harassment or ecological interactions in N.S.;
c. Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.]
There is something wrong when bats rate higher than expected. We just don't have the climate and habitat quality for many of them. Many of them benefit from man.
Overall - a good way to analyze. (Respondent 2)

[. . . set priorities for planning and management . . .] + $
Yes, but have yet to see how this info. will be presented and to whom. Will they listen?
I would like to have discussed a few of these variables for certain species, with others knowledgeable in the field. (Respondent 3)

No. No rigorous way of assessing expertise of those that fill in the questionnaire. (Respondent 4)

Yes - see #1
[Appropriate for what? For your thesis title - they may be workable if a group of people work together on the matrix and agree on what the terms mean. Working alone it is difficult to know what you mean.] (Respondent 5)

Best available (Respondent 6)

Atlantic whitefish is an eg. where priority might be high, but little can be done to improve the status - given that chain pickerel, acid rain, dams, etc. are here to stay. (Respondent 7)

If you target your recipients well it can work. You may need to provide a little more guidance in your definitions of variables - e.g., what do you mean by management in "no management activities directed at taxon" - to some wildlife biologists - a legal hunt is management. (Respondent 8)

Yes, but only for species with data, therefore not for shrews/bats.
Define human-altered? - what about what about native activity (pre European). (Respondent 10)

Yes, if we increase our knowledge in category 6 (Respondent 14)

It is an attempt to input objectivity into a very subjective process (Respondent 15)

Probably more important in political context than biologically (Respondent 16)

I was reluctant to complete the matrix for the simple reason that by "filling in" the spaces might be interpreted as "reliable knowledge". There are few data for most of the cells in the matrix. Thus, there might be a tendency for the matrix to be based largely upon subjective opinion (which I suppose might be all right if it was indicated as such). (Respondent 18)

There is a lot of useful information in the matrix and it can be used in lots of different ways, so it is useful in its own right. But you might want to clarify the focal purpose, for example, see the title of the matrix: it is useful for this, but is this what you really mean, particularly in regards to "extirpated" and "human-altered" (all are in N.S.)? See the notes above, regarding purpose (Respondent 20)

Yes, with the qualification that the matrix needs to be scaled down to a readily workable form to allow those priorities to evolve through discussion and allow experts to fill-in the information. There are too many vacancies in the matrix. The matrix is a readily digested visual summary of complex information to provide digestible, readily seen information for decision making, and allowing you to recognize patterns from the data. The use of experts is good; ideally, any status evaluation system has to pull from the largest pool of expertise available, and use peer review for a meaningful decision-making system. (Respondent 21)

5. (b) What are the strengths of the process?

A means for priority species
A means of evaluating problems and deciding which species are of concern or need highlighting. (Respondent 2)

Presents a good across the board comparison for priority setting in management programs. (Respondent 3)

Any work to study and survey our fauna and the knowledge of our fauna is truly valuable in the long run in terms of protecting these organisms. (Respondent 4)

Considers a lot of factors in the headings (Respondent 5)

Comprehensive (Respondent 6)

Good general exercise to focus limited research/management resources (Respondent 7)

Allows the use of the subjective professional judgment in a controlled and standardized manner (Respondent 8)

See above [Refer to previous answers by respondent 10] (Respondent 10)

Broad-based; attempts to be comprehensive (Respondent 18)

There are two aspects of the process that can be assessed: 1) the process of identifying species of concern; and, 2) the process of using experts. Which is it that you are looking for? The strengths are:
1. In the breadth of the information base - the species and variables - that is collected;
2. the process of using local expertise of information; it qualifies or "softly quantifies" information on local species using local experts;

3. It educates people about and gives them input into development of the approach, so it is more likely to be used or adopted by others (Respondent 20)

You can draw something about this from the comments I already made (Respondent 21)

5. (c) What are the weaknesses of the process?

Subjectivity - with so many different species requiring slightly different interpretations (Respondent 1)

Not enough rationalization of the value of some variables over another. Value added?
Lack of info./data (Respondent 2)

The end product will tell. Again, will those that control the $ listen or care. (Respondent 3)

Any idiot can be considered an expert and could bias the data. (Respondent 4)

You are only concentrating on vertebrate animals. (Respondent 5)

Requires vast amount of data;
needs more of a hand book to go along with the matrix, clearer explanations and definitions (Respondent 6)

If populations of spp. are not endangered elsewhere, and species is at edge of range, we may be fighting a losing battle with a changing climate, etc. (Respondent 7)

Same as the strength - the definition of terms needs to be tight - some things are a little too open ended. - what is diff. between- ? and ( ) (Respondent 8)

See above [Refer to previous answers by respondent 8] (Respondent 10)

For amphibians and reptiles:
Do we have enough baseline data to fill a matrix like this? (Respondent 14)

Subjective; lack of data; lack of precision in the characteristic designations (Respondent 18)

1. The breadth of the process is also a weakness in that it is hard for anyone to be an expert in all of these species and in all of the variables. Therefore, it is hard to be consistent across the board or the matrix, and with all of these people.
2. A lot of information is available to base assessments on, but our understanding is still limited. (Respondent 20)

You can draw some inferences from my previous comments to answer this question as well. (Respondent 21)

6. What are your thoughts about the process of completing the matrix? What was your experience?

Found matrix a bit intimidating at first. (Respondent 1)

It is complicated by our knowledge or lack of it. A little knowledge is dangerous. We can be drawn to a few because of their charisma but forget others due to lack of info. or because they are not so pretty. (Respondent 2)

An interesting process. But you should have a number of qualified opinions on each species.
I questioned and changed many of the x + √ that had already been entered. (Respondent 3)

A difficult exercise; frustrating. (Respondent 4)

Too long and time consuming. (Respondent 5)

Difficult to keep all the variables straight. (Respondent 6)

Frustrating - realize after studying some of these species how little we really know (Respondent 7)

I had to fight the urge to fill in things based on hearsay info. rather than personal experience or reading (Respondent 8)

Sorry - don't know about N.S. distribution well enough to do much of the matrix.
Section 3 and 4 (of which I do know) look great.

- Gaspé shrew at high trophic level?
- N. flying squirrel is a keystone for hypogean fungi/mycorhieae
- Ermine is not a habitat specialist but is a food specialist
- Beaver is a keystone for wetlands (Respondent 10)

For amphibians and reptiles: I will recommend a search for further references. A lot of the information is based on anecdotal sources? (Respondent 14)

I felt that it was over my head, but that it was a valuable learning experience. It would have been best to assemble a team of people to go over the matrix as it requires very broad knowledge of many species. Because of demands from other tasks and priorities it was not possible to get a group of Parks staff to do this (Respondent 15)

The potential danger is that a fully completed matrix gives the appearance of being based on science when it may be largely based on guesses and opinions (or "gut feelings"). (Respondent 18)

I didn't complete the matrix but think it is a useful thing because rarely as an individual do you get a chance to take such a wide-angle view or such a coarse filter approach. Fun! (Respondent 20)

Unwieldy - too many variables. I found myself continually looking at a variable and then thinking, didn't I already answer that? I wasn't sure where the lines were between the variables. I found it difficult to even meaningfully assign values to some of these variables. For example, the habitat-related variabilities have quite plastic definitions. Take specialization - even non-generalists have some incredible adaptability, using different resources across the country and over time. For example, black-throated blue warblers are quite specialized in N.S., but use a different type of habitat in Ontario. Also, pine martin may be adapting to different forest types. Many species seem to have some degree of plasticity, although there are also those that are "monophagous" - single diet (versus polyphagous). (Respondent 21)

7. Based on the exercise of completing the matrix and your best professional judgment, which species would you identify as being the most vulnerable to extirpation in human-altered landscapes in Nova Scotia? What are the major reasons or variables? (List to a maximum of ten.)

Species:	**Major reason for identification:**
(Northern Cape Breton)	
Gaspé shrew	small isolated population
rock vole	"
bog lemming	"
marten	" & top carnivore & habitat loss
lynx	small (?) population; trapping by-catch? (Respondent 1)

marten	loss of habitat & trapping
fisher	"
lynx	bobcat comp. & "
Blanding's turtle	low pop.
wood turtle	"
cougar	low numbers
Atlantic whitefish	low numbers; water quality? (Respondent 2)

I don't feel qualified to answer. Perhaps after seeing final report & discussing with others. In my area of responsibility, moose on mainland N.S. are in very low numbers relative to the past. We don't know why. There is very high demand to use (see and hunt) and they are very valuable in terms of tourism, recreationally and subsistence hunting. (Respondent 3)

All amphibians, except bullfrog (Respondent 4)

What is human-altered environment? a road through unbroken forest or a parking lot? (Respondent 5)

Eastern Cougar	gone now
lynx	exotic invasion - bobcat
Blanding's turtle	range edge - humans on nesting beaches
American martin	forestry - habitat loss
fisher	forestry - habitat loss
hoary bat	? - habitat loss
wood turtle	habitat loss/degradation
southern flying squirrel	range edge (Respondent 6)

Atlantic whitefish	lack of knowledge, dams, acid rain, introduced predator
Blanding's turtle	disjunct population, reprod. problems within range (Respondent 7)

I have no opinion on this . . . sorry (Respondent 8)

Gaspé shrew	COSEWIC
American marten	trapping sensitive
lynx	trapping sensitive
rock vole	habitat sensitive
Blanding's turtle	disjunct population
ribbon snake	rarity / disjunct / data ignorance
four-toed salamander	" " " / habitat
wood turtle	pet trade / riparian use by cottages / Dogs
*Cougar - not	waste of time for N.S. (Respondent 10)

For amphibians and reptiles:

Blanding's turtle	Categories 1 , 2, and 5
northern ribbon snake	" " " " "
wood turtle	" " " " "
	(Respondent 14)

1. Blanding's turtle	disjunct species; small population + territory
2. Atlantic salmon	over fishing; lack of fish ladders/passages
3. southern flying squirrel	disjunct species
4. eastern cougar	totally extirpated?
5. lynx	over harvesting
6. northern ribbon snake	disjunct species
7. blue-spotted salamander	disjunct species
8. piping plover	endangered
9. bald eagle	protected; pollution sensitive
10. pine marten [American]	over trapping; habitat destruction
	(Respondent 15)

Atlantic whitefish	Habitat loss (Respondent 18)

I want to co-opt out on this question and just say that I want these to be the Red-listed species on [NSDNR] lists; even the yellows, too. Because these lists of species have been developed based on some consistent application of criteria.

[Mammals: Red: American Marten; Eastern Cougar; Lynx
Yellow: Eastern Pipistrelle; Fisher; Hoary Bat; long-tailed Shrew; Northern Long-eared Bat; Red Bat; Rock Vole; Silver-haired Bat; Southern Flying Squirrel
Reptiles and amphibians: Red: Blanding's Turtle
Yellow: Northern Ribbon Snake; Wood Turtle;
Blue-spotted Salamander; Four-toed Salamander] (Respondent 20)

The red-listed species [NSDNR]. Also, the yellow listings reflect species that for a variety of reasons are ecologically sensitive or indicator species for environmental quality.

[Mammals: Red: American Marten; Eastern Cougar; Lynx
Yellow: Eastern Pipistrelle; Fisher; Hoary Bat; long-tailed Shrew; Northern Long-eared Bat; Red Bat; Rock Vole; Silver-haired Bat; Southern Flying Squirrel
Reptiles and amphibians: Red: Blanding's Turtle
Yellow: Northern Ribbon Snake; Wood Turtle;
Blue-spotted Salamander; Four-toed Salamander] (Respondent 21)

8. Other comments:

Might be worth running known extinctions (e.g. caribou, wolf) through exercise as well. (Respondent 1)

Dietary & reprod. specialization: very subjective unless you really narrow it down; example: How much different is a skunk than a mink? Shrews & mice & others are extremely variable in pop. numbers but it is irrelevant to the purpose. They vary due to their reprod. strategy or food or disease. Need to be careful about habitat specialization! Water shrews may live in marshes, stream banks but can be quite common but seldom seen. The habitat is abundant but scattered. No more specialized than a jumping mouse? (Respondent 2)

Thanks for asking. Good luck. (Respondent 3)

How do we define, judge, evaluate, assess, etc. expertise? (Respondent 4)

Sorry I didn't have time to circulate this, or think more about it and put more time into it. Would be interesting to fill out the matrix in a room full of biologists to gather bits of info. together about a species - combine experiences. Good luck! (Respondent 7)

Birds? Don't know anything about fish!
Where is big brown bat?
Porcupine is major influence on conifer/[illegible word], killed by foresters (Respondent 10)

Why wood turtles are still legally harvested or killed in N.S.?
Put scientific names on organisms. (Respondent 14)

Scientific names instead of common names should be used, or both used, to avoid confusion. (Respondent 15)

In the "legally harvested" variable: The idea of harvesting wildlife means non-fish vertebrates. The basic premise is that everything is protected, and then things are "unprotected" by legal harvest, i.e., seasonal and bag limits. This changes by year.

Harvest, or "use" (harvest is one form),is also for science and for museum collections and that sort of thing. You want to avoid "blaming", implicitly, the hunters and trappers. "Use" also includes recreational activity; people running around in the woods just "looking" for pine martins and bird watching can have a real impact on populations. Look in the NSDNR hunting booklet for this years' seasonal and bag limits for species. Put a footnote explaining how you interpreted this, for example, with Arctic shrew, even though you do not give it a check mark for "use", there is provision in the Wildlife Act to protect property - houses, barns - from damage, allowing certain species to be legally killed (see page 11 in the booklet [NSDNR 1996c]).

Your categories may be not right. For example, rare is a biological characteristic, like low fecundity. Population change is what we are interested in: decline in population, decline in distribution; and reproductive success - these are population status variables. Genetic form is also a biological characteristic. "Use" should go under the information status category, changed from "legally harvested"; just because there is a "use" does not mean that there is a negative impact.

If there is a single weak point, it is that there is no clear statement about what your purposes are. The next part of the process - summarizing - is the next potential weakness. Get your purposes clear so that interpretation of the information will reflect clearly your purposes: ground the interpretation in the purpose. How you package it has to reflect why you package it. (Respondent 20)

With the listing criteria ... [NSDNR] used, there are definite patterns of decline, long term loss, critical habitat, and where we know there are broad scale declines internationally, and where there are also stressors that are directly or indirectly growing, such as acid rain, methyl-mercury, and organo-chlorines. There is a need to bring attention to these factors. For example, the loons: there are lots in Canada; they have no risk status in Canada, yet based on the long-term historic data it is obvious that there are declines due to habitat loss and disturbance and pollution. We need to be cognizant of these other factors, and look at the species with yellow status.

The weakness is in the "yellows". What I mean is, the reds are very rapidly declining, but others are also declining in our history and these do not appear on the status. What we need to do is hold up the populations of the yellow species and other common species, rather than wait until they are down and then try to bolster them up. Yellows are the challenge - the species of concern. Two criteria that would weight for designating vulnerability are the Threats to habitat and to populations: historic changes in population and distribution trend (as well as the geographic distribution factor and number of occurrences). (Respondent 21)

<u>General Responses (cover letters):</u>

I have partially answered your questionnaire but I am not sure how you wanted it completed. I do not have great knowledge about the individual species listed but I have some knowledge of the habitat needs of wildlife and the province's wildlife management programs. Therefore I have limited my answers to the right side of the page.

If I did not agree with what the column heading stated I presumed there should be an X in the cell. This caused me to change many of your check marks. For example your check marks indicate that bats are legally harvested in Nova Scotia - this is not true so I changed your checks to an X. Also to state that we know nothing of the distribution, and do not monitor the populations of our important game animals indicates a naïveté on your part, so I put and X in these cells. However I did not take the time to put Xs in many other blank cells that were similarly untrue, e.g. in the column "Factors limiting populations . . . ".

Generally I feel you may have trouble interpreting the results of your questionnaire because your headings could be interpreted in many ways. For example what is a major influence on vegetation? What habitats are provincially rare? What is harassment or an ecological interaction? You should not lump answers from people working independently and who may be interpreting the questions differently. (Respondent 5)

I completed the matrix with no species in mind. My review was based on knowledge of the Wildlife Act and the programs of the Wildlife Division. I indicated that you had some serious errors in the information relative to harvested species; populations that were threatened by exploitation and habitat loss etc.; management activities directed at the taxon and population monitoring. I do not consider myself an expert in any species in particular. I was trying to correct many mistakes in the information you had already entered into the matrix and suggesting the matrix was a little confusing relative to these columns in the matrix. (Respondent 5)

. . . I am not able to provide the detailed information you are after for most species and so will not attempt to fill in the matrices. . . .

Seeking the input of "experts" to fill in the matrices is a good idea; however you should be cautious of "pseudo-referencing". Very few people can provide first-hand information of the resolution you desire, particularly across a [sic] entire vertebrate class or order. The problem is that many people provide the information anyway, and are referencing generally-held ideas resulting from very few papers. The fact that you may receive the same information from many reviewers does not necessarily give it more power!

Here are some general answers to your questionnaire - even though I didn't fill out the matrix!

The relevancy of your variables depends in part on the use to which you (or others) will put the matrix. Some variables will give you a predictable list, while others may provide some new insight. For example, the qualities of being nationally endangered, at the edge of one's range, or rare in NS are reasonable predictors of vulnerability, but the relationships are tautological [repetition of the same idea; necessarily true because it includes all possibilities; going back to the same thing] in nature and little new is gained with these.

The biological characteristics (block 2) provide useful variables, especially those relating to high space demands, high variability in population parameters, and limited dispersal ability. Space and dispersal are not independent of course, nor is either independent of body size.

Dietary or habitat specialization (block 3) is useful but should be associated with particular dietary items and (or) habitat types, and be complemented with assessments of current abundance and expected future trends in these items. Being a specialist for an abundant, resilient habitat does not make one vulnerable!

The section on ecological importance (block 4) is interesting, and the variables are of considerable use to selecting species as indicator or "important" species. However, being important does not make one vulnerable so I don't see the connection here.

I consider vulnerability to be most relevant for species when considered over their entire range, rather than within a single jurisdiction. Although vulnerability of a species in NS may result from many things, at a larger scale it is primarily a function of the degree of dependence on habitat types (or items) coupled with abundance of those habitats (or items). (Response to toxins and vulnerability to harvest may also be relevant.) The most important variables are therefore those that address habitat - composition, scale and spatial pattern. (Respondent 9)

I have suggested two variable name changes, noted on the matrix. The first one simply summarizes what the variable is about [change "Genetically distinct form" to "Monotypic and/or disjunct species"]. The second also proposes changing the variable definition to include recurring population fluctuations that are not regular but can be extreme and are caused by such things as epizootics or crashes in food/prey species. All the species I have checked in that column are subject to such extreme fluctuations [change "Extremely variable in population density" to Population density cyclic, or subject to unpredictable crashes"].

There is enough overlap between "summit predator" and "species at higher trophic level" that I think they could be merged into a single variable. There are enough other compound variables in the matrix that another won't hurt. And in the definitions of summit predators, add "felids" to the list.

In the Response Key, I have added one for "sometimes" to cover cases like Meadow Vole. (Respondent 17)

- change "Genetically distinct form" to "Monotypic and/or disjunct species"
- change "Extremely variable in population density" to "Population density cyclic, or subject to unpredictable crashes)
- some overlap between "Summit predator" and "Species that occur at higher trophic levels"
- add another category for response: Sometimes (S) (notes on matrix, Respondent 17)

- It would have been better to use a blank matrix, with no answers provided, to better determine consensus, expert opinion, and information status.
- It would be easier for the expert if you use one sheet per species, rather than a matrix/table; I found myself getting lost so I made up single species sheets for my own use
- use headings that more closely reflect the definitions or what you actually mean, or include the definitions right on the sheet with the headings; this is possible if you use one sheet for each species, instead of the matrix - one gets confused. (personal communication, Respondent 17)

Appendix 3.4: Assessment of importance of variables by respondents

Variables	Most Impor-tant	Least Impor-tant	Respondents' Comments (Summarized from Appendix 3.2)
1. Rarity/population status			Categories may be wrong; i.e., rarity and genetic form are biological characteristics; change in population and distribution and reproductive success are of greater concern and are population status variables
Nationally rare (COSEWIC)	5	2	should give more value to endangered than to vulnerable species; tautological; need other than COSEWIC to determine national rarity or priorities (IUCN; TNC); focus at provincial level, then regional, national and global rarity
Small population in N.S.	7	1	Varies from year to year for amphibians
Population declining in N.S.	6	1	Varies from year to year for amphibians
Small no. of occurrences in N.S.	4		tautological
Small geographic range/distribution in N.S.	4		ranges are less than clear for many species
Decline in range/distribution in N.S.	5		
Large percentage of range/distribution in N.S.	3		Valuable but should tie-in with endemic to and with large percentage of range in N.S
Species existing at range edge in N.S.	1		tautological; we may be facing a losing battle with climate change; should be in a memo-field, rather than a ranking criteria
Genetically distinct form	2	1	arguable; good for information but not important for ranking; change to Monotypic and/or disjunct species
2. Biological Characteristics			
Space-demanding/wide ranging	4	1	
Population seasonally/daily concentrating	4	1	
Extremely variable in population density	5	2	sometimes irrelevant to the purpose (i.e., shrews, mice); need tighter definition; change to "Population density cyclic or subject to unpredictable crashes
Limited dispersal power	6	2	
Low reproductivity/low fecundity (mammals/reptiles/amphibians)	6	1	Poor reproductive success; absolute or relative scale?
Large-bodied (largest members of feeding class) (mammals/reptiles/amphibians)	3	3	definition too complicated; absolute or relative scale: relative is better, i.e. largest species in its functional group
Older age at first reproduction (freshwater fishes only)	2		need tighter definition
Pollution susceptible/ accumulator species	4	1	

Appendix 3.4 (continued)

3. Habitat-related vulnerability			
Dietary and reproductive specialization (mammals/reptiles/amphibians)	3	1	should have been separated; should be associated with particular dietary items and complimented with assessments of current abundance and future trends; very subjective unless you narrow it down (i.e., skunk vs. mink); need better definition
Habitat specialization (mammals/reptiles/amphibians)	3	1	should be associated with particular habitats and complimented withassessments of current abundance and future trends; need better definition
Habitat/dietary/reproductive specialization (fish only)	1		need better definition
Sensitive to high annual variation in river/stream flow (freshwater fishes only)	2		need better definition
Dependent upon unimpeded/unobstructed watercourse (fish only)	1		need tighter definition
Dependent upon provincially rare habitat	4		need tighter definition What habitats are provincially rare?
Climatic sensitivity	3	3	change to climatic change sensitivity? How do you quantify this? need better definition
4. Species of major ecological importance			
Summit predator	1	2	Overlap with Species that occur at higher trophic levels
Species that occur at higher trophic levels	1	2	Overlap with Summit predator
Major vegetation influencer (mammals/reptiles/amphibians)	1	2	What is a major influence on vegetation?
Keystone species	3	2	arguable; in generic or ecologically specific sense?; change to functionally important species
5. Human-impact factors			
Legally harvested or killed in N.S.	3	2	Need to distinguish between "use" in larger sense and "harvest"; need management category, or include in Information Status, rather than "impact"; Note species refered to in N.S. Hunting and Furharvesting Regulations for 1996 and footnote as such
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	7		What is harassment or an ecological interaction? need memo-field to keep track of threat
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	7		need memo-field to keep track of threat
No management activities directed at taxon	3	2	what do you mean by management?

Appendix 3.4 (continued)

6. Information status			
Limited knowledge of distribution in N.S.	2	3	very subjective
Population trends not regularly monitored in N.S.	2	2	What do you mean by "regularly" and by "monitored"?
Factors limiting population in N.S. unknown	2	2	
No autecological studies in N.S.	2	2	
No (meta-) population viability analysis in N.S.	2	2	

Additional variables suggested by Respondents
Susceptible to predation by domestic and feral cats?; introduced predators affecting species
Information on use and value to humans, past and present (economic, aesthetic, recreational, tourism, subsistence)
Whether species is native or introduced
Under biological characteristics: - Niche specialist - Negative interactions with humans (i.e., nest on beaches) - genetic issues: uniqueness; diversity; fitness or integrity (i.e., bottleneck) - reproductive success; offspring survivorship (mass reproducers -frogs/toads- versus reptiles)* - Disease susceptibility*
Irreversible land use practices
Is species effectively doomed - even if management efforts were directed
Assessment of current abundance and expected future trends in dietary items and habitats required by specialists
Management category (for Legal "use"; Monitoring status; Other management variables)
Variables that adress habitat composition, scale, and spatial pattern
Global Status (IUCN); Species vulnerable over entire range The Nature Conservancy value (North American)
Provincial status; Regional rarity in Maritimes / Neighboring jurisdiction status
Meta-population assessment

Notes:

1. Variables that do not occur on all three matrices - for mammals, reptiles and amphibians and freshwater fishes - are noted according to the matrix or matrices on which they do appear
2. In response to question 2 - *which variables do you consider to be most important?*- respondent 3 answered, "Population declining in N.S.; Decline in range/distribution in N.S. All!", based on his review of the mammal matrix only. For column number 2 - Most important - only those two variables were counted.
3. Respondent 4 answered that "autecological information (#6) "[variables category] was most important for amphibians and reptiles matrix. Therefore, for column 2 - Most important - all variables in category 6 - Information status - were marked or counted
4. Respondent 5 answered that "rarity" was the most important factor. It is uncertain whether he meant Nationally rare (COSEWIC) or the entire set of Rarity/Population Status variables. For column 2 - Most important - only the "rarity" variables, Nationally rare (COSEWIC) and Small population in N.S., were counted.
5. Both respondents 6 and 7 qualified their selection of most important variables with the caution that it varies from species to species.
6. Respondent 6's specification of "rate of decline" was interpreted to include Population declining in N.S ; Decline in range/distribution in N.S.; and Population threatened by direct exploitation, harassment or ecological interactions in N.S.

7. Respondent 7's specification of "Population parameters" was interpreted to mean Small population in N.S., and Population declining in N.S., rather than the entire Category 1 - Rarity/Population status. Habitat vulnerability was interpreted to mean the entire Category 3 - Habitat-related vulnerability. Human impact factors was interpreted to be the entire Category -5.
8. The following most important variables were interpreted from general comments made in a letter from Respondent 9: Space-demanding/wide-ranging; Population seasonally/daily concentrating; Extremely variable in population density; Limited dispersal power; Dietary and reproductive specialization; Habitat specialization; Dependent upon provincially rare habitat; Habitat threatened by loss, conversion degradation, or fragmentation in N.S.; and all variables in category 4 - Species of major ecological importance.
9. Respondent 14 indicated Category 1, which depends upon Category 6. Therefore, all variables in Category 1 and 6 were marked, as well as categories 2 and 5 which were also indicated by the Respondent.
10.* Variables indicated with an asterisk refer to those for amphibians and reptiles, specifically
11. Most important variables interpreted from Respondent 20: Population decline; Decline in range and distribution; Threats to population; Threats to habitat; and, low reproductivity fecundity (to be changed to reproductive success)
12. Most important variables interpreted from Respondent 21 are: NSDNR criteria (7); National rarity (with comment that COSEWIC may not be the best measure); and Percentage of range distribution in N.S. (with comment that it should be tied-in with species endemic to and with large percentage of range in N.S.)
13. For Least Important variables, Respondent 16's indication of Population characteristics was interpreted to mean Small population in N.S., and Population declining in N.S.
14. Least Important variables identified by Respondent 21 are all those not indicated as Most Important, however, variables pertaining to fish species only were not counted.
15. One respondent (3) indicated that _all_ the variables are Most important; five respondents (6,7,9,20,21) indicated that it depends upon the species considered and upon the purposes of the information or ranking. Two respondents indicated that _no_ variables should be deleted (10, 20), and two indicated that Least Important depends upon the intended use or purpose of the information (3, 20). One respondent indicated that the range of variables is good (8). Five of the Respondents indicated that the strength of the matrix process is in the broad range of variables or factors considered in the headings or its comprehensiveness (3,5,6,18,20). However, others indicated that this breadth is also a weakness because of a lack of priority or weighting of some variables over others, redundancy among variables, a general lack of data or knowledge to fill-in the information, and because it makes the process too "unwieldy", "difficult", and/or "time consuming" (1,2,5,6,14,18,20,21).

Appendix 3.5: Most vulnerable species identified by respondents in questionnaire

Species identified as most vulnerable by Respondents on questionnaire	No. of times identified	Major reasons for identification as stated by Respondents on questionnaire
Mammals		
Gaspé Shrew	1 1	small isolated population, COSEWIC
Long-tailed Shrew	1 1	N.S.D.N.R. draft "YELLOW " status species N.S.D.N.R. draft "YELLOW " status species
Northern Long-eared Bat	1 1	N.S.D.N.R. draft "YELLOW " status species N.S.D.N.R. draft "YELLOW " status species
Eastern Pipistrelle	1 1	N.S.D.N.R. draft "YELLOW " status species N.S.D.N.R. draft "YELLOW " status species
Silver Haired Bat	1 1	N.S.D.N.R. draft "YELLOW " status species N.S.D.N.R. draft "YELLOW " status species
Red Bat	1 1	N.S.D.N.R. draft "YELLOW " status species N.S.D.N.R. draft "YELLOW " status species
Hoary Bat	1 1 1	? - habitat loss N.S.D.N.R. draft "YELLOW " status species N.S.D.N.R. draft "YELLOW " status species
American Marten	1 1 1 1 1 1 1 1	small isolated population, top carnivore, habitat loss loss of habitat and trapping forestry - habitat loss trapping sensitive over trapping; habitat destruction N.S.D.N.R. draft "RED " status species N.S.D.N.R. draft "RED " status species rare-vulnerable; biological characteristics; over-trapping in 1800s; habitat requirements / loss
Fisher	1 1 1 1 1	habitat loss, forestry - habitat loss trapping N.S.D.N.R. draft "YELLOW " status species N.S.D.N.R. draft "YELLOW " status species over-trapping in 1800s; habitat requirements / loss
Eastern Cougar	1 1 (* not) 1 1 1 1	low numbers, gone now, (* waste of time for N.S.) totally extirpated? N.S.D.N.R. draft "RED " status species N.S.D.N.R. draft "RED " status species no concrete evidence of remaining in N.S.
Lynx	1 1 1 1 1 1 1 1	small (?) population,; trapping bycatch (?) bobcat competition, habitat loss and trapping exotic invasion - bobcat trapping sensitive over harvesting N.S.D.N.R. draft "RED " status species N.S.D.N.R. draft "RED " status species Unlikely remaining on mainland
American Moose (Mainland population)	1 1	Very low numbers relative to the past and we don't know why; high demand for use (see and hunt); very valuable for tourism, recreation, subsistence hunting Major vegetation influencer
Southern Flying Squirrel	1 1 1 1	range edge disjunct species N.S.D.N.R. draft "YELLOW " status species N.S.D.N.R. draft "YELLOW " status species
Southern Bog Lemming	1	small isolated population

Rock Vole	1	small isolated population,
	1	habitat sensitive
	1	N.S.D.N.R. draft "YELLOW" status species
	1	N.S.D.N.R. draft "YELLOW" status species
Reptiles and Amphibians		
Wood Turtle	1	low population,
	1	habitat loss/degradation,
	1	pet trade, riparian use by cottagers,dogs
	1	Rarity/Population status; Biological characteristics; Human-impact factors
	1	N.S.D.N.R. draft "YELLOW" status species
	1	N.S.D.N.R. draft "YELLOW" status species
Blanding's Turtle	1	low population,
	1	range edge, humans on nesting beaches,
	1	disjunct population, reprod. problems within range
	1	disjunct population
	1	Rarity/Population status; Biological characteristics; Human-impact factors
	1	Disjunct species; small population and territory
	1	N.S.D.N.R. draft "RED" status species
	1	N.S.D.N.R. draft "RED" status species
	1	Why so limited in range? Limited dispersal power?
Northern Ribbon Snake	1	rarity, disjunct , data ignorance
	1	Rarity/Population status; Biological characteristics; Human-impact factors
	1	disjunct species
	1	N.S.D.N.R. draft "YELLOW" status species
	1	N.S.D.N.R. draft "YELLOW" status species
	1	Why so limited in range? Limited dispersal power?
Eastern American Toad	1	all amphibians except bullfrog are vulnerable
Northern Spring Peeper	1	all amphibians except bullfrog are vulnerable
Green Frog	1	all amphibians except bullfrog are vulnerable
Mink Frog	1	all amphibians except bullfrog are vulnerable
Northern Leopard Frog	1	all amphibians except bullfrog are vulnerable
Pickerel Frog	1	all amphibians except bullfrog are vulnerable
Wood Frog	1	all amphibians except bullfrog are vulnerable
Yellow-spotted Salamander	1	all amphibians except bullfrogare vulnerable
Blue-spotted Salamander	1	all amphibians except bullfrogare vulnerable
	1	disjunct species
	1	N.S.D.N.R. draft "YELLOW" status species
	1	N.S.D.N.R. draft "YELLOW" status species
Red-spotted Newt	1	all amphibians except bullfrog are vulnerable
Red-backed Salamander	1	all amphibians except bullfrog are vulnerable
Four-toed Salamander	1	all amphibians except bullfrog are vulnerable
	1	Rarity, disjunct, data ignorance, habitat
	1	N.S.D.N.R. draft "YELLOW" status species
	1	N.S.D.N.R. draft "YELLOW" status species
Freshwater Fishes		
Atlantic Whitefish	1	low numbers, water quality?
	1	lack of knowledge, dams, acid rain, introduced predator
		Habitat loss
	1	
Atlantic Salmon	1	over fishing; lack of fish ladders/passages

3.6 Composite list of categories and variables for identifying focal-species derived from literature and questionnaire responses

1. Vulnerable species

a) Biological characteristics

Populations with a low level of genetic variation/fitness/integrity
Space-demanding/large area requirements/wide-ranging
Long-distance migratory mammals/Migratory birds
Population seasonally/daily concentrating/tendency to congregate in large groups
Extremely variable in population density
Limited dispersal power/poor dispersal ability
Low reproductivity or fecundity/Low offspring survivorship/Older-age at first reproduction
Habitat specialization/Dietary specialization/Reproductive specialization
Ground-nesting habits
Niche specialist
Summit predator
K-strategist (long-lived, habitat specialists, with low rates of dispersal, and low reproductive rates)
Large-bodied species/Largest member of feeding class
Species that occur at higher trophic levels
Sensitive to high annual variation in river/stream flow (freshwater fishes only)
Dependent upon unimpeded/unobstructed watercourse (freshwater fishes only)
Dependent upon patchy or unpredictable resources
Disease susceptible
Pollution susceptible/accumulator species
Climatic sensitivity/sensitive to climate change

b) Rarity/endangerment

Globally rare (IUCN - Red listed species)
Nationally rare/endangered (COSEWIC)
Provincially rare/endangered
Regionally rare/endangered/Rare in park
Small population in N.S.
Small number of occurrences in N.S.
Small geographic range/distribution in N.S.

c) Rate of decline/decline since settlement

Decline in population in N.S.
Decline in range/distribution in N.S.

2. Keystone/ecologically important species

Important as food for many species
Summit predator (raptors, mustelids, canids, cats)
Dominant species at its trophic level
Pivotal species
Major vegetation influencer

3. Special populations

Genetically distinct form/genetic uniqueness
Large percentage of range/distribution in N.S.
Species existing at range edge in N.S.
Population is a special gene pool

4. Umbrella and flagship

Popular or charismatic species that can galvanize public support
Large, conspicuous species (mega-vertebrates)
Species with large home ranges/area requirements and broad habitat needs

5. Ecological indicator species

Species that signal the effects of perturbations/management practices on a number of other species
Species with narrow tolerances for environmental conditions, specific habitat or habitat-feature requirements (climate sensitive; pollution susceptible/accumulator species)

6. Species threatened by context, management and information related factors

Population threatened by direct exploitation, harassment or ecological interactions in N.S.
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.
Dependent upon provincially rare habitat
Species threatened by regulations/management practices or by lack of regulations/ management
Knowledge of distribution in N.S. is limited/lacking
Population trends not regularly monitored in N.S.
Factors limiting population in N.S. unknown
No autecological studies in N.S.
No (meta-) population viability analysis in N.S.

Appendix 4
Compilation of matrix responses by species and respondent with identification of consensus

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<u>4.1 List of contents - Appendix 4:</u>

- **4.2 Notes related to Appendix 4 tables**

The following tables compile the responses included in the matrices returned by the participants as well as key references. Consensus responses are identified.

- **4.3 Comparison of matrix responses on a per-species basis - *Mammals:***

4.3.1 Arctic shrew
4.3.2 Common shrew
4.3.3 Smokey shrew
4.3.4 Gaspé shrew
4.3.5 Long-tailed shrew
4.3.6 Water shrew
4.3.7 Pygmy shrew
4.3.8 Short-tailed shrew
4.3.9 Star-nosed mole
4.3.10 Little brown bat
4.3 11 Northern long-eared bat
4.3.12 Eastern pipistrelle
4.3.13 Silver-haired bat
4.3.14 Red bat
4.3.15 Hoary bat
4.3.16 Coyote
4.3.17 Red fox
4.3.18 American black bear
4.3.19 Racoon
4.3.20 American marten
4.3.21 Fisher
4.3.22 Ermine/Weasel
4.3.23 American mink
4.3.24 Striped skunk
4.3 25 River otter
4.3 26 Eastern cougar
4.3.27 Lynx
4.3 28 Bobcat
4.3.29 White-tailed deer
4.3.30 Moose
4.3.31 Eastern chipmunk
4.3.32 Woodchuck/Groudhog
4.3.33 American red squirrel
4.3.34 Southern flying squirrel
4.3.35 Northern flying squirrel
4.3.36 American beaver
4.3.37 Deer mouse
4.3.38 White-footed mouse
4.3.39 Red-backed vole
4.3.40 Southern bog lemming
4.3.41 Muskrat
4.3.42 Meadow vole
4.3.43 Rock vole
4.3.44 Woodland jumping mouse
4.3.45 Meadow jumping mouse
4.3.46 American porcupine
4.3.47 Snowshoe hare

- **4.4 Comparison of matrix responses on a per-species basis - *Reptiles and Amphibians:***
  - 4.4.1 Snapping turtle
  - 4.4.2 Wood turtle
  - 4.4.3 Blanding's turtle
  - 4.4.4 Eastern painted turtle
  - 4.4.5 Maritime garter snake
  - 4.4.6 Northern ribbon snake
  - 4.4.7 Northern ringneck snake
  - 4.4.8 Eastern smooth green snake
  - 4.4.9 Northern redbelly snake
  - 4.4.10 Eastern American toad
  - 4.4.11 Northern spring peeper
  - 4.4.12 Bullfrog
  - 4.4.13 Green frog
  - 4.4.14 Mink frog
  - 4.4.15 Northern leopard frog
  - 4.4.16 Pickerel frog
  - 4.4.17 Wood frog
  - 4.4.18 Yellow-spot. salamander
  - 4.4.19 Blue-spotted salamander
  - 4.4.20 Red-spotted newt
  - 4.4.21 Red-backed salamander
  - 4.4.22 Four-toed salamander

- **4.5 Comparison of matrix responses on a per-species basis - *Freshwater fishes:***
  - 4.5.1 Sea lamprey
  - 4.5.2 Atlantic sturgeon
  - 4.5.3 American eel
  - 4.5.4 Blueback herring
  - 4.5.5 Gaspereau, Alewife
  - 4.5.6 American shad
  - 4.5.7 Atlantic whitefish
  - 4.5.8 Lake whitefish
  - 4.5.9 Atlantic salmon
  - 4.5.10 Brook trout
  - 4.5.11 Lake trout
  - 4.5.12 Rainbow smelt
  - 4.5.13 Northern redbelly dace
  - 4.5.14 Lake chub
  - 4.5.15 Golden shiner
  - 4.5.16 Common shiner
  - 4.5.17 Blacknose shiner
  - 4.5.18 Blacknose dace
  - 4.5.19 Creek chub
  - 4.5.20 Fallfish
  - 4.5.21 Pearl dace
  - 4.5.22 White sucker
  - 4.5.23 Brown bullhead
  - 4.5.24 Atlantic tomcod
  - 4.5.25 Banded killifish
  - 4.5.26 Mummichog
  - 4.5.27 Fourspine stickleback
  - 4.5.28 Brook stickleback
  - 4.5.29 Threespine stickleback
  - 4.5.30 Ninespine stickleback
  - 4.5.31 White perch
  - 4.5.32 Striped bass
  - 4.5 33 Yellow perch

4.2 Notes related to tables:

1. Column headed "KB" indicates responses derived from the literature and provided on the matrix prior to circulation to expert participants (see matrices for references to the literature cited)

2. Columns headed "1" to "19" indicate responses provided by expert participants (respondents)

3. Responses from Respondent 1 (*) refer to species and context in northern Cape Breton and Cape Breton Highlands National Park

4. Responses from Respondent 15 (^) refer to species and context in S.W.N.S. Uplands region and Kejimkujik National Park

5. Column headed "Consensus 1" indicates consensus responses received from respondents (columns 1-19); two or more affirmative or negative responses in agreement without any opposing affirmative or negative responses is considered to constitute consensus;
Column headed "Consensus 2" indicates consensus responses from respondents as well as from other references (see note 6). Consensus 2 has been used to construct consensus tables 4.8.1 to 4.8.4 in Chapter 4, Volume 1.

7. Columns headed "Ref. 1 & 2" to "Ref. 5" indicate responses derived from COSEWIC listing, Provincial regulations, literature provided and authored by respondents, (Elderkin and Boates 1996; Herman and Scott 1992; 1994; Beaudette-NBDNRE 1997), as well as from a meeting involving experts from Acadia University and NSDNR at Acadia University, March 3, 1997 (Boates et al. 1997).

References Include:

Ref. 1 & 2:

1. 1996 List of Species at Risk designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (re: Nationally rare - endangered, threatened or vulnerable species)

2a. Elderkin and Boates 1996, Proposal for ranking species in Nova Scotia under the National Framework for Endangered Species Conservation and Species Status Evaluation. NSDNR (1996a) (Draft) (re: Small population in N.S.; Population declining in N.S.; Small no. of occurrences in N.S.; Small geographic range/distribution in N.S.; Decline in range/distribution in N.S.; Population threatened by direct exploitation, harassment or ecological interactions in

N.S.; Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.). (See note 9, re: interpretation of ranking scores). A revised draft status evaluation for mammals has recently been completed (NSDNR 1997b) and has resulted in changes in status for some mammal species from the earlier draft status evaluation. The earlier draft status evaluation was used by some respondents in their responses to the questionnaire and to identify species they considered to be vulnerable (Refer to Appendices 3.3 and 3.5 and Table 4.11). These earlier responses and NSDNR (1996a) were used to determine consensus responses and are reflected in the assessment of responses and the results. Reptile and Amphibian status are based on draft evaluation (NSDNR 1996a); revised evaluation in progress. Freshwater fishes have not been evaluated. Status of Eastern cougar has been deferred pending status report by F.W. Scott (NSDNR 1997b). (Refer also to note 10.)

2b. NSDNR. Nova Scotia 1996 Hunting & Furharvesting Summary of Regulations (re: Legally harvested or killed in N.S.); and, 1997 Angling/Summary of regulations - Nova Scotia (NSDFA 1997a) and 1997 Salmon Regulations (NSDFA 1997b) (See note 11, re: interpretation of regulations)

Ref. 3: Herman and Scott 1992, 1994 (See note 12, re: interpretation of response from ranking scores)

Ref. 4: Boates; Bondrup-Nielsen; Elderkin; Herman; and Scott - notes from a meeting at Acadia University, March 3, 1997, re: NSDNR's Status evaluation for bats, eastern cougar, lynx, American marten and southern flying squirrel; eastern cougar was not addressed in detail as the consensus was that the presence and identity of the species within the province is "a big question mark" (Boates et al. 1997). (See Ref. 2a, above, re: variables considered) (See note 9, re: interpretation of response from ranking scores)

Ref. 5: Beaudette 1997, NBDNRE (Table: Classification of species with respect to 3 ecological indicators - Food type; Home range size; and Body size) (Draft) (re: Space-demanding/wide-ranging; Large-bodied; Species that occur at higher trophic levels) (See note 13, re: interpretation of response) (Beaudette 1997 pers. comm.)

7. Responses in bold print indicate responses that deviate from those provided by KB

8. For the seven variables scored by NSDNR (Elderkin and Boates 1996; NSDNR 1996a) and Boates et al. (1997) (see note 7 - Ref. 2a and 4, above), affirmative responses were identified

from A, B, and A or B scores; negative responses were identified from C, D, and C or D scores; scores of "A or D" and "B or C" were interpreted as constituting neither an affirmative nor negative response and were left blank.

9. A comparison of the earlier draft status evaluation for mammals (NSDNR 1996a) with the revised draft status evaluation (NSDNR 1997b) shows that species status evaluation has changed as follows:

- Eastern cougar: status deferred
- Gaspé shrew and little brown bat: changed from green to yellow
- American moose: changed form green to red
- Rock vole: changed form yellow to green

However, a cursory review of the criteria for those species with revised evaluation status indicates that consensus responses and assessments of total and affirmative response rates are not affected by the changes, with the exception of Rarity/Population status of rock vole. Adjustments have been made in Appendices and Tables to reflect these changes (Appendices 1.2, 4.3.43, 7.3.1, 8.4.1, 8.5.1, 8.6.1, 9.2.1, and Table 4.8.1).

10. Re: Legally harvested or killed in N.S. - All species are generally protected under the Wildlife Act. Provision is made for exceptions permitting hunting, harvesting or killing according to annual regulations. Non-fish vertebrates are regulated as Big game, Small game, Furbearers and Other harvestable wildlife. Species which may be hunted, harvested or killed with or without licenses and according to seasons and bag limits are described. "Other harvestable wildlife" may be taken in season or may be taken or killed without a license or permit at any time by the owner, occupier, or agent of the property for the purpose of preventing damage to the property. All species not specifically mentioned in the regulations are protected at all times. The variable "legally harvested or killed in N.S." is interpreted to mean those big game, small game, furbearers and other harvestable wildlife species that may be legally trapped, shot or possessed, hunted, taken or killed with or without a license, but does not include those which may only be taken or killed by the owner/occupier of the property or the owner's/occupier's agent "for the purpose of preventing damage to property" (mice, porcupine, chipmunk, skunk, voles, moles, shrews, and woodchuck/groundhog) as described in Nova Scotia 1996 Hunting & Furharvesting Summary of Regulations (NSDNR 1996c, 10-11). Fisher is listed as a furbearer that may be trapped, shot or possessed with a license, however closed season for fisher is also noted, with the provision that one (1) fisher may be kept if taken accidentally in a trap lawfully set for another species (NSDNR 1996c).

Generally, all freshwater fishes, with the exception of Atlantic (Acadian) whitefish, may be harvested in N.S. within sport fishing (salmon fishing or angling) seasons and with a fishing license (general or salmon). Seasons, bag- and size- limits, fishery areas and other restrictions apply to some species. Season is closed to Atlantic (Acadian) whitefish angling/fishing all year (NSDFA 1997a).

11. Affirmative responses from Ref. 3 (Herman and Scott 1992; 1994) were recorded for those species identified as having the following scores: population size>/=7; population trend >/=6; range size >/=7; distribution trend >/=5; population concentration >/=6; reproductive potential >/=5; reproductive specialization and dietary specialization >/=4 (combined); habitat specialization >2; climatic sensitivity >/=10; distribution knowledge >/=5; population trend knowledge >/=5; limiting factor knowledge =10; management activities =10; systematic significance >/=1; % of total range in NS >/=4; harvest in NS >/=2.

12. Affirmative responses from Ref. 5 (Beaudette 1997 pers. comm.) were recorded for those species identified as having a large home range size (>21ha) (Space-demanding/wide-ranging), a large or medium large body size (>/= 98kg; 3.6-25kg; frogs >4cm; salamanders>12cm; snakes >40cm; turtles > 28cm) (Large-bodied/largest member of its feeding class), or are carnivores, omnivores, or insectivores (Species that occur at higher trophic levels).

13. Responses provided by respondents 1 and 15 refer to species and context within national parks and their regions. Therefore, the responses to the variable "Small population in N.S." actually indicate "Small population in Park or region", rather than in N.S. In some instances, this has required interpretation of the response to determine consensus relative to the provincial population status. For example, Respondent 1 provided affirmative responses for Small population of Northern flying squirrel and American beaver, referring to their status in Cape Breton Highlands National Park rather than in N.S. A similar circumstance arises with Respondent 15's affirmative responses for Small population of Red fox and woodchuck/groundhog, again referring to their status within a national park rather than within the province. Therefore the affirmative responses provided by Respondents 1 and 15 do not contradict the consensus responses of "negative". Respondents 1 and 15 did not complete the matrices for species that do not occur within the Park or region.

Table 4.3.1: Comparison of matrix responses by species - Arctic shrew

Respondent No. / Variables (Mammals)	KB	2	5	6	7	10	^15	17	19	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N		N	N		N	N		N				N
Small population in N.S.		?					?	Y			N	N		N
Population declining in N.S.		?					?	N			N	N		N
Small no. of occurrences in N.S.		?					?	N			Y			
Small geographic range/distribution in N.S.	Y	Y		Y	Y		Y	Y		Y	N	Y		
Decline in range/distribution in N.S.		?					?	N			N	N		N
Large percentage of range/distribution NS.	Y	N		Y	Y		?	Y	Y			N		
Species existing at range edge in N.S.	Y	Y		Y	Y		Y	N	N					
Genetically distinct form	Y	Y		Y	Y		Y	Y		Y		Y		Y
2. Biological characteristics Space-demanding/wide-ranging	N	N		N	N	N	N	N		N			N	N
Population seasonally/daily concentrating	N	N		N	N	N	N	N		N		N		N
Extremely variable in population density		(Y)					?	N						
Limited dispersal power		(N)					?	Y	Y					
Low reproductivity or fecundity	N	N		N	N	N	N	N		N		N		N
Large-bodied (largest member feed. class)		N					?	N	N	N			N	N
Pollution susceptible/accumulator species		?					?	?	Y					
3. Habitat-related vulnerability Dietary and reproductive specialization		N					?	Y	Y			N		
Habitat specialization	Y	N		Y	Y	Y	Y	Y	Y			N		
Dependent upon provincially rare habitat		N					?	Y	Y					
Climatic sensitivity	Y	Y		Y	Y	Y	Y	Y		Y		Y		Y
4. Species of major ecological importance Summit predator	N	N	N	N	N	N	N	N		N				N
Species that occur at higher trophic levels	Y	Y	Y	Y	Y	Y	Y	Y		Y			Y	Y
Major vegetation influencer	N	N	N	N	N	N	N	N		N				N
Keystone species							?	N						
5. Human-impact factors Legally harvested or killed in N.S.							?	N			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.							?	N			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.							?	?	Y		N			
No management activities directed at taxon	Y	Y	Y	Y	Y		Y	Y		Y		Y		Y
6. Information status Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		Y	Y		Y		Y		Y
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y		Y		Y		Y
Factors limiting population in N.S. unknown							?	Y				N		
No autecological studies in N.S.		Y					?	Y		Y				Y
No (meta-) pop. viability analysis in N.S.		Y					?	Y		Y				Y

Table 4.3.2: Comparison of matrix responses by species - Common shrew

Respondent No. / Variables (Mammals)	K B	* 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N				N
Small population in N.S.	N		N		N	N		N	N	N	N	N		N
Population declining in N.S.		N	N					?	N	N	N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	N	N	N		N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N					?	N	N	N	N		N
Large percentage of range/distribution NS.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N				N
Genetically distinct form			N					?	N	N		N		N
2. Biological characteristics														
Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density			Y					?	Y	Y				Y
Limited dispersal power			N					?						
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest member feed. class)		N	N					?		N			N	N
Pollution susceptible/accumulator species			?					?						
3. Habitat-related vulnerability														
Dietary and reproductive specialization	N	N	N		N	N	N	N	N	N		N		N
Habitat specialization	N	N	N		N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat	N	N	N		N	N	N	N	N	N				N
Climatic sensitivity			?					?				N		
4. Species of major ecological importance														
Summit predator	N	N	N	N	N	N	N	N	N	N				N
Species that occur at higher trophic levels	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer	N	N	N	N	N	N	N	N	N	N				N
Keystone species	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y				Y
5. Human-impact factors														
Legally harvested or killed in N.S.								?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N						?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.								?			N			
No management activities directed at taxon	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
6. Information status														
Limited knowledge of distribution in N.S.								Y				N		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown								?				N		
No autecological studies in N.S.		Y	Y					?		Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y					?		Y				Y

Table 4.3.3: Comparison of matrix responses by species - Smokey shrew

Respondent No. / Variables (Mammals)	KB	2	5	6	7	10	^ 15	17	19	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N		N	N		N	N		N				N
Small population in N.S.		N					y^	N	N	N	N	N		N
Population declining in N.S.		N					?				N	N		N
Small no. of occurrences in N.S.		N					?				N			N
Small geographic range/distribution in N.S.		N					?				N	N		N
Decline in range/distribution in N.S.		N					?				N	N		N
Large percentage of range/distributionNS.	N	N		N	N		N	N		N		N		N
Species existing at range edge in N.S.	N	N		N	N		N	N		N				N
Genetically distinct form							?	N				N		N
2. Biological characteristics														
Space-demanding/wide -ranging	N	N		N	N	N	N	N		N			N	N
Population seasonally/daily concentrating	N	N		N	N	N	N	N		N		N		N
Extremely variable in population density		Y					?							
Limited dispersal power		N					?							
Low reproductivity or fecundity	N	N		N	N	N	N	N		N		N		N
Large-bodied (largest member feed. class)		N					?						N	N
Pollution susceptible/accumulator species		?					?							
3. Habitat-related vulnerability														
Dietary and reproductive specialization	N	N		N	N	N	N	N		N		N		N
Habitat specialization		N					Y	N	N			N		
Dependent upon provincially rare habitat		N					?							
Climatic sensitivity	Y	Y		Y	Y	Y	Y	N	N			Y		
4. Species of major ecological importance														
Summit predator	N	N	N	N	N	N	N	N		N				N
Species that occur at higher trophic levels	Y	Y	Y	Y	Y	Y	Y	Y		Y			Y	Y
Major vegetation influencer	N	N	N	N	N	N	N	N		N				N
Keystone species							?							
5. Human-impact factors														
Legally harvested or killed in N.S.							?				N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.							?				N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.							?				N			
No management activities directed at taxon	Y	Y	Y	Y	Y		Y	Y		Y		Y		Y
6. Information status														
Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		Y	Y		Y		Y		Y
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y		Y		Y		Y
Factors limiting population in N.S. unknown							?					N		
No autecological studies in N.S.		Y					?							
No (meta-) pop. viability analysis in N.S.		Y					?							

Table 4.3.4: Comparison of matrix responses by species - Gaspé shrew

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	10	17	19	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	Y	Y	Y		Y	Y		Y		Y				Y
Small population in N.S.	Y	Y	Y		Y	Y		Y		Y	N	Y		
Population declining in N.S.			?								N	N		N
Small no. of occurrences in N.S.	Y	Y	Y		Y	Y		Y		Y	Y			Y
Small geographic range/distribution in N.S.	Y	Y	Y		Y	Y		Y		Y	Y	Y		Y
Decline in range/distribution in N.S.		N	N							N	N	N		N
Large percentage of range/distribution N.S.	Y	Y	Y		Y	Y		Y		Y		Y		Y
Species existing at range edge in N.S.	Y	Y	Y		Y	Y		N	N					
Genetically distinct form	Y	Y	Y		Y	Y		Y		Y		Y		Y
2. Biological characteristics Space-demanding/wide-ranging	N	N	N		N	N	N	N		N			N	N
Population seasonally/daily concentrating	N	N	N		N	N	N	N		N				N
Extremely variable in population density			?									N		
Limited dispersal power		Y	?											
Low reproductivity or fecundity	N	N	N		N	N	N	N		N				N
Large-bodied (largest member feed. class)		N	N							N			N	N
Pollution susceptible/accumulator species			?											
3. Habitat-related vulnerability Dietary and reproductive specialization	Y	Y	N		Y	Y	Y	Y	Y			Y		
Habitat specialization	Y	Y	Y		Y	Y	Y	Y		Y		Y		Y
Dependent upon provincially rare habitat		?	Y					Y		Y				Y
Climatic sensitivity		N	?											
4. Species of major ecological importance Summit predator	N	N	N	N	N	N	N	N		N				N
Species that occur at higher trophic levels	Y	Y	Y	Y	Y	Y	?	Y		Y			Y	Y
Major vegetation influencer	N	N	N	N	N	N	N	N		N				N
Keystone species	N	N	N	N	N	N	N	N		N				N
5. Human-impact factors Legally harvested or killed in N.S.											N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N									N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		Y									N			
No management activities directed at taxon												N		
6. Information status Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y	Y		Y		Y		Y		Y
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y		Y		Y		Y
Factors limiting population in N.S. unknown	Y	Y	Y	Y	Y	Y		Y		Y		Y		Y
No autecological studies in N.S.		Y	Y							Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y							Y				Y

Table 4.3.5: Comparison of matrix responses by species - Long-tailed shrew

Respondent No. Variables (Mammals)	K B	* 2	5	6	7	10	17	19	Consensus 1	Ref. 1 & 2	Ref. 3	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N		N	N		N		N	N		N
Small population in N.S.	Y	Y		Y	Y		Y		Y	Y	Y	Y
Population declining in N.S.		?					N			N	N	N
Small no. of occurrences in N.S.	Y	Y		Y	Y		Y		Y	Y		Y
Small geographic range/distribution in N.S.	Y	Y		Y	Y		Y		Y	Y	Y	Y
Decline in range/distribution in N.S.		?					N			N	N	N
Large percentage of range/distribution in N.S.		?					N				N	N
Species existing at range edge in N.S.		?					Y					
Genetically distinct form	Y	Y		Y	Y		Y		Y		Y	Y
2. Biological characteristics Space-demanding/wide-ranging	N	N		N	N	N	N		N			N
Population seasonally/daily concentrating	N	N		N	N	N	N		N		N	N
Extremely variable in population density		?										
Limited dispersal power		?										
Low reproductivity or fecundity	N	N		N	N	N	N		N		N	N
Large-bodied (largest members of feeding class)		N										
Pollution susceptible/accumulator species		?										
3. Habitat-related vulnerability Dietary and reproductive specialization	Y	N		Y	Y	Y	Y	Y			Y	
Habitat specialization	Y	Y		Y	Y	Y	Y		Y		Y	Y
Dependent upon provincially rare habitat							Y					
Climatic sensitivity		?									N	
4. Species of major ecological importance Summit predator	N	N	N	N	N	N	N		N			N
Species that occur at higher trophic levels	Y	Y	Y	Y	Y	Y	Y		Y			Y
Major vegetation influencer	N	N	N	N	N	N	N		N			N
Keystone species	N	N	N	N	N	N	N		N			N
5. Human-impact factors Legally harvested or killed in N.S.										N	N	N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.										N		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.										N		
No management activities directed at taxon	Y	Y	Y	Y	Y		Y		Y		Y	Y
6. Information status Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		Y		Y		Y	Y
Population trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y		Y		Y	Y
Factors limiting population in N.S. unknown	Y	Y	Y	Y	Y		Y		Y		Y	Y
No autecological studies in N.S.		Y										
No (meta-) population viability analysis in N.S.		Y										

Table 4.3.6: Comparison of matrix responses by species - Water shrew

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	10	15	17	19	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N	N		N	N		N	N		N	N			N
Small population in N.S.		Y	N					?	Y	Y		N	N		
Population declining in N.S.			N					?	N		N	N	N		N
Small no. of occurrences in N.S.	Y	Y	Y		Y	Y		Y	N	N		Y			
Small geographic range/distrib. in NS.	Y	Y	Y		Y	Y		Y	N	N		Y	N		
Decline in range/distribution in N.S.			N					?	N		N	N	N		N
Large percent of range/distrib. in N.S.	N	N	N		N	N		N	N		N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N		N				N
Genetically distinct form	N	N	N		N	N		N	N		N		N		N
2. Biological characteristics Space-demanding/wide-ranging	N	N	N		N	N	N	N	N		N			N	N
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N		N		N		N
Extremely variable in pop. density			Y					?	N	N					
Limited dispersal power	N	N	N		N	N	N	N	Y	N					
Low reproductivity or fecundity	N	N	N		N	N	N	N	N		N		N		N
Large-bodied (largest members of feeding class)	N	N	N		N	N	N	N	Y	Y				N	
Pollution susceptible/accumulator sp.	N	N	N		N	N	N	N	?		N				N
3. Habitat-related vulnerability Dietary and/or reproductive specialization	Y	Y	N		Y	Y	Y	Y	N	N			Y		
Habitat specialization	Y	Y	N		Y	Y	Y	Y	Y	Y			Y		
Dependent upon prov. rare habitat			N					?	N	N	N				N
Climatic sensitivity		Y	?					?	N	N			N		
4. Species of major ecological importance Summit predator	N	N	N	N	N	N	N	N	N		N				N
Sp. that occur at higher trophic levels	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y				Y
Major vegetation influencer	N	N	N	N	N	N	N	N	N		N				N
Keystone species		N						?	N		N				N
5. Human-impact factors Legally harvested or killed in N.S.								?	N			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N						?	N		N	N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.								?	N			N			N
No management activities directed at taxon	Y	Y	Y	Y	Y	Y		Y	Y		Y		Y		Y
6. Information status Limited knowledge of distrib. in N.S.	Y	Y	Y	Y	Y	Y		Y	Y		Y		Y		Y
Population trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y		Y		Y		Y
Factors limiting population in N.S. unknown								?	Y				N		
No autecological studies in N.S.		Y	Y					?	Y		Y				Y
No (meta-) pop. viability analysis in NS		Y	Y					?	Y		Y				Y

Table 4.3.7: Comparison of matrix responses by species - Pygmy shrew

Respondent No. / Variables (Mammals)	K B	* 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N			N
Small population in N.S.		Y	N					?	Y		N	N		
Population declining in N.S.			N					?	N	N	N	N		N
Small no. of occurrences in N.S.	Y	Y	Y		Y	Y		Y	Y	Y	Y			Y
Small geographic range/distribution in N.S.	Y	Y	Y		Y	Y		Y	N		Y	N		
Decline in range/distribution in N.S.			N					?	N	N	N	N		N
Large percentage of range/distribution N.S.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N				N
Genetically distinct form								?	N			N		N
2. Biological characteristics														
Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density			Y					?	N					
Limited dispersal power		Y	N					?	Y					
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest member feed. class)		N	N					N	N	N			N	N
Pollution susceptible/accumulator species			?					?	?					
3. Habitat-related vulnerability														
Dietary and/or reproductive specialization			Y					?	N			N		
Habitat specialization			N					?	N	N		N		N
Dependent upon provincially rare habitat			N					?	N	N				N
Climatic sensitivity		N	?					?	N	N		N		N
4. Species of major ecological importance														
Summit predator	N	N	N	N	N	N	N	N	N	N				N
Species that occur at higher trophic levels	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer	N	N	N	N	N	N	N	N	N	N				N
Keystone species		N						?	N	N				N
5. Human-impact factors														
Legally harvested or killed in N.S.								?	N		N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N						?	N	N	N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.								?	N		N			N
No management activities directed at taxon	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
6. Information status														
Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown								?	Y			N		
No autecological studies in N.S.		Y	Y					?	Y	Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y					?	Y	Y				Y

Table 4.3.8: Comparison of matrix responses by species - Short-tailed shrew

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N			N
Small population in N.S.		Y	N					?			N	N		N
Population declining in N.S.			N					?			N	N		N
Small no. of occurrences in N.S.		Y	N					?			N			
Small geographic range/distribution in N.S.		Y	N					?			N	N		
Decline in range/distribution in N.S.		N	N					?		N	N	N		N
Large percent of range/distribution in N.S.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N				N
Genetically distinct form								?	N			N		N
2. Biological characteristics Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density			Y					?	Y	Y				Y
Limited dispersal power		Y	N					?						
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest member feed. class)		N	Y					?					N	
Pollution susceptible/accumulator species			?					?						
3. Habitat-related vulnerability Dietary and reproductive specialization	N	N	N		N	N	N	N	N	N		N		N
Habitat specialization	Y	Y	Y		Y	Y	Y	Y	N			Y		
Dependent upon provincially rare habitat	N	N	N		N	N	N	N	N	N				N
Climatic sensitivity	Y	Y	Y		Y	Y	Y	Y	N			Y		
4. Species of major ecological importance Summit predator	N	N	N	N	N	N	N	N	N	N				N
Species that occur at higher trophic levels	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer	N	N	N	N	N	N	N	N	N	N				N
Keystone species	N	N	N	N	N	N	N	N	N	N				N
5. Human-impact factors Legally harvested or killed in N.S.								?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N						?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.								?			N			
No management activities directed at taxon	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
6. Information status Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown								?				N		
No autecological studies in N.S.		Y	Y					?		Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y					?		Y				Y

Table 4.3.9: Comparison of matrix responses by species - Star-nosed mole

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N			N
Small population in N.S.		Y	N					?			N	N		N
Population declining in N.S.		?	N					?			N	N		N
Small no. of occurrences in N.S.		Y	N					?			N			
Small geographic range/distribution in N.S.	Y	Y	Y		Y	Y		Y	N		Y		N	
Decline in range/distribution in N.S.		Y	N					?			N	N		
Large percentage of range/distrib. in N.S.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N				N
Genetically distinct form	Y	Y	Y		Y	Y		Y	Y	Y		Y		Y
2. Biological characteristics														
Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density			?					?						
Limited dispersal power		Y	N					?						
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest member. feed. class)		N	Y					?					N	
Pollution susceptible/accumulator species			?					?						
3. Habitat-related vulnerability														
Dietary and reproductive specialization	Y	Y	N		Y	Y	Y	Y	Y			Y		
Habitat specialization	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y		Y
Dependent upon provincially rare habitat			N					?						
Climatic sensitivity		Y	?					?				N		
4. Species of major ecological importance														
Summit predator	N	N	N	N	N	N	N	N	N	N				N
Species that occur at higher trophic levels	Y	Y	N	Y	Y	Y	Y	Y	Y				Y	
Major vegetation influencer	N	N	N	N	N	N	N	N	N	N				N
Keystone species	N	N	N	N	N	N	N	N	N	N				N
5. Human-impact factors														
Legally harvested or killed in N.S.								?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N						?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		?						?			N			
No management activities directed at taxon	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
6. Information status														
Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Pop trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown								?				Y		
No autecological studies in N.S.		Y	Y					?		Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y					?		Y				Y

Table 4.3.10: Comparison of matrix responses by species - Little brown bat

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N			N
Small population in N.S.	N	N	N		N	N		N	N	N	N	N		N
Population declining in N.S.		N	N					?	N	N	N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	N	N	N		N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N					?	N	N	N	N		N
Large percentage of range/distrib. in N.S.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N				N
Genetically distinct form	N	N	N		N	N		N	N	N		N		N
2. Biological characteristics														
Space-demanding/wide-ranging	N	N	N		N	N	N	N	Y					
Population seasonally/daily concentrating	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y		Y
Extremely variable in population density			?					?	N					
Limited dispersal power		N	N					?	N	N				N
Low reproductivity or fecundity	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y		Y
Large-bodied (largest member. feed. class)		N	N					?	N	N			N	N
Pollution susceptible/accumulator species			?					?	Y					
3. Habitat-related vulnerability														
Dietary and reproductive specialization	Y	Y	N		Y	Y	Y	Y	Y			Y		
Habitat specialization	Y	Y	Y		Y	Y	Y	Y	Y	Y		N		
Dependent upon provincially rare habitat			N					?	Y					
Climatic sensitivity		N	?					?	?			N		N
4. Species of major ecological importance														
Summit predator	N	N	N	N	N	N	N	N	N	N				N
Species that occur at higher trophic levels		Y	Y					Y	Y	Y			Y	Y
Major vegetation influencer	N	N	N	N	N	N	N	N	N	N				N
Keystone species	N	N	N	N	N	N	N	N	N	N				N
5. Human-impact factors														
Legally harvested or killed in N.S.	Y	?	N	N	Y	Y		Y	Y		N	N		* N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	?	Y	N	Y	Y		Y	Y		Y			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	N	Y	Y		Y	Y		Y			
No management activities directed at taxon				N				Y	N			N		
6. Information status														
Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y	Y		Y	N			Y		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown								?	N			N		N
No autecological studies in N.S.		Y	Y					?	Y	Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y					?	Y	Y				Y

Table 4.3.11: Comparison of responses by species- Northern long-eared bat

Respondent No. Variables (Mammals)	KB	* 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 4	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N				N
Small population in N.S.	Y	Y	Y		Y	Y		Y	Y	Y	Y	N	N		
Population declining in N.S.								?			N	N	?		N
Small no. of occurrences in N.S.	Y	Y	Y		Y	Y		Y	Y	Y	Y		Y		Y
Small geographic range/distrib. in N.S.	Y	Y	Y		Y	Y		Y	N		Y	N	?		
Decline in range/distribution in N.S.			N					?			N	N	?		N
Large percentage of range/distrib. NS.	N	N	N		N	N		N	N	N		N			N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N					N
Genetically distinct form	Y	Y	Y		Y	Y		Y	N			Y			
2. Biological characteristics Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N					N
Population seasonally/daily concentrating	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y			Y
Extremely variable in pop. density								?							
Limited dispersal power		N	N					?		N					N
Low reproductivity or fecundity	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y			Y
Large-bodied (largest members of feeding class)		N	N					?		N				N	N
Pollution susceptible/accumulator sp.			?					?							
3. Habitat-related vulnerability Dietary and reproductive specialization	Y	Y	N		Y	Y	Y	Y	Y			Y			
Habitat specialization			?					?	Y			N			
Dependent upon prov. rare habitat			N					?							
Climatic sensitivity			?					?				N			
4. Species of major ecological importance Summit predator	N	N	N	N	N	N	N	N	N	N					N
Species that occur at higher trophic levels		Y	Y					Y	Y	Y				Y	Y
Major vegetation influencer	N	N	N	N	N	N	N	N	N	N					N
Keystone species	N	N	N	N	N	N	N	N	N	N					N
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	N	N	Y	Y		Y	N		N	N			** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	N	Y	Y		Y	Y		Y		Y		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	?	Y	Y		Y	Y		Y		Y		Y
No management activities directed at taxon				N								N			N
6. Information status Limited knowledge of distrib. in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y			Y
Population trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y			Y
Factors limiting pop. in N.S. unknown								?				N			
No autecological studies in N.S.		Y	Y					?		Y					Y
No (meta-) pop. viability analysis in NS		Y	Y					?		Y					Y

Table 4.3.12: Comparison of matrix responses by species - Eastern pipistrelle

Respondent No. / Variables (Mammals)	KB	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 4	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N		N	N		N	N	N	N			N
Small population in N.S.	Y	Y		Y	Y		?	Y	Y	Y	Y	Y	Y
Population declining in N.S.							?	?		N	N	Y	
Small no. of occurrences in N.S.	Y	Y		Y	Y		Y	Y	Y	Y		Y	Y
Small geographic range/distribution in N.S.	Y	Y		Y	Y		Y	?	Y	Y	Y	?	Y
Decline in range/distribution in N.S.		N					?	?		N	N	?	N
Large percentage of range/distribution in N.S.	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	Y	Y		Y	Y		Y	Y	Y				Y
Genetically distinct form	N	N		N	N		N	N	N		N		N
2. Biological characteristics Space-demanding/wide-ranging	N	N		N	N	N	N	Y					
Population seasonally/daily concentrating	Y	Y		Y	Y	Y	Y	Y	Y		Y		Y
Extremely variable in population density							?	N					
Limited dispersal power		N					?	N	N				N
Low reproductivity or fecundity	Y	Y		Y	Y	Y	Y	Y	Y		Y		Y
Large-bodied (largest members of feed. class)		N					?	N	N				N
Pollution susceptible/accumulator species		?					?	Y					
3. Habitat-related vulnerability Dietary and reproductive specialization	Y	N		Y	Y	Y	Y	Y			Y		
Habitat specialization	Y	Y		Y	Y	Y	Y	Y	Y		N		
Dependent upon provincially rare habitat		N					?	Y					
Climatic sensitivity		?					?	?			N		
4. Species of major ecological importance Summit predator	N	N	N	N	N	N	N	N	N				N
Species that occur at higher trophic levels		Y					Y	Y	Y				Y
Major vegetation influencer	N	N	N	N	N	N	N	N	N				N
Keystone species	N	N	N	N	N	N	N	N	N				N
5. Human-impact factors Legally harvested or killed in N.S.	Y	N	N	Y	Y		Y	N		N	N		* N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	N	Y	Y		Y	N		Y		Y	
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	?	Y	Y		Y	N		Y		?	
No management activities directed at taxon	Y	Y	N	Y	Y		Y	Y			Y		
6. Information status Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Population trends not regularly monitored in NS	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown							?	Y			N		
No autecological studies in N.S.		Y					?	Y	Y				Y
No (meta-) population viability analysis in N.S.		Y					?	Y	Y				Y

Table 4.3.13: Comparison of matrix responses by species - Silver-haired bat

Respondent No. / Variables (Mammals)	KB	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 4	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N		N	N		N	N	N	N				N
Small population in N.S.	Y	Y		Y	Y		?	?	Y	Y	Y	?		Y
Population declining in N.S.	Y	Y		Y	Y		?	N		N	Y	?		
Small no. of occurrences in N.S.	Y	Y		Y	Y		Y	Y	Y	Y		Y		Y
Small geographic range/distribution in N.S.	Y	Y		Y	Y		Y	N		Y	Y	?		
Decline in range/distribution in N.S.		N					?	N	N	N	N	?		N
Large percentage of range/distrib. in N.S.	N	N		N	N		N	N	N					N
Species existing at range edge in N.S.	Y	Y		Y	Y		Y	Y	Y					Y
Genetically distinct form	Y	Y		Y	Y		Y	Y	Y		Y			Y
2. Biological characteristics														
Space-demanding/wide-ranging	N	N		N	N	N	N	Y						
Population seasonally/daily concentrating	Y	Y		Y	Y	Y	Y	?	Y		N			
Extremely variable in population density							?	N						
Limited dispersal power		N					?	N	N					N
Low reproductivity or fecundity	Y	Y		Y	Y	Y	Y	Y	Y		N			
Large-bodied (largest member. feed. class)		N					?	N	N				N	N
Pollution susceptible/accumulator species		?					?	Y						
3. Habitat-related vulnerability														
Dietary and reproductive specialization	Y	N		Y	Y	Y	Y	Y			Y			
Habitat specialization	Y	Y		Y	Y	Y	Y	N			N			
Dependent upon provincially rare habitat		N					?	N	N					N
Climatic sensitivity		?					?	?			N			
4. Species of major ecological importance														
Summit predator	N	N		N	N	N	N	N	N					N
Species that occur at higher trophic levels		Y					Y	Y	Y				Y	Y
Major vegetation influencer	N	N		N	N	N	N	N	N					N
Keystone species	N	N		N	N	N	N	N	N					N
5. Human-impact factors														
Legally harvested or killed in N.S.	Y	N	N	Y	Y		Y	N		N	N			* N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	N	Y	Y		Y	N		Y		?		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.							?	N		N		?		N
No management activities directed at taxon	Y	Y	N	Y	Y		Y	Y			Y			
6. Information status														
Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y			Y
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y			Y
Factors limiting population in N.S. unknown							?	Y			N			
No autecological studies in N.S.		Y					?	Y	Y					Y
No (meta-) pop. viability analysis in N.S.		Y					?	Y	Y					Y

Table 4.3.14: Comparison of matrix responses by species - Red bat

Respondent No. / Variables (Mammals)	KB	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 4	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N		N	N		N	N	N	N				N
Small population in N.S.	Y	Y		Y	Y		?	?	Y	Y	Y	Y		Y
Population declining in N.S.	Y	Y		Y	Y		?	N		N	Y	?		
Small no. of occurrences in N.S.	Y	Y		Y	Y		Y	Y	Y	Y		Y		Y
Small geographic range/distribution in N.S.	Y	Y		Y	Y		Y	N		Y	N	?		
Decline in range/distribution in N.S.		N					?	N	N	N	N	?		N
Large percentage of range/distrib.in N.S.	N	N		N	N		N	N	N		N			N
Species existing at range edge in N.S.	Y	Y		Y	Y		Y	Y	Y					Y
Genetically distinct form	N	N		N	N		N	N	N		N			N
2. Biological characteristics														
Space-demanding/wide-ranging	N	N		N	N	N	N	Y						
Population seasonally/daily concentrating	N	N		N	N	N	N	N	N		N			N
Extremely variable in population density							?	N						
Limited dispersal power		N					?	N	N					N
Low reproductivity or fecundity	N	N		N	N	N	N	Y			N			
Large-bodied (largest member. feed. class)		N					?	Y					N	
Pollution susceptible/accumulator species		?					?	Y						
3. Habitat-related vulnerability														
Dietary and reproductive specialization	Y	N		Y	Y	Y	Y	Y			Y			
Habitat specialization		?					?	N			N			N
Dependent upon provincially rare habitat		N					?	N	N					N
Climatic sensitivity		?					?	N			N			N
4. Species of major ecological importance														
Summit predator	N	N		N	N	N	N	N	N					N
Species that occur at higher trophic levels		Y					Y	Y	Y				Y	Y
Major vegetation influencer	N	N		N	N	N	N	N	N					N
Keystone species	N	N		N	N	N	N	N	N					N
5. Human-impact factors														
Legally harvested or killed in N.S.	Y	N	N	Y	Y		Y	N		N	N			** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	N	Y	Y		Y	N		Y		?		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.							?	N		N		?		N
No management activities directed at taxon	Y	Y	N	Y	Y		Y	Y			Y			
6. Information status														
Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y			Y
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y			Y
Factors limiting population in N.S. unknown							?	Y			N			
No autecological studies in N.S.		Y					?	Y	Y					Y
No (meta-) pop. viability analysis in N.S.		Y					?	Y	Y					Y

Table 4.3.15: Comparison of matrix responses by species - Hoary bat

Respondent No. / Variables (Mammals)	K B	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 4	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N		N	N		N	N	N	N				N
Small population in N.S.	Y	Y		Y	Y		?	?	Y	Y	Y	N		
Population declining in N.S.	Y	Y		Y	Y		?	N		N	Y	?		
Small no. of occurrences in N.S.	Y	Y		Y	Y		Y	Y	Y	Y		Y		Y
Small geographic range/distribution in N.S.	Y	Y		Y	Y		Y	N		Y	N	?		
Decline in range/distribution in N.S.		N					?	N	N	N	N	?		N
Large percentage of range/distrib. in N.S.	N	N		N	N		N	N	N		N			N
Species existing at range edge in N.S.	Y	Y		Y	Y		Y	N						
Genetically distinct form	Y	Y		Y	Y		Y	N			Y			
2. Biological characteristics Space-demanding/wide-ranging	N	N		N	N	N	N	Y						
Population seasonally/daily concentrating	N	N		N	N	N	N	N	N		N			N
Extremely variable in population density							?	N						
Limited dispersal power		N					?	N	N					N
Low reproductivity or fecundity	N	N		N	N	N	N	Y			N			
Large-bodied (largest member. feed. class)		Y					?	Y					N	
Pollution susceptible/accumulator species		?					?	Y						
3. Habitat-related vulnerability Dietary and reproductive specialization	Y	N		Y	Y	Y	Y	Y			Y			
Habitat specialization		?					?	N			N			N
Dependent upon provincially rare habitat		N					?	N	N					N
Climatic sensitivity		?					?	N			N			N
4. Species of major ecological importance Summit predator	N	N		N	N	N	N	N	N					N
Species that occur at higher trophic levels		Y					Y	Y	Y				Y	Y
Major vegetation influencer	N	N		N	N	N	N	N	N					N
Keystone species	N	N		N	N	N	N	N	N					N
5. Human-impact factors Legally harvested or killed in N.S.	Y	N	N	Y	Y	Y	Y	N		N	N			** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	N	Y	Y	Y	Y	N		Y		?		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.							?	N		N		?		N
No management activities directed at taxon	Y	Y	N	Y	Y		Y	Y			Y			
6. Information status Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y			Y
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y			Y
Factors limiting population in N.S. unknown							?	Y			N			
No autecological studies in N.S.		Y					?	Y	Y					Y
No (meta-) pop. viability analysis in N.S.		Y					?	Y	Y					Y

Table 4.3.16: Comparison of matrix responses on a species basis - Coyote

Respondent No. / Variables (Mammals)	KB	*1	2	3	5	6	7	8	10	^15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N	N	N		N	N	N		N	N	N	N			N
Small population in N.S.		N	N	N				N		?		N	N	N		N
Population declining in N.S.		Y	N	N				N		N		N	N	N		N
Small no. of occurrences in N.S.		N	N	N				N		?		N	N			N
Small geo. range/distrib. in N.S.		N	N	N				N		N		N	N	N		N
Decline in range/distrib. in N.S.	N	N	N	N		N	N	N		N	N	N	N	N		N
Lrg. percent. of range/dist. in N.S.	N	N	N	N		N	N	N		N	N	N		N		N
Sp.existing at range edge in N.S.		N		N				M		N		N				N
Genetically distinct form	N	N	N	N		N	N	N		N	N	N		N		N
2. Biological characteristics Space-demanding/wide-ranging	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
Pop. season./daily concentrating	N	N	N	N		N	N	N	N	N	N	N		N		N
Extremely variable in pop. density			Y	N						N						
Limited dispersal power		N	N	N				N		N		N				N
Low reproductivity or fecundity	N	N	N	N		N	N	N	N	N	N	N		N		N
Lrg.-body/lrgst. memb.feed. class	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
Pollution susc./accum.species			?	N				N		N		N				N
3. Habitat-related vulnerability Diet. and repro. specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Habitat specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Depend. upon prov. rare habitat	N	N	N	N		N	N	N	N	N	N	N				N
Climatic sensitivity		N	?	N				N		N		N		N		N
4. Species of major ecological importance Summit predator	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
Sps. occurs at high. trophic levels	Y	Y	Y	N		Y	Y	Y	Y	Y	Y				Y	
Major vegetation influencer	N	N	N	N		N	N	N	N	N	N	N				N
Keystone species	N	N	N	N		N	N	N	N	N	N	N				N
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y		Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N		N				N		N		N	N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N		N				N		N		N	N			N
No management directed at taxon	Y	Y	Y	N	N	Y	Y	N		Y	Y			Y		
6. Information status Limited knowledge of distrib. N.S.				N				N		N		N		N		N
Pop. trends not monitored in N.S.				N	N			N		N		N		N		N
Factors limiting pop. NS. unknown				N						N		N		N		N
No autecological studies in N.S.		Y	Y	N				?		N						
No (meta-) pop. viability analysis		Y	Y	Y				Y		N						

Table 4.3.17: Comparison of matrix responses by species - Red fox

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	8	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status															
Nationally rare (COSEWIC)	N	N	N		N	N	N		N	N	N	N			N
Small population in N.S.	N	N	N		N	N	N		Y	N	N	N	N		N
Population declining in N.S.		N	N				N		?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N	N		N	N	N	N			N
Small geographic range/distrib. in N.S.	N	N	N		N	N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N				N		?		N	N	N		N
Large percent of range/distrib. in N.S.	N	N	N		N	N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N	N		N	N	N				N
Genetically distinct form	N	N	N		N	N	N		N	N	N		N		N
2. Biological characteristics															
Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N	N				N
Pop. seasonally/daily concentrating	N	N	N		N	N	N	N	N	N	N		N		N
Extremely variable in pop. density			Y				N		N						
Limited dispersal power		N	N				N		N		N				N
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N	N		N		N
Large-bodied (largest members of feeding class)		N	N				N		?		N			N	N
Pollution susceptible/accumulator sp.			?				N		N						
3. Habitat-related vulnerability															
Dietary and reproductive specialization	N	N	N		N	N	N	N	N	N	N		N		N
Habitat specialization	N	N	N		N	N	N	N	N	N	N		N		N
Dependent upon prov. rare habitat	N	N	N		N	N	N	N	N	N	N				N
Climatic sensitivity		N	?				N		N		N		N		N
4. Species of major ecological importance															
Summit predator	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
Sp. that occur at higher trophic levels	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer	N	N	N		N	N	N	N	N	N	N				N
Keystone species	N	N	N		N	N	N	N	N	N	N				N
5. Human-impact factors															
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N					N		?	?	N	N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N					N		?		N	N			N
No management activities directed at taxon		Y		N			?		Y				N		
6. Information status															
Limited knowledge of distrib. in N.S.							N		Y				N		
Population trends not regularly monitored in N.S.				N			?		Y				N		
Factors limiting pop. in N.S. unknown									?				N		
No autecological studies in N.S.		Y	Y						?		Y				Y
No (meta-) pop. viability analysis in NS		Y	Y						?		Y				Y

Table 4.3.18: Comparison of responses by species - American black bear

Respondent No. / Variables (Mammals;)	K B	* 1	2	3	5	6	7	8	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status																
Nationally rare (COSEWIC)	N	N	N	N		N	N	N		N	N	N	N			N
Small population in N.S.	Y	Y	N	N		Y	Y			Y	N		N	Y		
Population declining in N.S.		N	N	N				N		?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N	N		N	N	N		N	N	N	N			N
Small geog. range/distrib. in N.S.	N	N	N	N		N	N	N		N	N	N	N	N		N
Decline in range/distrib. in N.S.		N	N	N				N		?		N	N	N		N
Lrg. percent of range/distri. in NS.	N	N	N	N		N	N	N		N	N	N		N		N
Sp. existing at range edge in N.S.	N	N	N	N		N	N	N		N	N	N				N
Genetically distinct form	N	N	N	N		N	N	N		N	N	N		N		N
2. Biological characteristics																
Space-demanding/wide-ranging	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
Pop. season./daily concentrating	N	N	N	N		N	N	N	N	N	N	N		N		N
Extremely variable in pop. density			Y	N				?		N						
Limited dispersal power		N	N	N				N		N		N				N
Low reproductivity or fecundity	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
Lrg.-body/lrgst. memb. feed. class	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y	Y
Pollution susc/accumulator sp.			?	N				N		N		N				N
3. Habitat-related vulnerability																
Diet.and repro. specialization	N	N	N	Y		N	N	N	N	N	N			N		
Habitat specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Depend.upon prov. rare habitat	N	N	N	N		N	N	N	N	N	N	N				N
Climatic sensitivity			?	N				N		N		N		N		N
4. Species of major ecological importance																
Summit predator	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y					
Sp. occurs at higher trophic levels	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y				Y	
Major vegetation influencer		N		N	N			M		N		N				N
Keystone species	N	N	N	N	N	N	N	N	N	N	N	N				N
5. Human-impact factors																
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N		N				M		?		N	N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				N				N		?		N	N			N
No management directed at taxon		Y		N	N			N		N				N		
6. Information status																
Limited knowledge of distrib. NS.				N				N		N		N		N		N
Pop. trends not monitored in N.S.				N	N			N		Y				N		
Factors limiting pop. NS. unknown				N						N		N		N		N
No autecological studies in N.S.		Y	Y	N						?						
No (meta-) pop.viability analysis		Y	Y	Y						?		Y				Y

Table 4.3.19: Comparison of matrix responses by species - Racoon

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	8	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N	N		N	N	N		N	N	N	N			N
Small population in N.S.	N	N	N		N	N	N		Y	N	N	N	N		N
Population declining in N.S.	N	N	N		N	N	N		Y	N	N	N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N	N		Y	N	N				N
Small geographic range/distrib. in N.S.	N	N	N		N	N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N						Y		N	N	N		N
Large percentage of range/distrib. NS.	N	N	N		N	N	N		N	N	N		N		N
Species existing at range edge in N.S.	Y	Y	Y		Y	Y	Y		Y	Y	Y				Y
Genetically distinct form	N	N	N		N	N	N		N	N	N		N		N
2. Biological characteristics Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N	N				N
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N	N		N		N
Extremely variable in pop. density			Y						Y		Y				Y
Limited dispersal power		N	N						N		N				N
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N	N		N		N
Large-bodied (largest members of feeding class)		N	N						?		N			N	N
Pollution susceptible/accumulator sp.			?				N		N		N				N
3. Habitat-related vulnerability Dietary and reproductive specialization	N	N	N		N	N	N	N	N	N	N		N		N
Habitat specialization	N	N	N		N	N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat	N	N	N		N	N	N	N	N	N	N				N
Climatic sensitivity		N	?						N		N		N		N
4. Species of major ecological importance Summit predator			N				N		N		N				N
Sp. that occur at higher trophic levels	Y	Y	Y		Y	Y	Y	Y	Y	N				Y	
Major vegetation influencer	N	N	N		N	N	N	N	N	N	N				N
Keystone species	N	N	N		N	N	N	N	N	N	N				N
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y			Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N					N		?		N	N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N					N		?		N	N			N
No management activities directed at taxon	Y	Y	Y	N	Y	Y	Y		Y	Y			Y		
6. Information status Limited knowledge of distrib. in N.S.									N				N		N
Population trends not regularly monitored in N.S.				N					N		N		N		N
Factors limiting pop. in N.S. unknown									N				N		N
No autecological studies in N.S.		Y	Y						N						
No (meta-) pop. viability analysis in NS		Y	Y						N						

Table 4.3.20: Comparison of matrix responses by species - American marten

Respondent No. / Variables (Mammals)	KB	*1	2	5	6	7	8	10	^15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 4	Ref. 5	Consensus 2
1. Rarity/Population status																
Nationally rare (COSEWIC)	N	N	N		N	N	N		N	N	N	N				N
Small population in N.S.	Y	Y	Y		Y	Y	Y		Y	Y	Y	Y	Y	Y		Y
Population declining in N.S.	Y	Y	Y		Y	Y	Y		?	?	Y	Y	N	N/Y		
Small no. of occurrences in N.S.	Y	Y	Y		Y	Y	Y		Y	Y	Y	Y/N		N/Y		
Small geog. range/distrib. in N.S.	Y	Y	Y		Y	Y	Y		Y	Y	Y		Y	Y		Y
Decline in range/distribution in N.S.	Y	Y	Y		Y	Y	Y		Y	Y	Y	Y	Y	N/Y		
Lrg. percent. range/distrib. in NS.	N	N	N		N	N	N		N	N	N		N			N
Sp.existing at range edge in N.S.	N	N	N		N	N	N		N	N	N					N
Genetically distinct form	Y	Y	Y		Y	Y	Y		Y	N			Y			
2. Biological characteristics																
Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N	N					N
Pop. season./daily concentrating	N	N	N		N	N	N	N	N	N	N		N			N
Extremely variable in po. density			N				Y		N							
Limited dispersal power	N	N	N		N	N	N	N	N	N	N					N
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N	N		N			N
Lrg.-body/lrgst. memb. feed. class	N	N	N		N	N	N	N	N	N	N				N	N
Pollution susc./accumulator sp.	N	N	N		N	N	N	N	N	N	N					N
3. Habitat-related vulnerability																
Dietary and repro. specialization	Y	Y	N		Y	Y	Y	Y	Y	Y			Y			
Habitat specialization	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y			Y
Depend. upon prov. rare habitat		?	?						Y							
Climatic sensitivity			?				N		?				N			N
4. Species of major ecological importance																
Summit predator	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y					Y
Sp. occurs at higher trophic levels	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y	Y
Major vegetation influencer	N	N	N		N	N	N	N	N	N	N					N
Keystone species	N	N	N		N	N	N	N	N	N	N					N
5. Human-impact factors																
Legally harvested or killed in N.S.	Y	Y	N	N	Y	Y	Y		Y	Y		N	Y			** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	N	Y	Y	Y		Y	Y		Y		Y		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
No management directed at taxon		Y		N			N		N				N			
6. Information status																
Limited knowledge of distrib. N.S.	Y	Y	Y	N	Y	Y	Y		Y	Y			Y			
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		N	Y			Y			
Factors limiting pop. NS. unknown									?				N			
No autecological studies in N.S.		Y	Y						N							
No (meta-) pop. viability analysis		Y	Y				Y		N							

Table 4.3.21: Comparison of matrix responses by species - Fisher

Respondent No. Variables (Mammals)	KB	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N		N	N		N	N	N	N			N
Small population in N.S.	Y	Y		Y	Y		Y	Y	Y	Y	Y		Y
Population declining in N.S.	Y	Y		Y	Y		?	?	Y	Y/ N	N		
Small no. of occurrences in N.S.							Y			N			
Small geographic range/distribution in N.S.	Y	Y		Y	Y		Y	Y	Y		Y		Y
Decline in range/distribution in N.S.	Y	Y		Y	Y		Y	Y	Y	Y/ N	Y		Y
Large percentage of range/distribution in N.S.	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N		N	N		N	N	N				N
Genetically distinct form	Y	Y		Y	Y		Y	N			Y		
2. Biological characteristics Space-demanding/wide-ranging	Y	Y		Y	Y	Y	Y	Y	Y				Y
Population seasonally/daily concentrating	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density		N					N		N				N
Limited dispersal power	N	N		N	N	N	N	N	N				N
Low reproductivity or fecundity	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest members of feed. class)	N	N		N	N	N	N	N	N			N	N
Pollution susceptible/accumulator species	N	N		N	N	N	N	N	N				N
3. Habitat-related vulnerability Dietary and reproductive specialization	Y	N		Y	Y	Y	Y	Y			Y		
Habitat specialization	Y	N		Y	Y	Y	Y	Y			Y		
Dependent upon provincially rare habitat		N					?						
Climatic sensitivity		?					?				N		
4. Species of major ecological importance Summit predator	Y	Y		Y	Y	Y	Y	Y	Y				Y
Species that occur at higher trophic levels	Y	Y		Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer	N	N		N	N	N	N	N	N				N
Keystone species	N	N		N	N	N	N	N	N				N
5. Human-impact factors Legally harvested or killed in N.S.*	Y	N	Y	Y	Y		Y	Y		N	Y		** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	N	Y	Y		Y	Y					
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.							?			N			
No management activities directed at taxon			N				Y				N		
6. Information status Limited knowledge of distribution in N.S.	Y	Y	N	Y	Y		Y	Y			Y		
Pop. trends not regularly monitored in N.S.	Y	Y	N	Y	Y		Y	Y			Y		
Factors limiting population in N.S. unknown							?				N		
No autecological studies in N.S.		Y					?						
No (meta-) population viability analysis in N.S.		Y					?						

Table 4.3.22: Comparison of responses by species - Ermine/weasel

Respondent No. / Variables (Mammals)	KB	• 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N			N
Small population in N.S.	N	N	N		N	N		N	N	N	N	N		N
Population declining in N.S.		N	N					?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	N	N	N		N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N					?		N	N	N		N
Large percent. of range/distribution in N.S.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N				N
Genetically distinct form	N	N	N		N	N		N	N	N		N		N
2. Biological characteristics														
Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density			Y					N						
Limited dispersal power		N	N					?		N				N
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest member. feed. class)		N	N					?		N				N
Pollution susceptible/accumulator species			?					N						
3. Habitat-related vulnerability														
Dietary and reproductive specialization	Y	Y	N		Y	Y	Y	Y	Y			Y		
Habitat specialization	Y	Y	N		Y	Y		Y	Y			Y		
Dependent upon provincially rare habitat	N	N	N		N	N	N	N	N	N				N
Climatic sensitivity		N	?					?				N		N
4. Species of major ecological importance														
Summit predator	Y	Y	Y		Y	Y	Y	Y	Y	Y				Y
Species that occur at higher trophic levels	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer	N	N	N		N	N	N	N	N	N				N
Keystone species	N	N	N		N	N	N	N	N	N				N
5. Human-impact factors														
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y			Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N						?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N						?			N			N
No management activities directed at taxon	Y	Y	Y	N	Y	Y		Y	Y			Y		
6. Information status														
Limited knowledge of distribution in N.S.	Y	Y	Y	N	Y	Y		Y	Y			Y		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	N	Y	Y		Y	Y			Y		
Factors limiting population in N.S. unknown								?				N		
No autecological studies in N.S.		Y	Y					?		Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y					?		Y				Y

Table 4.3.23: Comparison of matrix responses by species - American mink

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N			N
Small population in N.S.	N	N	N		N	N		N	N	N	N	N		N
Population declining in N.S.		N	N					?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	N	N	N		N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N					?		N	N	N		N
Large percent. of range/distribution in N.S.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N				N
Genetically distinct form	N	N	N		N	N		N	N	N		N		N
2. Biological characteristics														
Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N				N
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density			N					N		N				N
Limited dispersal power		N	N					?		N				N
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest member. feed. class)		N	N					?		N			N	N
Pollution susceptible/accumulator species			?					N						
3. Habitat-related vulnerability														
Dietary and reproductive specialization	Y	Y	N		Y	Y	Y	Y	Y			Y		
Habitat specialization	Y	Y	N		Y	Y	Y	Y	Y			Y		
Dependent upon provincially rare habitat	N	N	N		N	N	N	N	N	N				N
Climatic sensitivity		N	?					?				N		N
4. Species of major ecological importance														
Summit predator	Y	Y	Y		Y	Y	Y	Y	Y	Y				Y
Species that occur at higher trophic levels	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer	N	N	N		N	N	N	N	N	N				N
Keystone species	N	N	N		N	N	N	N	N	N				N
5. Human-impact factors														
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y			Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N						?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N						?			N			N
No management activities directed at taxon				N				Y				N		
6. Information status														
Limited knowledge of distribution in N.S.				N				Y				N		
Pop. trends not regularly monitored in N.S.				N				Y				N		
Factors limiting population in N.S. unknown								?				N		
No autecological studies in N.S.		Y	Y					?		Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y					?		Y				Y

Table 4.3.24: Comparison of matrix responses by species - Striped skunk

Respondent No. / Variables (Mammals)	K B	2	5	6	7	8	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N		N	N	N		N	N	N	N			N
Small population in N.S.	N	N		N	N	N		?	N	N	N	N		N
Population declining in N.S.		N				N		?		N	N	N		N
Small no. of occurrences in N.S.	N	N		N	N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	N	N		N	N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N				N		?		N	N	N		N
Large percent. of range/distribution in N.S.	N	N		N	N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N		N	N	N		N	N	N				N
Genetically distinct form	N	N		N	N	N		N	N	N		N		N
2. Biological characteristics Space-demanding/wide-ranging	N	N		N	N	N	N	N	N	N				N
Population seasonally/daily concentrating	N	N		N	N	N	N	N	N	N		N		N
Extremely variable in population density		Y						N						
Limited dispersal power		N				N		?		N				N
Low reproductivity or fecundity	N	N		N	N	N	N	N	N	N		N		N
Large-bodied (largest member. feed. class)		N				N		?		N			N	N
Pollution susceptibleaccumulator species		?				N		N		N				N
3. Habitat-related vulnerability Dietary and reproductive specialization	N	N		N	N	N	N	N	N	N		N		N
Habitat specialization	N	N		N	N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat	N	N		N	N	N	N	N	N	N				N
Climatic sensitivity		?				N		N		N		N		N
4. Species of major ecological importance Summit predator		N				N		N		N				N
Species that occur at higher trophic levels	Y	Y		Y	Y	Y	Y	Y	N				Y	
Major vegetation influencer	N	N		N	N	N	N	N	N	N				N
Keystone species	N	N		N	N	N	N	N	N	N				N
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	N			** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.						N		?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.						N		?			N			N
No management activities directed at taxon	Y	Y	N	Y	Y	Y		Y	Y			Y		
6. Information status Limited knowledge of distribution in N.S.			N			N		?		N		N		N
Pop. trends not regularly monitored in N.S.	Y	Y	N	Y	Y	Y		Y	Y			Y		
Factors limiting population in N.S. unknown								?				N		
No autecological studies in N.S.		Y						N						
No (meta-) pop. viability analysis in N.S.		Y						N						

Table 4.3.25: Comparison of matrix responses by species - River otter

Respondent No. / Variables (Mammals)	KB	1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N			N
Small population in N.S.	Y	Y	N		Y	M		Y	N		Y	Y		
Population declining in N.S.	Y	Y	N		Y	M		?	Y			N		
Small no. of occurrences in N.S.	N	N	N		N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	Y	Y	N		Y	Y		Y	N		Y	N		
Decline in range/distribution in N.S.			N		Y			?			N	N		
Large percent. of range/distribution in N.S.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N				N
Genetically distinct form	N	N	N		N	N		N	N	N		N		N
2. Biological characteristics														
Space-demanding/wide-ranging	Y	Y	Y		Y	Y	Y	Y	Y	Y				Y
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density			N					N		N				N
Limited dispersal power		N	N					?		N				N
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest member. feed. class)		N	N					?		N			N	N
Pollution susceptible/accumulator species			?					?						
3. Habitat-related vulnerability														
Dietary and reproductive specialization	Y	Y	N		Y	Y	Y	Y	Y			Y		
Habitat specialization	Y	Y	N		Y	Y	Y	Y	Y			Y		
Dependent upon provincially rare habitat	N	N	N		N	N	N	N	N	N				N
Climatic sensitivity		N	?					?				N		N
4. Species of major ecological importance														
Summit predator	Y	Y	Y		Y	Y	Y	Y	Y	Y				Y
Species that occur at higher trophic levels	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer	N	N	N		N	N	N	N	N	N				N
Keystone species	N	N	N		N	N	N	N	N	N				N
5. Human-impact factors														
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	?	Y	Y		Y	Y	Y				Y
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y		N	Y	Y		Y	Y					
No management activities directed at taxon		Y		N				Y				N		
6. Information status														
Limited knowledge of distribution in N.S.	Y	Y	Y	N	Y	Y		Y	Y			Y		
Pop. trends not regularly monitored in N.S.				N				Y				N		
Factors limiting population in N.S. unknown								?				N		
No autecological studies in N.S.		Y	Y					?		Y				Y
No (meta-) pop. viability analysis in N.S.		N	Y					?						

Table 4.3.26: Comparison of matrix responses by species - Eastern Cougar

Respondent No. / Variables (Mammals)	K B	* 1	2	3	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	Y	Y	Y	Y		Y	Y		Y	Y	Y	Y			Y
Small population in N.S.	Y	Y	Y	M		Y	Y		?	Y	Y	Y	Y		Y
Population declining in N.S.	Y	Y		N		Y	?		?	N		Y	N		
Small no. of occurrences in N.S.	Y	Y	Y	?		Y	Y		Y	N					
Small geographic range/distrib. in N.S.				?			N		?	N		N	N		N
Decline in range/distribution in N.S.	Y	Y	Y	?		Y	N		Y	N		Y	Y		
Large percent. of range/distrib. in N.S.	N	N	N	N		N	Y		N	N			N		
Species existing at range edge in N.S.	Y	Y	Y	Y		Y	Y		?	Y	Y				Y
Genetically distinct form	N	N	N	?		N	N		N	?	N		N		N
2. Biological characteristics Space-demanding/wide-ranging	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y				Y
Population seasonally/daily concentrating	N	N	N	N		N	N	N	N	N	N		N		N
Extremely variable in pop. density				?					N	?					
Limited dispersal power	N	N	N	N		N	N	N	N	N	N				N
Low reproductivity or fecundity	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y		Y
Large-bodied (largest members of feeding class)	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y				Y
Pollution susceptible/accumulator sp.			?	?					N	N	N				N
3. Habitat-related vulnerability Dietary and reproductive specialization	Y	Y	Y	Y		Y	Y	Y	Y	N			Y		
Habitat specialization			N	N					?	N	N		N		N
Dependent upon prov. rare habitat			N	?					?	N	N				N
Climatic sensitivity		N	?	?					N	N	N		N		N
4. Species of major ecological importance Summit predator	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y				Y
Sp. that occur at higher trophic levels	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y				Y
Major vegetation influencer	N	N	N	N		N	N	N	N	N	N				N
Keystone species	N	N	N	N		N	N	N	N	N	N				N
5. Human-impact factors Legally harvested or killed in N.S.				N			N		N	N	N	N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	N	?	Y	Y		Y	?					
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	N	Y	Y	Y		Y	Y					
No management activities directed at taxon	Y	Y	Y	Y	N	Y	Y		Y	Y			Y		
6. Information status Limited knowledge of distrib. in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Population trends not regularly monitored in N.S.	Y	Y	Y	N	Y	Y	Y		Y	Y			Y		
Factors limiting pop. in N.S. unknown				Y					?	Y	Y		N		
No autecological studies in N.S.		Y	Y	Y					?	Y	Y				Y
No (meta-) pop. viability analysis in NS		Y	Y	Y					?	Y	Y				Y

Table 4.3.27: Comparison of matrix responses by species - Lynx

Respondent No. / Variables (Mammals)	K B	* 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 4	Ref. 5	Consensus 2
1. Rarity/Population status															
Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N				N
Small population in N.S.	Y	Y	Y		Y	Y		?	Y	Y	Y	Y	Y		Y
Population declining in N.S.	Y	Y	Y		Y	Y		?	Y	Y	Y	N	Y		
Small no. of occurrences in N.S.	Y	Y	Y		Y	Y		Y	Y	Y	Y		Y		Y
Small geographic range/distrib. in N.S.	Y	Y	Y		Y	Y		?	Y	Y	Y	Y	Y		Y
Decline in range/distribution in N.S.	Y	Y	Y		Y	Y		Y	Y	Y	Y	Y	Y		Y
Large percent. of range/distrib. in N.S.	N	N	N		N	N		N	N	N		N			N
Species existing at range edge in N.S.		Y						Y		Y					Y
Genetically distinct form	N	N	N		N	N		N	N	N		N			N
2. Biological characteristics															
Space-demanding/wide-ranging	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y	Y
Pop. seasonally/daily concentrating	N	N	N		N	N	N	N	N	N	N	N			N
Extremely variable in pop. density			Y					N							
Limited dispersal power	N	N	N		N	N	N	N	N	N					N
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N		N			N
Large-bodied (largest members of feeding class)	Y	Y	Y		Y	Y	Y	Y	Y	Y					Y
Pollution susceptible/accumulator sp.	N	N	N		N	N	N	N	N	N					N
3. Habitat-related vulnerability															
Dietary and reproductive specialization	Y	Y	Y		Y	Y	Y	Y	Y	Y		N			
Habitat specialization	Y	Y	N		Y	Y	Y	Y	Y			Y			
Dependent upon provincially rare habitat		Y	N					?							
Climatic sensitivity		N	?					N		N		N			N
4. Species of major ecological importance															
Summit predator	Y	Y	Y		Y	Y	Y	Y	Y	Y					Y
Sp. that occur at higher trophic levels	Y	Y	Y		Y	Y	Y	Y	Y	Y				Y	Y
Major vegetation influencer	N	N	N		N	N	N	N	N	N					N
Keystone species	N	N	N		N	N	N	N	N	N					N
5. Human-impact factors															
Legally harvested or killed in N.S.	Y	N	N	N	Y	Y		Y	Y		N	Y			** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	?	Y	Y		Y	Y	Y	Y		Y		Y
No management activities directed at taxon				N				Y				N			
6. Information status															
Limited knowledge of distrib. in N.S.	Y	Y	Y	N	Y	Y		Y	Y			Y			
Population trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y			Y
Factors limiting pop. in N.S. unknown								?				N			
No autecological studies in N.S.		Y	Y					?		Y					Y
No (meta-) pop. viability analysis in NS		Y	Y					?		Y					Y

Table 4.3.28: Comparison of matrix responses by species - Bobcat

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N			N
Small population in N.S.	N	N	N		N	N		Y	N	N	N	N		N
Population declining in N.S.			N					?			N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N		?	N	N	N			N
Small geographic range/distribution in N.S.								?			N	N		N
Decline in range/distribution in N.S.	Y	Y	Y		Y	Y		?	?	Y		N		
Large percent. of range/distribution in N.S.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	Y	Y	Y		Y	Y		Y	Y	Y				Y
Genetically distinct form	N	N	N		N	N		N	N	N		N		N
2. Biological characteristics Space-demanding/wide-ranging	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y	Y
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density			Y					N						
Limited dispersal power	N	N	N		N	N	N	N	N	N				N
Low reproductivity or fecundity								Y				N		
Large-bodied (largest member. feed. class)	Y	Y	Y		Y	Y	Y	Y	Y	Y				Y
Pollution susceptible/accumulator species			?					N						
3. Habitat-related vulnerability Dietary and reproductive specialization	N	N	N		N	N	N	N	N	N		N		N
Habitat specialization	N	N	N		N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat		N	N					?		N				N
Climatic sensitivity		N	?					N		N		N		N
4. Species of major ecological importance Summit predator	Y	Y	Y		Y	Y	Y	Y	Y	Y				Y
Species that occur at higher trophic levels	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer	N	N	N		N	N	N	N	N	N				N
Keystone species	N	N	N		N	N	N	N	N	N				N
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.								?			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.								?			N			
No management activities directed at taxon				N				Y				N		
6. Information status Limited knowledge of distribution in N.S.	Y	Y	Y	N	Y	Y		Y	Y			Y		
Pop. trends not regularly monitored in N.S.				N				Y				N		
Factors limiting population in N.S. unknown								?				N		
No autecological studies in N.S.		Y	Y					?		Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y					?		Y				Y

Table 4.3.29: Comparison of matrix responses by species - White-tailed deer

Respondent No. / Variables (Mammals)	KB	* 1	2	3	5	6	7	8	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N	N	N		N	N	N		N	N	N	N			N
Small population in N.S.	N	N	N	N		N	N	N		Y	N	N	N	N		N
Population declining in N.S.		Y	N	N						?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N	N		N	N	N		N	N	N	N			N
Small geog. range/distrib. in N.S.	N	N	N	N		N	N	N		N	N	N	N	N		N
Decline in range/distrib. in N.S.		N	N	N						?		N	N	N		N
Lrg. percent. of range/distrib. N.S.	N	N	N	N		N	N	N		N	N	N		N		N
Sp. existing at range edge in N.S.	N	N	N	N		N	N	N		N	N	N				N
Genetically distinct form	N	N	N	N		N	N	N		N	N	N		N		N
2. Biological characteristics Space-demanding/wide-ranging	Y	Y	Y	N		Y	Y	Y	Y	Y	Y				Y	
Pop. season./daily concentrating	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		N		
Extremely variable in pop. density			Y	Y						N						
Limited dispersal power	N	N	N	N		N	N	N	N	N	N	N				N
Low reproductivity or fecundity	Y	Y	Y	N		Y	Y	Y	Y	Y	Y			N		
Lrg.-body/lrgst. memb.feed. class	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y	Y
Pollution susc./accumulator sp.	N	N	N	N		N	N	N	N	N	N	N				N
3. Habitat-related vulnerability Dietary and repro. specialization			N	N						?		N		N		N
Habitat specialization			N	N						?		N		N		N
Depend. upon prov. rare habitat		N	N	N						N		N				N
Climatic sensitivity		N	?	N						N		N		N		N
4. Species of major ecological importance Summit predator	N	N	N	N		N	N	N	N	N	N	N				N
Sp. occur at higher trophic levels		N	N	N						N		N			N	N
Major vegetation influencer	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
Keystone species				N						?						
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N		N				N		Y			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N		N				N		?			N			N
No management activities directed at taxon				N	N			N		N		N		N		N
6. Information status Limited knowledge of distrib. N.S.				N	N			N		N		N		N		N
Po. trends not monitored in N.S.				N	N			N		N		N		N		N
Factors limiting pop. NS. unknown				N				N		N		N		N		N
No autecological studies in N.S.		Y	Y	N						N						
No (meta-) po. viability analysis		Y	Y	Y						N						

Table 4.3.30: Comparison of matrix responses by species - American moose

Respondent No. / Variables (Mammals)	KB	* 1	2	3	5	6	7	8	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status																
Nationally rare (COSEWIC)	N	N	N	N		N	N	N		N	N	N	N			N
Small population in N.S.	Y	N	Y	N		Y	Y	Y		Y	Y		N	Y		
Population declining in N.S.		N	N	Y						?			N	N		
Small no. of occurrences in N.S.		N	N	N						Y		N	N			N
Small geog. range/distrib. in N.S.		N		N						Y		N	N	N		N
Decline in range/distrib. in N.S.	Y	Y	Y	Y		Y	Y	Y		Y	Y	Y	N	N		
Lrg. percent. of range/distrib. N.S.	N	N	N	N		N	N	N		N	N	N				N
Sp. existing at range edge in N.S.	N	N	N	N		N	N	N		N	N	N				N
Genetically distinct form	N	N	N	N		N	N	N		N	N	N		N		N
2. Biological characteristics																
Space-demanding/wide-ranging	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y	Y
Pop. season./daily concentrating	N	N	N	N		N	N	N	N	N	N	N		N		N
Extremely variable in pop. density			Y	N						N						
Limited dispersal power	N	N	N	N		N	N	N	N	N	N	N				N
Low reproductivity or fecundity	Y	Y	Y	N		Y	Y	Y	Y	Y	Y		N			
Large-bodied (largest members of feeding class)	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y	Y
Pollution susc./accumulator sp.	N	N	N	N		N	N	N	N	N	N	N				N
3. Habitat-related vulnerability																
Dietary and/or repro.specialization			N	Y						?				N		
Habitat specialization	Y	Y	N	N		Y	Y	Y	Y	Y	Y			Y		
Depend. upon prov. rare habitat		N	N	N						?		N				N
Climatic sensitivity		N	?	N						?		N		N		N
4. Species of major ecological importance																
Summit predator	N	N	.N	N		N	N	N	N	N	N	N				N
Species that occur at higher trophic levels		N	N	N						N		N			N	N
Major vegetation influencer	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
Keystone species	N	N	N	N		N	N	N	N	N	N	N				N
5. Human-impact factors																
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y
Population threatened by direct exploitation; harassment or ecological interactions in N.S.		N		Y				N		Y			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N		N				?		Y			N			
No management activities directed at taxon				N	N			N		N		N		N		N
6. Information status																
Limited knowledge of distrib. N.S.				N	N			N		Y				N		
Pop. trends not monitored in N.S.				Y	N			N		Y				N		
Factors limiting pop. NS. unknown				Y				N		?				N		
No autecological studies in N.S.		N	Y	Y						?						
No (meta-) pop. viability analysis		Y	Y	Y						?		Y				Y

Table 4.3.31: Comparison of matrix responses by species - Eastern chipmunk

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N			N
Small population in N.S.	N	N	N		N	N		N	N	N	N	N		N
Population declining in N.S.		N	N					?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	N	N	N		N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N					?		N	N	N		N
Large percent. of range/distribution in N.S.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N				N
Genetically distinct form	N	N	N		N	N		N	N	N		N		N
2. Biological characteristics														
Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density			Y					Y		Y				Y
Limited dispersal power		N	N					?		N				N
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest member. feed. class)		N	N					N		N			N	N
Pollution susceptible/accumulator species			?					N						
3. Habitat-related vulnerability														
Dietary and reproductive specialization	N	N	N		N	N	N	N	N	N		N		N
Habitat specialization	N	N	N		N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat	N	N	N		N	N	N	N	N	N				N
Climatic sensitivity		N	?					N		N		N		N
4. Species of major ecological importance														
Summit predator	N	N	N		N	N	N	N	N	N				N
Species that occur at higher trophic levels		N	N					N		N			N	N
Major vegetation influencer	N	N	N		N	N	N	N	N	N				N
Keystone species		N						N		N				N
5. Human-impact factors														
Legally harvested or killed in N.S.								?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N						N			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N						N			N			N
No management activities directed at taxon	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
6. Information status														
Limited knowledge of distribution in N.S.	Y	Y	Y	N	Y	Y		Y	Y			Y		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown								?				N		
No autecological studies in N.S.		Y	Y					?		Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y					?		Y				Y

Table 4.3.32: Comparison of matrix responses by species - Woodchuck

Respondent No. / Variables (Mammals)	KB	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N		N	N		N	N	N	N			N
Small population in N.S.	N	N		N	N		Y	N	N	N	N		N
Population declining in N.S.		N					?			N	N		N
Small no. of occurrences in N.S.	N	N		N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	N	N		N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N					?			N	N		N
Large percentage of range/distribution in N.S.	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N		N	N		N	N	N				N
Genetically distinct form	N	N		N	N		N	N	N		N		N
2. Biological characteristics Space-demanding/wide-ranging	N	N		N	N	N	N	N	N				N
Population seasonally/daily concentrating	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density		Y					?						
Limited dispersal power		N					?						
Low reproductivity or fecundity	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest members of feed. class)		Y					?						
Pollution susceptible/accumulator species		?					N						
3. Habitat-related vulnerability Dietary and reproductive specialization	N	N		N	N	N	N	N	N		N		N
Habitat specialization	N	N		N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat	N	N		N	N	N	N	N	N				N
Climatic sensitivity		?					N		N		N		N
4. Species of major ecological importance Summit predator	N	N		N	N	N	N	N	N				N
Species that occur at higher trophic levels		N					N		N			N	N
Major vegetation influencer	N	N		N	N	N	N	N	N				N
Keystone species							N						
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y		Y	Y	Y	N	Y		** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.							N			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.							N			N			N
No management activities directed at taxon	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
6. Information status Limited knowledge of distribution in N.S.			N				Y				N		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown							?				N		
No autecological studies in N.S.		Y					?						
No (meta-) population viability analysis in N.S.		Y					?						

Table 4.3.33: Comparison of responses by species - American red squirrel

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N			N
Small population in N.S.	N	N	N		N	N		N	N	N	N	N		N
Population declining in N.S.		N	N					?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	N	N	N		N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N					N		N	N	N		N
Large percent. of range/distribution in N.S.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N				N
Genetically distinct form	N	N	N		N	N		N	N	N		N		N
2. Biological characteristics														
Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density			Y					Y	Y	Y				Y
Limited dispersal power		N	N					?		N				N
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest member. feed. class)		N	N					?		N			N	N
Pollution susceptible/accumulator species			?					N						
3. Habitat-related vulnerability														
Dietary and/or reproductive specialization	N	N	N		N	N	N	N	N	N		N		N
Habitat specialization	Y	Y	N		Y	Y	Y	Y	Y			N		
Dependent upon provincially rare habitat		N	N					N		N				N
Climatic sensitivity		N	?					N		N		N		N
4. Species of major ecological importance														
Summit predator	N	N	N		N	N	N	N	N	N				N
Species that occur at higher trophic levels			N					N		N			N	N
Major vegetation influencer	N	N	N		N	N	N	N	N	N				N
Keystone species								?						
5. Human-impact factors														
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N						N		N	N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N						N		N	N			N
No management activities directed at taxon	Y	Y	Y	N	Y	Y		Y	Y			Y		
6. Information status														
Limited knowledge of distribution in N.S.				N				Y				N		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	N	Y	Y		Y	Y			Y		
Factors limiting population in N.S. unknown								?				N		
No autecological studies in N.S.		Y	Y					?		Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y					?		Y				Y

Table 4.3.34: Comparison of responses by species - Southern flying squirrel

Respondent No. / Variables (Mammals)	KB	2	5	6	7	10	15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 4	Consensus 2
1. Rarity/Population status													
Nationally rare (COSEWIC)	Y	Y		Y	Y		Y	Y	Y	Y			Y
Small population in N.S.	Y	Y		Y	Y		?	Y	Y	Y	Y	Y	Y
Population declining in N.S.	Y			Y	Y		Y	N			N	N	
Small no. of occurrences in N.S.	Y	Y		Y	Y		Y	Y	Y	Y		Y	Y
Small geographic range/distribution in N.S.	Y	Y		Y	Y		Y	Y	Y	N	Y	N	
Decline in range/distribution in N.S.	Y	Y		Y	Y		Y	N		N	N	N	
Large percentage of range/distribution in N.S.							N	N	N		N		N
Species existing at range edge in N.S.							Y	Y	Y				Y
Genetically distinct form	Y	Y		Y	Y		Y	N			Y		
2. Biological characteristics													
Space-demanding/wide-ranging	N	N		N	N	N	N	N	N				N
Population seasonally/daily concentrating							?	N			N		N
Extremely variable in population density		Y		Y			N	N					
Limited dispersal power		N		Y			?	N					
Low reproductivity or fecundity	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest members of feed. class)		N					N	N	N				N
Pollution susceptible/accumulator species		?					?	N					
3. Habitat-related vulnerability													
Dietary and reproductive specialization	Y	Y		Y	Y	Y	Y	Y	Y		Y		Y
Habitat specialization	N	N		N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat	N	N		N	N	N	N	N	N				N
Climatic sensitivity		?		M			?	?			N		
4. Species of major ecological importance													
Summit predator	N	N		N	N	N	N	N	N				N
Species that occur at higher trophic levels		N					?	N	N				N
Major vegetation influencer	N	N		N	N	N	N	N	N				N
Keystone species	N	N		N	N	N	N	N	N				N
5. Human-impact factors													
Legally harvested or killed in N.S.							?	N		N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.							?	N		N		N	N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.							?	N		N		N	N
No management activities directed at taxon			N				Y	N			N		
6. Information status													
Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		Y	N			Y		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown							?	Y			N		
No autecological studies in N.S.		Y					?	Y	Y				Y
No (meta-) population viability analysis in N.S.		Y					?	Y	Y				Y

Table 4.3.35: Comparison of responses by species - Northern flying squirrel

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	8	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status															
Nationally rare (COSEWIC)	N	N	N		N	N	N		N	N	N	N			N
Small population in N.S.	N	Y	N		N	N	N		?	N	N	N	N		N
Population declining in N.S.		?	N		M		?		?			N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N	N		N	N	N	N			N
Small geographic range/distrib. in N.S.	N	N	N		N	N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N				?		?		N	N	N		N
Large percent. of range/distrib. in N.S.	N	N	N		N	N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N	N		N	N	N				N
Genetically distinct form									?	N			N		N
2. Biological characteristics															
Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N	N			N	N
Pop. seasonally/daily concentrating	N	N	N		N	N	N	N	N	N	N		N		N
Extremely variable in pop. density					Y				N						
Limited dispersal power		N	N		Y				?						
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N	N		N		N
Large-bodied (largest members of feeding class)		N	Y				N		?					N	
Pollution susceptible/accumulator sp.			?				N		?						
3. Habitat-related vulnerability															
Dietary and/or repro. specialization	Y	Y	N		Y	Y	Y	Y	Y	Y			Y		
Habitat specialization	Y	Y	N		Y	Y	Y	Y	Y	N			N		
Dependent upon prov. rare habitat	N	N	N		N	N	N	N	N	N	N				N
Climatic sensitivity			?				N		N		N		N		N
4. Species of major ecological importance															
Summit predator	N	N	N		N	N	N	N	N	N	N				N
Species that occur at higher trophic levels		N	N				N		?		N			N	N
Major vegetation influencer	N	N	N		N	N	N	N	N	N	N				N
Keystone species		N					M	Y	?						
5. Human-impact factors															
Legally harvested or killed in N.S.							N		?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N							?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		?					Y		?			N			
No management activities directed at taxon							Y		Y				N		
6. Information status															
Limited knowledge of distrib. in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Population trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting pop. in N.S. unknown									?				N		
No autecological studies in N.S.		Y	Y						?		Y				Y
No (meta-) pop. viability analysis in NS		Y	Y						?		Y				Y

Table 4.3.36: Comparison of matrix responses by species - American beaver

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	8	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N	N		N	N	N		N	N	N	N			N
Small population in N.S.	N	Y	N		N	N	N		?	N	N	N	N		N
Population declining in N.S.		N	N				N		?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N	N		N	N	N	N			N
Small geographic range/distrib. in N.S.	N	N	N		N	N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N				N		?		N	N	N		N
Large percent. of range/distrib. in N.S.	N	N	N		N	N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N	N		N	N	N				N
Genetically distinct form	N	N	N		N	N	N		N	N	N		N		N
2. Biological characteristics Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N	N			N	N
Pop. seasonally/daily concentrating	N	N	N		N	N	N	N	N	N	N		N		N
Extremely variable in pop. density			N				N		?		N				N
Limited dispersal power	N	N	N		N	N	N	N	N	N	N				N
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N	N		N		N
Large-bodied (largest members of feeding class)	N	N	N		N	N	N	N	N	N	N				N
Pollution susceptible/accumulator sp.	N	N	N		N	N	N	N	N	N	N				N
3. Habitat-related vulnerability Dietary and/or repro. specialization		Y	N						?				N		
Habitat specialization	Y	Y	N		Y	Y	Y	Y	Y	Y			Y		
Dependent upon prov. rare habitat	N	N	N		N	N	N	N	N	N	N				N
Climatic sensitivity		?	?						N				N		N
4. Species of major ecological importance Summit predator	N	N	N		N	N	N	N	N	N	N				N
Sp. that occur at higher trophic levels		N	N				N		N		N			N	N
Major vegetation influencer		Y		Y			Y		Y		Y				Y
Keystone species		N					Y	Y	Y						
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N					N		?		N	N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N					N		?		N	N			N
No management activities directed at taxon				N			N		Y				N		
6. Information status Limited knowledge of distrib. in N.S.				N			N		Y				N		
Population trends not regularly monitored in N.S.				N			N		Y				N		
Factors limiting pop. in N.S. unknown							N		N		N		N		N
No autecological studies in N.S.		N	Y						?						
No (meta-) pop. viability analysis in NS		Y	Y						?		Y				Y

Table 4.3.37: Comparison of matrix responses by species - Deer mouse

Respondent No. / Variables (Mammals)	K B	* 1	2	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status													
Nationally rare (COSEWIC)	N	N	N	N	N		N	N	N	N			N
Small population in N.S.	N	N	N	N	N		N	N	N	N	N		N
Population declining in N.S.		N	N				?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N	N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	N	N	N	N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N	N			N		N	N	N		N
Large percentage of range/distribution in N.S.	N	N	N	N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N	N	N		N	N	N				N
Genetically distinct form	N	N	N	N	N		N	N	N		N		N
2. Biological characteristics													
Space-demanding/wide-ranging	N	N	N	N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N	N	N	N	N	N	N		N		N
Extremely variable in population density			Y				Y	Y	Y				Y
Limited dispersal power		N	N				?		N				N
Low reproductivity or fecundity	N	N	N	N	N	N	N	N	N		N		N
Large-bodied (largest members of feed. class)		N	N				?		N			N	N
Pollution susceptible/accumulator species			?				N						
3. Habitat-related vulnerability													
Dietary and/or reproductive specialization	N	N	N	N	N	N	N	N	N		N		N
Habitat specialization	N	N	N	N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat	N	N	N	N	N	N	N	N	N				N
Climatic sensitivity		N	?				N		N		N		N
4. Species of major ecological importance													
Summit predator	N	N	N	N	N	N	N	N	N				N
Species that occur at higher trophic levels		N	N				N		N			N	N
Major vegetation influencer	N	N	N	N	N	N	N	N	N				N
Keystone species	Y	Y	Y	Y	Y	Y	Y	Y	Y				Y
5. Human-impact factors													**
Legally harvested or killed in N.S.							?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N					?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N					?			N			N
No management activities directed at taxon	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
6. Information status													
Limited knowledge of distribution in N.S.							?				N		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown							?				Y		
No autecological studies in N.S.		Y	Y				?		Y				Y
No (meta-) population viability analysis in N.S.		Y	Y				?		Y				Y

Table 4.3.38: Comparison of matrix responses by species - White-footed mouse

Respondent No. / Variables (Mammals)	KB	2	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Consensus 2
1. Rarity/Population status											
Nationally rare (COSEWIC)	N	N	N	N		N	N	N	N		N
Small population in N.S.	N	N	N	N		N	N	N	N	N	N
Population declining in N.S.		N				?			N	N	N
Small no. of occurrences in N.S.	N	N	N	N		N	N	N	N		N
Small geographic range/distribution in N.S.	N	N	N	N		N	N	N	N	N	N
Decline in range/distribution in N.S.		N				?			N	N	N
Large percentage of range/distribution in N.S.	N	N	N	N		N	N	N		N	N
Species existing at range edge in N.S.	Y	Y	Y	Y		Y	Y	Y			Y
Genetically distinct form	Y	Y	Y	Y		Y	Y	Y		Y	Y
2. Biological characteristics											
Space-demanding/wide-ranging	N	N	N	N	N	N	N	N			N
Population seasonally/daily concentrating	N	N	N	N	N	N	N	N		N	N
Extremely variable in population density		Y				?					
Limited dispersal power		N				?					
Low reproductivity or fecundity	N	N	N	N	N	N	N	N		N	N
Large-bodied (largest members of feeding class)		N				?					
Pollution susceptible/accumulator species		?				N					
3. Habitat-related vulnerability											
Dietary and/or reproductive specialization	N	N	N	N	N	N	N	N		N	N
Habitat specialization	N	N	N	N	N	N	N	N		N	N
Dependent upon provincially rare habitat	N	N	N	N	N	N	N	N			N
Climatic sensitivity		?				?				N	
4. Species of major ecological importance											
Summit predator	N	N	N	N	N	N	N	N			N
Species that occur at higher trophic levels		N				?					
Major vegetation influencer	N	N	N	N	N	N	N	N			N
Keystone species						?					
5. Human-impact factors											**
Legally harvested or killed in N.S.						?			N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.						?			N		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.						?			N		
No management activities directed at taxon	Y	Y	Y	Y		Y	Y	Y		Y	Y
6. Information status											
Limited knowledge of distribution in N.S.	Y	Y	Y	Y		Y	Y	Y		Y	Y
Population trends not regularly monitored in N.S.	Y	Y	Y	Y		Y	Y	Y		Y	Y
Factors limiting population in N.S. unknown						?				N	
No autecological studies in N.S.		Y				?					
No (meta-) population viability analysis in N.S.		Y				?					

Table 4.3.39: Comparison of responses by species - Red-backed vole

Respondent No. / Variables (Mammals)	KB	*1	2	6	7	10	^15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status													
Nationally rare (COSEWIC)	N	N	N	N	N		N	N	N	N			N
Small population in N.S.	N	N	N	N	N		N	N	N	N	N		N
Population declining in N.S.		N	N				?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N	N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	N	N	N	N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N				?		N	N	N		N
Large percentage of range/distribution in N.S.		N					N		N		N		N
Species existing at range edge in N.S.		N					?						
Genetically distinct form		N					?	N	N		N		N
2. Biological characteristics													
Space-demanding/wide-ranging	N	N	N	N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N	N	N	N	N	N	N		N		N
Extremely variable in population density			Y				Y		Y				Y
Limited dispersal power		N	N				?		N				N
Low reproductivity or fecundity	N	N	N	N	N	N	N	N	N		N		N
Large-bodied (largest members of feed. class)		N	N				?		N			N	N
Pollution susceptible/accumulator species			?				?						
3. Habitat-related vulnerability													
Dietary and reproductive specialization	N	N	N	N	N	N	N	N	N		N		N
Habitat specialization	N	N	N	N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat	N	N	N	N	N	N	N	N	N				N
Climatic sensitivity	Y	Y	Y	Y	Y	Y	Y	N			Y		
4. Species of major ecological importance													
Summit predator	N	N	N	N	N	N	N	N	N				N
Species that occur at higher trophic levels		N	N				?		N			N	N
Major vegetation influencer	N	N	N	N	N	N	N	N	N				N
Keystone species	Y	Y	Y	Y	Y	Y	Y	Y	Y				Y
5. Human-impact factors													**
Legally harvested or killed in N.S.							?			N			N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N					?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N					?			N			N
No management activities directed at taxon	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
6. Information status													
Limited knowledge of distribution in N.S.							Y				N		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown							?				N		
No autecological studies in N.S.		Y	Y				?		Y				Y
No (meta-) population viability analysis in N.S.		Y	Y				?		Y				Y

Table 4.3.40: Comparison of responses by species - Southern bog lemming

Respondent No. / Variables (Mammals)	KB	* 1	2	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N	N	N	N		N	N	N	N			N
Small population in N.S.		M	N				?			N	N		N
Population declining in N.S.			N				?			N	N		N
Small no. of occurrences in N.S.			N				?			N			N
Small geographic range/distribution in N.S.	Y	Y	Y	Y	Y		?	N			N		
Decline in range/distribution in N.S.		N	N				?		N	N	N		N
Large percentage of range/distribution in N.S.	N	N	N	N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N	N	N		N	N	N				N
Genetically distinct form	N	N	N	N	N		N	N	N		N		N
2. Biological characteristics Space-demanding/wide-ranging	N	N	N	N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N	N	N	N	N	N	N		N		N
Extremely variable in population density			Y				Y		Y				Y
Limited dispersal power	N	Y	N	N	N	N	N	N					
Low reproductivity or fecundity	N	N	N	N	N	N	N	N	N		N		N
Large-bodied (largest members of feed. class)	N	N	Y	N	N	N	N	N				N	
Pollution susceptible/accumulator species	N	N	N	N	N	N	N	N	N				N
3. Habitat-related vulnerability Dietary and/or reproductive specialization			N				?				N		N
Habitat specialization	Y	Y	N	Y	Y	Y	Y	Y			N		
Dependent upon provincially rare habitat							?						
Climatic sensitivity		N	?				?				N		N
4. Species of major ecological importance Summit predator	N	N	N	N	N	N	N	N	N				N
Species that occur at higher trophic levels		N	N				N		N			N	N
Major vegetation influencer	N	N	N	N	N	N	N	N	N				N
Keystone species		N					?						
5. Human-impact factors Legally harvested or killed in N.S.							?			N			** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N					?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.							?			N			
No management activities directed at taxon	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
6. Information status Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
No autecological studies in N.S.		Y	Y				?		Y				Y
No (meta-) population viability analysis in N.S.		Y	Y				?		Y				Y

Table 4.3.41: Comparison of matrix responses by species - Muskrat

Respondent No. / Variables (Mammals)	KB	* 1	2	5	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N			N
Small population in N.S.	N	Y	N		N	N		Y	N		N	N		N
Population declining in N.S.			N					?			N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	N	N	N		N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.			N					?			N	N		N
Large percent. of range/distribution in N.S.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N				N
Genetically distinct form	Y	Y	Y		Y	Y		Y	Y	Y		Y		Y
2. Biological characteristics Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N				N
Extremely variable in population density			Y					?						
Limited dispersal power		N	N					?		N				N
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest member. feed. class)		N	Y					?					N	
Pollution susceptible/accumulator species			?					N						
3. Habitat-related vulnerability Dietary and/or reproductive specialization	N	N	N		N	N	N	N	N	N		N		N
Habitat specialization	Y	Y	N		Y	Y	Y	Y	Y			Y		
Dependent upon provincially rare habitat	N	N	N		N	N	N	N	N	N				N
Climatic sensitivity		?	?					N				N		N
4. Species of major ecological importance Summit predator	N	N	N		N	N	N	N	N	N				N
Species that occur at higher trophic levels		N	N					N		N			N	N
Major vegetation influencer	N	N	N		N	N	N	N	N	N				N
Keystone species		N						?						
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.								?			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.								?			N			
No management activities directed at taxon				N				Y			N			
6. Information status Limited knowledge of distribution in N.S.				N				Y				N		
Pop. trends not regularly monitored in N.S.				N				Y				N		
Factors limiting population in N.S. unknown								?				N		
No autecological studies in N.S.		Y	Y					?		Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y					?		Y				Y

Table 4.3.42: Comparison of matrix responses by species - Meadow vole

Variables (Mammals) / Respondent No.	KB	*1	2	5	6	7	10	^15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N	N		N	N		N	N	N	N		N	N
Small population in N.S.	N	N	N		N	N		N	N	N	N	N		N
Population declining in N.S.		N	N					?	N	N	N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N		N	N	N	N			N
Small geographic range/distribution in N.S.	N	N	N		N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N					?	N	N	N	N		N
Large percent. of range/distribution in N.S.	N	N	N		N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N				N
Genetically distinct form								?	N			N		N
2. Biological characteristics														
Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N		N	N	N	N	N	N		N		N
Extremely variable in population density			Y					Y	Y	Y				Y
Limited dispersal power		N	N					?	Y					
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N		N		N
Large-bodied (largest member. feed. class)		N	Y					?	N				N	
Pollution susceptible/accumulator species			?					N	N		N			N
3. Habitat-related vulnerability														
Dietary and reproductive specialization	N	N	N		N	N	N	N	N	N		N		N
Habitat specialization	N	N	N		N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat	N	N	N		N	N	N	N	N	N				N
Climatic sensitivity	Y	Y	Y		Y	Y	Y	Y	N			Y		
4. Species of major ecological importance														
Summit predator	N	N	N		N	N	N	N	N	N				N
Species that occur at higher trophic levels		N	N					N	N	N			N	N
Major vegetation influencer	N	N	N		N	N	N	N	Y					
Keystone species	Y	Y	Y		Y	Y	Y	Y	Y	Y				Y
5. Human-impact factors														
Legally harvested or killed in N.S.								?	N		N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N						?	N	N	N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N						?	N	N	N			N
No management activities directed at taxon	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
6. Information status														
Limited knowledge of distribution in N.S.				N				Y	N			N		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown								Y	N			N		
No autecological studies in N.S.		Y	Y					?	Y	Y				Y
No (meta-) pop. viability analysis in N.S.		Y	Y					?	Y	Y				Y

Table 4.3.43: Comparison of matrix responses by species - Rock vole

Respondent No. / Variables (Mammals)	KB	* 1	2	6	7	10	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status												
Nationally rare (COSEWIC)	N	N	N	N	N		N	N	N			N
Small population in N.S.	Y	Y	Y	Y	Y		Y	Y	N	Y		
Population declining in N.S.		?					N		N	N		N
Small no. of occurrences in N.S.	Y	Y	Y	Y	Y		Y	Y	Y			Y
Small geographic range/distribution in N.S.	Y	Y	Y	Y	Y		Y	Y	N	Y		
Decline in range/distribution in N.S.	Y	Y	Y	Y	Y		N		N	N		
Large percentage of range/distribution in N.S.	N	N	N	N	N		N	N		N		N
Species existing at range edge in N.S.		?					N					
Genetically distinct form	Y	Y	Y	Y	Y		Y	Y		Y		Y
2. Biological characteristics												
Space-demanding/wide-ranging	N	N	N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N	N	N	N	N	N		N		N
Extremely variable in population density							N					
Limited dispersal power		?					Y					
Low reproductivity or fecundity	N	N	N	N	N	N	N	N		N		N
Large-bodied (largest members of feeding class)		N	N				Y				N	
Pollution susceptible/accumulator species			?				N					
3. Habitat-related vulnerability												
Dietary and/or reproductive specialization			N				N	N		N		N
Habitat specialization	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y
Dependent upon provincially rare habitat		Y	?				Y	Y				Y
Climatic sensitivity		N	?				N	N		N		N
4. Species of major ecological importance												
Summit predator	N	N	N	N	N	N	N	N				N
Species that occur at higher trophic levels		N	N				N	N			N	N
Major vegetation influencer	N	N	N	N	N	N	N	N				N
Keystone species	N	N	N	N	N	N	N	N				N
5. Human-impact factors												
Legally harvested or killed in N.S.							N		N			N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N					N	N	N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.							N		N			N
No management activities directed at taxon	Y	Y	Y	Y	Y		N			Y		
6. Information status												
Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		N			Y		
Population trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y		Y		Y
Factors limiting population in N.S. unknown	Y	Y	Y	Y	Y		N			Y		
No autecological studies in N.S.		Y	Y				Y	Y				Y
No (meta-) population viability analysis in N.S.		Y	Y				Y	Y				Y

Table 4.3.44: Comparison of responses by species - Woodland jumping mouse

Respondent No. / Variables (Mammals)	KB	* 1	2	6	7	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status													
Nationally rare (COSEWIC)	N	N	N	N	N		N	N	N	N			N
Small population in N.S.	N	N	N	N	N		N	N	N	N	N		N
Population declining in N.S.			N				?			N	N		N
Small no. of occurrences in N.S.			N				?			N			N
Small geographic range/distribution in N.S.	Y	Y	Y	Y	Y		Y	N			N		
Decline in range/distribution in N.S.		?	N				?			N	N		N
Large percentage of range/distribution in N.S.	N	N	N	N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N	N	N		N	N	N				N
Genetically distinct form	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
2. Biological characteristics													
Space-demanding/wide-ranging	N	N	N	N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N	N	N	N	N	N	N		N		N
Extremely variable in population density			Y				?						
Limited dispersal power		N	N				?		N				N
Low reproductivity or fecundity	N	N	N	N	N	N	N	N	N		N		N
Large-bodied (largest members of feed. class)		N	N				?		N			N	N
Pollution susceptible/accumulator species			?				N						
3. Habitat-related vulnerability													
Dietary and/or reproductive specialization	Y	Y	N	Y	Y	Y	Y	Y			Y		
Habitat specialization			N				?				N		N
Dependent upon provincially rare habitat	N	N	N	N	N	N	N	N	N				N
Climatic sensitivity			?				N				N		N
4. Species of major ecological importance													
Summit predator	N	N	N	N	N	N	N	N	N				N
Species that occur at higher trophic levels		N	N				?		N			N	N
Major vegetation influencer	N	N	N	N	N	N	N	N	N				N
Keystone species		N					?						
5. Human-impact factors													**
Legally harvested or killed in N.S.							?			N			N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N					?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N					?			N			N
No management activities directed at taxon		Y					Y				N		
6. Information status													
Limited knowledge of distribution in N.S.							Y				N		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown							?				N		
No autecological studies in N.S.		Y	Y				?		Y				Y
No (meta-) population viability analysis in N.S.		Y	Y				?		Y				Y

Table 4.3.45: Comparison of responses by species - Meadow jumping mouse

Respondent No. Variables (Mammals)	KB	*1	2	6	7	10	^15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N	N	N	N		N	N	N	N			N
Small population in N.S.	N	Y	N	N	N		N	N	N	N	N		N
Population declining in N.S.			N				?			N	N		N
Small no. of occurrences in N.S.			N				?			N			N
Small geographic range/distribution in N.S.	Y	Y	Y	Y	Y		Y	N			N		
Decline in range/distribution in N.S.		N	N				?		N	N	N		N
Large percentage of range/distribution in N.S.	N	N	N	N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N	N	N		N	N	N				N
Genetically distinct form	N	N	N	N	N		N	N	N		N		N
2. Biological characteristics Space-demanding/wide-ranging	N	N	N	N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N	N	N	N	N	N	N	N		N		N
Extremely variable in population density			Y				?						
Limited dispersal power		N	N				?		N				N
Low reproductivity or fecundity	N	N	N	N	N	N	N	N	N		N		N
Large-bodied (largest members of feed. class)		N	N				?		N			N	N
Pollution susceptible/accumulator species			?				N						
3. Habitat-related vulnerability Dietary and/or reproductive specialization	Y	Y	N	Y	Y	Y	Y	Y			Y		
Habitat specialization	N	N	N	N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat	N	N	N	N	N	N	N	N	N				N
Climatic sensitivity			?				N				N		N
4. Species of major ecological importance Summit predator	N	N	N	N	N	N	N	N	N				N
Species that occur at higher trophic levels		N	N				?		N			Y	
Major vegetation influencer	N	N	N	N	N	N	N	N	N				N
Keystone species		N					?						
5. Human-impact factors Legally harvested or killed in N.S.							?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N					?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N					?			N			N
No management activities directed at taxon	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
6. Information status Limited knowledge of distribution in N.S.							Y				N		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown							Y				N		
No autecological studies in N.S.		Y	Y				?		Y				Y
No (meta-) population viability analysis in N.S.		Y	Y				?		Y				Y

Table 4.3.46: Comparison of responses by species - American porcupine

Respondent No. / Variables (Mammals)	KB	2	5	6	7	8	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)	N	N		N	N	N		N	N	N	N			N
Small population in N.S.	N	N		N	N	N		N	N	N	N	N		N
Population declining in N.S.		N						?			N	N		N
Small no. of occurrences in N.S.		N				N		N		N	N			N
Small geographic range/distribution in N.S.	Y	Y		Y	Y	Y		Y	N			N		
Decline in range/distribution in N.S.		N				N		N		N	N	N		N
Large percent. of range/distribution in N.S.	N	N		N	N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N		N	N	N		N	N	N				N
Genetically distinct form	Y	Y		Y	Y	Y		Y	N			Y		
2. Biological characteristics														
Space-demanding/wide-ranging	N	N		N	N	N	N	N	N	N			N	N
Population seasonally/daily concentrating	N	N		N	N	N	N	N	N	N		N		N
Extremely variable in population density		Y						?						
Limited dispersal power		N						?						
Low reproductivity or fecundity	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
Large-bodied (largest member. feed. class)		Y						?						
Pollution susceptible/accumulator species		?				N		N		N				N
3. Habitat-related vulnerability														
Dietary and/or reproductive specialization	Y	N		Y	Y	Y	Y	Y	Y			Y		
Habitat specialization	N	N		N	N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat	N	N		N	N	N	N	N	N	N				N
Climatic sensitivity		?				N		N		N		N		N
4. Species of major ecological importance														
Summit predator	N	N		N	N	N	N	N	N	N				N
Species that occur at higher trophic levels		N				N		N		N			N	N
Major vegetation influencer						M	Y	Y		Y				Y
Keystone species						N		?						
5. Human-impact factors														
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y		** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.								N			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.								N			N			N
No management activities directed at taxon	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
6. Information status														
Limited knowledge of distribution in N.S.			N					Y				N		
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown								Y				N		
No autecological studies in N.S.		Y						?						
No (meta-) pop. viability analysis in N.S.		Y						?						

Table 4.3.47: Comparison of responses by species - Snowshoe hare

Respondent No. Variables (Mammals)	KB	* 1	2	5	6	7	8	10	^ 15	17	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	N	N	N		N	N	N		N	N	N	N			N
Small population in N.S.	N	N	N		N	N	N		N	N	N	N	N		N
Population declining in N.S.		N	N				N		?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N	N		N	N	N	N			N
Small geographic range/distrib. in N.S.	N	N	N		N	N	N		N	N	N	N	N		N
Decline in range/distribution in N.S.		N	N				N		?		N	N	N		N
Large percent. of range/distrib. in N.S.	N	N	N		N	N	N		N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N	N		N	N	N				N
Genetically distinct form	N	N	N		N	N	N		N	N	N		N		N
2. Biological characteristics Space-demanding/wide-ranging	N	N	N		N	N	N	N	N	N	N			N	N
Pop. seasonally/daily concentrating	N	N	N		N	N	N	N	N	N	N		N		N
Extremely variable in pop. density	Y		Y		Y	Y	Y	Y	Y	Y	Y				Y
Limited dispersal power	N	N	N		N	N	N	N	N	N	N				N
Low reproductivity or fecundity	N	N	N		N	N	N	N	N	N	N		N		N
Large-bodied (largest members of feeding class)	N	N	N		N	N	N	N	N	N	N			N	N
Pollution susceptible/ accumulator species	N	N	N		N	N	N	N	N	N	N				N
3. Habitat-related vulnerability Dietary and/or repro.specialization			N				N		?		N		N		N
Habitat specialization			N						?				N		N
Dependent upon prov. rare habitat	N	N	N		N	N	N	N	N	N	N				N
Climatic sensitivity		N	?				N		N		N		N		N
4. Species of major ecological importance Summit predator	N	N	N		N	N	N	N	N	N	N				N
Sp. occurs at higher trophic level			N				N		N		N			N	N
Major vegetation influencer	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
Keystone species	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
5. Human-impact factors Legally harvested or killed in N.S.	Y	N	Y	Y	Y	Y	Y		Y	Y		Y	Y		** Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N					Y		?			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N					N		?		N	N			N
No management directed at taxon				N					Y				N		
6. Information status Limited knowledge of distrib. in N.S.				N			N		?		N		N		N
Pop. trends not monitored in N.S.				N					Y				N		
Factors limiting pop. in N.S. unknown									?				N		
No autecological studies in N.S.		Y	Y						?		Y				Y
No (meta-) pop. viability analysis in NS		Y	Y						?		Y				Y

Table 4.4.1: Comparison of matrix responses by species - Snapping turtle

Respondent No. **Variables** (Reptiles and amphibians)	KB	2	5	6	7	10	14	^ 15	16	17	19	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)		N						?		N	N	N	N			N
Small population in N.S.	N	N		N	N		N	N	N			N	N	N		N
Population declining in N.S.		N						?		N	N	N	N	N		N
Small no. of occurrences in N.S.	N	N		N	N		N	N	N			N	N			N
Small geog. range/distrib. in N.S.		N						?		N	N	N	N	N		N
Decline in range/distribution in NS		N						?		N	N	N	N	N		N
Lrg. percent. range/distrib. in N.S.	N	N		N	N		N	N	N	N	N	N		N		N
Species existing range edge NS	Y	Y		Y	Y		Y	Y	Y			Y				Y
Genetically distinct form	Y	Y		Y	Y		?	Y	Y	Y	Y	Y		Y		Y
2. Biological characteristics Space-demanding/wide-ranging		N						N	Y	Y	Y				N	
Po. seasonally/daily concentrating		N						?		Y	Y			N		
Extremely variable in pop. density		N						?		N	N	N				N
Limited dispersal power		N						?		N	N	N				N
Low reproductivity or fecundity	Y	Y		Y	Y	Y	Y	Y	Y	N	N			Y		
Lrg.-body/lrgst. memb. feed. class	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y
Pollution susc/accumulator sp.		N						Y	Y	Y	Y					
3. Habitat-related vulnerability Diet and/or repro. specialization	N	N		N	N	N	N	N	N	N	N	N		N		N
Habitat specialization	N	N		N	N	N	N	N	N	N	N	N		N		N
Depend. upon prov. rare habitat		N						?		N	N	N				N
Climatic sensitivity		N						?		Y	Y			N		
4. Species of major ecological importance Summit predator	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y				Y
Sp. occurs at higher trophic level	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer		N						N		N	N	N				N
Keystone species		N						?		N	N	N				N
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	N	N	Y	Y		Y	Y	Y	Y	Y	Y	Y			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	N	N	Y	Y		Y	Y	Y	N	N		Y			
No management activities directed at taxon	Y	Y	N	Y	Y		Y	Y	Y	N	N			Y		
6. Information status Limited knowledge of distrib. N.S.	Y	N	Y	Y	Y		Y	Y	Y	N	N			Y		
Pop. trends not. monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown		M						N		N	N	N		N		N
No autecological studies in N.S.		Y						N		N	N					
No (meta-) pop. viability analysis		Y						N		Y	Y					

Table 4.4.2: Comparison of matrix responses by species - Wood turtle

Respondent No. / Variables (Reptiles and amphibians)	KB	*1	2	5	6	7	10	14	16	17	19	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)	Y	Y	Y		Y	Y		Y	Y			Y	Y			Y
Small population in N.S.	Y	Y	Y		Y	Y		Y	Y			Y	N	Y		
Population declining in N.S.			M		M					Y	Y	Y	N	N		
Small no. of occurrences in N.S.	N	N	N		N	N		N	N			N	N			N
Small geog. range/distrib. in N.S.	Y	Y	Y		Y	Y		Y	Y	Y	Y	Y	Y	N		
Decline in range/distribution in NS			M		Y					Y	Y	Y	N	N		
Lrg. percent. range/distrib. in N.S.	N	N	N		N	N		N	N	N	N	N		N		N
Species existing range edge NS			Y							Y	Y	Y				Y
Genetically distinct form	Y	Y	Y		Y	Y		?	Y	N	N			Y		
2. Biological characteristics Space-demanding/wide-ranging		N	N							Y	Y				N	
Po. seasonally/daily concentrating			N							Y	Y			N		
Extremely variable in pop. density			N							N	N	N				N
Limited dispersal power	Y	Y	Y		Y	Y	Y	Y	Y			Y				Y
Low reproductivity or fecundity	Y	Y	Y		Y	Y	Y	Y	Y			Y		Y		Y
Lrg.-body/lrgst. memb. feed. class			N							N	N	N			N	N
Pollution susc/accumulator sp.	Y	Y	Y		Y	Y	Y	Y	Y	N	N					
3. Habitat-related vulnerability Diet and/or repro. specialization			M							Y	Y	Y		N		
Habitat specialization	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		N		
Depend. upon prov. rare habitat			M							Y	Y	Y				Y
Climatic sensitivity	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		Y		Y
4. Species of major ecological importance Summit predator			N							N	N	N				N
Sp. occurs at higher trophic level			N							N	N	N			Y	
Major vegetation influencer		N	N							N	N	N				N
Keystone species			N							N	N	N				N
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	N	Y	Y			Y	N	N	N	N	Y		** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y
No management activities directed at taxon	Y	Y	Y	N	Y	Y		Y	Y	N	N			Y		
6. Information status Limited knowledge of distrib. N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y		Y
Pop. trends not. monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown			M							N	N	N		N		N
No autecological studies in N.S.			Y							N	N					
No (meta-) pop. viability analysis			Y							Y	Y	Y				Y

Table 4.4.3: Comparison of matrix responses by species - Blanding's turtle

Respondent No. / Variables (Reptiles and amphibians)	KB	2	5	6	7	8	10	14	15	16	17	19	Consensus 1	Ref. 1 & 2	Ref. 3	Consensus 2
1. Rarity/Population status																
Nationally rare (COSEWIC)	Y	Y		Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y
Small population in N.S.	Y	Y		Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
Population declining in N.S.		M		M		M			?		?	?		N	N	N
Small no. of occurrences in N.S.	Y	Y		Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y
Small geog. range/distrib. in N.S.	Y	Y		Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
Decline in range/distribution in NS		M							?		?	?		N	N	N
Lrg. percent. range/distrib. in N.S.	N	N		N	N	N		N	N	N	N	N	N		N	N
Species existing range edge NS	Y	Y		Y	Y	Y		Y	Y	Y	Y	Y	Y			Y
Genetically distinct form	Y	Y		Y	Y	Y		?	Y	Y	Y	Y	Y		Y	Y
2. Biological characteristics																
Space-demanding/wide-ranging		N				N			N		Y	Y				
Po. seasonally/daily concentrating		M							?		Y	Y	Y		N	
Extremely variable in pop. density		N							?		N	N	N			N
Limited dispersal power	Y	Y		Y	Y	Y	Y	Y	Y	Y	N	N				
Low reproductivity or fecundity	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y
Lrg.-body/lrgst. memb. feed. class		N							?		N	N	N			N
Pollution susc/accumulator sp.	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y
3. Habitat-related vulnerability																
Diet and/or repro. specialization	N	N		N	N	N	N	N	N	N	Y	Y			N	
Habitat specialization	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		N	
Depend. upon prov. rare habitat		M							?							
Climatic sensitivity	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y
4. Species of major ecological importance																
Summit predator		N				M			?		N	N	N			N
Sp. occurs at higher trophic level		N				Y			Y		Y	Y				
Major vegetation influencer		N				N			N		N	N	N			N
Keystone species		N							?		N	N	N			N
5. Human-impact factors																
Legally harvested or killed in N.S.		N				N				?	N	N	N	N	N	N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y
No management activities directed at taxon		N	N			N			N		N	N	N		N	N
6. Information status																
Limited knowledge of distrib. N.S.		M	Y			N			N		Y	Y			N	
Pop. trends not. monitored in N.S.	Y	Y	N	Y	Y	Y		Y	N	Y	N	N			Y	
Factors limiting pop. NS. unknown		M							N		N	N	N		N	N
No autecological studies in N.S.		N							N		N	N	N			N
No (meta-) pop. viability analysis		M				?			N		N	N	N			N

Table 4.4.4: Comparison of matrix responses by species - Eastern painted turtle

Respondent No. **Variables** (Reptiles and amphibians)	K B	2	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)		N						?			N			N
Small population in N.S.		N						?			N	N		N
Population declining in N.S.		N						?			N	N		N
Small no. of occurrences in N.S.		N						?			N			N
Small geographic range/distribution in N.S.		N						?			N	N		N
Decline in range/distribution in N.S.		N						?			N	N		N
Large percentage of range/distribution N.S.	N	N		N	N		N	N	N	N		N		N
Species existing at range edge in N.S.	Y	Y		Y	Y		Y	Y	Y	Y				Y
Genetically distinct form	Y	Y		Y	Y		?	Y	Y	Y		N		
2. Biological characteristics Space-demanding/wide-ranging		N						N		N			N	N
Population seasonally/daily concentrating		N						?				N		N
Extremely variable in population density		N						?						
Limited dispersal power		N						?						
Low reproductivity or fecundity	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
Large-bodied/largest member feed. class		N						?					N	N
Pollution susceptible/accumulator species		N						Y						
3. Habitat-related vulnerability Dietary and/or reproductive specialization	N	N		N	N	N	N	N	N	N		N		N
Habitat specialization	N	N		N	N	N	N	N	N	N		N		N
Dependent upon provincially rare habitat		N						?						
Climatic sensitivity		N						?				N		N
4. Species of major ecological importance Summit predator		N						?						
Species that occur at higher trophic levels		N						?					Y	
Major vegetation influencer		N						N		N				N
Keystone species		N						?						
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	N	Y	Y			Y	Y		N	Y		** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N						?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N						?			N			N
No management activities directed at taxon	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Pop. trends not reg. monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown		M						?				N		
No autecological studies in N.S.		Y						?						
No (meta-) population viability analysis NS		Y						?						

Table 4.4.5: Comparison of matrix responses - Maritime garter snake

Respondent No. / Variables (Reptiles and amphibians)	KB	*1	2	5	6	7	8	10	14	^15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status																
Nationally rare (COSEWIC)			N							?			N			N
Small population in N.S.	N	N	N		N	N	N		N	N	N	N	N	N		N
Population declining in N.S.			N				N			?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N	N		N	N	N	N	N			N
Small geog. range/distrib. in N.S.	N	N	N		N	N	N		N	N	N	N	N	N		N
Decline in range/distribution in NS			N				N			?		N	N	N		N
Lrg. percent. range/distrib. in N.S.	N	N	N		N	N	N		N	N	N	N		N		N
Species existing range edge NS	N	N	N		N	N	N		N	N	N	N				N
Genetically distinct form			N				?			?				N		N
2. Biological characteristics																
Space-demanding/wide-ranging		N	N				N			N		N			N	N
Po. seasonally/daily concentrating	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		N		
Extremely variable in pop. density			N				N			Y						
Limited dispersal power			N							?						
Low reproductivity or fecundity			N				N			N		N		N		N
Lrg.-body/lrgst. memb. feed. class			N				N			?					Y	
Pollution susc/accumulator sp.			N				N			Y						
3. Habitat-related vulnerability																
Diet and/or repro. specialization	N	N	N		N	N	N	N	N	N	N	N		N		N
Habitat specialization	N	N	N		N	N	N	N	N	N	N	N		N		N
Depend. upon prov. rare habitat			N				N			N		N				N
Climatic sensitivity	N	N	N		N	N	N	N	N	N	N	N		N		N
4. Species of major ecological importance																
Summit predator		Y	N				N			?						
Sp. occurs at higher trophic level	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer		N	N				N			N		N				N
Keystone species			N				N			?		N				N
5. Human-impact factors																
Legally harvested or killed in N.S.			Y				N			?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N				N			?		N	N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N				N			?		N	N			N
No management activities directed at taxon	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status																
Limited knowledge of distrib. N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Pop. trends not. monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown			M							?				N		
No autecological studies in N.S.			Y							?						
No (meta-) pop. viability analysis			Y							?						

Table 4.4.6: Comparison of responses by species - Northern ribbon snake

Respondent No. / Variables (Reptiles and amphibians)	KB	2	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Consensus 2
1. Rarity/Population status													
Nationally rare (COSEWIC)		N						?			N		N
Small population in N.S.	Y	Y		Y	Y		Y	Y	Y	Y	Y	Y	Y
Population declining in N.S.		M						?			N	N	N
Small no. of occurrences in N.S.	Y	Y		Y	Y		Y	Y	Y	Y	Y		Y
Small geographic range/distribution in N.S.	Y	Y		Y	Y		Y	Y	Y	Y	Y	Y	Y
Decline in range/distribution in N.S.		M						?			N	N	N
Large percentage of range/distribution in N.S.	N	N		N	N		N	N	N	N		N	N
Species existing at range edge in N.S.	Y	Y		Y	Y		Y	Y	Y	Y			Y
Genetically distinct form	Y	Y		Y	Y		?	Y	Y	Y		Y	Y
2. Biological characteristics													
Space-demanding/wide-ranging		N						N		N			N
Population seasonally/daily concentrating	Y	Y		Y	Y	Y	Y	Y	Y	Y		N	
Extremely variable in population density		N						?					
Limited dispersal power		N						?					
Low reproductivity or fecundity		N						?				N	N
Large-bodied (largest members of feed. class)		N						?					
Pollution susceptible/accumulator species		N						Y					
3. Habitat-related vulnerability													
Dietary and/or reproductive specialization		M						?				N	
Habitat specialization	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y	Y
Dependent upon provincially rare habitat		N						?					
Climatic sensitivity		M						?				N	
4. Species of major ecological importance													
Summit predator		N						?					
Species that occur at higher trophic levels	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y
Major vegetation influencer		N						N		N			N
Keystone species		N						?					
5. Human-impact factors													
Legally harvested or killed in N.S.		Y						?			N	N	N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	?	Y	Y		Y	Y	Y	Y	Y		Y
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	?	Y	Y		Y	Y	Y	Y	Y		Y
No management activities directed at taxon	Y	Y	N	Y	Y		Y	Y	Y			Y	
6. Information status													
Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	Y
Population trends not reg. monitored in N.S.	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	Y
Factors limiting population in N.S. unknown		M						?				N	
No autecological studies in N.S.		Y						?					
No (meta-) population viability analysis in N.S.		Y						?					

Table 4.4.7: Comparison of responses by species - Northern ringneck snake

Respondent No. / Variables (Reptiles and amphibians)	KB	*1	2	6	7	10	14	^15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status														
Nationally rare (COSEWIC)			N					?			N			N
Small population in N.S.	N	N	N	N	N		N	N	N	N	N	N		N
Population declining in N.S.			N					?			N	N		N
Small no. of occurrences in N.S.	N	N	N	N	N		N	N	N	N	N			N
Small geographic range/distribution in N.S.	N	N	N	N	N		N	N	N	N	N	N		N
Decline in range/distribution in N.S.			N					?			N	N		N
Large percentage of range/distrib. in N.S.	N	N	N	N	N		N	N	N	N		N		N
Species existing at range edge in N.S.	N	N	N	N	N		N	N	N	N				N
Genetically distinct form	Y	Y	Y	Y	Y		?	Y	Y	Y		Y		Y
2. Biological characteristics														
Space-demanding/wide-ranging		N	N					N		N			N	N
Population seasonally/daily concentrating	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		N		
Extremely variable in population density			N					?						
Limited dispersal power			N					?						
Low reproductivity or fecundity			N	Y				?				N		
Large-bodied/largest member feed. class			N					?					N	N
Pollution susceptible/accumulator species			N					Y						
3. Habitat-related vulnerability														
Dietary and/or reproductive specialization	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y
Habitat specialization	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y
Dependent upon provincially rare habitat			N					?						
Climatic sensitivity	N	N	N	N	N	N	N	N	N	N		N		N
4. Species of major ecological importance														
Summit predator		Y	N					?						
Species that occur at higher trophic levels	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer		N	N					N		N				N
Keystone species			N					?						
5. Human-impact factors														
Legally harvested or killed in N.S.			Y					?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N					?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N					?			N			N
No management activities directed at taxon	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status														
Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Population trends not reg. monitored in NS.	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting population in N.S. unknown			M					Y				N		
No autecological studies in N.S.			Y					?						
No (meta-) population viability analysis NS.			Y					?						

Table 4.4.8: Comparison of responses by species - Eastern smooth green snake

Respondent No. **Variables** (Reptiles and amphibians)	K B	* 1	2	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)			N						?			N			N
Small population in N.S.	N	N	N		N	N		N	N	N	N	N	N		N
Population declining in N.S.			N						?			N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N		N	N	N	N	N			N
Small geographic range/distrib. in N.S.	N	N	N		N	N		N	N	N	N	N	N		N
Decline in range/distribution in N.S.			N						?			N	N		N
Large percent. of range/distrib. in N.S.	N	N	N		N	N		N	N	N	N		N		N
Species existing at range edge in N.S.	N	N	N		N	N		N	N	N	N				N
Genetically distinct form			N					?	?				N		N
2. Biological characteristics Space-demanding/wide-ranging		N	N						N		N			N	N
Pop. seasonally/daily concentrating	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		N		
Extremely variable in pop. density			N						?						
Limited dispersal power			N						?						
Low reproductivity or fecundity			N						?				N		N
Large-body /lrgst. memb. feed. class			N						?					Y	
Pollution susceptible/accumulator sp.			N						Y						
3. Habitat-related vulnerability Dietary/reproductive specialization	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
Habitat specialization	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
Dependent upon prov. rare habitat			N						?						
Climatic sensitivity	N	N	N		N	N	N	N	N	N	N		N		N
4. Species of major ecological importance Summit predator			N						N		N				N
Sp. that occur at higher trophic levels	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y	Y
Major vegetation influencer		N	N						N		N				N
Keystone species			N						?						
5. Human-impact factors Legally harvested or killed in N.S.			Y						?			N	N		** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N						?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N						?			N			N
No management directed at taxon	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status Limited knowledge of distribution N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting pop. in N.S. unknown			M						Y						
No autecological studies in N.S.			Y						?						
No (meta-) pop. viability analysis in NS			Y						?						

Table 4.4.9: Comparison of responses by species - Northern redbelly snake

Respondent No. / Variables (Reptiles and amphibians)	K B	* 1	2	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status															
Nationally rare (COSEWIC)			N						?			N			N
Small population in N.S.	N	N	N		N	N		N	N	N	N	N	N		N
Population declining in N.S.			N						?			N	N		N
Small no. of occurrences in N.S.	N	N	N		N	N		N	N	N	N	N			N
Small geographic range/distrib. in N.S.	N	N	N		N	N		N	N	N	N	N	N		N
Decline in range/distribution in N.S.			N						?			N	N		N
Large percent. of range/distrib. in N.S.	N	N	N		N	N		N	N	N	N		N		N
Species existing at range edge in N.S.			N						N		N				N
Genetically distinct form			N					?	?				N		N
2. Biological characteristics															
Space-demanding/wide-ranging		N	N						N		N			N	N
Pop. seasonally/daily concentrating	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		N		
Extremely variable in pop. density			N						?						
Limited dispersal power			N						?						
Low reproductivity or fecundity			N						?				N		N
Large-body /lrgst. memb. feed. class			N						?					N	N
Pollution susceptible/accumulator sp.			N						Y						
3. Habitat-related vulnerability															
Dietary/reproductive specialization	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
Habitat specialization	N	N	N		N	N	N	N	N	N	N		N		N
Dependent upon prov. rare habitat			N						?						
Climatic sensitivity	N	N	N		N	N	N	N	N	N	N		N		N
4. Species of major ecological importance															
Summit predator			N						N		N				N
Sp. that occur at higher trophic levels	Y	N	Y		Y	Y	Y	Y	Y	Y				Y	
Major vegetation influencer		N	N						N		N				N
Keystone species			N						?						
5. Human-impact factors															
Legally harvested or killed in N.S.			Y						?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N						?			N			N
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N						?			N			N
No management directed at taxon	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status															
Limited knowledge of distribution N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting pop. in N.S. unknown			M						Y				N		
No autecological studies in N.S.			Y						?						
No (meta-) pop. viability analysis in NS			Y						?						

Table 4.4.10: Comparison of responses by species - Eastern American toad

Respondent No. / Variables (Reptiles and amphibians)	KB	* 1	2	4	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status																
Nationally rare (COSEWIC)			N							N		N	N			N
Small population in N.S.	N	N	N	N		N	N		N	N	N	N	N	N		N
Population declining in N.S.		N	N							?		N	N	N		N
Small no. of occurrences in N.S.	N	N	N	N		N	N		N	N	N	N	N			N
Small geog. range/distrib. in N.S.	N	N	N	N		N	N		N	N	N	N	N	N		N
Decline in range/distribution in NS			N							?			N	N		N
Lrg. percent. range/distrib. in N.S.	N	N	N	N		N	N		N	N	N	N		N		N
Species existing range edge NS	N	N	N	N		N	N		N	N	N	N				N
Genetically distinct form			N						?	?				N		N
2. Biological characteristics																
Space-demanding/wide-ranging		N	N							N		N			N	N
Po. seasonally/daily concentrating	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		N		
Extremely variable in pop. density			N	Y						?						
Limited dispersal power			N							?						
Low reproductivity or fecundity			N							N		N		N		N
Lrg.-body/lrgst. memb. feed. class			N							?					Y	
Pollution susc/accumulator sp.			N	Y						Y						
3. Habitat-related vulnerability																
Diet and/or repro. specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Habitat specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Depend. upon prov. rare habitat			N							N		N				N
Climatic sensitivity			N							?				N		N
4. Species of major ecological importance																
Summit predator			N	N						?		N				N
Sp. occurs at higher trophic level			N	Y						Y					Y	
Major vegetation influencer		N	N	N						N		N				N
Keystone species	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
5. Human-impact factors																
Legally harvested or killed in N.S.			Y	N						?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N	Y						?			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N	Y						?			N			
No management activities directed at taxon	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status																
Limited knowledge of distrib. N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Pop. trends not. monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown			M	M						Y				N		
No autecological studies in N.S.			Y	Y						?		Y				Y
No (meta-) pop. viability analysis			Y	Y						?		Y				Y

Table 4.4.11: Comparison of responses by species - Northern spring peeper

Respondent No. / Variables (Reptiles and amphibians)	KB	* 1	2	4	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)			N							N		N	N			N
Small population in N.S.	N	N	N	N		N	N		N	N	N	N	N	N		N
Population declining in N.S.		N	M							?			N	N		N
Small no. of occurrences in N.S.	N	N	N	N		N	N		N	N	N	N	N			N
Small geog. range/distrib. in N.S.	N	N	N	N		N	N		N	N	N	N	N	N		N
Decline in range/distribution in NS			M							?			N	N		N
Lrg. percent. range/distrib. in N.S.	N	N	N	N		N	N		N	N	N	N		N		N
Species existing range edge NS	N	N	N	N		N	N		N	N	N	N				N
Genetically distinct form			N						?	?				N		N
2. Biological characteristics Space-demanding/wide-ranging		N	N							N		N			N	N
Po. seasonally/daily concentrating	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		N		
Extremely variable in pop. density			N							?						
Limited dispersal power			N							?						
Low reproductivity or fecundity			N							N		N		N		N
Lrg.-body/lrgst. memb. feed. class			N							?					N	N
Pollution susc/accumulator sp.			Y	Y						Y		Y				Y
3. Habitat-related vulnerability Diet and/or repro. specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Habitat specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Depend. upon prov. rare habitat			N							?						
Climatic sensitivity	N	N	N	N		N	N	N	N	N	N	N		N		N
4. Species of major ecological importance Summit predator			N	N						?		N				N
Sp. occurs at higher trophic level			N	Y						Y					Y	
Major vegetation influencer		N	N	N						N		N				N
Keystone species	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
5. Human-impact factors Legally harvested or killed in N.S.			Y	N						?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N	Y						?			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N	Y						?			N			
No management activities directed at taxon	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status Limited knowledge of distrib. N.S.	Y	Y	Y	Y	N	Y	Y		Y	Y	Y			Y		
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown			M	M						Y				N		
No autecological studies in N.S.			Y	Y						?		Y				Y
No (meta-) pop. viability analysis			Y	Y						?		Y				Y

Table 4.4.12: Comparison of matrix responses by species - Bullfrog

Respondent No. **Variables** (Reptiles and amphibians)	KB	2	4	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)		N							N		N	N		N
Small population in N.S.	N	N	N		N	N		N	N	N	N	N	N	N
Population declining in N.S.		M			M				?			N	N	N
Small no. of occurrences in N.S.	N	N	N		N	N		N	N	N	N	N		N
Small geographic range/distribution in N.S.	N	N	N		N	N		N	N	N	N	N	N	N
Decline in range/distribution in N.S.		M							?			N	N	N
Large percent. of range/distribution in N.S.	N	N	N		N	N		N	N	N	N		N	N
Species existing at range edge in N.S.	Y	Y	Y		Y	Y		Y	Y	Y	Y			Y
Genetically distinct form		N						?	?				N	N
2. Biological characteristics Space-demanding/wide-ranging		N							N		N			N
Population seasonally/daily concentrating	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		N	
Extremely variable in population density		N							?					
Limited dispersal power		N							?					
Low reproductivity or fecundity		N							N		N		N	N
Large-bodied/largest member feed. class	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y
Pollution susceptibleaccumulator species		Y	Y						Y		Y			Y
3. Habitat-related vulnerability Dietary and/or reproductive specialization	N	N	N		N	N	N	N	N	N	N		N	N
Habitat specialization	N	N	N		N	N	N	N	N	N	N		N	N
Dependent upon provincially rare habitat		N							?					
Climatic sensitivity		M							?				N	
4. Species of major ecological importance Summit predator		N	N						?		N			N
Species that occur at higher trophic levels		N	Y						Y					
Major vegetation influencer		N	M						N		N			N
Keystone species	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		N	Y						?			N		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		N	Y						?			N		
No management activities directed at taxon	Y	Y	Y	N	Y	Y		Y	Y	Y			Y	
6. Information status Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	Y
Pop. trends not regularly monitored in N.S.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	Y
Factors limiting population in N.S. unknown		M	M						Y				N	
No autecological studies in N.S.		Y	Y						?		Y			Y
No (meta-) pop. viability analysis in N.S.		Y	Y						?		Y			Y

Table 4.4.13: Comparison of matrix responses by species - Green frog

Respondent No. / Variables (Reptiles and amphibians)	KB	*1	2	4	5	6	7	10	14	^15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Consensus 2
1. Rarity/Population status															
Nationally rare (COSEWIC)			N							N		N	N		N
Small population in N.S.	N	N	N	N		N	N		N	N	N	N	N	N	N
Population declining in N.S.		N	M							?			N	N	N
Small no. of occurrences in N.S.	N	N	N	N		N	N		N	N	N	N	N		N
Small geographic range/distrib. in N.S.	N	N	N	N		N	N		N	N	N	N	N	N	N
Decline in range/distribution in N.S.			M							?			N	N	N
Large percent of range/distrib. in N.S.	N	N	N	N		N	N		N	N	N	N		N	N
Species existing at range edge in N.S.	N	N	N	N		N	N		N	N	N	N			N
Genetically distinct form			N						?	?				N	N
2. Biological characteristics															
Space-demanding/wide-ranging		N	N							N		N			N
Pop. seasonally/daily concentrating	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		N	
Extremely variable in pop. density			N	M						?					
Limited dispersal power			N							?					
Low reproductivity or fecundity			N							N		N		N	N
Large-bodied (largest members of feeding class)			N							?					
Pollution susceptible/accumulator sp.			Y	Y						Y		Y			Y
3. Habitat-related vulnerability															
Dietary /reproductive specialization	N	N	N	N		N	N	N	N	N	N	N		N	N
Habitat specialization	N	N	N	N		N	N	N	N	N	N	N		N	N
Dependent upon prov. rare habitat			N							N		N			N
Climatic sensitivity	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y	Y
4. Species of major ecological importance															
Summit predator			N	N						?		N			N
Sp. that occur at higher trophic levels			N	Y						Y					
Major vegetation influencer		N	N	M						N		N			N
Keystone species	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y
5. Human-impact factors															
Legally harvested or killed in N.S.			Y	N						?			N	N	N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N	Y						?			N		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N	Y						N			N		
No management directed at taxon	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	Y
6. Information status															
Limited knowledge of distribution NS.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	Y
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	Y
Factors limiting pop. in N.S. unknown			M	M						Y				N	
No autecological studies in N.S.			Y	Y						?		Y			Y
No (meta-) pop. viability analysis in NS			Y	Y						?		Y			Y

Table 4.4.14: Comparison of matrix responses by species - Mink frog

Respondent No. / Variables (Reptiles and amphibians)	KB	* 1	2	4	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Consensus 2
1. Rarity/Population status															
Nationally rare (COSEWIC)			N							N		N	N		N
Small population in N.S.	N	N	N	N		N	N		N	N	N	N	N	N	N
Population declining in N.S.			M							?			N	N	N
Small no. of occurrences in N.S.	N	N	N	N		N	N		N	N	N	N	N		N
Small geographic range/distrib. in N.S.	N	N	N	N		N	N		N	N	N	N	N	N	N
Decline in range/distribution in N.S.			M							?			N	N	N
Large percent of range/distrib. in N.S.	N	N	N	N		N	N		N	N	N	N		N	N
Species existing at range edge in N.S.	N	N	N	N		N	N		N	N	N	N			N
Genetically distinct form			N						?	?				N	N
2. Biological characteristics															
Space-demanding/wide-ranging		N	N							N		N			N
Pop. seasonally/daily concentrating	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		N	
Extremely variable in pop. density			N	M						?					
Limited dispersal power			N							?					
Low reproductivity or fecundity			N							N		N		N	N
Large-bodied (largest members of feeding class)			N							?					
Pollution susceptible/accumulator sp.			Y	Y						Y		Y			Y
3. Habitat-related vulnerability															
Dietary /reproductive specialization	N	N	N	N		N	N	N	N	N	N	N		N	N
Habitat specialization	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		N	
Dependent upon prov. rare habitat			N							?					
Climatic sensitivity	N	N	N	N		N	N	N	N	N	N	N		N	N
4. Species of major ecological importance															
Summit predator			N	N						?		N			N
Sp. that occur at higher trophic levels			N	Y						Y					
Major vegetation influencer		N	N	N						N		N			N
Keystone species	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y			Y
5. Human-impact factors															
Legally harvested or killed in N.S.			Y	N						?			N	N	N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N	Y						?			N		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N	Y						?			N		
No management directed at taxon	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	Y
6. Information status															
Limited knowledge of distribution NS.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	Y
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	Y
Factors limiting pop. in N.S. unknown			M	M						Y				N	
No autecological studies in N.S.			Y	Y						?		Y			Y
No (meta-) pop. viability analysis in NS			Y	Y						?		Y			Y

Table 4.4.15: Comparison of responses by species - Northern leopard frog

Respondent No. / Variables (Reptiles and amphibians)	KB	* 1	2	4	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status																
Nationally rare (COSEWIC)			N							N		N	N			N
Small population in N.S.	N	N	N	N		N	N		N	N	N	N	N	N		N
Population declining in N.S.			M	M		M				?			N	N		N
Small no. of occurrences in N.S.	N	N	N	N		N	N		N	N	N	N	N			N
Small geog. range/distrib. in N.S.	N	N	N	N		N	N		N	N	N	N	N	N		N
Decline in range/distribution in NS			M	M						?			N	N		N
Lrg. percent. range/distrib. in N.S.	N	N	N	N		N	N		N	N	N	N		N		N
Species existing range edge NS	N	N	N	N		N	N		N	N	N	N				N
Genetically distinct form			N						?	?				N		N
2. Biological characteristics																
Space-demanding/wide-ranging		N	N							N		N			N	N
Po. seasonally/daily concentrating	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		N		
Extremely variable in pop. density	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
Limited dispersal power			N							?						
Low reproductivity or fecundity			N							N		N		N		N
Lrg.-body/lrgst. memb. feed. class			N							?					Y	
Pollution susc/accumulator sp.			Y	Y						Y		Y				Y
3. Habitat-related vulnerability																
Diet and/or repro. specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Habitat specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Depend. upon prov. rare habitat			N							N		N				N
Climatic sensitivity	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
4. Species of major ecological importance																
Summit predator			N	N						?		N				N
Sp. occurs at higher trophic level			N	Y						Y						
Major vegetation influencer		N	N	N						N		N				N
Keystone species	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
5. Human-impact factors																**
Legally harvested or killed in N.S.	Y	Y	Y	Y	N	Y	Y		Y	Y	Y		N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N	Y						?			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	N	N	N	N	N	N	N		?	N	N	N	N			N
No management activities directed at taxon	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status																
Limited knowledge of distrib. N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Pop. trends not. monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown			M	M						Y				N		
No autecological studies in N.S.			Y	Y						?		Y				Y
No (meta-) pop. viability analysis			Y	Y						?		Y				Y

Table 4.4.16: Comparison of matrix responses by species - Pickerel frog

Respondent No. / Variables (Reptiles and amphibians)	KB	* 1	2	4	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)			N							N		N	N			N
Small population in N.S.			N							N		N	N	N		N
Population declining in N.S.			M							?			N	N		N
Small no. of occurrences in N.S.	N	N	N	N		N	N		N	N	N	N	N			N
Small geog. range/distrib. in N.S.	N	N	N	N		N	N		N	N	N	N	N	N		N
Decline in range/distrib. in N.S.			M							?			N	N		N
Lrg. percent range/distrib. in NS.	N	N	N	N		N	N		N	N	N	N		N		N
Species existing at range edge in N.S.	N	N	N	N		N	N		N	N	N	N				N
Genetically distinct form			N						?	?				N		N
2. Biological characteristics Space-demanding/wide-ranging		N	N							N		N			N	N
Pop. season./daily concentrating	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		N		
Extremely variable in pop. density			N	M						?						
Limited dispersal power	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
Low reproductivity or fecundity			N							N		N		N		N
Large-bodied (largest members of feeding class)			N							?						
Pollution susc/accumulator sp.	Y	Y	Y	Y		Y	Y	Y	?	Y	Y	Y				Y
3. Habitat-related vulnerability Diet/reproductive specialization			N							N		N		N		N
Habitat specialization										Y				N		
Depend. upon prov. rare habitat			N							?						
Climatic sensitivity	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
4. Species of major ecological importance Summit predator			N	N						?		N				N
Sp. occurs at higher trophic level			N	Y						Y					Y	
Major vegetation influencer		N	N	N						N		N				N
Keystone species	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
5. Human-impact factors Legally harvested or killed in N.S.			Y	N						?			N	N		** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N	Y						?			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N	Y						?			N			
No management directed at taxon	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status Limited knowledge of distrib. NS.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown			M	M						Y				N		
No autecological studies in N.S.			Y	Y						?		Y				Y
No (meta-) pop. viability analysis			Y	Y						?		Y				Y

Table 4.4.17: Comparison of matrix responses by species - Wood frog

Respondent No. / Variables (Reptiles and amphibians)	KB	*1	2	4	5	6	7	10	14	^15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)			N							N		N	N			N
Small population in N.S.	N	N	N	N		N	N		N	N	N	N	N	N		N
Population declining in N.S.		N	M							?			N	N		N
Small no. of occurrences in N.S.	N	N	N	N		N	N		N	N	N	N	N			N
Small geog. range/distrib. in N.S.	N	N	N	N		N	N		N	N	N	N	N	N		N
Decline in range/distrib. in N.S.			M							?			N	N		N
Lrg. percent range/distrib. in NS.	N	N	N	N		N	N		N	N	N	N		N		N
Species existing at range edge in N.S.	N	N	N	N		N	N		N	N	N	N				N
Genetically distinct form			N						?	?				N		N
2. Biological characteristics Space-demanding/wide-ranging		N	N							N		N			N	N
Pop. season./daily concentrating	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		N		
Extremely variable in pop. density			N	M						?						
Limited dispersal power			N	Y						?						
Low reproductivity or fecundity			N							N		N		N		N
Large-bodied (largest members of feeding class)			N							?					Y	
Pollution susc/accumulator sp.			Y	Y						Y		Y				Y
3. Habitat-related vulnerability Diet/reproductive specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Habitat specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Depend. upon prov. rare habitat			N							N		N				N
Climatic sensitivity	N	N	N	N		N	N	N	N	N	N	N		N		N
4. Species of major ecological importance Summit predator			N	N						?		N				N
Sp. occurs at higher trophic level			N	Y						Y					Y	
Major vegetation influencer		N	N	N						N		N				N
Keystone species	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
5. Human-impact factors Legally harvested or killed in N.S.			Y	N						?			N	N		** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N	Y						?			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N	Y						N			N			
No management directed at taxon	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status Limited knowledge of distrib. NS.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown			M	M						Y				N		
No autecological studies in N.S.			Y	Y						?		Y				Y
No (meta-) pop. viability analysis			Y	Y						?		Y				Y

Table 4.4.18: Comparison of responses - Yellow-spotted salamander

Respondent No. / Variables (Reptiles and amphibians)	K B	* 1	2	4	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)			N							N		N	N			N
Small population in N.S.			N							N		N	N	N		N
Population declining in N.S.		N	M							?			N	N		N
Small no. of occurrences in N.S.		N	N							?		N	N			N
Small geog. range/distrib. in N.S.		N								?			N	N		N
Decline in range/distrib. in N.S.			N							?			N	N		N
Lrg. percent range/distrib. in NS.	N	N	N	N		N	N		N	N	N	N		N		N
Species existing at range edge in N.S.	N	N	N	N		N	N		N	N	N	N				N
Genetically distinct form			N						?	?				N		N
2. Biological characteristics Space-demanding/wide-ranging		N	N							N		N			N	N
Pop. season./daily concentrating			N	Y						?				N		
Extremely variable in pop. density			N	M						?						
Limited dispersal power			N	Y						?	Y					
Low reproductivity or fecundity			N							N		N		N		N
Large-bodied (largest members of feeding class)			N							?					Y	
Pollution susc/accumulator sp.			Y	Y						Y	Y	Y				Y
3. Habitat-related vulnerability Diet/reproductive specialization			N							N		N		N		N
Habitat specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Depend. upon prov. rare habitat			N							N		N				N
Climatic sensitivity	N	N	N	N		N	N	N	N	N	N	N		N		N
4. Species of major ecological importance Summit predator			N	N						?		N				N
Sp. occurs at higher trophic level			N	Y						Y					Y	
Major vegetation influencer		N	N	N						N		N				N
Keystone species		Y	M	M						?						
5. Human-impact factors Legally harvested or killed in N.S.			Y	N						?			N	N		** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N	Y						?			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N	Y						N			N			
No management directed at taxon	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status Limited knowledge of distrib. NS.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown			M	M						Y				N		
No autecological studies in N.S.			Y	Y						?		Y				Y
No (meta-) pop. viability analysis			Y	Y						?		Y				Y

Table 4.4.19: Comparison of responses - Blue-spotted salamander

Respondent No. / Variables (Reptiles and amphibians)	K B	* 1	2	4	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status																
Nationally rare (COSEWIC)			N							N		N	N			N
Small population in N.S.			N							Y			N	N		N
Population declining in N.S.			M							?			N	N		N
Small no. of occurrences in N.S.	Y	Y	Y	Y		Y	Y		?	Y	Y	Y	Y			Y
Small geog. range/distrib. in N.S.	Y	Y	Y	Y		Y	Y		?	Y	Y	Y	Y	N		
Decline in range/distrib. in N.S.			N							?			N	N		N
Lrg. percent range/distrib. in NS.	N	N	N	N		N	N		N	N	N	N		N		N
Species existing at range edge in N.S.	N	N	N	N		N	N		N	N	N	N				N
Genetically distinct form	Y	Y	Y	Y		Y	Y		?	Y	Y	Y		Y		Y
2. Biological characteristics																
Space-demanding/wide-ranging		N	N							N		N			N	N
Pop. season./daily concentrating			N	Y						?				N		
Extremely variable in pop. density			N	M						?						
Limited dispersal power			N	Y						?	Y					
Low reproductivity or fecundity			N							N		N		N		N
Large-bodied (largest members of feeding class)			N							?					Y	
Pollution susc/accumulator sp.			Y	Y						Y	Y	Y				Y
3. Habitat-related vulnerability																
Diet/reproductive specialization			N							?				N		N
Habitat specialization	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
Depend. upon prov. rare habitat			N							?						
Climatic sensitivity	N	N	N	N		N	N	N	N	N	N	N		N		N
4. Species of major ecological importance																
Summit predator			N	N						?		N				N
Sp. occurs at higher trophic level			N	Y						Y					Y	
Major vegetation influencer		N	N	N						N		N				N
Keystone species			M	M						?						
5. Human-impact factors																
Legally harvested or killed in N.S.			Y	N						?			N	N		** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	Y	?	Y	Y	Y	Y	Y	Y	Y	Y			Y
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	Y	?	Y	Y	Y	Y	Y	Y	Y	Y			Y
No management directed at taxon	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y
6. Information status																
Limited knowledge of distrib. NS.										Y				N		
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown			M	M						Y				N		
No autecological studies in N.S.			Y	Y						?		Y				Y
No (meta-) pop. viability analysis			Y	M						?						

Table 4.4.20: Comparison of responses by species - Red-spotted newt

Respondent No. / Variables (Reptiles and amphibians)	K B	* 1	2	4	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status Nationally rare (COSEWIC)			N							N		N	N			N
Small population in N.S.			N							?			N	N		N
Population declining in N.S.			M							?			N	N		N
Small no. of occurrences in N.S.			N							?			N			N
Small geog. range/distrib. in N.S.										?			N	N		N
Decline in range/distrib. in N.S.			N							?			N	N		N
Lrg. percent range/distrib. in NS.	N	N	N	N		N	N		N	N	N	N		N		N
Species existing at range edge in N.S.	N	N	N	N		N	N		N	N	N	N				N
Genetically distinct form			N						?	?				N		N
2. Biological characteristics Space-demanding/wide-ranging		N	N							N		N			N	N
Pop. season./daily concentrating			N	Y						?				N		
Extremely variable in pop. density			N	M						?						
Limited dispersal power			N	Y						?						
Low reproductivity or fecundity			N							N		N		N		N
Large-bodied (largest members of feeding class)			N							?					N	N
Pollution susc/accumulator sp.			Y	Y						Y		Y				Y
3. Habitat-related vulnerability Diet/reproductive specialization	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
Habitat specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Depend. upon prov. rare habitat			N							?						
Climatic sensitivity	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
4. Species of major ecological importance Summit predator			N	N						?		N				N
Sp. occurs at higher trophic level			N	Y						Y					Y	
Major vegetation influencer		N	N	N						N		N				N
Keystone species		Y	M	M						?						
5. Human-impact factors Legally harvested or killed in N.S.			Y	N						?			N	N		** N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N	Y						?			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	Y	?	Y	Y		Y	Y	Y	Y	Y			Y
No management directed at taxon	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status Limited knowledge of distrib. NS.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown			M	M						Y				N		
No autecological studies in N.S.			Y	Y						?		Y				Y
No (meta-) pop. viability analysis			Y	M						?						

Table: 4.4.21 Comparison of responses - Red-backed salamander

Respondent No. Variables (Reptiles and amphibians)	KB	* 1	2	4	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status																
Nationally rare (COSEWIC)			N							N		N	N			N
Small population in N.S.			N							?			N	N		N
Population declining in N.S.			M							?			N	N		N
Small no. of occurrences in N.S.			N							?			N			N
Small geog. range/distrib. in N.S.										?			N	N		N
Decline in range/distrib. in N.S.			N							?			N	N		N
Lrg. percent range/distrib. in NS.	N	N	N	N		N	N		N	N	N	N		N		N
Species existing at range edge in N.S.	N	N	N	N		N	N		N	N	N					
Genetically distinct form			N						?	?				N		N
2. Biological characteristics																
Space-demanding/wide-ranging		N	N							N		N			N	N
Pop. season./daily concentrating			N	Y						?				N		
Extremely variable in pop. density			N	M						?						
Limited dispersal power			N	Y						?	Y					
Low reproductivity or fecundity			N	Y						N				N		
Large-bodied (largest members of feeding class)			N							?					N	N
Pollution susc/accumulator sp.			Y	Y						Y		Y				Y
3. Habitat-related vulnerability																
Diet/reproductive specialization	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
Habitat specialization	N	N	N	N		N	N	N	N	N	N	N		N		N
Depend. upon prov. rare habitat			N							N		N				N
Climatic sensitivity	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
4. Species of major ecological importance																
Summit predator			N	N						?		N				N
Sp. occurs at higher trophic level			N	Y						Y					Y	
Major vegetation influencer		N	N	N						N		N				N
Keystone species	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y				Y
5. Human-impact factors																**
Legally harvested or killed in N.S.			Y	N						?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N	Y						?			N			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N	Y						N			N			
No management directed at taxon	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
6. Information status																
Limited knowledge of distrib. NS.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown			M	M						Y				N		
No autecological studies in N.S.			Y	Y						?		Y				Y
No (meta-) pop. viability analysis			Y	M						?						

Table 4.4.22: Comparison of responses by species - Four-toed salamander

Respondent No. **Variables** (Reptiles and amphibians)	K B	* 1	2	4	5	6	7	10	14	^ 15	16	Consensus 1	Ref. 1 & 2	Ref. 3	Ref. 5	Consensus 2
1. Rarity/Population status																
Nationally rare (COSEWIC)			N	Y						?			N			N
Small population in N.S.			M	M		Y				?			N	N		
Population declining in N.S.			M							?			N	N		N
Small no. of occurrences in N.S.			M	Y						?			Y			Y
Small geog. range/distrib. in N.S.	Y	Y	Y	Y		Y	Y		Y	Y	Y	Y	Y	N		
Decline in range/distrib. in N.S.			M	M						?			N	N		N
Lrg. percent range/distrib. in NS.	N	N	N	N		N	N		N	N	N	N		N		N
Species existing at range edge in N.S.	N	N	N	N		N	N		N	N	N	N				N
Genetically distinct form	Y	Y	Y	Y		Y	Y		?	Y	Y	Y		Y		Y
2. Biological characteristics																
Space-demanding/wide-ranging		N	N							N		N			N	N
Pop. season./daily concentrating			N	?						?				N		N
Extremely variable in pop. density			N	M						?						
Limited dispersal power			N	Y						?	Y					
Low reproductivity or fecundity			N	Y						N				N		
Large-bodied (largest members of feeding class)			N							?					N	N
Pollution susc/accumulator sp.			Y	Y						Y		Y				Y
3. Habitat-related vulnerability																
Diet/reproductive specialization	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
Habitat specialization	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y		Y		Y
Depend. upon prov. rare habitat			N	Y						?						
Climatic sensitivity	N	N	N	N		N	N	N	N	N	N	N		N		N
4. Species of major ecological importance																
Summit predator			N	N						?		N				N
Sp. occurs at higher trophic level			N	Y						Y					Y	
Major vegetation influencer		N	N	N						N		N				N
Keystone species			M	M						?						
5. Human-impact factors																**
Legally harvested or killed in N.S.			Y	N						?			N	N		N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	Y	?	Y	Y		Y	Y	Y	Y	Y			Y
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	Y	?	Y	Y		Y	Y	Y	Y	Y			Y
No management directed at taxon	Y	Y	Y	Y	N	Y	Y		Y	Y	Y			Y		
6. Information status																
Limited knowledge of distrib. NS.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Pop. trends not monitored in N.S.	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
Factors limiting pop. NS. unknown	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y		Y
No autecological studies in N.S.			Y	Y						?		Y				Y
No (meta-) pop. viability analysis			Y	Y						?		Y				Y

Table 4.5.1: Comparison of matrix responses by species - Sea lamprey

Variables (Freshwater fishes) / **Respondent No.**	KB	7	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)				** N
Small population in N.S.	N	N	N	N
Population declining in N.S.				
Small no. of occurrences in N.S.	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N
Genetically distinct form	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging	Y	Y	Y	Y
Population seasonally/daily concentrating	Y	Y	Y	Y
Limited dispersal power	N	N	N	N
Older age at first reproduction			Y	
Extremely variable in population density			N	
Pollution susceptible/ accumulator species			?	
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	N	N	N	N
Sensitive to high annual variation in river/stream flow			Y	
Dependent upon unimpeded/ unobstructed watercourses			Y	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance Summit predator			M	
Species that occur at higher trophic levels			Y	
Keystone species				
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.2: Comparison of matrix responses - Atlantic sturgeon

Respondent No. **Variables** (Freshwater fishes)	KB	2	7	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)					** N
Small population in N.S.	N		?	N	N
Population declining in N.S.		M	?		
Small no. of occurrences in N.S.	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N
Decline in range/distribution in N.S.		M			
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N	N
Genetically distinct form	N	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging	Y	Y	Y	Y	Y
Population seasonally/daily concentrating	Y	Y	Y	Y	Y
Limited dispersal power	N	N	N	N	N
Older age at first reproduction	Y	Y	Y	Y	Y
Extremely variable in population density		?		N	
Pollution susceptible/accumulator species		?		?	
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization		M		N	
Sensitive to high annual variation in river/stream flow		M		Y	
Dependent upon unimpeded/ unobstructed watercourses		M		Y	
Dependent upon provincially rare habitat		M			
Climatic sensitivity					
4. Species of major ecological importance Summit predator				N	
Species that occur at higher trophic levels				Y	
Keystone species					
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.					
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		M			
No management activities directed at taxon		Y			
6. Information status Limited knowledge of distribution in N.S.		Y	Y		Y
Population trends not regularly monitored in N.S.		Y			
Factors limiting population in N.S. unknown		Y			
No autecological studies in N.S.		Y			
No (meta-) population viability analysis in N.S.		Y			

Table 4.5.3: Comparison of matrix responses by species - American eel

Respondent No. / **Variables** (Freshwater fishes)	KB	2	7	^ 15	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)				N		** N
Small population in N.S.	N	N	N	N	N	N
Population declining in N.S.			Y	?		
Small no. of occurrences in N.S.	N	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N	N
Decline in range/distribution in N.S.				?		
Large percentage of range/distribution in N.S.	N	N	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N	N	N
Genetically distinct form	N	N	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging	Y	Y	Y	Y	Y	Y
Population seasonally/daily concentrating				?	N	
Limited dispersal power	N	N	N	N	N	N
Older age at first reproduction				?	Y	
Extremely variable in population density				?	N	
Pollution susceptible/ accumulator species				?	?	
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	N	N	N	N	N	N
Sensitive to high annual variation in river/stream flow				N	N	N
Dependent upon unimpeded/ unobstructed watercourses				N	M	
Dependent upon provincially rare habitat				N		
Climatic sensitivity				N		
4. Species of major ecological importance Summit predator				N	N	N
Species that occur at higher trophic levels				Y	Y	Y
Keystone species				?		
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			Y	N		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				N		
No management activities directed at taxon				Y		
6. Information status Limited knowledge of distribution in N.S.				Y		
Population trends not regularly monitored in N.S.				Y		
Factors limiting population in N.S. unknown				Y		
No autecological studies in N.S.				?		
No (meta-) population viability analysis in N.S.				?		

Table 4.5.4: Comparison of responses by species - Blueback herring

Respondent No. / **Variables** (Freshwater fishes)	KB	2	7	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)					** N
Small population in N.S.		M			
Population declining in N.S.		M			
Small no. of occurrences in N.S.		M			
Small geographic range/distribution in N.S.		M			
Decline in range/distribution in N.S.		M			
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.	Y	Y	Y	Y	Y
Genetically distinct form	N	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging	Y	Y	Y	Y	Y
Population seasonally/daily concentrating		Y		Y	Y
Limited dispersal power	N	N	N	N	N
Older age at first reproduction	N	N	N	N	N
Extremely variable in population density		M		Y	
Pollution susceptible/ accumulator species		M			
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	N	N	N	N	N
Sensitive to high annual variation in river/stream flow		M		Y	
Dependent upon unimpeded/unobstructed watercourses		M		Y	
Dependent upon provincially rare habitat		M			
Climatic sensitivity					
4. Species of major ecological importance Summit predator				N	
Species that occur at higher trophic levels				N	
Keystone species	Y	Y	Y	Y	Y
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		Y			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		Y			
No management activities directed at taxon		Y			
6. Information status Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y
Population trends not regularly monitored in N.S.		Y			
Factors limiting population in N.S. unknown		Y			
No autecological studies in N.S.		Y			
No (meta-) population viability analysis in N.S.		Y			

Table 4.5.5: Comparison of responses by species - Gaspereau/Alewife

Respondent No. **Variables** (Freshwater fishes)	KB	2	7	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)					** N
Small population in N.S.	N	N	N	N	N
Population declining in N.S.					
Small no. of occurrences in N.S.	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N
Decline in range/distribution in N.S.					
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N	N
Genetically distinct form	N	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging	Y	Y	Y	Y	Y
Population seasonally/daily concentrating					
Limited dispersal power					
Older age at first reproduction					
Extremely variable in population density				Y	
Pollution susceptible/ accumulator species					
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	Y	Y	Y	Y	Y
Sensitive to high annual variation in river/stream flow				Y	
Dependent upon unimpeded/ unobstructed watercourses	Y			Y	Y
Dependent upon provincially rare habitat					
Climatic sensitivity					
4. Species of major ecological importance Summit predator				N	
Species that occur at higher trophic levels				N	
Keystone species	Y	Y	Y	Y	Y
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.					
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.					
No management activities directed at taxon					
6. Information status Limited knowledge of distribution in N.S.					
Population trends not regularly monitored in N.S.					
Factors limiting population in N.S. unknown					
No autecological studies in N.S.					
No (meta-) population viability analysis in N.S.					

Table 4.5.6: Comparison of responses on a species basis - American shad

Respondent No. / **Variables** (Freshwater fishes)	KB	2	7	18	Consensus
1. Rarity/Population status					**
Nationally rare (COSEWIC)					N
Small population in N.S.	N	N	N	N	N
Population declining in N.S.					
Small no. of occurrences in N.S.	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N
Decline in range/distribution in N.S.					
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N	N
Genetically distinct form	N	N	N	N	N
2. Biological characteristics					
Space-demanding/wide-ranging	Y	Y	Y	Y	Y
Population seasonally/daily concentrating		Y		Y	Y
Limited dispersal power	N	N	N	N	N
Older age at first reproduction	N	N	N	N	N
Extremely variable in population density		Y		Y	Y
Pollution susceptible/accumulator species		Y		?	
3. Habitat-related vulnerability					
Habitat / Dietary / Reproductive specialization	N	N	N	N	N
Sensitive to high annual variation in river/stream flow		Y		Y	Y
Dependent upon unimpeded/unobstructed watercourses	Y	Y		Y	Y
Dependent upon provincially rare habitat					
Climatic sensitivity		M			
4. Species of major ecological importance					
Summit predator				N	
Species that occur at higher trophic levels				N	
Keystone species	Y	Y	Y	Y	Y
5. Human-impact factors					
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		Y			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		Y			
No management activities directed at taxon		Y			
6. Information status					
Limited knowledge of distribution in N.S.		N			
Population trends not regularly monitored in N.S.		N			
Factors limiting population in N.S. unknown		Y			
No autecological studies in N.S.		Y			
No (meta-) population viability analysis in N.S.		Y			

Table 4.5.7: Comparison of responses by species - Atlantic whitefish

Variables (Freshwater fishes) — **Respondent No.**	KB	2	7	18	Consensus
1. Rarity/Population status					
Nationally rare (COSEWIC)	Y	Y	Y	Y	Y
Small population in N.S.	Y	Y	Y	Y	Y
Population declining in N.S.	Y	Y	Y	Y	Y
Small no. of occurrences in N.S.	Y	Y	Y	Y	Y
Small geographic range/distribution in N.S.	Y	Y	Y	Y	Y
Decline in range/distribution in N.S.					
Large percentage of range/distribution in N.S.	Y	Y	Y	Y	Y
Species existing at range edge in N.S.	Y	Y	Y	Y	Y
Genetically distinct form	Y	Y	Y	Y	Y
2. Biological characteristics					
Space-demanding/wide-ranging	Y	Y	Y	Y	Y
Population seasonally/daily concentrating	Y	Y	Y	Y	Y
Limited dispersal power				Y	
Older age at first reproduction				Y	
Extremely variable in population density				N	
Pollution susceptible/accumulator species				?	
3. Habitat-related vulnerability					
Habitat / Dietary / Reproductive specialization				N	
Sensitive to high annual variation in river/stream flow				N	
Dependent upon unimpeded/unobstructed watercourses				N	
Dependent upon provincially rare habitat			?	?	
Climatic sensitivity			?		
4. Species of major ecological importance					
Summit predator				Y	
Species that occur at higher trophic levels				Y	
Keystone species					
5. Human-impact factors					**
Legally harvested or killed in N.S.					N
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	Y	Y
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	Y	Y
No management activities directed at taxon			Y		
6. Information status					
Limited knowledge of distribution in N.S.			Y		
Population trends not regularly monitored in N.S.			N		
Factors limiting population in N.S. unknown					
No autecological studies in N.S.					
No (meta-) population viability analysis in N.S.					

Table 4.5.8: Comparison of matrix responses by species - Lake whitefish

Variables (Freshwater fishes) — **Respondent No.**	KB	2	7	18	Consensus
1. Rarity/Population status					
Nationally rare (COSEWIC)					** N
Small population in N.S.	Y	Y	Y	Y	Y
Population declining in N.S.			?		
Small no. of occurrences in N.S.	Y	Y	Y	Y	Y
Small geographic range/distribution in N.S.	Y	Y	Y	Y	Y
Decline in range/distribution in N.S.					
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.					
Genetically distinct form	N	N	N	N	N
2. Biological characteristics					
Space-demanding/wide-ranging				Y	
Population seasonally/daily concentrating				N	
Limited dispersal power	Y	Y	Y	Y	Y
Older age at first reproduction				Y	
Extremely variable in population density				N	
Pollution susceptible/accumulator species				?	
3. Habitat-related vulnerability					
Habitat / Dietary / Reproductive specialization	N	N	N	N	N
Sensitive to high annual variation in river/stream flow				N	
Dependent upon unimpeded/unobstructed watercourses				N	
Dependent upon provincially rare habitat					
Climatic sensitivity					
4. Species of major ecological importance					
Summit predator				Y	
Species that occur at higher trophic levels				Y	
Keystone species					
5. Human-impact factors					
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	Y	Y
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	Y	Y
No management activities directed at taxon					
6. Information status					
Limited knowledge of distribution in N.S.					
Population trends not regularly monitored in N.S.					
Factors limiting population in N.S. unknown					
No autecological studies in N.S.					
No (meta-) population viability analysis in N.S.					

Table 4.5.9: Comparison of responses by species - Atlantic salmon

Respondent No. / **Variables** (Freshwater fishes)	K B	* 1	2	6	7	8	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)								** N
Small population in N.S.								
Population declining in N.S.		?	M	Y		Y		Y
Small no. of occurrences in N.S.								
Small geographic range/distribution in N.S.								
Decline in range/distribution in N.S.	Y	Y	Y	Y	Y	Y	Y	Y
Large percentage of range/distribution in N.S.	N	N	N	N	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N	N	N	N	N
Genetically distinct form	N	N	N	N	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging	Y	Y	Y	Y	Y	Y	Y	Y
Population seasonally/daily concentrating	Y	Y	Y	Y	Y	Y	Y	Y
Limited dispersal power	N	N	N	N	N	N	N	N
Older age at first reproduction		Y					Y	Y
Extremely variable in population density		Y	Y				N	
Pollution susceptible/accumulator species	Y	Y	Y	Y	Y	Y	Y	Y
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	Y	Y	Y	Y	Y	Y	Y	Y
Sensitive to high annual variation in river/stream flow		Y	Y			Y	Y	Y
Dependent upon unimpeded/unobstructed watercourses		Y	Y			Y	Y	Y
Dependent upon provincially rare habitat								
Climatic sensitivity			M				Y	
4. Species of major ecological importance Summit predator							N	
Species that occur at higher trophic levels						Y	Y	Y
Keystone species	Y	Y	Y	Y	Y	Y	Y	Y
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	Y	Y	Y	Y	Y
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.	Y	Y	Y	Y	Y	Y	Y	Y
No management activities directed at taxon		N	N				N	N
6. Information status Limited knowledge of distribution in N.S.			N				N	N
Population trends not regularly monitored in N.S.			N					
Factors limiting population in N.S. unknown			N				N	N
No autecological studies in N.S.			N					
No (meta-) population viability analysis in N.S.			Y					

Table 4.5.10: Comparison of matrix responses by species - Brook trout

Variables (Freshwater fishes) / **Respondent No.**	KB	* 1	2	7	8	^ 15	18	Consensus
1. Rarity/Population status								**
Nationally rare (COSEWIC)						N		N
Small population in N.S.					N	N		N
Population declining in N.S.						?		
Small no. of occurrences in N.S.	N	N	N	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N	N	N	N
Decline in range/distribution in N.S.					N	?		
Large percentage of range/distribution in N.S.	N	N	N	N	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N	N	N	N	N
Genetically distinct form	N	N	N	N	N	N	N	N
2. Biological characteristics								
Space-demanding/wide-ranging	Y	Y	Y	Y	Y	Y	Y	Y
Population seasonally/daily concentrating	Y	Y	Y	Y	Y	Y	Y	Y
Limited dispersal power	N	N	N	N	N	N	N	N
Older age at first reproduction						?	N	
Extremely variable in population density						?	N	
Pollution susceptible/ accumulator species					Y	Y		Y
3. Habitat-related vulnerability								
Habitat / Dietary / Reproductive specialization	Y	Y	Y	Y	Y	Y	Y	Y
Sensitive to high annual variation in river/stream flow			Y			Y	Y	Y
Dependent upon unimpeded/unobstructed watercourses			Y		N	?	Y	
Dependent upon provincially rare habitat					N	?		
Climatic sensitivity			Y		N	?	Y	
4. Species of major ecological importance								
Summit predator						Y	M	
Species that occur at higher trophic levels	Y	Y	Y	Y	Y	Y	Y	Y
Keystone species						?		
5. Human-impact factors								
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.	Y	Y	Y	Y	Y	Y	Y	Y
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		Y	Y			?		Y
No management activities directed at taxon			N		N	N		N
6. Information status								
Limited knowledge of distribution in N.S.			N		N	N		N
Population trends not regularly monitored in N.S.			N		N	N		N
Factors limiting population in N.S. unknown			N			N		N
No autecological studies in N.S.			N			N		N
No (meta-) population viability analysis in N.S.			N			N		N

Table 4.5.11: Comparison of matrix responses by species - Lake trout

Variables (Freshwater fishes) / **Respondent No.**	KB	2	7	18	Consensus
1. Rarity/Population status					**
Nationally rare (COSEWIC)			N		N
Small population in N.S.		Y	Y		Y
Population declining in N.S.		M	?		
Small no. of occurrences in N.S.		Y	Y		Y
Small geographic range/distribution in N.S.		Y			
Decline in range/distribution in N.S.		M			
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.		M			
Genetically distinct form	N	N	N	N	N
2. Biological characteristics					
Space-demanding/wide-ranging		M		Y	
Population seasonally/daily concentrating	Y	Y	Y	Y	Y
Limited dispersal power		M		Y	
Older age at first reproduction	Y	Y	Y	Y	Y
Extremely variable in population density		M		N	
Pollution susceptible/accumulator species		M			
3. Habitat-related vulnerability					
Habitat / Dietary / Reproductive specialization	Y	Y	Y	Y	Y
Sensitive to high annual variation in river/stream flow		Y		N	
Dependent upon unimpeded/unobstructed watercourses		Y		N	
Dependent upon provincially rare habitat		M			
Climatic sensitivity		M			
4. Species of major ecological importance					
Summit predator				Y	
Species that occur at higher trophic levels	Y	Y	Y	Y	Y
Keystone species					
5. Human-impact factors					
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.		M			
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.		M			
No management activities directed at taxon		M	Y		
6. Information status					
Limited knowledge of distribution in N.S.	Y	Y	Y	Y	Y
Population trends not regularly monitored in N.S.		M			
Factors limiting population in N.S. unknown		M			
No autecological studies in N.S.		M			
No (meta-) population viability analysis in N.S.		M			

Table 4.5.12: Comparison of responses by species - Rainbow smelt

Variables (Freshwater fishes) — Respondent No.	KB	7	8	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)					** N
Small population in N.S.	N	N	N	N	N
Population declining in N.S.			N		
Small no. of occurrences in N.S.			N		
Small geographic range/distribution in N.S.			N		
Decline in range/distribution in N.S.			N		
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N	N
Genetically distinct form	N	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging	Y	Y	Y	Y	Y
Population seasonally/daily concentrating	Y	Y	Y	Y	Y
Limited dispersal power	N	N	N	N	N
Older age at first reproduction	N	N	N	N	N
Extremely variable in population density				Y	
Pollution susceptible/accumulator species			Y	?	
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	Y	Y	Y	Y	Y
Sensitive to high annual variation in river/stream flow				Y	
Dependent upon unimpeded/ unobstructed watercourses			Y	Y	Y
Dependent upon provincially rare habitat			N		
Climatic sensitivity				Y	
4. Species of major ecological importance Summit predator			N	N	N
Species that occur at higher trophic levels	Y	Y	Y	Y	Y
Keystone species					
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.					
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.					
No management activities directed at taxon					
6. Information status Limited knowledge of distribution in N.S.			N		
Population trends not regularly monitored in N.S.			N		
Factors limiting population in N.S. unknown					
No autecological studies in N.S.					
No (meta-) population viability analysis in N.S.					

Table 4.5.13: Comparison of responses by species - Northern redbelly dace

Respondent No. / Variables (Freshwater fishes)	KB	7	18	Consensus
1. Rarity/Population status				**
Nationally rare (COSEWIC)				N
Small population in N.S.	N	N	N	N
Population declining in N.S.				
Small no. of occurrences in N.S.	N	N	N	N
Small geographic range/distribution in N.S.				
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N
Genetically distinct form	N	N	N	N
2. Biological characteristics				
Space-demanding/wide -ranging	N	N	N	N
Population seasonally/daily concentrating	N	N	N	N
Limited dispersal power	Y	Y	Y	Y
Older age at first reproduction	N	N	N	N
Extremely variable in population density			?	
Pollution susceptible/ accumulator species			?	
3. Habitat-related vulnerability				
Habitat / Dietary / Reproductive specialization	Y	Y	Y	Y
Sensitive to high annual variation in river/stream flow			Y	
Dependent upon unimpeded/ unobstructed watercourses			N	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance				
Summit predator			N	
Species that occur at higher trophic levels			N	
Keystone species	Y	Y	Y	Y
5. Human-impact factors				
Legally harvested or killed in N.S.	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status				
Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.14: Comparison of matrix responses by species - Lake chub

Respondent No. **Variables** (Freshwater fishes)	KB	7	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)				** N
Small population in N.S.				
Population declining in N.S.				
Small no. of occurrences in N.S.				
Small geographic range/distribution in N.S.				
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N
Genetically distinct form	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging			Y	
Population seasonally/daily concentrating	Y	Y	Y	Y
Limited dispersal power	Y	Y	Y	Y
Older age at first reproduction	N	N	N	N
Extremely variable in population density			?	
Pollution susceptible/ accumulator species				
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	N	N	N	N
Sensitive to high annual variation in river/stream flow			N	
Dependent upon unimpeded/ unobstructed watercourses			N	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance Summit predator			N	
Species that occur at higher trophic levels			N	
Keystone species	Y	Y	Y	Y
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.15: Comparison of matrix responses by species - Golden shiner

Respondent No. Variables (Freshwater fishes)	KB	7	^ 15	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)			N		** N
Small population in N.S.	N	N	N	N	N
Population declining in N.S.			?		
Small no. of occurrences in N.S.	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N
Decline in range/distribution in N.S.			?		
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.			N		
Genetically distinct form	N	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging			?	Y	
Population seasonally/daily concentrating			?	Y	
Limited dispersal power	Y	Y	Y	Y	Y
Older age at first reproduction	N	N	N	N	N
Extremely variable in population density			?	?	
Pollution susceptible/ accumulator species			?	?	
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	N	N	N	N	N
Sensitive to high annual variation in river/stream flow			?	N	
Dependent upon unimpeded/ unobstructed watercourses			?	N	
Dependent upon provincially rare habitat			N		
Climatic sensitivity			N		
4. Species of major ecological importance Summit predator			?	N	
Species that occur at higher trophic levels			Y	N	
Keystone species	Y	Y	Y	Y	Y
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			?		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			?		
No management activities directed at taxon			Y		
6. Information status Limited knowledge of distribution in N.S.			Y		
Population trends not regularly monitored in N.S.			Y		
Factors limiting population in N.S. unknown			Y		
No autecological studies in N.S.			?		
No (meta-) population viability analysis in N.S.			?		

Table 4.5.16: Comparison of responses by species - Common shiner

Variables (Freshwater fishes) / Respondent No.	KB	7	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)				** N
Small population in N.S.				
Population declining in N.S.				
Small no. of occurrences in N.S.				
Small geographic range/distribution in N.S.				
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.				
Genetically distinct form	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging	N	N	N	N
Population seasonally/daily concentrating	N	N	N	N
Limited dispersal power	Y	Y	Y	Y
Older age at first reproduction	N	N	N	N
Extremely variable in population density			?	
Pollution susceptible/ accumulator species			?	
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization			N	
Sensitive to high annual variation in river/stream flow			N	
Dependent upon unimpeded/ unobstructed watercourses			N	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance Summit predator			N	
Species that occur at higher trophic levels			N	
Keystone species	Y	Y	Y	Y
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.17: Comparison of responses by species - Blacknose shiner

Respondent No. / Variables (Freshwater fishes)	KB	7	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)				** N
Small population in N.S.	N	N	N	N
Population declining in N.S.				
Small no. of occurrences in N.S.	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.	Y	Y	Y	Y
Genetically distinct form	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging	N	N	N	N
Population seasonally/daily concentrating	N	N	N	N
Limited dispersal power	Y	Y	Y	Y
Older age at first reproduction	N	N	N	N
Extremely variable in population density			?	
Pollution susceptible/ accumulator species			?	
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	Y	Y	Y	Y
Sensitive to high annual variation in river/stream flow			N	
Dependent upon unimpeded/ unobstructed watercourses			N	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance Summit predator			N	
Species that occur at higher trophic levels			N	
Keystone species	Y	Y	Y	Y
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.18: Comparison of responses by species - Blacknose dace

Variables (Freshwater fishes) / Respondent No.	KB	7	18	Consensus
1. Rarity/Population status				
Nationally rare (COSEWIC)				** N
Small population in N.S.				
Population declining in N.S.				
Small no. of occurrences in N.S.	Y	Y	Y	Y
Small geographic range/distribution in N.S.	Y	Y	Y	Y
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N
Genetically distinct form	N	N	N	N
2. Biological characteristics				
Space-demanding/wide-ranging	N	N	N	N
Population seasonally/daily concentrating			N	
Limited dispersal power	Y	Y	Y	Y
Older age at first reproduction	N	N	N	N
Extremely variable in population density			?	
Pollution susceptible/ accumulator species			?	
3. Habitat-related vulnerability				
Habitat / Dietary / Reproductive specialization	Y	Y	Y	Y
Sensitive to high annual variation in river/stream flow			Y	
Dependent upon unimpeded/ unobstructed watercourses			N	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance				
Summit predator			N	
Species that occur at higher trophic levels			N	
Keystone species	Y	Y	Y	Y
5. Human-impact factors				
Legally harvested or killed in N.S.				** Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status				
Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.19: Comparison of matrix responses by species - Creek chub

Respondent No. Variables (Freshwater fishes)	K B	7	^ 15	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)			N		** N
Small population in N.S.	N	N	N	N	N
Population declining in N.S.			?		
Small no. of occurrences in N.S.	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N
Decline in range/distribution in N.S.			?		
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N	N
Genetically distinct form	N	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging	N	N	N	N	N
Population seasonally/daily concentrating	N	N	N	N	N
Limited dispersal power	Y	Y	Y	Y	Y
Older age at first reproduction	N	N	N	N	N
Extremely variable in population density			?	?	
Pollution susceptible/ accumulator species			?	?	
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization			?	?	
Sensitive to high annual variation in river/stream flow			?	Y	
Dependent upon unimpeded/ unobstructed watercourses			?	N	
Dependent upon provincially rare habitat			?		
Climatic sensitivity			?		
4. Species of major ecological importance Summit predator			?	N	
Species that occur at higher trophic levels			Y	N	
Keystone species			?		
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			?		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			?		
No management activities directed at taxon			Y		
6. Information status Limited knowledge of distribution in N.S.			Y		
Population trends not regularly monitored in N.S.			Y		
Factors limiting population in N.S. unknown			Y		
No autecological studies in N.S.			?		
No (meta-) population viability analysis in N.S.			?		

Table 4.5.20: Comparison of matrix responses by species - Fallfish

Variables (Freshwater fishes) / Respondent No.	KB	*1	2	Consensus
1. Rarity/Population status				**
Nationally rare (COSEWIC)				N
Small population in N.S.	Y	Y	Y	Y
Population declining in N.S.				
Small no. of occurrences in N.S.	Y	Y	Y	Y
Small geographic range/distribution in N.S.	Y	Y	Y	Y
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.				
Genetically distinct form	N	N	N	N
2. Biological characteristics				
Space-demanding/wide-ranging	N	N	N	N
Population seasonally/daily concentrating			N	
Limited dispersal power	Y	Y	Y	Y
Older age at first reproduction	N	N	N	N
Extremely variable in population density			?	
Pollution susceptible/ accumulator species			?	
3. Habitat-related vulnerability				
Habitat / Dietary / Reproductive specialization			?	
Sensitive to high annual variation in river/stream flow			Y	
Dependent upon unimpeded/ unobstructed watercourses			N	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance				
Summit predator			N	
Species that occur at higher trophic levels			N	
Keystone species				
5. Human-impact factors				**
Legally harvested or killed in N.S.				Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status				
Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.21: Comparison of matrix responses by species - Pearl dace

Variables (Freshwater fishes) / Respondent No.	KB	7	18	Consensus
1. Rarity/Population status				**
Nationally rare (COSEWIC)				N
Small population in N.S.				
Population declining in N.S.				
Small no. of occurrences in N.S.				
Small geographic range/distribution in N.S.	Y	Y	Y	Y
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N
Genetically distinct form	N	N	N	N
2. Biological characteristics				
Space-demanding/wide-ranging	N	N	N	N
Population seasonally/daily concentrating	N	N	N	N
Limited dispersal power	Y	Y	Y	Y
Older age at first reproduction	N	N	N	N
Extremely variable in population density			?	
Pollution susceptible/ accumulator species			?	
3. Habitat-related vulnerability				
Habitat / Dietary / Reproductive specialization	Y	Y	Y	Y
Sensitive to high annual variation in river/stream flow			Y	
Dependent upon unimpeded/ unobstructed watercourses			N	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance				
Summit predator			N	
Species that occur at higher trophic levels			N	
Keystone species	Y	Y	Y	Y
5. Human-impact factors				**
Legally harvested or killed in N.S.				Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status				
Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.22: Comparison of matrix responses by species - White sucker

Respondent No. Variables (Freshwater fishes)	KB	7	^ 15	18	Consensus
1. Rarity/Population status					**
Nationally rare (COSEWIC)			N		N
Small population in N.S.	N	N	N	N	N
Population declining in N.S.			?		
Small no. of occurrences in N.S.	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N
Decline in range/distribution in N.S.			?		
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N	N
Genetically distinct form	N	N	N	N	N
2. Biological characteristics					
Space-demanding/wide-ranging			?	N	
Population seasonally/daily concentrating			?	Y	
Limited dispersal power	Y	Y	Y	Y	Y
Older age at first reproduction			?	N	
Extremely variable in population density			?	?	
Pollution susceptible/ accumulator species			N	?	
3. Habitat-related vulnerability					
Habitat / Dietary / Reproductive specialization	N	N	N	N	N
Sensitive to high annual variation in river/stream flow			?	Y	
Dependent upon unimpeded/ unobstructed watercourses			?	M	
Dependent upon provincially rare habitat			N		
Climatic sensitivity			N		
4. Species of major ecological importance					
Summit predator			N	N	N
Species that occur at higher trophic levels			Y	N	
Keystone species			Y		
5. Human-impact factors					
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			?		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N		
No management activities directed at taxon			Y		
6. Information status					
Limited knowledge of distribution in N.S.			Y		
Population trends not regularly monitored in N.S.			Y		
Factors limiting population in N.S. unknown			Y		
No autecological studies in N.S.			?		
No (meta-) population viability analysis in N.S.			?		

Table 4.5.23: Comparison of responses by species - Brown bullhead

Variables (Freshwater fishes) / **Respondent No.**	K B	7	^ 15	18	Consensus
1. Rarity/Population status					
Nationally rare (COSEWIC)			N		** N
Small population in N.S.	N	N	N	N	N
Population declining in N.S.			?		
Small no. of occurrences in N.S.	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N
Decline in range/distribution in N.S.			?		
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.			N		
Genetically distinct form	N	N	N	N	N
2. Biological characteristics					
Space-demanding/wide-ranging	N	N	N	N	N
Population seasonally/daily concentrating	N	N	N	N	N
Limited dispersal power	Y	Y	Y	Y	Y
Older age at first reproduction	N	N	N	N	N
Extremely variable in population density			?	N	
Pollution susceptible/ accumulator species	N	N	N	N	N
3. Habitat-related vulnerability					
Habitat / Dietary / Reproductive specialization	N	N	N	N	N
Sensitive to high annual variation in river/stream flow			?	N	
Dependent upon unimpeded/ unobstructed watercourses			?	N	
Dependent upon provincially rare habitat			N		
Climatic sensitivity			N		
4. Species of major ecological importance					
Summit predator			N	N	
Species that occur at higher trophic levels			Y	N	
Keystone species			?		
5. Human-impact factors					
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			?		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N		
No management activities directed at taxon			Y		
6. Information status					
Limited knowledge of distribution in N.S.			Y		
Population trends not regularly monitored in N.S.			Y		
Factors limiting population in N.S. unknown			Y		
No autecological studies in N.S.			?		
No (meta-) population viability analysis in N.S.			?		

Table 4.5.24: Comparison of responses by species - Atlantic tomcod

Variables (Freshwater fishes) / Respondent No.	KB	*1	2	Consensus
1. Rarity/Population status				**
Nationally rare (COSEWIC)				N
Small population in N.S.	N	N	N	N
Population declining in N.S.				
Small no. of occurrences in N.S.	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N
Genetically distinct form	N	N	N	N
2. Biological characteristics				
Space-demanding/wide-ranging			N	
Population seasonally/daily concentrating			N	
Limited dispersal power	N	N	N	N
Older age at first reproduction			M	
Extremely variable in population density			?	
Pollution susceptible/ accumulator species	Y	Y	Y	Y
3. Habitat-related vulnerability				
Habitat / Dietary / Reproductive specialization	N	N	N	N
Sensitive to high annual variation in river/stream flow			?	
Dependent upon unimpeded/ unobstructed watercourses			?	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance				
Summit predator			N	
Species that occur at higher trophic levels			M	
Keystone species				
5. Human-impact factors				
Legally harvested or killed in N.S.	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status				
Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.25: Comparison of responses by species - Banded killifish

Variables (Freshwater fishes) / Respondent No.	KB	7	^ 15	18	Consensus
1. Rarity/Population status					**
Nationally rare (COSEWIC)			N		N
Small population in N.S.	N	N	N	N	N
Population declining in N.S.			?		
Small no. of occurrences in N.S.	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N
Decline in range/distribution in N.S.			?		
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N	N
Genetically distinct form	N	N	N	N	N
2. Biological characteristics					
Space-demanding/wide-ranging	N	N	N	N	N
Population seasonally/daily concentrating	N	N	N	N	N
Limited dispersal power	Y	Y	Y	Y	Y
Older age at first reproduction			?	N	
Extremely variable in population density			?	N	
Pollution susceptible/ accumulator species			?	?	
3. Habitat-related vulnerability					
Habitat / Dietary / Reproductive specialization	N	N	N	N	N
Sensitive to high annual variation in river/stream flow			?	M	
Dependent upon unimpeded/ unobstructed watercourses			?	N	
Dependent upon provincially rare habitat			N		
Climatic sensitivity			?		
4. Species of major ecological importance					
Summit predator			N	N	
Species that occur at higher trophic levels			Y	N	
Keystone species	Y	Y	Y	Y	Y
5. Human-impact factors					
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			?		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N		
No management activities directed at taxon			Y		
6. Information status					
Limited knowledge of distribution in N.S.			Y		
Population trends not regularly monitored in N.S.			Y		
Factors limiting population in N.S. unknown			Y		
No autecological studies in N.S.			?		
No (meta-) population viability analysis in N.S.			?		

Table 4.5.26: Comparison of matrix responses by species - Mummichog

Variables (Freshwater fishes) — Respondent No.	KB	7	18	Consensus
1. Rarity/Population status				**
Nationally rare (COSEWIC)				N
Small population in N.S.	N	N	N	N
Population declining in N.S.				
Small no. of occurrences in N.S.	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N
Genetically distinct form	N	N	N	N
2. Biological characteristics				
Space-demanding/wide-ranging	N	N	N	N
Population seasonally/daily concentrating			Y	
Limited dispersal power	N	N	N	N
Older age at first reproduction			N	
Extremely variable in population density			N	
Pollution susceptible/ accumulator species			?	
3. Habitat-related vulnerability				
Habitat / Dietary / Reproductive specialization	N	N	N	N
Sensitive to high annual variation in river/stream flow			M	
Dependent upon unimpeded/ unobstructed watercourses			N	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance				
Summit predator			N	
Species that occur at higher trophic levels			N	
Keystone species	Y	Y	Y	Y
5. Human-impact factors				
Legally harvested or killed in N.S.	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status				
Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.27: Comparison of responses by species - Fourspine stickleback

Variables (Freshwater fishes) — Respondent No.	KB	7	18	Consensus
1. Rarity/Population status				**
Nationally rare (COSEWIC)				N
Small population in N.S.	N	N	N	N
Population declining in N.S.				
Small no. of occurrences in N.S.	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.				
Species existing at range edge in N.S.	N	N	N	N
Genetically distinct form	N	N	N	N
2. Biological characteristics				
Space-demanding/wide-ranging			N	
Population seasonally/daily concentrating			N	
Limited dispersal power	N	N	N	N
Older age at first reproduction	N	N	N	N
Extremely variable in population density			N	
Pollution susceptible/ accumulator species			?	
3. Habitat-related vulnerability				
Habitat / Dietary / Reproductive specialization	N	N	N	N
Sensitive to high annual variation in river/stream flow			N	
Dependent upon unimpeded/ unobstructed watercourses			N	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance				
Summit predator			N	
Species that occur at higher trophic levels			N	
Keystone species				
5. Human-impact factors				**
Legally harvested or killed in N.S.				Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status				
Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.28: Comparison of responses by species - Brook stickleback

Variables (Freshwater fishes) / Respondent No.	KB	7	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)				** N
Small population in N.S.	Y	Y	Y	Y
Population declining in N.S.				
Small no. of occurrences in N.S.	Y	Y	Y	Y
Small geographic range/distribution in N.S.	Y	Y	Y	Y
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.				
Genetically distinct form	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging			N	
Population seasonally/daily concentrating			N	
Limited dispersal power	Y	Y	Y	Y
Older age at first reproduction	N	N	N	N
Extremely variable in population density			N	
Pollution susceptible/ accumulator species				
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	Y	Y	Y	Y
Sensitive to high annual variation in river/stream flow			?	
Dependent upon unimpeded/ unobstructed watercourses			N	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance Summit predator			N	
Species that occur at higher trophic levels			N	
Keystone species				
5. Human-impact factors Legally harvested or killed in N.S.				** Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.29: Comparison of responses - Threespine stickleback

Respondent No. Variables (Freshwater fishes)	KB	*1	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)				** N
Small population in N.S.	N	N	N	N
Population declining in N.S.				
Small no. of occurrences in N.S.	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N
Genetically distinct form	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging			N	
Population seasonally/daily concentrating			N	
Limited dispersal power	N	N	N	N
Older age at first reproduction	N	N	N	N
Extremely variable in population density			N	
Pollution susceptible/ accumulator species			?	
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	N	N	N	N
Sensitive to high annual variation in river/stream flow			Y	
Dependent upon unimpeded/ unobstructed watercourses			N	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance Summit predator			N	
Species that occur at higher trophic levels			N	
Keystone species	Y	Y	Y	Y
5. Human-impact factors Legally harvested or killed in N.S.				** Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.30: Comparison of responses by species - Ninespine stickleback

Respondent No. **Variables** (Freshwater fishes)	**KB**	**7**	**^ 15**	**18**	**Consensus**
1. Rarity/Population status Nationally rare (COSEWIC)			N		** N
Small population in N.S.	N	N	N	N	N
Population declining in N.S.			?		
Small no. of occurrences in N.S.	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N
Decline in range/distribution in N.S.			?		
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N	N
Genetically distinct form	N	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging			?	N	
Population seasonally/daily concentrating			?	N	
Limited dispersal power	N	N	N	N	N
Older age at first reproduction	N	N	N	N	N
Extremely variable in population density			?	N	
Pollution susceptible/ accumulator species			?	?	
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	N	N	N	N	N
Sensitive to high annual variation in river/stream flow			?	?	
Dependent upon unimpeded/ unobstructed watercourses			?	N	
Dependent upon provincially rare habitat			?		
Climatic sensitivity			?		
4. Species of major ecological importance Summit predator			N	N	N
Species that occur at higher trophic levels			Y	N	
Keystone species	Y	Y	Y	Y	Y
5. Human-impact factors Legally harvested or killed in N.S.			?		** Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			?		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			?		
No management activities directed at taxon			Y		
6. Information status Limited knowledge of distribution in N.S.			Y		
Population trends not regularly monitored in N.S.			Y		
Factors limiting population in N.S. unknown			Y		
No autecological studies in N.S.			?		
No (meta-) population viability analysis in N.S.			?		

Table: 4.5.31 Comparison of matrix responses by species - White perch

Respondent No. **Variables** (Freshwater fishes)	K B	7	^ 15	18	Consensus
1. Rarity/Population status Nationally rare (COSEWIC)			N		** N
Small population in N.S.	N	N	N	N	N
Population declining in N.S.			N		
Small no. of occurrences in N.S.	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N
Decline in range/distribution in N.S.			?		
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.			N		
Genetically distinct form	N	N	N	N	N
2. Biological characteristics Space-demanding/wide-ranging			?	N	
Population seasonally/daily concentrating	Y	Y	Y	Y	Y
Limited dispersal power	N	N	N	N	N
Older age at first reproduction	N	N	N	N	N
Extremely variable in population density			?	Y	
Pollution susceptible/ accumulator species			Y	?	
3. Habitat-related vulnerability Habitat / Dietary / Reproductive specialization	N	N	N	N	N
Sensitive to high annual variation in river/stream flow			?	Y	
Dependent upon unimpeded/ unobstructed watercourses			?	Y	
Dependent upon provincially rare habitat			N		
Climatic sensitivity			N		
4. Species of major ecological importance Summit predator			N	M	
Species that occur at higher trophic levels			Y	Y	Y
Keystone species			?		
5. Human-impact factors Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N		
No management activities directed at taxon			N		
6. Information status Limited knowledge of distribution in N.S.			N		
Population trends not regularly monitored in N.S.			N		
Factors limiting population in N.S. unknown			N		
No autecological studies in N.S.			N		
No (meta-) population viability analysis in N.S.			N		

Table 4.5.32: Comparison of matrix responses by species - Striped bass

Variables (Freshwater fishes) / Respondent No.	KB	7	18	Consensus
1. Rarity/Population status				**
Nationally rare (COSEWIC)				N
Small population in N.S.	N	N	N	N
Population declining in N.S.				
Small no. of occurrences in N.S.	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N
Decline in range/distribution in N.S.				
Large percentage of range/distribution in N.S.	N	N	N	N
Species existing at range edge in N.S.	N	N	N	N
Genetically distinct form	N	N	N	N
2. Biological characteristics				
Space-demanding/wide-ranging	Y	Y	Y	Y
Population seasonally/daily concentrating	Y	Y	Y	Y
Limited dispersal power	N	N	N	N
Older age at first reproduction			N	
Extremely variable in population density			Y	
Pollution susceptible/ accumulator species			?	
3. Habitat-related vulnerability				
Habitat / Dietary / Reproductive specialization	N	N	N	N
Sensitive to high annual variation in river/stream flow			Y	
Dependent upon unimpeded/ unobstructed watercourses			Y	
Dependent upon provincially rare habitat				
Climatic sensitivity				
4. Species of major ecological importance				
Summit predator			M	
Species that occur at higher trophic levels	Y	Y	Y	Y
Keystone species				
5. Human-impact factors				
Legally harvested or killed in N.S.	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.				
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.				
No management activities directed at taxon				
6. Information status				
Limited knowledge of distribution in N.S.				
Population trends not regularly monitored in N.S.				
Factors limiting population in N.S. unknown				
No autecological studies in N.S.				
No (meta-) population viability analysis in N.S.				

Table 4.5.33: Comparison of matrix responses by species - Yellow perch

Variables (Freshwater fishes) — Respondent No.	KB	7	^ 15	18	Consensus
1. Rarity/Population status					**
Nationally rare (COSEWIC)			N		N
Small population in N.S.	N	N	N	N	N
Population declining in N.S.			N		
Small no. of occurrences in N.S.	N	N	N	N	N
Small geographic range/distribution in N.S.	N	N	N	N	N
Decline in range/distribution in N.S.			?		
Large percentage of range/distribution in N.S.	N	N	N	N	N
Species existing at range edge in N.S.			N		
Genetically distinct form	N	N	N	N	N
2. Biological characteristics					
Space-demanding/wide-ranging			?	Y	
Population seasonally/daily concentrating	Y	Y	Y	Y	Y
Limited dispersal power	Y	Y	Y	Y	Y
Older age at first reproduction	N	N	N	N	N
Extremely variable in population density			?	N	
Pollution susceptible/ accumulator species			?	?	
3. Habitat-related vulnerability					
Habitat / Dietary / Reproductive specialization	N	N	N	N	N
Sensitive to high annual variation in river/stream flow			?	N	
Dependent upon unimpeded/ unobstructed watercourses			?	N	
Dependent upon provincially rare habitat			N		
Climatic sensitivity			N		
4. Species of major ecological importance					
Summit predator			N	M	
Species that occur at higher trophic levels			Y	Y	
Keystone species	Y	Y	Y	Y	Y
5. Human-impact factors					
Legally harvested or killed in N.S.	Y	Y	Y	Y	Y
Population threatened by direct exploitation, harassment or ecological interactions in N.S.			N		
Habitat threatened by loss, conversion, degradation, or fragmentation in N.S.			N		
No management activities directed at taxon			N		
6. Information status					
Limited knowledge of distribution in N.S.			N		
Population trends not regularly monitored in N.S.			N		
Factors limiting population in N.S. unknown			N		
No autecological studies in N.S.			N		
No (meta-) population viability analysis in N.S.			N		

Appendix 5
Summary and assessment of total response rates from matrices

The following tables summarize the total number of both affirmative (√) and negative (X) responses included in the matrices returned by the participants. The purpose of this assessment is to determine the relative state or level of knowledge about the various classes, families and species in relation to the variables. Assessments were done by averaging all of the individual responses as well as from the "consensus" derived from the responses (see Appendix 4 and Tables 4.8.1 to 4.8.4 in Chapter 4 of Volume 1). A brief discussion of this assessment is included in Chapter 4. Tables included in Appendix 5 are listed below.

<u>5.1 List of tables:</u>

- **5.2 Number of total responses by species and respondent**
  - 5.2.1 Number of total responses by species and respondent - Mammals
  - 5.2.2 Number of total responses by species and respondent - Reptiles and Amphibians
  - 5.2.3 Number of total responses by species and respondent - Freshwater Fishes

- **5.3 Total response rates by species from average and consensus responses**
  - 5.3.1 Total response rates by species from average and consensus - Mammals
  - 5.3.2 Total response rates by from average and consensus - Reptiles and Amphibians
  - 5.3.3 Total response rates by species from average and consensus - Freshwater Fishes

- **5.4 Total response rates by family from average and consensus responses**

Appendix 5.2.1: Total (affirmative & negative) responses by species and respondent

Mammals / Respondent	KB	1*	2	3	6	7	8	10	15 ^	17	Aver-age
Arctic shrew	16		23		16			16	15	33	20.6
Common shrew	18	24	26		18			18	19	22	21.2
Smokey shrew	14		26		14			14	16	17	17.4
Gaspé shrew	19	27	24		19			18		20	21.6
Long-tailed shrew	18		21		18			18		23	20
Water shrew	20	26	27		20			20	20	32	20.3
Pygmy shrew	14	22	25		14			14	15	32	20.3
Short-tailed shrew	17	25	27		17			17	17	19	20.3
Star-nosed mole	17	25	26		17			17	17	17	19.8
Little brown bat	20	26	28		20			20	22	32	24.7
Northern long-eared bat	19	24	26		19			19	20	21	21.5
Eastern pipistrelle	21		28		21			21	21	29	24
Silver-haired bat	21		28		21			21	21	30	24.2
Red bat	20		26		20			20	20	31	23.4
Hoary bat	20		26		20			20	20	31	23.4
Coyote	17	28	25	33	17		29	17	31	17	24.6
Red fox	18	28	25		18		28	18	25	18	22.9
American black bear	18	26	24	33	18		26	18	27	18	23.8
Racoon	19	27	26		19		23	19	30	19	23.3
American marten	26	29	29		26		30	26	30	25	27.9
Fisher	24		28		24			24	26	23	25
Ermine/Weasel	21	30	28		21			20	23	21	23.8
American mink	18	27	25		18			18	23	18	21.5
Striped skunk	19		27		19		29	19	24	19	22.8
River otter	22	28	27		23	20		22	24	22	23.8
Eastern cougar	23	26	26	24	23	24		23	25	30	25.1
Lynx	25	30	29		25			25	27	25	26.8
Bobcat	19	23	24		19			19	23	18	21
White-tailed deer	16	25	25	33	16		22	16	27	16	22.5
Moose	17	27	25	33	17		22	17	26	17	23
Eastern chipmunk	18	29	26		18			18	26	18	22.5
Woodchuck	18		26		18			18	25	18	21
American red squirrel	17	27	26		17			17	26	18	21.8
Southern flying squirrel	17		22		19			17	23	31	22.4
Northern flying squirrel	16	24	23		18		23	17	18	17	20
American beaver	17	27	24		17		28	18	24	17	22.1
Deer mouse	18	28	26		18			18	23	19	22
White-footed mouse	18		26		18			18	19	18	19.8
Red-backed vole	16	28	24		16			16	19	17	20
Southern bog lemming	18	25	27		18			18	19	18	20.8
Muskrat	16	22	24		16			16	22	16	19.3
Meadow vole	18	27	26		18			18	23	32	24
Rock vole	18	25	23		18			18		33	23.4
Woodland jumping mouse	14	23	24		14			14	18	14	17.8
Meadow jumping mouse	16	25	25		16			16	18	16	19.3
American porcupine	16		25		16		22	17	26	16	20.3
Snowshoe hare	19	25	26		19		27	19	23	19	22.6
Average											22.1

Notes:
1. * Refers to regional context and species in Northern Cape Breton only (Respondent 1)
2. ^ Refers to Southwest N.S. Uplands region and species that exist or may exist in Kejimkujik National Park only (Respondent 15)
3. Average figures do not include responses provided by KB.

Appendix 5.2.2: Total (affirmative & negative) responses by species and respondent

Respondent Reptiles and Amphibians	KB	1*	2	4	5	6	7	8	10	14	^ 15	16	19	Aver-age
Snapping turtle	17		32		17	17	17	17	17	16	23	19	30	20.5
Wood turtle	17	19	28		17	18	17	17	17	15		17	28	19.3
Blanding's turtle	16		26		18	16	16	22	16	15	24	16	30	19.9
Eastern painted turtle	10		32		9	10	10	10	10	8	13	10		12.4
Maritime garter snake	13	16	32		13	13	13	27	13	13	19	13		17.2
Northern ribbon snake	14		28		12	14	14	14	14	13	17	14		15.6
Northern ringneck snake	14	17	32		14	15	14	14	14	13	18	14		16.5
East. smooth green snake	13	15	32		13	13	13	13	13	13	18	13		15.6
Northern redbelly snake	12	14	32		12	12	12	12	12	12	18	12		14.8
Eastern American toad	12	15	32	21	12	12	12	12	12	12	20	12		15.6
Northern spring peeper	13	16	30	21	13	13	13	13	13	13	20	13		16.2
Bullfrog	14		29	21	14	14	14	14	14	14	21	14		16.9
Green frog	13	16	30	21	13	13	13	13	13	13	22	13		16.4
Mink frog	13	15	30	22	13	13	13	13	13	13	20	13		16.2
Northern leopard frog	16	18	30	23	16	16	16	16	16	15	24	16		18.7
Pickerel frog	12	14	29	20	12	12	12	12	12	10	21	12		15.1
Wood frog	13	16	30	23	13	13	13	13	13	13	22	13		16.5
Yellow-spotted salamander	7	13	29	18	7	7	7	7	7	7	18	9		11.7
Blue-spotted salamander	11	13	29	19	9	11	11	11	11	8	20	13		14.1
Red-spotted newt	9	12	29	18	8	9	9	9	9	9	16	9		12.5
Red-backed salamander	9	11	30	20	9	9	9	9	9	9	18	10		13
Four-toed salamander	13	15	28	25	10	14	13	13	13	12	18	14		15.9
Average														15.9

Notes:

1. * Responses refer to regional context and species in Northern Cape Breton only (Respondent 1)
2. ^ Refers to Southwest N.S. Uplands region and species that exist or may exist in Kejimkujik National Park only (Respondent 15)
3. Average figures do not include responses provided by KB.

Appendix 5.2.3: Total (affirmative &negative) responses by species and respondent

Respondent / Freshwater Fish Species	KB	1*	2	6	7	8	15^	18	Aver-age
Sea lamprey	11			11	11			17	13
Atlantic sturgeon	11		16	11	11			17	13.8
American eel	10			10	12		22	17	15.3
Blueback herring	10		18	10	10			16	13.5
Gaspereau, Alewife	14			14	14			19	15.7
American shad	13		26	13	13			19	17.8
Atlantic whitefish	13			13	15			21	16.3
Lake whitefish	10			10	10			18	12.7
Atlantic salmon	14	19	23	15	14	21		21	18.8
Brook trout	12	13	22	12	12	21	23	18	17.3
Lake trout	8		13	8	12	8		14	11
Rainbow smelt	11			11	11	21		16	14.8
Northern redbelly dace	12			12	12			16	13.3
Lake chub	9			9	9			14	10.7
Golden shiner	10			10	10	19		16	13.8
Common shiner	8			8	8			13	9.7
Blacknose shiner	13			13	13			17	14.3
Blacknose dace	10			10	10			15	11.7
Creek chub	11			11	11	17		15	13.5
Fallfish	8			8	8			13	9.7
Pearl dace	10			10	10			14	11.3
White sucker	9			9	9	21		16	13.8
Brown bullhead	12			12	12	23		17	16
Atlantic tomcod	10			10	10			13	11
Banded killifish	12			12	12	21		17	15.5
Mummichog	11			11	11			17	13
Fourspine stickleback	8			8	8			15	10.3
Brook stickleback	8			8	8			14	10
Threespine stickleback	10			10	10			17	12.3
Ninespine stickleback	10			10	10	17		16	13.3
White perch	10			10	10	26		15	15.3
Striped bass	12			12	12			16	13.3
Yellow perch	11			11	11	26		16	16
Average									17.2

Notes:

1. * Responses refer to regional context in northern Cape Breton; responses limited to salmonids (Respondent 1)
2. ^ Responses refer to Southwest N.S. Upland region and species existing and possibly existing in Kejimkujik National Park (Respondent 15)
3. Average figures do not include responses provided by KB.

Appendix 5.3.1: Total response rates from average and consensus - Mammals

Data/Assessment Type	Total number of affirmative and negative responses	
Mammal Species	**Average**	**Consensus**
Arctic shrew	20.6	20
Common shrew	21.2	27
Smokey shrew	17.4	21
Gaspé shrew	21.6	24
Long-tailed shrew	20	21
Water shrew	20.3	23
Pygmy shrew	20.3	26
Short-tailed shrew	20.3	24
Star-nosed mole	19.8	20
Little brown bat	24.7	23
Northern long-eared bat	21.5	22
Eastern pipistrelle	24	21
Silver-haired bat	24.2	20
Red bat	23.4	21
Hoary bat	23.4	19
Coyote	24.6	28
Red fox	22.9	28
American black bear	23.8	25
Racoon	23.3	29
American marten	27.9	19
Fisher	25.	18
Ermine/Weasel	23.8	25
American mink	21.5	26
Striped skunk	22.8	26
River otter	23.8	20
Eastern cougar	25.1	22
Lynx	26.8	24
Bobcat	21.	23
White-tailed deer	22.5	25
Moose	23.	20
Eastern chipmunk	22.5	30
Woodchuck/Groundhog	21.	24
American red squirrel	21.8	26
Southern flying squirrel	22.4	22
Northern flying squirrel	20.	23
American beaver	22.1	25
Deer mouse	22.	30
White-footed mouse	19.8	21
Red-backed vole	20.	28
Southern bog lemming	20.8	26
Muskrat	19.3	22
Meadow vole	24.	27
Rock vole	23.4	24
Woodland jumping mouse	17.8	25
Meadow jumping mouse	19.3	25
American porcupine	20.3	22
Snowshoe hare	22.6	29
Average	22.1	23.8

Bold type indicates rates below average rates of response.

Appendix 5.3.2: Total response rates from average and consensus - Reptiles and Amphibians

Data/Assessment Type	Total number of affirmative and negative responses	
Reptiles and Amphibians	**Average**	**Consensus**
Snapping turtle	20.5	22
Wood turtle	19.3	20
Blanding's turtle	19.9	24
Eastern painted turtle	12.4	22
Maritime garter snake	17.2	24
Northern ribbon snake	15.6	19
Northern ringneck snake	16.5	22
Eastern smooth green snake	15.6	23
Northern redbelly snake	14.8	23
Eastern American toad	15.6	24
Northern spring peeper	16.2	24
Bullfrog	16.9	23
Green frog	16.4	25
Mink frog	16.2	23
Northern leopard frog	18.7	27
Pickerel frog	15.1	24
Wood frog	16.5	25
Yellow-spot. salamander	11.7	24
Blue-spotted salamander	14.1	22
Red-spotted newt	12.5	24
Red-backed salamander	13	24
Four-toed salamander	15.9	24
Average	15.9	23.3

Bold type indicates rates below average rates of response.

Appendix 5.3.3: Total response rates from average and consensus - Freshwater Fishes

Data/Assessment Type	Total number of affirmative and negative responses	
Freshwater fishes	**Average**	**Consensus**
Sea lamprey	**13**	**12**
Atlantic sturgeon	13.8	13
American eel	15.3	14
Blueback herring	**13.5**	**12**
Gaspereau/Alewife	15.7	**12**
American shad	17.8	17
Atlantic whitefish	16.3	13
Lake whitefish	**12.7**	**11**
Atlantic salmon	18.8	22
Brook trout	17.3	23
Lake trout	**11**	**11**
Rainbow smelt	14.8	14
Northern redbelly dace	**13.3**	13
Lake chub	**10.7**	**10**
Golden shiner	13.8	**11**
Common shiner	**9.7**	**9**
Blacknose shiner	14.3	14
Blacknose dace	**11.7**	**12**
Creek chub	**13.5**	**12**
Fallfish	**9.7**	**10**
Pearl dace	**11.3**	**12**
White sucker	13.8	**11**
Brown bullhead	16	14
Atlantic tomcod	**11**	**11**
Banded killifish	15.5	14
Mummichog	**13**	**12**
Fourspine stickleback	**10.3**	**10**
Brook stickleback	**10**	**10**
Threespine stickleback	**12.3**	**12**
Ninespine stickleback	**13.3**	13
White perch	15.3	**12**
Striped bass	**13.3**	13
Yellow perch	16	13
Average	13.6	12.8

Bold type indicates rates below average rates of response.

Appendix 5.4: Average number of total (affirmative and negative) responses per species by family

Data source*	Average responses*	Consensus responses*
Mammal families		
Soricidae (shrews)	20.2	23.3
Talpidae (moles)	19.8	20
Vespertilionidae (plain-nose bats)	23.5	21
Canidae (wolves, dogs, foxes)	23.8	28
Ursidae (bears)	23.8	25
Procyonidae (racoons)	23.3	29
Mustelidae (weasels, otters, skunks)	24.1	22.3
Felidae (cats)	24.3	23
Cervidae (deer, moose)	22.8	22.5
Sciuridae (squirrels, marmots)	21.5	25
Catoridae (beavers)	22.1	25
Cricetidae (mice)	20.9	25.5
Arvicolidae (voles, lemmings)	21.5	25.4
Zapodidae (jumping mice)	18.6	25
Erethizontidae (porcupine)	20.3	22
Leporidae (hares, rabbits)	22.6	29
Reptiles		
Chelydridae (snapping turtles)	20.5	22
Emydidae (semiaquatic, pond, marsh turtles)	17.2	22
Colubridae (typical snakes)	15.9	22.2
Amphibians		
Bufonidae (toads)	**15.6**	24
Hylidae (tree frogs)	**16.2**	24
Ranidae (typical frogs)	16.6	24.5
Ambystomatidae (mole salamanders)	**12.9**	23
Salamandridae (newts)	**12.5**	24
Plethodontidae (lungless salamanders)	**14.5**	24
Freshwater Fishes		
Petromyzontidae (lampreys)	**13**	**12**
Acipenseridae (sturgeons)	**13.8**	**13**
Angillidae (eels)	**15.3**	**14**
Clupeidae (herrings)	**15.7**	**13.7**
Salmonidae (trouts)	**15.2**	**16**
Osmeridae (smelts)	**14.8**	**14**
Cyprinidae (minnows and carps)	**12**	**11.5**
Catostomidae (suckers)	**13.8**	**11**
Ictaluridae (freshwater catfishes)	**16**	**14**
Gadidae (codfishes)	**11**	**11**
Cyprinodontidae (killifishes)	**14.3**	**13**
Gasterodteidae (sticklebacks)	**11.5**	**11.3**
Percichthyidae (temperate basses)	**14.3**	**12.5**
Percidaes (perches)	**16**	**13**

Bold font indicates response rates below 50%;
toned areas indicates families with lowest response rates in each class.

Appendix 6
Summary and assessment of number of total responses by species and by category

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<u>6.1 List of tables:</u>

- **6.2 Average number of total (affirmative and negative) responses by species and category from respondents**
  - 6.2.1 Average number of total (affirmative and negative) responses by species and category from respondents - Mammals
  - 6.2.2 Average number of total (affirmative and negative) responses by species and category from respondents - Reptiles and Amphibians
  - 6.2.3 Average number of total (affirmative and negative) responses by species and category from respondents - Freshwater Fishes

- **6.3 Number of total (affirmative and negative) responses by species and category from consensus**
  - 6.3.1 Number of total (affirmative and negative) responses by species and category from consensus - Mammals
  - 6.3.2 Number of total (affirmative and negative) responses by species and category from consensus - Reptiles and Amphibians
  - 6.3 .3 Number of total (affirmative and negative) responses by species and category from consensus - Freshwater Fishes

- **6.4 Number of total responses by family and category from consensus**

- **6.5 Number of total responses by class and category from average of responses and from consensus**

Appendix 6.2.1: Average number of total (affirmative and negative) responses by category and species from respondents

Category / Mammal Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human impact factors	6. Informa-tion status
Arctic shrew	5	3.9	2.7	3.1	**1.3**	2.8
Common shrew	7.1	3.7	3	4	**1.1**	1.7
Smokey shrew	**4**	3.5	2.6	3	**1**	**2.3**
Gaspé shrew	6.3	3.5	2.3	3.9	**.4**	3.7
Long-tailed shrew	6	**3.2**	2	4	**1**	3.4
Water shrew	6.6	5.8	2.8	3.3	**1.6**	3
Pygmy shrew	6.3	3.8	**1.1**	3.3	**1.6**	3
Short-tailed shrew	4.7	3.8	4	4	**1.1**	2.6
Star-nosed mole	6.2	3.6	2.3	4	**1.1**	2.6
Little brown bat	8	4	2.4	3.5	3.1	3
Northern long-eared bat	7.2	3.6	**1.3**	3.5	2.3	2.6
Eastern pipistrelle	6.8	4	2.3	3.1	3.8	2.8
Silver-haired bat	7.8	3.8	2.3	3.5	3.2	2.8
Red bat	7.8	4	**1.7**	3.5	3.2	2.8
Hoary bat	7.8	4	**1.7**	3.5	3	2.8
Coyote	6.6	5.2	3.4	4	2.8	**2.3**
Red fox	7.8	4.5	3.4	4	**1.9**	**1.1**
American black bear	7.9	5.2	3.3	3.4	2	**1.9**
Racoon	8.4	4.1	3.3	3.4	2.5	**1.3**
American marten	8.7	6.4	2.3	4	3.5	2.9
Fisher	7.8	6.3	2.2	4	2.3	**2.3**
Ermine/Weasel	7.7	4	3	4	2.3	2.6
American mink	7.7	4	3.1	4	**1.6**	**1.1**
Striped skunk	7.5	4.1	3.3	3.4	2.3	**1.9**
River otter	7.8	3.8	3.1	4	3.1	**1.9**
Eastern cougar	6.9	5.4	2	4	3.3	3.3
Lynx	7.8	6.3	2.6	4	3.1	2.6
Bobcat	6.7	4.6	2.6	4	1.3	**1.9**
White-tailed deer	7.8	6.3	**1.2**	2.6	2.2	**2.4**
Moose	7.3	6.3	**1.8**	3.4	2.2	**1.8**
Eastern chipmunk	7.7	4.1	3.2	2.7	**1.6**	2.6
Woodchuck/Groundhog	7.4	3.7	3.2	2.5	2.3	1.7
American red squirrel	7.8	4.1	2.7	2.3	2.6	**1.9**
Southern flying squirrel	7.4	4	3	3.3	**1**	2.8
Northern flying squirrel	6.5	4.1	3.3	2.6	**.6**	2.5
American beaver	7.7	6.3	2.4	2.2	**1.9**	**1.4**
Deer mouse	8	5.1	3.3	3.3	**1.3**	**1.7**
White-footed mouse	7.4	3.7	3	2.2	**1**	**2.4**
Red-backed vole	5.5	3.9	4	3.3	**1.3**	**1.8**
Southern bog lemming	5.7	6.3	**1.3**	2.3	**1.2**	3.7
Muskrat	7.3	3.8	3.1	2.6	**1.3**	**1.1**
Meadow vole	7.2	4.6	4	3.6	**1.7**	2.6
Rock vole	7.4	4	2	3.5	**1.8**	4.2
Woodland jump. mouse	6.5	3.9	2.3	2.4	**.7**	**1.8**
Meadow jumping mouse	6.6	3.9	3.1	2.4	**1.3**	**2**
American porcupine	7.2	3.7	3.3	**1.8**	2.3	**1.7**
Snowshoe hare	7.9	6.9	**1.8**	3.4	1.8	**1**
Cells /species/category	9	7	4	4	4	5

Bold type indicates average number of total responses < 50% of total number of cells.

Appendix 6.2.2: Average number of total (affirmative and negative) responses by category and species from respondents

Category Reptile and Amphibian Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human impact factors	6. Informa-tion status
Snapping turtle	5.4	3.1	2.3	2.4	4	2.7
Wood turtle	6.1	3.6	2	.6	3.9	2.3
Blanding's turtle	6.9	4	3	.9	2.8	2
Eastern painted turtle	3.6	2	2.3	.6	2.3	2.4
Maritime garter snake	5.7	2.7	3.3	2	1.7	2.3
Northern ribbon snake	6	2	1.3	1.7	2.6	2.4
Northern ringneck snake	6.2	2.1	3.1	1.7	1.3	2.5
E. smooth green snake	5.4	2	3.1	1.7	1.3	2.5
Northern redbelly snake	4.7	2	3.1	1.7	1.3	2.5
Eastern American toad	5.6	2.2	2.3	1.9	1.6	2.7
Northern spring peeper	5.4	2.1	3.1	1.9	1.6	2.7
Bullfrog	5.3	3	2.1	1.8	2.4	2.8
Green frog	5.4	2.1	3.2	1.8	1.7	2.7
Mink frog	5.3	2.1	3.1	1.9	1.6	2.7
Northern leopard frog	5.8	3	3.2	1.9	3.1	2.7
Pickerel frog	4.5	3.6	1.4	1.9	1.6	2.7
Wood frog	5.4	2.2	3.2	1.9	1.7	2.7
Yellow-spot. salamander	3	1.6	2.4	1	1.7	2.7
Blue-spotted salamander	5.2	1.6	2.2	.9	3	2
Red-spotted newt	2.6	1.4	3.1	1	2.3	2.6
Red-backed salamander	2.6	1.6	3.2	1.9	1.7	2.6
Four-toed salamander	4.3	1.5	3.2	.9	3	3.7
Cells/species/category	9	7	4	4	4	5

Bold font indicates response rate of <50% of total number of cells per category.

Appendix 6.2.3: Average number of total (affirmative and negative) responses by category and species from respondents

Category / Freshwater Fish Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human -impact factors	6. Informa-tion status
Sea lamprey	6	4	**2**	**.5**	1	**0**
Atlantic sturgeon	5.3	4.3	**1**	.7	**1.3**	**2**
American eel	6.5	**2.8**	**2.3**	**1**	2	**.8**
Blueback herring	**3**	4	1.7	1.7	2	**2.3**
Gaspereau/Alewife	6	**1.3**	1.7	1.7	1	**0**
American shad	6	4.7	**2.3**	1.7	2	1.7
Atlantic whitefish	8	3	**1**	**.7**	2.3	**.7**
Lake whitefish	5	2.3	1.7	**.7**	3	**0**
Atlantic salmon	**4.3**	4.8	2.5	1.5	3.5	**1.2**
Brook trout	5.7	3.7	2.7	**1.2**	2.8	**2**
Lake trout	**4**	3	**2.3**	**1.3**	**1.3**	**1**
Rainbow smelt	5.3	4.7	2.7	1.7	**1**	**.7**
Northern redbelly dace	5	4	**2**	2	**1**	**0**
Lake chub	**3**	3.5	**2**	2	**1**	**0**
Golden shiner	5.7	**2.7**	**2.3**	2	**1.3**	**1**
Common shiner	**2**	4	**1.5**	2	**1**	**0**
Blacknose shiner	6	4	**2**	2	**1**	**0**
Blacknose dace	5	3.5	**2**	2	**0**	**0**
Creek chub	6.3	4	**.7**	**1**	**1.3**	**1**
Fallfish	5	3.5	**1**	**1**	**0**	**0**
Pearl dace	**4**	4	**2**	2	**0**	**0**
White sucker	6.3	**2.3**	**2**	1.7	1.7	**1**
Brown bullhead	5.7	5.3	**2.3**	**1.3**	1.7	**1**
Atlantic tomcod	6	3	**1**	**.5**	**1**	**0**
Banded killifish	6.3	3.7	**1.7**	2.3	**1.7**	**1**
Mummichog	6	3.5	**1.5**	2	**1**	**0**
Fourspine stickleback	5	3.5	**2**	**1**	**0**	**0**
Brook stickleback	5	3.5	**1.5**	**1**	**0**	**0**
Threespine stickleback	6	3.5	**2**	2	**0**	**0**
Ninespine stickleback	6.3	3	**1.3**	2.3	**.3**	**1**
White perch	6	3.3	**2.3**	**1**	2	**1.7**
Striped bass	6	4	**2**	**1**	**1**	**0**
Yellow perch	6	3.7	**2.3**	2	2	**1.7**
Cells/species/category	9	6	5	3	4	5

Bold type indicates response rate of <50% of total number of cells per category.

Appendix 6.3.1: Number of total (affirmative and negative) responses by species and category from consensus

Category / Mammal Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabili-ity	4. Species of major ecological import.	5. Human impact factors	6. Informa-tion status
Arctic shrew	5	4	1	3	3	4
Common shrew	9	5	3	4	3	3
Smokey shrew	9	4	1	3	2	2
Gaspé shrew	7	4	2	3	2	5
Long-tailed shrew	8	3	1	4	2	3
Water shrew	6	4	1	4	4	4
Pygmy shrew	7	4	3	4	4	4
Short-tailed shrew	7	4	2	4	3	4
Star-nosed mole	6	3	1	3	3	4
Little brown bat	9	4	1	4	1	4
Northern long-eared bat	6	5	0	4	3	4
Eastern pipistrelle	8	4	0	4	1	4
Silver-haired bat	7	2	1	4	2	4
Red bat	7	2	3	4	2	4
Hoary bat	4	2	3	4	2	4
Coyote	9	6	4	3	3	3
Red fox	9	6	4	4	3	2
American black bear	8	6	3	2	3	3
Racoon	9	7	4	3	3	3
American marten	5	6	2	4	2	0
Fisher	6	7	0	4	1	0
Ermine/Weasel	9	5	2	4	3	2
American mink	9	6	2	4	3	2
Striped skunk	9	6	4	3	3	1
River otter	5	6	2	4	2	1
Eastern cougar	5	6	3	4	1	3
Lynx	7	6	1	4	3	3
Bobcat	8	4	4	4	1	2
White-tailed deer	9	3	4	3	3	3
Moose	6	5	2	4	2	1
Eastern chipmunk	9	6	4	4	4	3
Woodchuck/Groundhog	9	3	4	3	4	1
American red squirrel	9	6	3	3	3	2
Southern flying squirrel	5	4	3	4	3	3
Northern flying squirrel	9	3	2	3	2	4
American beaver	9	7	2	3	3	2
Deer mouse	9	6	4	4	4	3
White-footed mouse	9	3	3	2	2	2
Red-backed vole	8	6	3	4	4	3
Southern bog lemming	8	5	2	3	3	5
Muskrat	9	4	3	3	1	2
Meadow vole	9	5	3	3	4	3
Rock vole	7	3	4	4	3	3
Woodland jump. mouse	8	5	3	3	3	3
Meadow jumping mouse	8	5	3	2	4	3
American porcupine	7	4	3	3	4	1
Snowshoe hare	9	7	4	4	2	3
Cells/species/category	9	7	4	4	4	5

Bold type indicates rate of total responses < 50% of total number of cells.

Appendix 6.3.2: Number of total (affirmative and negative) responses by category and species from consensus

Category / Reptile and Amphibian Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human impact factors	6. Informa-tion status
Snapping turtle	9	**3**	3	4	**1**	**2**
Wood turtle	**4**	4	2	3	3	4
Blanding's turtle	9	4	**1**	3	4	3
Eastern painted turtle	8	4	3	**1**	4	**2**
Maritime garter snake	9	**2**	4	3	4	**2**
Northern ribbon snake	9	**2**	**1**	2	3	**2**
Northern ringneck snake	9	**2**	3	2	4	**2**
E. smooth green snake	9	**2**	3	3	4	**2**
Northern redbelly snake	9	**3**	3	2	4	**2**
Eastern American toad	9	**2**	4	3	2	4
Northern spring peeper	9	4	3	3	2	3
Bullfrog	9	4	2	3	1	4
Green frog	9	**3**	4	3	2	4
Mink frog	9	**3**	2	3	2	4
Northern leopard frog	9	4	4	3	3	4
Pickerel frog	9	4	2	3	2	4
Wood frog	9	**3**	4	3	2	4
Yellow-spot. salamander	9	**3**	4	2	2	4
Blue-spotted salamander	8	**3**	3	2	4	**2**
Red-spotted newt	9	4	3	2	3	3
Red-backed salamander	9	**3**	4	3	2	3
Four-toed salamander	7	4	3	2	3	5
Cells/species/category	9	7	4	4	4	5

Bold font indicates response rate of <50% of total number of cells per category.

Appendix 6.3.3: Number of total (affirmative and negative) responses by category and species from consensus

Filters / Freshwater Fishes	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human -impact factors	6. Informa-tion status
Sea lamprey	7	3	**1**	**0**	**1**	**0**
Atlantic sturgeon	7	4	**0**	**0**	**1**	**1**
American eel	7	2	**2**	2	**1**	**0**
Blueback herring	**4**	4	**1**	**1**	**1**	**1**
Gaspereau/Alewife	7	1	**2**	**1**	**1**	**0**
American shad	7	5	3	**1**	**1**	**0**
Atlantic whitefish	8	2	**0**	**0**	3	**0**
Lake whitefish	6	1	**1**	**0**	3	**0**
Atlantic salmon	6	5	3	2	4	**2**
Brook trout	7	4	**2**	**1**	4	5
Lake trout	5	2	**1**	**1**	**1**	**1**
Rainbow smelt	5	4	**2**	2	**1**	**0**
Northern redbelly dace	6	4	**1**	**1**	**1**	**0**
Lake chub	**4**	3	**1**	**1**	**1**	**0**
Golden shiner	6	2	**1**	**1**	**1**	**0**
Common shiner	**3**	4	**0**	**1**	**1**	**0**
Blacknose shiner	7	4	**1**	**1**	**1**	**0**
Blacknose dace	6	3	**1**	**1**	**1**	**0**
Creek chub	7	4	**0**	**0**	**1**	**0**
Fallfish	6	3	**0**	**0**	**1**	**0**
Pearl dace	5	4	**1**	**1**	**1**	**0**
White sucker	7	1	**1**	**1**	**1**	**0**
Brown bullhead	6	5	**1**	**1**	**1**	**0**
Atlantic tomcod	7	2	**1**	**0**	**1**	**0**
Banded killifish	7	3	**1**	2	**1**	**0**
Mummichog	7	2	**1**	**1**	**1**	**0**
Fourspine stickleback	6	2	**1**	**0**	**1**	**0**
Brook stickleback	6	2	**1**	**0**	**1**	**0**
Threespine stickleback	7	2	**1**	**1**	**1**	**0**
Ninespine stickleback	7	2	**1**	2	**1**	**0**
White perch	6	3	**1**	**1**	**1**	**0**
Striped bass	7	3	**1**	**1**	**1**	**0**
Yellow perch	6	3	**1**	2	**1**	**0**
Cells/species/category	9	6	5	3	4	5

Bold type indicates response rate of <50% of total number of cells per category.

Appendix 6.4: Total (affirmative and negative) responses as percentage of number of cells by family and category from consensus

Category	1. Rarity/ population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological important	5. Human-impact factors	6. Informa-tion status
Mammal families						
Soricidae (shrews)	81	57	44	94	72	73
Talpidae (moles)	67	43	25	75	75	80
Vespertilionidae (plain-nose bats)	76	43	33	100	46	80
Canidae (wolves, dogs, foxes)	100	86	100	88	75	50
Ursidae (bears)	89	86	75	50	75	60
Procyonidae (racoons)	100	100	100	75	75	60
Mustelidae (weasel, skunk, otter)	80	86	50	96	54	20
Felidae (cats)	74	76	67	100	42	53
Cervidae (deer, moose)	83	64	75	88	63	40
Sciuridae (squirrels, marmots)	91	63	80	85	80	52
Catoridae (beavers)	100	100	50	75	75	40
Cricetidae (mice)	100	64	88	75	75	50
Arvicolidae (voles, lemmings)	89	66	75	80	75	64
Zapodidae (jumping mice)	91	71	75	63	88	60
Erethizontidae (porcupine)	78	57	75	75	100	20
Leporidae (hares, rabbits)	100	100	100	100	50	60
Reptile families						
Chelydridae (snapping turtles)	100	43	75	100	25	20
Emydidae (semiaquatic, pond and marsh turtles)	78	57	50	58	92	60
Colubridae (typical snakes)	100	31	70	60	95	40
Amphibian families						
Bufonidae (toads)	100	29	100	75	50	80
Hylidae (tree frogs)	100	57	75	75	50	60
Ranidae (typical frogs)	100	50	75	75	50	80
Ambystomatidae (mole salamander)	94	43	88	50	75	60
Salamandridae (newts)	100	57	75	50	75	60
Plethodontidae (lungless salamanders)	89	50	88	63	63	80

<u>**Appendix 6.4: (continued)**</u>

Category	1. Rarity/ population status	2. Biological character-istics	3. Habitat-related vulnerabili-ity	4. Species of major ecological important	5. Human-impact factors	6. Informa-tion status
Freshwater Fishes						
Petromyzontidae (lampreys)	78	50	20	0	20	0
Acipenseridae (sturgeons)	78	67	0	0	25	20
Angillidae (eels)	78	33	40	67	25	0
Clupeidae (herrings)	67	56	40	33	25	7
Salmonidae (trouts)	71	47	28	27	75	32
Osmeridae (smelts)	56	67	40	67	25	0
Cyprinidae (minnows and carps)	62	57	13	28	25	0
Catostomidae (suckers)	78	17	20	33	25	0
Ictaluridae (freshwater catfishes)	67	83	20	33	25	0
Gadidae (codfishes)	78	33	20	0	25	0
Cyprinodontidae (killifishes)	78	42	20	50	25	0
Gasterodteidae (sticklebacks)	72	33	20	25	25	0
Percichthyidae (temperate bass)	72	50	20	33	25	0
Percidaes (perches)	67	50	20	67	25	0

Notes:

1. "Response" refers to affirmative and negative responses for all species within each family as shown on the consensus matrix. Consensus responses (affirmative and negative) are quantified as a percentage of the total number of possible responses or "cells" within each family and category.
2. Toned areas indicate families and categories where the consensus responses (affirmative and negative) are less than 50% of the total number of cells or possible responses.

Appendix 6.5: Average number of total (affirmative and negative) responses by category and respondent

Category / Respondent	No. of cells	KB	1*	2	3	4	5	6	7	8	10	14	15^	16	17	18	Average	% of total cells
Mammals																		
1. Rarity/population status	423	310	275	392	40			311	308	325			284		324		282	67
2. Biological characteristics	329	173	174	268	33			177	173	190	173		219		220		181	55
3. Habitat-related vulnerability	188	106	107	139	18			106	106	115	105		125		132		106	56
4. Species of major ecological importance	188	142	123	169	20		109	142	142	151	144		161		153		131	70
5. Human impact factors	188	72	92	73	20		80	72	73	96			85		93		76	40
6. Information status	235	66	110	160	25		70	66	66	83			104		102		87	37
Reptiles and amphibians																		
1. Rarity/population status	198	101	82	155		55		103	101	102		90	110				100	50
2. Biological characteristics	154	26	34	153		37		27	26	30	26	25	78	34			47	31
3. Habitat-related vulnerability	88	55	45	82		34		55	55	56	55	55	63	55			56	63
4. Species of major ecological importance	88	16	33	84		46		16	16	21	16	16	53	16			32	36
5. Human impact factors	88	40	26	88		52	34	40	40	45		37	41				45	51
6. Information status	110	43	34	87		49	44	43	43	44		43	64				50	46
Freshwater fishes																		
1. Rarity/population status	297	169	9	28				170	172	176			72			169	114	38
2. Biological characteristics	198	96	9	28				96	96	98			30			156	73	37
3. Habitat-related vulnerability	165	32	5	14				32	31	39			25			96	35	21
4. Species of major ecological importance	99	20	2	5				20	20	22			24			76	24	24
5. Human impact factors	132	32	7	19				32	35	34			29			32	27	20
6. Information status	165	2	0	26				2	5	8			34			2	11	7

Notes:
1. * Responses limited to species and regional context in Northern Cape Breton only (34 mammal species; 17 reptiles and amphibians); Freshwater fishes responses limited to salmonids (2 species) (Respondent 1).
2. Respondent 2 freshwater fishes responses limited to 5 species.
3. Respondent 3 responses limited to 5 mammal species.
4. Respondent 4 responses limited to reptiles and amphibians.
5. Respondent 5 responses limited to categories 4, 5 and 6 for mammals (38 species only), and to categories 5 and 6 for reptiles and amphibians.
6. Respondent 10 responses limited to categories 2, 3 and 4, and to mammals and reptiles and amphibians.
7. Respondent 14 responses limited to reptiles and amphibians.
8. ^ Responses refer to Southwest N.S. uplands region and species existing or possibly existing in Kejimkujik National Park (44 mammal species; 21 reptiles and amphibians; 10 freshwater fishes) (Respondent 15)
9. Respondent 16 responses limited to categories 2, 3 and 4; reptiles and amphibians only.
10. Respondent 17 responses limited to mammals.
11. Average and % of total figures do not include responses provided by KB.

Appendix 7
Summary and assessment of affirmative responses to matrices

The following tables summarize the number of affirmative (√) responses per-species and family. The purpose of these assessments is to determine the relative vulnerability or need for special management attention of the various species and families relative to the variables. Assessments were done by averaging all of the responses as well as from the "consensus" derived from the responses (Refer to Tables 4.8.1 to 4.8.4 in Chapter 4). Affirmative responses were calculated as a simple number and as a percentage of total (√ + X) responses. Results are summarized and discussed in Chapter 4. Tables included in Appendix 7 are listed below.

7.1 List of tables:

- **7.2 Number of affirmative responses by species and respondent**
  - 7.2.1 Number of affirmative responses by species and respondent - Mammals
  - 7.2.2 Number of affirmative responses by species and respondent - Reptiles and Amphibians
  - 7.2.3 Number of affirmative responses by species and respondent - Freshwater Fishes

- **7.3 Affirmative response rate by species from average and consensus responses**
  - 7.3.1 Affirmative response rate by species from average and consensus responses - Mammals
  - 7.3.2 Affirmative response rate by species from average and consensus responses - Reptiles and Amphibians
  - 7.3.3 Affirmative response rate by species from average and consensus responses - Freshwater Fishes

- **7.4 Affirmative response rate per-species by family from average and consensus responses**

Appendix 7.2.1: Number of affirmative responses by species and respondent - Mammals

Respondent / Mammals	KB	1*	2	3	5	6	7	8	10	15^	17	Aver-age
Arctic shrew	10		11			10	10	10	10	9	17	11
Common shrew	4	6	7			4	4	4	4	5	5	4.4
Smokey shrew	5		8			5	5	5	5	7	4	5.6
Gaspé shrew	13	17	15			13	13	13	12		13	13.7
Long-tailed shrew	11		12			11	11	11	11		13	11.5
Water shrew	8	12	9			8	8	8	8	8	10	8.9
Pygmy shrew	6	10	10			6	6	6	6	6	10	7.5
Short-tailed shrew	6	11	10			6	6	6	6	6	5	7
Star-nosed mole	8	15	9			8	8	8	8	8	7	8.9
Little brown bat	9	10	10		6	9	9	9	9	11	14	9.7
Northern long-eared bat	12	15	13		9	12	12	12	12	13	11	12.1
Eastern pipistrelle	14		15		10	14	14	14	14	14	17	14
Silver-haired bat	15		16		12	15	15	15	15	15	14	14.6
Red bat	11		12		8	11	11	11	11	11	13	11
Hoary bat	12		14		9	12	12	12	12	12	13	12
Coyote	6	9	8	5	5	6	6	6	6	6	6	6.3
Red fox	3	6	6		3	3	3	3	3	7	3	4.1
American black bear	7	10	9	6	7	7	7	6	7	8	6	7.3
Racoon	4	6	7		3	4	4	4	4	9	3	4.9
American marten	15	18	15		12	15	15	17	15	14	13	14.9
Fisher	14		13		11	14	14	14	14	15	12	13.4
Ermine/Weasel	8	10	9		5	8	8	8	7	8	8	7.9
American mink	5	7	5		5	5	5	5	5	8	5	5.6
Striped skunk	4		7		2	4	4	4	4	4	3	4
River otter	12	14	8		9	13	10	12	12	13	10	11.2
Eastern cougar	17	19	18	13	15	17	16	17	17	15	15	16.2
Lynx	16	19	17		13	16	16	16	16	16	16	16.1
Bobcat	8	10	11		7	8	8	8	8	11	7	8.7
White-tailed deer	6	9	9	6	6	6	6	6	6	8	6	6.8
Moose	8	8	10	12	8	8	8	8	8	14	8	9.2
Eastern chipmunk	3	5	6		2	3	3	3	3	4	3	3.6
Woodchuck	3		7		3	3	3	3	3	5	3	3.8
American red squirrel	4	6	6		2	4	4	4	4	6	5	4.6
Southern flying squirrel	10		12		10	12	10	10	10	13	10	10.9
Northern flying squirrel	4	7	5		4	6	4	6	5	5	3	5
American beaver	2	6	3		3	2	2	4	3	7	2	9
Deer mouse	3	5	6			3	3	3	3	4	4	3.9
White-footed mouse	5		8			5	5	5	5	5	5	5.4
Red-backed vole	4	6	7			4	4	4	4	6	3	4.8
Southern bog lemming	6	9	9			6	6	6	6	6	5	6.6
Muskrat	3	6	6		3	3	3	3	3	7	3	4.1
Meadow vole	4	6	8		4	4	4	4	4	7	7	5.3
Rock vole	10	13	12			10	10	10	10		11	10.9
Woodland jump. mouse	4	7	6			4	4	4	4	6	3	4.8
Meadow jumping mouse	4	7	6			4	4	4	4	6	3	4.8
American porcupine	7		10		7	7	7	7	8	10	5	7.6
Snowshoe hare	4	4	6		4	4	4	5	4	6	4	4.6
Average												8.3

1. * Refers to regional context and species in Northern Cape Breton only (Respondent 1)
2. ^ Refers to Southwest N.S. Uplands region and species that exist or may exist in Kejimkujik National Park only (Respondent 15); where species are noted as "small population in N. S." and the mark is changed to "?" for "small population in Park/region", the mark has been counted as an affirmative response for those species of uncertain presence within the Park/region in order to be consistent with the definition of "small population" (See definitions in Appendix 2.5, and notes related to Appendix 4 in Appendix 4.2, note 13).
3. Average figures do not include responses provided by KB.
4. Bold type indicates 10 highest affirmative response rates; toned areas indicate 5 highest rates.

Appendix 7.2.2: Number of affirmative responses by species and respondent-Reptiles and Amphibians

Respondent / Reptiles and Amphibians	KB	1*	2	4	5	6	7	8	10	14	15^	16	19	Aver-age
Snapping turtle	12		11		9	12	12	12	12	11	13	14	12	11.8
Wood turtle	15	15	18		13	16	15	15	15	13		15	15	15
Blanding's turtle	14		14		14	14	14	15	14	13	14	14	17	14.3
Eastern painted turtle	7		9		6	7	7	7	7	5	8	7		7
Maritime garter snake	5	6	8		5	5	5	5	5	5	7	5		5.6
Northern ribbon snake	13		16		10	13	13	13	13	12	14	13		13
Northern ringneck snake	8	9	11		8	9	8	8	8	7	10	8		8.6
East. smooth green snake	7	7	10		7	7	7	7	7	7	9	7		7.5
Northern redbelly snake	6	5	9		6	6	6	6	6	6	8	6		6.4
Eastern American toad	5	5	8	11	5	5	5	5	5	5	8	5		6.1
Northern spring peeper	5	5	9	10	4	5	5	5	5	5	8	5		6
Bullfrog	8		11	14	7	8	8	8	8	8	11	8		9.1
Green frog	6	6	10	12	6	6	6	6	6	6	9	6		7.2
Mink frog	6	6	10	12	6	6	6	6	6	6	9	6		7.2
Northern leopard frog	8	8	11	13	7	8	8	8	8	8	11	8		8.9
Pickerel frog	8	8	11	13	8	8	8	8	8	7	11	8		8.9
Wood frog	5	5	9	12	5	5	5	5	5	5	8	5		6.3
Yellow-spotted salamander	3	4	7	11	3	3	3	3	3	3	6	5		4.6
Blue-spotted salamander	8	8	12	13	6	8	8	8	8	5	13	8		8.8
Red-spotted newt	6	7	10	12	5	6	6	6	6	6	9	6		7.2
Red-backed salamander	6	6	10	14	6	6	6	6	6	6	9	7		7.5
Four-toed salamander	10	10	14	19	7	11	10	10	10	9	12	11		11.2
Average														8.6

Notes:

1. * Responses refer to regional context and species existing in Northern Cape Breton only (Respondent 1)
2. ^ Responses refer to Southwest N.S. uplands region and species existing or may be existing in Kejimkujik National Park (Respondent 15)
3. Average figures do not include responses provided by KB.
4. Bold type indicates 5 highest affirmative response rates; toned areas indicate 2 highest rates.

Appendix 7.2.3: Number of affirmative responses by species and respondent - Freshwater Fishes

Respondent Freshwater Fish Species	KB	1*	2	6	7	8	15^	18	Aver-age
Sea lamprey	3			3	3			7	4.3
Atlantic sturgeon	4		10	4	5			6	6.3
American eel	2			2	4		6	4	4
Blueback herring	5		13	5	5			9	**8**
Gaspereau, Alewife	6			6	6			9	**7**
American shad	4		15	4	4			8	**7.8**
Atlantic whitefish	13			13	14			17	**14.7**
Lake whitefish	7			7	7			11	**8.3**
Atlantic salmon	10	14	14	11	10	14		15	**13**
Brook trout	6	7	10	6	6	7	9	9	**7.7**
Lake trout	6		11	6	9			9	**8.8**
Rainbow smelt	5			5	5	7		9	6.5
Northern redbelly dace	4			4	4			5	4.3
Lake chub	4			4	4			5	4.3
Golden shiner	3			3	3		8	5	4.8
Common shiner	3			3	3			3	3
Blacknose shiner	5			5	5			5	5
Blacknose dace	5			5	5			6	5.3
Creek chub	2			2	2		7	3	3.5
Fallfish	4			4	4			5	4.3
Pearl dace	4			4	4			5	4.3
White sucker	2			2	2		8	4	4
Brown bullhead	2			2	2		7	2	3.3
Atlantic tomcod	2			2	2			2	2
Banded killifish	3			3	3		8	3	4.3
Mummichog	2			2	2			3	2.3
Fourspine stickleback	0			0	0			0	0
Brook stickleback	5			5	5			5	5
Threespine stickleback	1			1	1			2	1.3
Ninespine stickleback	1			1	1		6	1	2.3
White perch	2			2	2		4	6	3.5
Striped bass	4			4	4			7	5
Yellow perch	4			4	4		5	6	4.8
Average									5.2

Notes:
1. * Responses refer to regional context in northern Cape Breton; responses limited to salmonids (Respondent 1)
2. ^ Responses refer to Southwest N.S. Upland region and species existing and possibly existing in Kejimkujik National Park (Respondent 15)
3. Average figures do not include responses provided by KB.
4. Bold type indicates 8 highest affirmative response rates; toned areas indicate 2 highest rates.

Appendix 7.3.1: Affirmative response rates for mammal species

Data/Assessment Type	Average affirmative response rate		Consensus affirmative response rate	
Mammal Species	**#**	**%**	**#**	**%**
Arctic shrew	11	**53.4**	**8**	**40**
Common shrew	4.4	20.8	7	25.9
Smokey shrew	5.6	32.2	4	19.
Gaspé shrew	**13.7**	**63.4**	**13**	**54.2**
Long-tailed shrew	**11.5**	**57.5**	**10**	**47.6**
Water shrew	8.9	43.8	6	26.1
Pygmy shrew	7.5	36.9	7	26.9
Short-tailed shrew	7.0	34.5	7	29.
Star-nosed mole	8.9	44.9	7	35.
Little brown bat	9.7	39.3	6	26.1
Northern long-eared bat	**12.1**	**56.3**	**9**	**41.**
Eastern pipistrelle	**14.**	**58.5**	**11**	**52.**
Silver-haired bat	**14.6**	**60.3**	**9**	**45.**
Red bat	11.	47.	7	33.
Hoary bat	**12.**	51.3	6	32.
Coyote	6.3	25.6	4	14.
Red fox	4.1	17.9	5	17.9
American black bear	7.3	30.7	5	20.
Racoon	4.9	21.	3	10.3
American marten	**14.9**	**53.4**	6	31.6
Fisher	**13.4**	**53.6**	6	33.
Ermine/Weasel	7.9	33.2	5	20.
American mink	5.6	26.	5	19.2
Striped skunk	4.0	17.5	0	0
River otter	11.2	47.1	6	30.
Eastern cougar	**16.2**	**64.5**	**11**	**50**
Lynx	**16.1**	**60.1**	**13**	**54.**
Bobcat	8.7	41.4	**8**	34.8
White-tailed deer	6.8	30.2	3	12.
Moose	9.2	40.	5	25.
Eastern chipmunk	3.6	16.	5	16.7
Woodchuck/Groundhog	3.8	18.1	2	8.3
American red squirrel	4.6	21.1	4	15.
Southern flying squirrel	10.9	48.7	**8**	**36.4**
Northern flying squirrel	5	25.	4	17.4
American beaver	9	40.7	2	8.
Deer mouse	3.9	17.7	6	20.
White-footed mouse	5.4	27.3	5	24.
Red-backed vole	4.8	24.	6	21.4
Southern bog lemming	6.6	31.7	7	27.
Muskrat	4.1	21.2	4	18.
Meadow vole	5.3	22.1	6	22.2
Rock vole	10.9	46.6	7	31.8
Woodland jumping mouse	4.8	27.	4	16.
Meadow jumping mouse	4.8	24.9	4	16.
American porcupine	7.6	37.4	4	18.2
Snowshoe hare	4.6	20.4	6	20.7
Average	8.3	35.9	6.1	26.5

Bold type indicates species with the 10 highest rates of affirmative responses; toned areas indicate species with the 5 highest rates.

Appendix 7.3.2: Affirmative response rates for reptiles and amphibians

Data/Assessment Type	Average affirmative response rate		Consensus affirmative response rate	
Reptiles and Amphibians	#	%	#	%
Snapping turtle	11.8	57.6	7	31.8
Wood turtle	15	77.7	11	55
Blanding's turtle	14.3	71.8	11	45.8
Eastern painted turtle	7	56.5	5	22.7
Maritime garter snake	5.6	32.6	4	16.7
Northern ribbon snake	13	83.3	11	57.9
Northern ringneck snake	8.6	52.1	7	31.8
Eastern smooth green snake	7.5	48.1	6	26.1
Northern redbelly snake	6.4	43.2	4	17.4
Eastern American toad	6.1	39.1	6	25
Northern spring peeper	6	37	6	25
Bullfrog	9.1	53.8	9	39
Green frog	7.2	43.9	8	32
Mink frog	7.2	44.4	7	30.4
Northern leopard frog	8.9	47.6	9	33.3
Pickerel frog	8.9	58.9	9	37.5
Wood frog	6.3	38.2	7	28
Yellow-spot. salamander	4.6	39.3	6	25
Blue-spotted salamander	8.8	62.4	9	41
Red-spotted newt	7.2	57.6	8	33.3
Red-backed salamander	7.5	57.7	8	33
Four-toed salamander	11.2	70.4	12	50
Average	8.6	53.3	7.7	33.5

Bold type indicates the ten highest rates of affirmative responses; toned areas indicate the five highest rates of affirmative responses.

Appendix 7.3.3: Affirmative response rates for freshwater fishes

Data/Assessment Type	Average affirmative response rate		Consensus affirmative response rate	
Freshwater fishes	#	%	#	%
Sea lamprey	4.3	33.1	3	25
Atlantic sturgeon	**6.3**	**45.7**	5	38.5
American eel	4	26.1	3	21.4
Blueback herring	**8**	**59.3**	**6**	**50**
Gaspereau/Alewife	**7**	**44.6**	5	**41.7**
American shad	**7.8**	43.8	**7**	41.1
Atlantic whitefish	**14.7**	**90.2**	**12**	**92.3**
Lake whitefish	**8.3**	**65.4**	**7**	**63.6**
Atlantic salmon	**13**	**69.1**	**14**	**64**
Brook trout	**7.7**	**44.5**	**9**	39.1
Lake trout	**8.8**	**80**	**8**	**72.7**
Rainbow smelt	**6.5**	43.9	**6**	**42.9**
Northern redbelly dace	4.3	32.3	4	30.8
Lake chub	4.3	40.2	4	40
Golden shiner	4.8	34.8	3	27.3
Common shiner	3	30.9	3	33.3
Blacknose shiner	5	35	5	35.7
Blacknose dace	5.3	**45.3**	**6**	**50**
Creek chub	3.5	25.9	2	16.7
Fallfish	4.3	44.3	5	**50**
Pearl dace	4.3	38.1	5	**41.7**
White sucker	4	29	2	18.2
Brown bullhead	3.3	20.6	2	14.3
Atlantic tomcod	2	18.2	2	18.2
Banded killifish	4.3	27.7	3	21.4
Mummichog	2.3	17.7	2	16.7
Fourspine stickleback	0	0	1	10
Brook stickleback	5	**50**	**6**	**60**
Threespine stickleback	1.3	10.6	2	16.7
Ninespine stickleback	2.3	17.3	2	15.4
White perch	3.5	22.9	3	25
Striped bass	5	37.6	4	30.8
Yellow perch	4.8	30	5	38.5
Average	5.2	38	4.7	37

Bold type indicates the ten highest rates of affirmative responses; toned areas indicate the five highest rates.

Appendix 7.4: Average per-species affirmative response rates by family

Data source*	Average responses*		Consensus responses*	
Assessment type (# or %)	#	%	#	%
Mammal families				
Soricidae (shrews)	8.7	43	7.8	34
Talpidae (moles)	8.9	45	7	35
Vespertilionidae (plain-nose bats)	12.2	**52**	8	38
Canidae (wolves, dogs, foxes)	5.2	22	4.5	16
Ursidae (bears)	7.3	31	5	20
Procyonidae (racoons)	4.9	21	3	10
Mustelidae (weasels, otters, skunks)	9.5	39	4.7	22
Felidae (cats)	13.7	**55**	10.7	46
Cervidae (deer, moose)	7.9	35	4	19
Sciuridae (squirrels, marmots)	5.6	26	4.6	20
Catoridae (beavers)	9	41	2	8
Cricetidae (mice)	4.7	23	5.5	22
Arvicolidae (voles, lemmings)	4.7	29	6.4	25
Zapodidae (jumping mice)	4.8	28	4	16
Erethizontidae (porcupine)	7.6	37	4	18
Leporidae (hares, rabbits)	7.6	20	6	21
Reptiles				
Chelydridae (snapping turtles)	11.8	**58**	7	32
Emydidae (semiaquatic, pond and marsh turtles)	12.1	**69**	9	41
Colubridae (typical snakes)	7.6	**52**	6.4	30
Amphibians				
Bufonidae (toads)	6.1	39	6	25
Hylidae (tree frogs)	6	37	6	25
Ranidae (typical frogs)	7.9	48	8.2	34
Ambystomatidae (mole salamanders)	6.7	**51**	7.5	33
Salamandridae (newts)	7.2	**58**	8	33
Plethodontidae (lungless salamanders)	9.4	**64**	10	42
Freshwater Fishes				
Petromyzontidae (lampreys)	4.3	33	3	25
Acipenseridae (sturgeons)	6.3	46	5	39
Angillidae (eels)	4	26	3	21
Clupeidae (herrings)	7.6	49	6	44
Salmonidae (trouts)	10.5	**70**	10	**66**
Osmeridae (smelts)	6.5	44	6	43
Cyprinidae (minnows and carps)	4.3	36	4.1	36
Catostomidae (suckers)	4	29	2	18
Ictaluridae (freshwater catfishes)	3.3	21	2	14
Gadidae (codfishes)	2	18	2	18
Cyprinodontidae (killifishes)	3.3	23	2.5	19
Gasterodteidae (sticklebacks)	2.2	20	2.8	25
Percichthyidae (temperate basses)	4.3	30	3.5	28
Percidaes (perches)	4.8	30	5	39

Notes:
1. * Data sources are "average" and "consensus" responses derived from from expert responses to matrices.
2. # - Affirmative response rate is a simple average number of affirmative responses for individual species.
3. % - Affirmative response rate is a percentage of the total number of affirmative and negative responses.
4. Bold type indicates affirmative response rate >50% of total number of cells; toned areas indicate the 5 highest affirmative response rates for each assessment type.

Appendix 8
Summary and assessment of affirmative response rates by category

The following tables summarize the number of affirmative (√) responses per-species and by category of variables, along with a comparison of results from the various assessments. The purpose of these assessments is to determine the relative need for special management attention of species in relation to the various categories of variables. Assessments were done by averaging all of the responses as well as from the "consensus" derived from the responses. Affirmative responses were calculated as a simple number and as a percentage of total (√ + X) responses. Tables included in Appendix 8 are listed below.

8.1 List of tables:

- **8.2 Number of affirmative responses by species and category from respondents**
  - 8.2.1 Number of affirmative responses by species and category from respondents - Mammals
  - 8.2.2 Number of affirmative responses by species and category from respondents - Reptiles and Amphibians
  - 8.2.3 Number of affirmative responses by species and category from respondents - Freshwater Fishes
- **8.3 Average affirmative response rate by species and category from respondents**
  - 8.3.1 Average affirmative response rate by species and category from respondents - Mammals
  - 8.3.2 Average affirmative response rate by species and category from respondents - Reptiles and Amphibians
  - 8.3.3 Average affirmative response rate by species and category from respondents - Freshwater Fishes
- **8.4 Affirmative response rate by species and category from consensus**
  - 8.4.1 Affirmative response rate by species and category from consensus - Mammals
  - 8.4.2 Affirmative response rate by species and category from consensus - Reptiles and Amphibians
  - 8.4.3 Affirmative response rate by species and category from consensus - Freshwater Fishes

- **8.5 Affirmative response rates by species and category and by data source and assessment type**
  - 8.5.1 Affirmative response rates by species and category and by data source and assessment type - Mammals
  - 8.5.2 Affirmative response rates by species and category and by data source and assessment type - Reptiles and Amphibians
  - 8.5.3 Affirmative response rates by species and category and by data source and assessment type - Freshwater Fishes
- **8.6: Summary of affirmative response rates by species, category and assessment type**

Appendix 8.2.1: Number of affirmative responses by category and species from respondents

Categories / Mammal Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerability	4. Species of major ecological import.	5. Human impact factors	6. Information status
Arctic shrew ^	3,4,3^,4	1,0,0,0^,1	1,2,2,2^,4	1,1,1,1^,1	1,1,1^,2	4,2,2^,5
Common shrew*^	0*,0,0,0^,0	0*,1,0,0, 0^,1	0*,0,0,0, 0^,0	2*,2,2,2, 2^,2	1*,1,1,1^,1	3*,3,1,2^,1
Smokey shrew^	0,0,1^,0	1,0,0,0^,0	1,1,1,2^,0	1,1,1,1^,1	1,1,1^,1	4,2,2^,2
Gaspé shrew*	7*,7,7,6	1*,0,0,0,0	2*,2,2,2,3	1*,1,1,0,1	1*,0,0,0	5*,5,3,3
Long-tailed shrew	4,4,5	0,0,0,0	1,2,2,3	1,1,1,1	1,1,1	5,3,3
Water shrew*^	3*,2,2,2^,1	0*,1,0,0, 0^,1	3*,0,2,2, 2^,1	1*,1,1,1, 1^,1	1*,1,1,1^,1	4*,4,2,2^,5
Pygmy shrew*^	3*,2,2,2^,2	1*,1,0,0, 0^,1	0*,1,0,0, 0^,0	1*,1,1,1, 1^,1	1*,1,1,1^,1	4*,4,2,2^,5
Short-tailed shrew*^	3*,0,0,0^,0	1*,2,0,0, 0^,1	2*,2,2,2, 2^,0	1*,1,1,1, 1^,1	1*,1,1,1^,1	4*,4,2,2^,2
Star-nosed mole*^	5*,2,2,2^,1	1*,1,0,0, 0^,0	3*,1,2,2, 2^,2	1*,0,1,1, 1^,1	1*,1,1,1^,1	4*,4,2,2^,2
Little brown bat*^	0*,0,0,0^,0	2*,2,2,2, 2^,4	2*,1,3,2, 2^,3	1*,1,0,0,0, 1^,1	1*,2,0,3, 4^,3	4*,4,2,2, 2^,3
Northern long-eared bat*^	4*,4,4,4^,2	2*,2,2,2, 2^,2	1*,0,1,1, 1^,2	1*,1,0,0,0, 1^,1	3*,2,0,3, 3^,2	4*,4,2,2, 2^,2
Eastern pipistrelle^	4,4,3^,3	2,2,2,2^,4	1,2,2,2^,3	1,0,0,0,1^,1	3,0,4,4^,1	4,2,2,2^,5
Silver-haired bat^	6,6,5^,3	2,2,2,2^,3	1,2,2,2^,1	1,0,0,0,1^,1	2,0,3,3^,1	4,2,2,2^,5
Red bat^	5,5,4^,2	0,0,0,0^,3	0,1,1,1^,1	1,0,0,0,1^,1	2,0,3,3^,1	4,2,2,2^,5
Hoary bat^	6,0,5^,1	1,0,0,0^,4	0,1,1,1^,1	1,0,0,0,1^,1	2,0,3,3^,1	4,2,2,2^,5
Coyote*^	1*,0,0,0,0, 0^,0	2*,3,2,2,2,2 ,2^,2	0*,0,0,0,0,0 ,0^,0	2*,2,1,2,2,2 ,2,2^,2	2*,1,1,1,2,1 ,2^,2	2*,2,1,0,0,1 ,0,0
Red fox*^	0*,0,0,0,0, 1^,0	0*,1,0,0,0,0 ,0^,0	0*,0,0,0,0,0 ,0^,0	2*,2,2,2,2,2 ,2,2^,2	2*,1,1,1,1,1 ,2^,1	2*,2,0,0,0,0 ,2^,0
American black bear*^	1*,0,0,1,0,1 ^,0	3*,4,3,3,3,3 ,3^,3	0*,0,1,0,0,0 ,0^,0	2*,2,0,2,2,2 ,2,2^,2	2*,1,1,1,1,1 ,1^,1	2*,2,1,0,0,0 ,1^,0
Racoon*^	1*,1,1,1, 5^,1	0,1,0,0,0, 1^,0	0*,0,0,0,0,0 ^,0	1*,1,1,1,1,1 ,1^,0	2*,2,1,2,2,2 ^,2	2*,2,0,0,0,0 ^,0
American marten*^	6*,6,6,6,5,4 ^	0*,0,0,1,0,0 ^,0	2*,1,2,2,2,3 ^,2	2*,2,2,2,2,2 ,2^,2	4*,2,1,3,3,3 ^,3	4*,4,1,2,3,1 ^,2
Fisher^	5,5,5,5^,3	1,1,1,1,1^,1	0,2,2,2,2^,2	2,2,2,2,2,2^ ,2	1,1,2,2,3^,2	4,0,2,2,2^,2
Ermine/Weasel *^	0*,0,0,0, 0^,0	0*,1,0,0,0,0 ^,0	2*,0,2,2,1,2 ^,2	2*,2,2,2,2,2 ,2^,2	2*,2,1,2,2,2 ^,2	4*,4,0,2,2,2 ^,2
American mink*^	0*,0,0,0, 0^,0	0*,0,0,0,0,0 ^,0	2*,0,2,2,2,2 ^,2	2*,2,2,2,2,2 ,2^,2	1*,1,1,1,1,2 ^,1	2*,2,0,0,0,2 ^,0
Striped skunk^	0,0,0,0^,0	1,0,0,0,0^,0	0,0,0,0,0^,0	1,1,1,1,1,1^ ,0	2,1,2,2,2^,2	3,0,1,1,1^,1
River otter*^	3*,0,4,1,3,2 ^,1	1*,1,1,1,1,1 ,1^,1	2*,0,2,2,2,2 ,2^,2	2*,2,2,2,2,2 ,2,2^,2	4*,2,1,3,3,3 ,4^,3	2*,3,0,1,1,1 ,2^,1
Eastern cougar *^	6*,5,2,6,5,6 ,4^,3	3*,3,3,3,3,3 ,3,3^,3	1*,1,1,1,1,1 ,1,1^,0	2*,2,2,2,2,2 ,2,2,2^,2	3*,3,1,1,3,3 ,3,3^,2	4*,4,4,2,2,2 ,2,2^,5
Lynx*^	6*,5,5,5,5,4 ^,5	2*,3,2,2,2,2 ,2^,2	3*,1,2,2,2,2 ,2^,2	2*,2,2,2,2,2 ,2,2^,2	2*,2,3,1,3,3 ,4^,3	4*,4,2,1,2,2 ,2^,2
Bobcat*^	2*,2,2,2,2,2 ^,1	2*,3,2,2,2,2 ,3^,2	0*,0,0,0,0,0 ,0^,0	2*,2,2,2,2,2 ,2,2^,2	1*,1,1,1,1,1 ,2^,1	3*,3,1,0,1,1 ,2^,1
White-tailed deer*^	1*,0,0,0,0,1 ^,0	4*,5,3,4,4,4 ,4^,4	0*,0,0,0,0,0 ,0^,0	1*,1,1,1,1,1 ,1,1^,1	1*,1,1,1,1,1 ,2^,1	2*,2,1,0,0,0 ,0^,0
Moose*^	1*,2,2 ,2, 2,4^,2	3*,4,2,3,3, 3,3^,3	1*,0,1,1,1,1 ,1^,1	1*,1,1,1,1,1 ,1,1^,1	1*,1,2,1,1,1 ,3^,1	1*,2,4,0,0,0 ,2^,0

Eastern chipmunk*^	0,0,0,0^,0	0*,1,0,0, 1^,0	0*,0,0,0, 0^,0	0*,0,0,0,0,0 ^,0	1*,1,1,1, 1^,1	4*,4,1,2, 2^,2
Woodchuck/Groundhog^	0,0,1^,0	2,0,0,0^,0	0,0,0,0^,0	0,0,0,0,0^,0	2,2,2,2^,2	3,1,1,2^,1
American red squirrel*^	0*,0,0,0^,0	0*,1,0,0, 1^,1	1*,0,1,1, 1^,1	0*,0,0,0,0, 0^,0	2*,2,1,2, 2^,2	3*,3,0,1, 2^,2
Southern flying squirrel^	6,7,7,8^,5	1,2,0,0,0^,0	1,1,1,1,1^,1	0,0,0,0,0,0^ ,0	0,0,0,0,1^,0	4,2,2,2,2^,4
Northern flying squirrel*^	1*,0,0,0, 0^,0	0*,1,2,0,0,0 ^,0	2*,0,2,2,2,2 ^,1	0*,0,0,0,0,1 ,0^,0	0*,0,0,0,2,1 ^,0	4*,4,2,2,2,2 ^,2
American beaver*^	1*,0,0,0, 0^,0	0*,0,0,0,0,0 ^,0	2*,0,1,1,1,1 ^,1	1*,0,1,0,2,1 ,2^,0	1*,1,1,1,1,2 ^,1	1*,2,0,0,0,2 ^,0
Deer mouse*^	0*,0,0,0^,0	0*,1,0,0, 1^,1	0*,0,0,0, 0^,0	1*,1,1,1,1,1 ^,1	1*,1,1,1, 1^,1	3*,3,1,1, 1^,1
White-footed mouse^	2,2,2^,2	1,0,0,0^,0	0,0,0,0^,0	0,0,0,0,0^,0	1,1,1,1^,1	4,2,2,2^,2
Red-backed vole *^	0*,0,0,0^,0	0*,1,0,0, 1^,0	1*,1,1,1, 1^,0	1*,1,1,1,1,1 ^,1	1*,1,1,1, 1^,1	3*,3,1,1, 2^,1
Southern bog lemming*^	1*,1,1,0^,0	1*,2,0,0, 1^,0	1*,0,1,1, 1^,1	0*,0,0,0,0,0 ^,0	1*,1,1,1, 1^,1	5*,5,3,3, 3^,3
Muskrat*^	2*,1,1,2^,1	0*,2,0,0, 0^,0	1*,0,1,1, 1^,1	0*,0,0,0,0,0 ^,0	1*,1,1,1, 2^,1	2*,2,0,0, 2^,0
Meadow vole *^	0*,0,0,0^,0	0*,2,0,0, 1^,2	1*,1,1,1, 1^,0	1*,1,1,1,1,1 ^,1	1*,1,1,1, 1^,1	3*,3,1,1, 3^,3
Rock vole*	5*,5,5,4	0*,0,0,0,2	2*,1,1,1,2	0*,0,0,0,0,0	1*,1,1,1.0	5*,5,3,3.3
Woodland jumping mouse*^	2*,2,2,2^,1	0*,1,0,0, 0^,0	1*,0,1,1, 1^,1	0*,0,0,0,0,0 ^,0	1*,0,0,0, 1^,0	3*,3,1,1, 2^,1
Meadow jumping mouse*^	2*,1,1,1^,0	0*,1,0,0, 0^,0	1*,0,1,1, 1^,1	0*,0,0,0,0,0 ^,0	1*,1,1,1, 1^,1	3*,3,1,1, 3^,1
American porcupine^	2,2,2,2^,0	3,1,1,1,1^,1	0,1,1,1,1^,1	0,0,0,0,1,1^ ,0	2,2,2,2,2^,2	3,1,1,1,3^,1
Snowshoe hare*^	0*,0,0,0, 0^,0	0*,1,1,1,1,1 ^,1	0*,0,0,0,0,0 ^,0	2*,2,2,2,2,2 ,2^,2	0*,1,1,1,2,2 ^,1	2*,2,0,0,0,1 ^,0

Notes:

1. * Marked responses refer to regional context and species in northern Cape Breton only (Respondent 1)
2. Respondent 3 limited responses to species from and including coyote to American black bear, and eastern cougar to moose.
3. Respondent 5 limited responses to categories from and including 4 to 6, and for species from and including little brown bat to snowshoe hare
4. Responses recorded from Respondent 7 are limited to and including river otter and eastern cougar.
5. Responses recorded from Respondent 8 are limited to and including coyote to moose, southern flying squirrel to American beaver, and American porcupine and snowshoe hare.
6. Responses from Respondent 10 are limited to and including categories 2 to 4.
7. ^ Marked responses refer to Southwest N.S.Upland region and species existing and possibly existing in Kejimkujik National Park only (Respondent 15)
8. Includes to and including Respondent 17.

Appendix 8.2.2: Number of affirmative responses by category and species from respondents

Category / Reptile and Amphibian Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human impact factors	6. Informa-tion status
Snapping turtle^	2,2,1,2^,1	2,2,2,4,3^,4,4	0,0,0,0,0^,0,0,1	2,2,2,2,2^,2,2,2	2,1,4,4,4^,4,2	3,2,2,2,2^,2,2
Wood turtle*	4*,5,5,3,4	3*,3,3,3,3,3,2	2*,2,2,2,2,2,4	0*,0,0,0,0,0,0	4*,4,2,4,3,2	2*,4,2,2,2,2
Blanding's turtle^^^	6,6,6^^,5,6^,6	3,3,3^^,3,3,3^,3,4	2,2,2^^,2,2,2^,2,3	0,0,1^^,0,0,1^,0,1	2,2,2,2^^,2,2^,2	1,1,1,1^^,1,0^,1
Eastern painted turtle^	2,2,1,2^	1,1,1,1,2^,1	0,0,0,0,0^,0	0,0,0,0,0^,0	2,1,2,1,2^	4,2,2,2,2^
Maritime garter snake*^^^	0*,0,0,0^^,0,0^	1*,1,1,1^^,1,1,3^,1	0*,0,0,0^^,0,0,0^,0	2*,1,1,1^^,1,1,1^,1	1*,2,1,1,1^^,1,1^	2*,4,2,2,2^^,2,2^
Northern ribbon snake^	5,5,4,5^	1,1,1,1,2^,1	1,1,1,1,1^,1	1,1,1,1,1^,1	4,0,3,3,3^	4,2,2,2,2^
Northern ringneck snake*^	1*,1,1,0,1^	1*,1,2,1,1,2^,1	2*,2,2,2,2,2^,2	2*,1,1,1,1,1^,1	1*,2,1,1,1,1^	2*,4,2,2,2,3^
Eastern smooth green snake*^	0*,0,0,0,0^	1*,1,1,1,1,2^,1	2*,2,2,2,2,2^,2	1*,1,1,1,1,1^,1	1*,2,1,1,1,1^	2*,4,2,2,2,3^
Northern redbelly snake*^	0*,0,0,0,0^	1*,1,1,1,1,2^,1	1*,1,1,1,1,1^,1	0*,1,1,1,1,1^,1	1*,2,1,1,1,1^	2*,4,2,2,2,3^
Eastern American toad*^	0*,0,0,0,0,0^	1*,1,3,1,1,1,2^,1	0*,0,0,0,0,0,0^,0	1*,1,2,1,1,1,2^,1	1*,2,3,1,1,1,1^	2*,4,4,2,2,2,3^
Northern spring peeper*^	0*,0,0,0,0,0^	1*,2,2,1,1,1,2^,1	0*,0,0,0,0,0,0^,0	1*,1,2,1,1,1,2^,1	1*,2,3,1,1,1,1^	2*,4,4,1,2,2,3^
Bullfrog^	1,1,1,1,1^	3,3,2,2,2,3^,2	0,0,0,0,0,0^,0	1,2,1,1,1,2^,1	2,4,1,2,2,2^	4,4,2,2,2,3^
Green frog*^	0*,0,0,0,0,0^	1*,2,2,1,1,1,2^,1	1*,1,1,1,1,1,1^,1	1*,1,2,1,1,1,2^,1	1*,2,3,1,1,1,1^	2*,4,4,2,2,2,3^
Mink frog*^	0*,0,0,0,0,0^	1*,2,2,1,1,1,2^,1	1*,1,1,1,1,1,1^,1	1*,1,2,1,1,1,2^,1	1*,2,3,1,1,1,1^	2*,4,4,2,2,2,3^
Northern leopard frog*^	0*,0,0,0,0,0^	2*,3,3,2,2,2,3^,2	1*,1,1,1,1,1,1^,1	1*,1,2,1,1,1,2^,1	2*,2,3,1,2,2,2^	2*,4,4,2,2,2,3^
Pikerel frog*^	0*,0,0,0,0,0^	3*,3,3,3,3,2,3^,3	1*,1,1,1,1,1,2^,1	1*,1,2,1,1,1,2^,1	1*,2,3,1,1,1,1^	2*,4,4,2,2,2,3^
Wood frog*^	0*,0,0,0,0,0^	1*,2,3,1,1,1,2^,1	0*,0,0,1,0,0,0^,0	1*,1,2,1,1,1,2^,1	1*,2,3,1,1,1,1^	2*,4,4,2,2,2,3^
Yellow-spotted salamander*^	0*,0,0,0,0,0^	0*,1,3,0,0,0,1^,2	0*,0,0,0,0,0,0^,0	1*,0,1,0,0,0,1^,0	1*,2,3,1,1,1,1^	2*,4,4,2,2,2,3^
Blue-spotted salamander*^	3*,3,3,3,0,4^	0*,1,3,0,0,0,1^,2	1*,1,1,1,1,1,1^,1	0*,0,1,0,0,0,1^,0	3*,4,3,1,3,3,3^	1*,3,2,1,1,1,3^
Red-spotted newt*^	0*,0,0,0,0,0^	0*,1,3,0,0,0,1^,0	2*,2,2,2,2,2,2^,2	1*,0,1,0,0,0,1^,0	2*,3,3,1,2,2,2^	2*,4,3,2,2,2,3^
Red-backed salamander*^	0*,0,0,0,0,0^	0*,1,4,0,0,0,1^,1	2*,2,2,2,2,2,2^,2	1*,1,2,1,1,1,2^,1	1*,2,3,1,1,1,1^	2*,4,3,2,2,2,3^
Four-toed salamander*^	2*,2,4,3,1,2^	0*,1,3,0,0,0,1^,1	2*,2,3,2,2,2,2^,2	0*,0,1,0,0,0,1^,0	3*,4,3,0,3,3,3^	3*,5,4,3,3,3,3^

Notes: 1. * Marked responses refer to context and species existing in Northern Cape Breton (Respondent1)
2. Responses from Respondent 4 are limited to amphibian species.
3. Responses from Respondent 5 are limited to categories 5 and 6
4. Responses from Respondent 7 were not included because no revisions or additions were made to those provided in the base matrix.
5. ^^Responses from Respondent 8 are limited to Blanding's turtle and Maritime garter snake, and refer to those in Kejimkujik National Park only. Other responses were not included because no revisions or additions were made to those provided in the base matrix
6. Responses from Respondent 10 are limited to and including categories 2 to 4.
7. ^Marked responses refer to context and species existing in Kejimkujik National Park (Respondent 15)
8. Responses from Respondent 16 are limited to and including categories 2 to 4.
9. Responses from Respondent 19 are limited to snapping turtle, wood turtle, and Blandings turtle.
10. Includes to and including Respondent 19.

Appendix 8.2.3: Number of affirmative responses by category and species from Respondents

Categories Freshwater Fish Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human -Impact factors	6. Informa-tion status
Sea lamprey *	2*,0,0	2*,2,3	0*,0,2	0*,0,1	1*,1,1	0*,0,0
Atlantic sturgeon *	2*,0,0,0	3*,3,3,3	0*,0,0,2	0*,0,0,0	1*,2,1,1	0*,5,1,0
American eel^	1,0^,0	1,1^,3	0,0^,0	0,1^,1	2,2^,1	0,2^,1
Blueback herring *	1,1,1	2,1,3	0,0,2	1,1,1	4,1,1	5,1,1
Gaspereau/Alewife	0,0	2,3	2,4	1,1	1,1	0,0
American shad *	0,0,0	4,1,3	3,1,3	1,1,1	4,1,1	3,0,0
Atlantic whitefish	8,8	2,4	0,1	0,2	3,2	1,0
Lake whitefish^	3,3	1,3	0,0	0,2	3,3	0,0
Atlantic salmon*	1*,1,2,1,2,1	5*,4,3,3,3,4	4*,4,2,2,4,4	1*,1,1,1,2,2	3*,3,3,3,3,3	0*,1,0,0,0,0
Brook trout*^	0*,0,0,0, 0^,0	2*,2,2,3, 3^,2	1*,4,1,1, 2^,4	1*,1,1,1, 2^,1	3*,3,2,2, 2^,2	0*,0,0,0, 0^,0
Lake trout	3,2,0,0	2,2,2,4	3,1,1,1	1,1,1,2	1,2,1,1	1,1,1,1
Rainbow smelt*	0*,0,0	2*,3,3	1*,2,4	1*,1,1	1*,1,1	0*,0,0
Northern redbelly dace	0,0	1,1	1,2	1,1	1,1	0,0
Lake chub	0,0	2,3	0,0	1,1	1,1	0,0
Golden shiner^	0,0^,0	1,1^,3	0,0^,0	1,2^,1	1,2^,1	0,3^,0
Common shiner	0,0	1,1	0,0	1,1	1,1	0,0
Blacknose shiner	1,1	1,1	1,1	1,1	1,1	0,0
Blacknose dace	2,2	1,1	1,2	1,1	0,0	0,0
Creek chub * ^	0,0^,0	1,1^,1	0,0^,1	0,1^,0	1,2^,1	0,3^,0
Fallfish	3,3	1,1	0,1	0,0	0,0	0,0
Pearl dace *	1,1	1,1	1,2	1,1	0,0	0,0
White sucker * ^	0,0^,0	1,1^,2	0,0^,1	0,2^,0	1,2^,1	0,3^,0
Brown bullhead^	0,0^,0	1,1^,1	0,0^,0	0,1^,0	1,2^,1	0,3^,0
Atlantic tomcod *	0,0	1,1	0,0	0,0	1,1	0,0
Banded killifish*^	0,0^,0	1,1^,1	0,0^,0	1,2^,1	1,2^,1	0,3^,0
Mummichog *	0,0	0,1	0,0	1,1	1,1	0,0
Fourspine stickleback*	0,0	0,0	0,0	0,0	0,0	0,0
Brook stickleback	3,3	1,1	1,1	0,0	0,0	0,0
Threespine stickleback*	0,0	0,0	0,1	1,1	0,0	0,0
Ninespine stickleback* ^	0,0^,0	0,0^,0	0,0^,0	1,2^,1	0,1^,0	0,3^,0
White perch^	0,0^,0	1,2^,2	0,0^,2	0,1^,1	1,1^,1	0,0^,0
Striped bass*	0,0	2,3	0,2	1,1	1,1	0,0
Yellow perch^	0,0^,0	2,2^,3	0,0^,0	1,2^,2	1,1^,1	0,0^,0

Notes:

1. * Marked responses refer to regional context and species in northern Cape Breton only (Respondent 1); category responses limited to salmonids .
2. Respondent 2 responses limited to Atlantic sturgeon, blueback herring, American shad, Atlantic salmon, brook trout, and lake trout.
3. Resondent 6 responses limited to Atlantic salmon
4. Respondent 8 responses limited to Atlantic salmon, brook trout, lake trout and rainbow smelt
5. ^ Marked responses refer to Southwest N.S. Uplands region and species existing and possibly existing in Kejimkujik National Park (Respondent 15)
6. Includes to and including Respondent 18.

Appendix 8.3.1: Average number of affirmative responses by category and species from respondents

Categories / Mammal Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human impact factors	6. Informa-tion status
Arctic shrew	3.5	.4	2.2	1	1.3	3.3
Common shrew	0	.3	0	2	1	2
Smokey shrew	.3	.2	1	1	1	2.5
Gaspé shrew	6.8	.2	2.2	.8	.3	4
Long-tailed shrew	4.3	0	2	1	1	3.7
Water shrew	2	.4	1.7	1	1	3.4
Pygmy shrew	2.2	.5	.2	1	1	3.4
Short-tailed shrew	.6	.7	1.7	1	1	2.8
Star-nosed mole	2.4	.3	2	.8	1	2.8
Little brown bat	0	2.3	2.2	.6	2.2	2.8
Northern long-eared bat	3.6	2	1	.6	2.2	2.7
Eastern pipistrelle	3.5	2.4	2	.5	2.4	3
Silver-haired bat	5	2.2	1.6	.5	1.8	3
Red bat	4	.6	.8	.5	1.8	3
Hoary bat	3	1	.8	.5	1.8	3
Coyote	.1	2.1	0	1.9	1.5	.8
Red fox	.1	.1	0	2	1.3	.8
American black bear	.4	3.1	.1	1.8	1.1	.8
Racoon	1.7	.3	0	.9	1.9	.6
American marten	5.5	.1	2	2	2.7	2.4
Fisher	4.6	1	1.7	2	1.8	2
Ermine/Weasel	0	.1	1.6	2	1.9	2.3
American mink	0	0	1.7	2	1.1	.9
Striped skunk	0	.2	0	.9	1.8	1.2
River otter	2	1	1.8	2	2.9	1.4
Eastern cougar	4.6	3	.9	2	2.4	3
Lynx	5	2.1	2	2	2.6	2.4
Bobcat	1.9	2.3	0	2	1.1	1.5
White-tailed deer	.3	4	0	1	1.1	.6
Moose	2.1	3	.9	1	1.4	1.1
Eastern chipmunk	0	.3	0	0	1	2.5
Woodchuck/Groundhog	.3	.4	0	0	2	1.6
American red squirrel	0	.5	.8	0	1.8	1.8
Southern flying squirrel	6.6	.5	1	0	.2	2.7
Northern flying squirrel	.2	.4	1.6	.1	.4	2.6
American beaver	.2	0	1	.9	1.1	.7
Deer mouse	0	.5	0	1	1	1.7
White-footed mouse	2	.2	0	0	1	2.4
Red-backed vole	0	.3	.8	1	1	1.8
Southern bog lemming	.6	.7	.8	0	1	3.7
Muskrat	1.4	.3	.8	0	1.2	1
Meadow vole	0	.8	.8	1	1	2.3
Rock vole	4.8	.4	1.4	0	.8	3.8
Woodland jump. mouse	1.8	.2	.8	0	.3	1.8
Meadow jumping mouse	1	.2	.8	0	1	2
American porcupine	1.6	1.3	.8	.3	2	1.7
Snowshoe hare	0	.9	0	2	1.1	.7

To and including Respondent 17; Bold type indicates 10 highest affirmative response rates in each category.

Appendix 8.3.2: Average number of affirmative responses by category and species from respondents

Categories Reptile and Amphibian Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human impact factors	6. Informa-tion status
Snapping turtle	1.6	**3**	.1	**2**	**3**	2.1
Wood turtle	**4.2**	**2.9**	**2**	0	**3.2**	2.3
Blanding's turtle	**5.8**	**3.1**	**2.1**	.4	**2**	.9
Eastern painted turtle	1.8	1.2	0	0	1.6	2.2
Maritime garter snake	0	1.3	0	1.1	1.1	2.3
Northern ribbon snake	**4.8**	1.2	1	1	**2.6**	2.4
Northern ringneck snake	.8	1.3	**2**	1.1	1.1	2.5
E. smooth green snake	0	1.1	**2**	1	1.1	2.5
Northern redbelly snake	0	1.1	1	.9	1.1	2.5
Eastern American toad	0	1.4	0	**1.3**	1.4	**2.7**
Northern spring peeper	0	1.4	0	**1.3**	1.4	2.6
Bullfrog	1	**2.4**	0	**1.3**	**2.2**	**2.8**
Green frog	0	1.4	1	**1.3**	1.4	**2.7**
Mink frog	0	1.4	1	**1.3**	1.4	**2.7**
Northern leopard frog	0	**2.4**	1	**1.3**	2	**2.7**
Pikerel frog	0	**2.9**	1.1	**1.3**	1.4	**2.7**
Wood frog	0	1.5	.1	**1.3**	1.4	**2.7**
Yellow-spot. salamander	0	.9	0	.4	1.4	**2.7**
Blue-spotted salamander	**2.7**	.9	1	.3	**2.9**	1.7
Red-spotted newt	0	.6	**2**	.4	2.1	2.6
Red-backed salamander	0	.9	**2**	**1.3**	1.4	2.6
Four-toed salamander	**2.3**	.8	**2.1**	.3	**2.7**	**3.4**

Includes to and including Respondent 19.
Bold type indicates the 5 highest affirmative response rates in each category.

Appendix 8.3.3: Average number of affirmative responses by category and species from respondents

Categories / Freshwater Fish Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human -impact factors	6. Informa-tion status
Sea lamprey	.7	2.3	.7	.3	1	0
Atlantic sturgeon	.5	3	.5	0	1.3	1.5
American eel	.3	1.7	0	.7	1.7	1
Blueback herring	1	2	.7	1	2	2.3
Gaspereau/Alewife	0	2.5	3	1	1	0
American shad	0	2.7	2.3	1	2	1
Atlantic whitefish	8	3	.5	1	2.5	.5
Lake whitefish	3	2	0	1	3	0
Atlantic salmon	1.3	3.7	3.3	1.3	3	.2
Brook trout	0	2.3	2.2	1.2	2.3	0
Lake trout	1.3	2.5	1.5	1.3	1.3	1
Rainbow smelt	0	2.7	2.3	1	1	0
Northern redbelly dace	0	1	1.5	1	1	0
Lake chub	0	2.5	0	1	1	0
Golden shiner	0	1.3	0	1.3	1.3	1
Common shiner	0	1	0	1	1	0
Blacknose shiner	1	1	1	1	1	0
Blacknose dace	2	1	1.5	1	0	0
Creek chub	0	1	.3	.3	1.3	1
Fallfish	3	1	.5	0	0	0
Pearl dace	1	1	1.5	1	0	0
White sucker	0	1.3	.3	.7	1.3	1
Brown bullhead	0	1	0	.3	1.3	1
Atlantic tomcod	0	1	0	0	1	0
Banded killifish	0	1	0	1.3	1.3	1
Mummichog	0	.5	0	1	1	0
Fourspine stickleback	0	0	0	0	0	0
Brook stickleback	3	1	1	0	0	0
Threespine stickleback	0	0	.5	1	0	0
Ninespine stickleback	0	0	0	1.3	.3	1
White perch	0	1.7	.7	.7	1	0
Striped bass	0	2.5	1	1	1	0
Yellow perch	0	2.3	0	1.7	1	0

Includes to and including Respondent 18.
Bold type indicates 5 highest affirmative response rates in each category.

Appendix 8.4.1: Number of affirmative responses by category and species from consensus

Categories / Mammal Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human impact factors	6. Informa-tion status
Arctic shrew	1	0	1	1	1	**4**
Common shrew	0	1	0	**2**	1	3
Smokey shrew	0	0	0	1	1	2
Gaspé shrew	**5**	0	**2**	1	0	**5**
Long-tailed shrew	**4**	0	1	1	1	3
Water shrew	0	0	0	1	1	**4**
Pygmy shrew	1	0	0	1	1	**4**
Short-tailed shrew	0	1	0	1	1	**4**
Star-nosed mole	1	0	1	0	1	**4**
Little brown bat	0	**2**	0	1	0	3
Northern long-eared bat	1	**2**	0	1	1	**4**
Eastern pipistrelle	**4**	**2**	0	1	0	**4**
Silver-haired bat	**4**	0	0	1	0	**4**
Red bat	**3**	0	0	1	0	**4**
Hoary bat	1	0	0	1	0	**4**
Coyote	0	**2**	0	1	1	0
Red fox	0	0	0	**2**	1	2
American black bear	0	**3**	0	0	1	1
Racoon	1	1	0	0	1	0
American marten	2	0	1	**2**	1	0
Fisher	**3**	1	0	**2**	0	0
Ermine/Weasel	0	0	0	**2**	1	2
American mink	0	0	0	**2**	1	2
Striped skunk	0	0	0	0	0	0
River otter	0	1	0	**2**	**2**	1
Eastern cougar	**3**	**3**	0	**2**	0	3
Lynx	**5**	**2**	0	**2**	**2**	3
Bobcat	1	**2**	0	**2**	1	2
White-tailed deer	0	1	0	1	1	0
Moose	0	**2**	0	1	1	1
Eastern chipmunk	0	1	0	0	1	3
Woodchuck/Groundhog	0	0	0	0	1	1
American red squirrel	0	1	0	0	1	2
Southern flying squirrel	**4**	0	1	0	0	3
Northern flying squirrel	0	0	0	0	0	**4**
American beaver	0	0	0	1	1	1
Deer mouse	0	1	0	1	1	3
White-footed mouse	2	0	0	0	1	2
Red-backed vole	0	1	0	1	1	3
Southern bog lemming	0	1	0	0	1	5
Muskrat	1	0	0	0	1	2
Meadow vole	0	1	0	1	1	3
Rock vole	2	0	**2**	0	0	3
Woodland jump. mouse	1	0	0	0	0	3
Meadow jumping mouse	0	0	0	0	1	3
American porcupine	0	1	0	1	1	1
Snowshoe hare	0	1	0	**2**	1	2

Bold type indicates 10 highest affirmative response rates in each category.

Appendix 8.4.2: Number of affirmative responses by category and species from consensus

Categories Reptile and Amphibian Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human impact factors	6. Informa-tion status
Snapping turtle	2	1	0	2	1	1
Wood turtle	2	2	2	0	2	3
Blanding's turtle	6	2	1	0	2	0
Eastern painted turtle	1	1	0	0	1	2
Maritime garter snake	0	0	0	1	1	2
Northern ribbon snake	5	0	1	1	2	2
Northern ringneck snake	1	0	2	1	1	2
E. smooth green snake	0	0	2	1	1	2
Northern redbelly snake	0	0	1	0	1	2
Eastern American toad	0	0	0	1	1	4
Northern spring peeper	0	1	0	1	1	3
Bullfrog	1	2	0	1	1	4
Green frog	0	1	1	1	1	4
Mink frog	0	1	0	1	1	4
Northern leopard frog	0	2	1	1	1	4
Pikerel frog	0	2	1	1	1	4
Wood frog	0	1	0	1	1	4
Yellow-spot. salamander	0	1	0	0	1	4
Blue-spotted salamander	2	1	1	0	3	2
Red-spotted newt	0	1	2	0	2	3
Red-backed salamander	0	1	2	1	1	3
Four-toed salamander	3	1	2	0	2	5

Bold type indicates the 10 highest affirmative response rates in each category.

Appendix 8.4.3: Number of affirmative responses by category and species from consensus

Categories Freshwater Fish Species	1. Rarity/ Population status	2. Biological character-istics	3. Habitat-related vulnerabil-ity	4. Species of major ecological import.	5. Human -impact factors	6. Informa-tion status
Sea lamprey	0	2	0	0	1	0
Atlantic sturgeon	0	3	0	0	1	1
American eel	0	1	0	1	1	0
Blueback herring	1	2	0	1	1	1
Gaspereau/Alewife	0	1	2	1	1	0
American shad	0	3	2	1	1	0
Atlantic whitefish	8	2	0	0	2	0
Lake whitefish	3	1	0	0	3	0
Atlantic salmon	2	4	3	2	3	0
Brook trout	0	3	2	1	3	0
Lake trout	2	2	1	1	1	1
Rainbow smelt	0	2	2	1	1	0
Northern redbelly dace	0	1	1	1	1	0
Lake chub	0	2	0	1	1	0
Golden shiner	0	1	0	1	1	0
Common shiner	0	1	0	1	1	0
Blacknose shiner	1	1	1	1	1	0
Blacknose dace	2	1	1	1	1	0
Creek chub	0	1	0	0	1	0
Fallfish	3	1	0	0	1	0
Pearl dace	1	1	1	1	1	0
White sucker	0	1	0	0	1	0
Brown bullhead	0	1	0	0	1	0
Atlantic tomcod	0	1	0	0	1	0
Banded killifish	0	1	0	1	1	0
Mummichog	0	0	0	1	1	0
Fourspine stickleback	0	0	0	0	1	0
Brook stickleback	3	1	1	0	1	0
Threespine stickleback	0	0	0	1	1	0
Ninespine stickleback	0	0	0	1	1	0
White perch	0	1	0	1	1	0
Striped bass	0	2	0	1	1	0
Yellow perch	0	2	0	2	1	0

Bold type indicates 5 highest affirmative response rates in each category.

Appendix 8.5.1: Affirmative response rates by category, data source and assessment type for mammal species

Categories / Mammal Species	1. Rarity/ Population status				2. Biological characteristics				3. Habitat-related vulnerability				4. Species of major ecological importance				5. Human impact factors				6. Information status			
Data source and Assessment type	Average		Consen-sus		Average		Consen-sus		Average		Consen-sus		Average		Consen-sus		Average		Consen-sus		Average		Consen-sus	
Affirmative response rate	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Arctic shrew	3.5	60	1	20	.4	15	0	0	2.2	84	1	100	1	32	1	33	1.3	78	1	33	3.3	100	4	100
Common shrew	0	0	0	0	.3	8	1	20	0	0	0	0	2	50	2	50	1	88	1	33	2	100	3	100
Smokey shrew	.3	4	0	0	.2	5	0	0	1	33	0	0	1	33	1	33	1	100	1	50	2.5	100	2	100
Gaspé shrew	6.8	11	5	71	.2	5	0	0	2.2	88	2	100	.8	22	1	33	.3	50	0	0	4	100	5	100
Long-tailed shrew	4.3	67	4	50	0	0	0	0	2	92	1	100	1	25	1	25	1	100	1	50	3.7	100	3	100
Water shrew	2	28	0	0	.4	9	0	0	1.7	59	0	0	1	31	1	25	1	64	1	25	3.4	100	4	100
Pygmy shrew	2.2	34	1	14	.5	10	0	0	.2	13	0	0	1	31	1	25	1	64	1	33	3.4	100	4	100
Short-tailed shrew	.6	11	0	0	.7	15	1	25	1.7	43	0	0	1	25	1	25	1	88	1	33	2.8	100	4	100
Star-nosed mole	2.4	38	1	17	.3	8	0	0	2	88	1	100	.8	25	0	0	1	88	1	33	2.8	100	4	100
Little brown bat	0	0	0	0	2.3	50	2	50	2.2	82	0	0	.6	14	1	25	2.2	73	0	0	2.8	90	3	75
Northern long-eared bat	3.6	51	1	17	2	56	2	40	1	78	0	0	.6	14	1	25	2.2	76	1	33	2.7	100	4	100
Eastern pipistrelle	3.5	53	4	50	2.4	50	2	50	2	86	0	0	.5	14	1	25	2.4	70	0	0	3	100	4	100
Silver-haired bat	5	64	4	57	2.2	52	0	0	1.6	71	0	0	.5	14	1	25	1.8	63	0	0	3	100	4	100
Red bat	4	51	3	43	.6	17	0	0	.8	50	0	0	.5	14	1	25	1.8	63	0	0	3	100	4	100
Hoary bat	3	59	1	20	1	21	0	0	.8	50	0	0	.5	14	1	25	1.8	67	0	0	3	100	4	100
Coyote	.1	2	0	0	2.1	40	2	33	0	0	0	0	1.9	47	1	33	1.5	56	1	33	.8	33	0	0
Red fox	.1	2	0	0	.1	3	0	0	0	0	0	0	2	50	2	50	1.3	67	1	33	.8	75	2	100
American black bear	.4	6	0	0	3.1	60	3	50	.1	3	0	0	1.8	53	0	0	1.1	56	1	33	.8	40	1	33
Racoon	1.7	19	1	11	.3	6	1	14	0	0	0	0	.9	26	0	0	1.9	75	1	33	.6	40	0	0
American marten	5.5	66	2	40	.1	2	0	0	2	89	1	50	2	50	2	50	2.7	21	1	50	2.4	83	0	0
Fisher	4.6	59	3	50	1	16	1	14	1.7	77	0	0	2	50	2	50	1.8	79	0	0	2	86	0	0
Ermine/Weasel	0	0	0	0	.1	4	0	0	1.6	52	0	0	2	50	2	50	1.9	81	1	33	2.3	89	2	100
American mink	0	0	0	0	0	0	0	0	1.7	55	0	0	2	50	2	50	1.1	64	1	33	.9	75	2	100
Striped skunk	0	0	0	0	.2	3	0	0	0	0	0	0	.9	25	0	0	1.8	81	0	0	1.2	62	0	0
River otter	2	23	0	0	1	26	1	17	1.8	56	0	0	2	50	2	50	2.9	91	2	100	1.4	77	1	100
Eastern cougar	4.6	63	3	60	3	56	3	50	.9	44	0	0	2	50	2	50	2.4	27	0	0	3	96	3	100
Lynx	5	62	4	57	2.1	34	2	33	2	76	0	0	2	50	2	50	2.6	82	2	67	2.4	94	3	100
Bobcat	1.9	28	1	13	2.3	50	2	50	0	0	0	0	2	50	2	50	1.1	89	1	100	1.5	85	2	100
White-tailed deer	.3	3	0	0	4	63	1	33	0	0	0	0	1	39	1	33	1.1	50	1	33	.6	26	0	0
Moose	2.1	28	0	0	3	47	2	40	.9	50	0	0	1	29	1	25	1.4	60	1	50	1.1	56	1	100

Appendix 8.5.1 (continued)

Categories / Mammal Species	1. Rarity/ Population status				2. Biological characteristics				3. Habitat-related vulnerability				4. Species of major ecological importance				5. Human impact factors				6. Information status			
Data source and Assessment type	Average		Consen-sus		Average		Consen-sus		Average		Consen-sus		Average		Consen-sus		Average		Consen-sus		Average		Consen-sus	
Affirmative response rate	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Eastern chipmunk	0	0	0	0	.3	7	1	17	0	0	0	0	0	0	0	0	1	64	1	25	2.5	94	3	100
Woodchuck/Groundhog	.3	0	0	0	.4	9	0	0	0	0	0	0	0	0	0	0	2	86	1	25	1.6	90	1	100
American red squirrel	0	0	0	0	.5	10	1	17	.8	32	0	0	0	0	0	0	1.8	72	1	33	1.8	85	2	100
Southern flying squirrel	6.6	86	4	80	.5	13	0	0	1	33	1	33	0	0	0	0	.2	17	0	0	2.7	94	3	100
Northern flying squirrel	.2	2	0	0	.4	9	0	0	1.6	50	0	0	.1	0	0	0	.4	60	0	0	2.6	100	4	100
American beaver	.2	0	0	0	0	0	0	0	1	42	0	0	.9	35	1	33	1.1	60	1	33	.7	45	1	50
Deer mouse	0	0	0	0	.5	8	1	17	0	0	0	0	1	29	1	25	1	75	1	25	1.7	100	3	100
White-footed mouse	2	27	2	22	.2	5	0	0	0	0	0	0	0	0	0	0	1	100	1	50	2.4	100	2	100
Red-backed vole	0	0	0	0	.3	7	1	17	.8	21	0	0	1	30	1	25	1	75	1	25	1.8	100	3	100
Southern bog lemming	.6	12	0	0	.7	9	1	20	.8	67	0	0	0	0	0	0	1	86	1	33	3.7	100	5	100
Muskrat	1.4	18	1	11	.3	7	0	0	.8	27	0	0	0	0	0	0	1.2	89	1	100	1	75	2	100
Meadow vole	0	0	0	0	.8	16	1	20	.8	21	0	0	1	32	1	33	1	58	1	25	2.3	83	3	100
Rock vole	4.8	65	2	40	.4	8	0	0	1.4	67	2	50	0	0	0	0	.8	44	0	0	3.8	90	3	100
Woodland jump. mouse	1.8	28	1	13	.2	4	0	0	.8	38	0	0	0	0	0	0	.3	50	0	0	1.8	100	3	100
Meadow jumping mouse	1	15	0	0	.2	4	0	0	.8	27	0	0	0	0	0	0	1	75	1	25	2	100	3	100
American porcupine	1.6	23	0	0	1.3	35	1	25	.8	26	0	0	.3	15	1	33	2	88	1	25	1.7	92	1	100
Snowshoe hare	0	0	0	0	.9	13	1	14	0	0	0	0	2	59	2	50	1.1	64	1	25	.7	63	2	67

Notes:
Bold type indicates 10 highest affirmative response rates for each category, data source (average and consensus) and assessment type (simple number or percentage); toned areas indicate species and categories where high affirmative responses rates were obtained with every data source and type of assessment within each category.

Appendix 8.5.2: Affirmative response rates by category and by data source and assessment type for reptile and amphibian species

Categories / Reptile and Amphibian Species	1. Rarity/ Population status				2. Biological characteristics				3. Habitat-related vulnerability				4. Species of major ecological importance				5. Human impact factors				6. Information status			
Data source and Assessment type	Average		Consensus		Average		Consensus		Average		Consensus		Average		Consensus		Average		Consensus		Average		Consensus	
Affirmative response rate	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Snapping turtle	1.6	30	2	22	3.	97	1	33	.1	4	0	0	2.	83	2	50	3.	75	1	100	2.1	81	1	50
Wood turtle	4.2	69	2	60	2.9	81	2	50	2.	100	2	100	0	0	0	0	3.2	82	2	67	2.3	100	3	100
Blanding's turtle	5.8	84	6	67	3.1	78	2	50	2.1	70	1	100	.4	44	0	0	2.	71	2	50	.9	45	0	0
Eastern painted turtle	1.8	50	1	13	1.2	60	1	25	0	0	0	0	0	0	0	0	1.6	70	1	25	2.2	92	2	100
Maritime garter snake	0	0	0	0	1.3	48	0	0	0	0	0	0	1.1	55	1	33	1.1	65	1	25	2.3	100	2	100
Northern ribbon snake	4.8	80	5	56	1.2	60	0	0	1	77	1	100	1	59	1	50	2.6	100	2	67	2.4	100	2	100
Northern ringneck snake	.8	13	1	11	1.3	62	0	0	2	65	2	67	1.1	65	1	50	1.1	85	1	25	2.5	100	2	100
E. smooth green snake	0	0	0	0	1.1	55	0	0	2	65	2	67	1	59	1	33	1.1	85	1	25	2.5	100	2	100
Northern redbelly snake	0	0	0	0	1.1	55	0	0	1	32	1	33	.9	53	0	0	1.1	85	1	25	2.5	100	2	100
Eastern American toad	0	0	0	0	1.4	64	0	0	0	0	0	0	1.3	68	1	33	1.4	88	1	50	2.7	100	4	100
Northern spring peeper	0	0	0	0	1.4	67	1	25	0	0	0	0	1.3	68	1	33	1.4	88	1	50	2.6	96	3	100
Bullfrog	1	19	1	11	2.4	80	2	50	0	0	0	0	1.3	72	1	33	2.2	92	1	100	2.8	100	4	100
Green frog	0	0	0	0	1.4	67	1	33	1	31	1	25	1.3	72	1	33	1.4	82	1	50	2.7	100	4	100
Mink frog	0	0	0	0	1.4	67	1	33	1	32	0	0	1.3	68	1	33	1.4	88	1	50	2.7	100	4	100
Northern leopard frog	0	0	0	0	2.4	80	2	50	1	31	1	25	1.3	68	1	33	2.	65	1	33	2.7	100	4	100
Pickerel frog	0	0	0	0	2.9	81	2	50	1.1	79	1	50	1.3	68	1	33	1.4	88	1	50	2.7	100	4	100
Wood frog	0	0	0	0	1.5	68	1	33	.1	3.1	0	0	1.3	68	1	33	1.4	82	1	50	2.7	100	4	100
Yellow-spot. salamander	0	0	0	0	.9	56	1	33	0	0	0	0	.4	40	0	0	1.4	82	1	50	2.7	100	4	100
Blue-spotted salamander	2.7	52	2	25	.9	56	1	33	1	46	1	33	.3	33	0	0	2.9	97	3	75	1.7	85	2	100
Red-spotted newt	0	0	0	0	.6	43	1	25	2	65	2	67	.4	40	0	0	2.1	91	2	67	2.6	100	3	100
Red-backed salamander	0	0	0	0	.9	56	1	33	2	63	2	50	1.3	68	1	33	1.4	82	1	50	2.6	100	3	100
Four-toed salamander	2.3	54	2	29	.8	53	1	25	2.1	66	2	67	.3	33	0	0	2.7	90	2	67	3.4	97	5	100

Notes:
Bold type indicates 5 highest affirmative response rates for each category, data source (average and consensus) and assessment type (simple number or percentage); toned areas indicate species and categories where high affirmative responses rates were obtained with every data source and type of assessment within each category .

Appendix 8.5.3: Affirmative response rates by category, data source and assessment type for freshwater fishes

Categories / Freshwater fishes	1. Rarity/ Population status				2. Biological characteristics				3. Habitat-related vulnerability				4. Species of major ecological import.				5. Human impact factors				6. Information status			
Data source	Average		Consen.		Average		Consen.		Average		Consen.		Average		Consen.		Average		Consen.		Average		Consen.	
Assessment type	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Sea lamprey	.7	0	0	0	2.3	50	2	67	.7	50	0	0	.3	100	0	0	1	100	1	100	0	0	0	0
Atlantic sturgeon	.5	0	0	0	3	69	3	75	.5	67	0	0	0	50	0	0	1.3	100	1	100	1.5	100	1	100
American eel	.3	4	0	0	1.7	45	1	50	0	0	0	0	.7	50	1	50	1.7	75	1	100	1	100	0	0
Blueback herring	1	33	1	25	2	50	2	50	.7	40	0	0	1	60	1	100	2	100	1	100	2.3	100	1	100
Gaspereau, Alewife	0	0	0	0	2.5	100	1	100	3	100	2	100	1	60	1	100	1	100	1	100	0	0	0	0
American shad	0	0	0	0	2.7	57	3	60	2.3	57	2	67	1	60	1	100	2	100	1	100	1	60	0	0
Atlantic whitefish	5	100	8	100	3	89	2	100	.5	0	0	0	1	100	0	0	2.5	100	2	67	.5	50	0	0
Lake whitefish	3	80	3	50	2	71	1	100	0	0	0	0	1	100	0	0	3	100	3	100	0	0	0	0
Atlantic salmon	1.3	31	2	33	3.7	76	4	80	3.3	100	3	100	1.3	89	2	100	3	86	3	75	.2	14	0	0
Brook trout	0	0	0	0	2.3	64	3	75	2.2	81	2	100	1.2	100	1	100	2.3	82	3	75	0	0	0	0
Lake trout	1.3	42	2	40	2.5	89	2	100	1.5	71	1	100	1.3	100	1	100	1.3	100	1	100	1	100	1	100
Rainbow smelt	0	0	0	0	2.7	57	2	50	2.3	88	2	100	1	60	1	50	1	100	1	100	0	0	0	0
North. redbelly dace	0	0	0	0	1	25	1	25	1.5	75	1	100	1	50	1	100	1	100	1	100	0	0	0	0
Lake chub	0	0	0	0	2.5	71	2	67	0	0	0	0	1	50	1	100	1	100	1	100	0	0	0	0
Golden shiner	0	0	0	0	1.3	63	1	50	0	0	0	0	1.3	67	1	100	1.3	100	1	100	1	100	0	0
Common shiner	0	0	0	0	1	25	1	25	0	0	0	0	1	50	1	100	1	100	1	100	0	0	0	0
Blacknose shiner	1	17	1	14	1	25	1	25	1	50	1	100	1	50	1	100	1	100	1	100	0	0	0	0
Blacknose dace	2	40	2	33	1	29	1	33	1.5	75	1	100	1	50	1	100	1	100	1	100	0	0	0	0
Creek chub	0	0	0	0	1	25	1	25	.3	50	0	0	.3	33	0	0	1.3	100	1	100	1	100	0	0
Fallfish	3	60	3	50	1	29	1	33	.5	50	0	0	0	0	0	0	0	0	1	100	0	0	0	0
Pearl dace	1	25	1	20	1	25	1	25	1.5	75	1	100	1	50	1	100	0	0	1	100	0	0	0	0
White sucker	0	0	0	0	1.3	57	1	100	.3	17	0	0	.7	40	0	0	1.3	80	1	100	1	100	0	0
Brown bullhead	0	0	0	0	1	19	1	20	0	0	0	0	.3	25	0	0	1.3	80	1	100	1	100	0	0
Atlantic tomcod	0	0	0	0	1	33	1	50	0	0	0	0	0	0	0	0	1	100	1	100	0	0	0	0
Banded killifish	0	0	0	0	1	27	1	33	0	0	0	0	1.3	57	1	50	1.3	80	1	100	1	100	0	0
Mummichog	0	0	0	0	.5	14	0	0	0	0	0	0	1	50	1	100	1	100	1	100	0	0	0	0
Fourspine stickback.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100	0	0	0	0
Brook stickleback	3	60	3	50	1	29	1	50	1	67	1	100	0	0	0	0	0	0	1	100	0	0	0	0
Threespine sticklack.	0	0	0	0	0	0	0	0	.5	25	0	0	1	50	1	100	0	0	1	100	0	0	0	0
Ninespine stcklback.	0	0	0	0	0	0	0	0	0	0	0	0	1.3	57	1	50	.3	100	1	100	1	100	0	0
White perch	0	0	0	0	1.7	30	1	33	.7	29	0	0	.7	67	1	100	1	50	1	100	0	0	0	0
Striped bass	0	0	0	0	2.5	63	2	67	1	50	0	0	1	100	1	100	1	100	1	100	0	0	0	0
Yellow perch	0	0	0	0	2.3	64	2	67	0	0	0	0	1.7	83	2	100	1	50	1	100	0	0	0	0

Bold type indicates 5 highest affirmative response rates for each data source (average and consensus) and assessment type (simple number or percentage); toned areas indicate species and categories where high affirmative responses rates were obtained with every data sourceand assessment type within each category.

Appendix 8.6.1: Summary of assessments of affirmative responses by category and species

Mammal Species	No. of categories in which species scored within 10 highest affirmative response rates:		No. of assessments in which species scored within 10 highest affirmative response rates
	In every assessment type	In at least one assessment type	
Arctic shrew	2	3	9
Common shrew	1	3	7
Smokey shrew	0	2	4
Gaspé shrew	2	3	11
Long-tailed shrew	2	4	13
Water shrew	1	1	4
Pygmy shrew	1	1	4
Short-tailed shrew	0	2	4
Star-nosed mole	1	3	8
Little brown bat	1	4	8
Northern long-eared bat	0	4	7
Eastern pipistrelle	2	5	13
Silver-haired bat	2	4	11
Red bat	1	2	6
Hoary bat	1	2	5
Coyote	0	1	3
Red fox	1	2	5
American black bear	1	2	5
Racoon	0	0	0
American marten	2	4	12
Fisher	2	3	9
Ermine/Weasel	1	2	5
American mink	1	2	5
Striped skunk	0	0	0
River otter	2	4	10
Eastern cougar	3	5	15
Lynx	2	6	16
Bobcat	2	4	11
White-tailed deer	0	1	2
Moose	1	2	6
Eastern chipmunk	0	1	1
Woodchuck/Groundhog	0	2	2
American red squirrel	0	1	1
Southern flying squirrel	1	3	7
Northern flying squirrel	0	1	3
American beaver	0	0	0
Deer mouse	0	1	2
White-footed mouse	0	2	4
Red-backed vole	0	1	2
Southern bog lemming	1	1	4
Muskrat	0	2	3
Meadow vole	0	1	1
Rock vole	0	3	8
Woodland jump. mouse	0	1	2
Meadow jumping mouse	0	1	2
American porcupine	0	2	3
Snowshoe hare	0	1	4

Bold type indicates 10 highest rates; toned areas indicate 5 highest rates.

Appendix 8.6.2: Summary of assessments of affirmative responses by category and species

Reptiles and Amphibians	No. of categories in which species scored within 5 highest affirmative response rates: In every assessment type	No. of categories in which species scored within 5 highest affirmative response rates: In at least one assessment type	No. of assessments in which species scored within 5 highest affirmative response rates
Snapping turtle	1	4	9
Wood turtle	3	5	17
Blanding's turtle	2	4	12
Eastern painted turtle	0	1	1
Maritime garter snake	0	2	4
Northern ribbon snake	2	5	14
Northern ringneck snake	0	3	7
E. smooth green snake	0	3	7
Northern redbelly snake	0	1	2
Eastern American toad	2	2	8
Northern spring peeper	1	2	5
Bullfrog	3	4	14
Green frog	2	2	8
Mink frog	2	2	8
Northern leopard frog	3	3	12
Pikerel frog	3	4	13
Wood frog	2	2	8
Yellow-spot. salamander	1	1	4
Blue-spotted salamander	2	3	9
Red-spotted newt	0	3	8
Red-backed salamander	1	3	8
Four-toed salamander	4	4	16

Bold type indicates 10 highest rates; toned areas indicate 5 highest rates.

Appendix 8.6.3: Summary of assessments of affirmative responses by category and species

Freshwater Fishes	**No. of categories in which species scored within 5 highest affirmative response rates:**		**No. of assessments in which species scored within 5 highest affirmative response rates**
	In every assessment type	**In at least one assessment type**	
Sea lamprey	0	3	4
Atlantic sturgeon	1	3	8
American eel	0	3	3
Blueback herring	1	4	10
Gaspereau/Alewife	1	4	10
American shad	0	5	9
Atlantic whitefish	2	4	12
Lake whitefish	2	4	11
Atlantic salmon	3	4	14
Brook trout	1	4	10
Lake trout	2	6	17
Rainbow smelt	1	4	9
Northern redbelly dace	0	3	6
Lake chub	0	3	5
Golden shiner	0	3	7
Common shiner	0	2	4
Blacknose shiner	0	3	5
Blacknose dace	0	4	7
Creek chub	0	2	4
Fallfish	1	2	5
Pearl dace	0	3	5
White sucker	0	3	4
Brown bullhead	0	2	3
Atlantic tomcod	0	1	2
Banded killifish	0	3	5
Mummichog	0	2	3
Fourspine stickleback	0	1	1
Brook stickleback	1	3	6
Threespine stickleback	0	2	3
Ninespine stickleback	0	3	6
White perch	0	2	3
Striped bass	0	3	6
Yellow perch	0	3	5

Bold type indicates 10 highest rates; toned areas indicate 5 highest rates.

Appendix 9
Summary of assessments by data source and assessment type

9.1 List of tables:

9.2 Compilation of assessments of affirmative response rates by data source and assessment type - total by species, and by category

- 9.2.1 Affirmative response rates by data source and assessment type - Mammals
- 9.2.2 Affirmative response rates by data source and assessment type - Reptiles and Amphibians
- 9.2.3 Affirmative response rates by data source and assessment type - Freshwater Fishes

9.3 Summary Tables: High affirmative response rates

9.3.1 High percentage affirmative response rates by family

9.3.2 Highest total affirmative response rates by assessment type

9.3.2.1 Species with ten highest total affirmative response rates by assessment type

9.3.2.2 Species with consistently highest total affirmative response rates in every assessment

9.3.3 Highest affirmative response rates in several categories

9.3.3.1 Mammal species with high response rates in several categories

9.3.3.2 Herpetofaunal species with high response rates in several categories

9.3.3.3 Freshwater fishes with high response rates in several categories

9.3.3.4 Species with consistently high response rates in several categories

Appendix 9.2.1: Affirmative response rates by data source and assessment type

Assessment Type	Identi-fied by experts in survey	Affirmative response rate				No. of categories in which sps. scored within 10 highest affirmative response rates			
Data source		Average		Consensus		Average		Consensus	
Mammal Species		#	%	#	%	#	%	#	%^
Arctic shrew		11	53.4	8	40.	2	3	2	2
Common shrew		4.4	20.8	7	25.9	1	3	1	2
Smokey shrew		5.6	32.2	4	19.		2		2
Gaspé shrew	2	13.7	63.4	13	54.2	3	2	3	3
Long-tailed shrew	2	11.5	57.5	10	47.6	3	4	2	4
Water shrew		8.9	43.8	6	26.1	1	1	1	1
Pygmy shrew		7.5	36.9	7	26.9	1	1	1	1
Short-tailed shrew		7.0	34.5	7	29.	3	3	1	1
Star-nosed mole		8.9	44.9	7	35.	1	3	2	2
Little brown bat		9.7	39.3	6	26.1	2	2		1
Northern long-eared bat	2	12.1	56.3	9	41.	1	2	2	1
Eastern pipistrelle	2	14.	58.3	11	52.	4	3	3	3
Silver-haired bat	2	14.6	60.3	9	45.	3	4	2	2
Red bat	2	11.	47.	7	33.	2	1	2	2
Hoary bat	3	12.	51.3	6	32.	1	2	1	1
Coyote		6.3	25.6	4	14.	1	1	1	
Red fox		4.1	17.9	5	17.9	1	1	1	2
American black bear		7.3	30.7	5	20.	1	2	1	1
Racoon		4.9	21.	3	10.3				
American marten	8	14.9	53.4	6	31.6	4	3	2	3
Fisher	5	13.4	53.6	6	33.	2	3	2	2
Ermine/Weasel		7.9	33.2	5	20.	1	1	1	2
American mink		5.6	26.	5	19.2	1	1	1	2
Striped skunk		4.0	17.5	0	0				
River otter		11.2	47.1	6	30.	3	2	2	3
Eastern cougar	6	16.2	64.5	11	50	5	3	3	4
Lynx	6	16.1	60.1	13	54.	5	3	4	3
Bobcat		8.7	41.4	8	34.8	2	3	2	4
White-tailed deer		6.8	30.2	3	12.	1	1		
Moose	2	9.2	40.	5	25.	1	1	1	3
Eastern chipmunk		3.6	16.	5	16.7				1
Woodchuck/Groundhog		3.8	18.1	2	8.3	1			1
American red squirrel		4.6	21.1	4	15.				1
Southern flying squirrel	4	10.9	48.7	8	36.4	1	1	2	3
Northern flying squirrel		5	25.	4	17.4		1	1	1
American beaver		9	40.7	2	8.				
Deer mouse		3.9	17.7	6	20.		1		1
White-footed mouse		5.4	27.3	5	24.		2		2
Red-backed vole		4.8	24.	6	21.4		1		1
Southern bog lemming	1	6.6	31.7	7	27.	1	1	1	1
Muskrat		4.1	21.2	4	18.		1		2
Meadow vole		5.3	22.1	6	22.2				1
Rock vole	4	10.9	46.6	7	31.8	2	1	1	1
Wood. jumping mouse		4.8	27.	4	16.		1		1
Meadow jumping mouse		4.8	24.9	4	16.		1		1
American porcupine		7.6	37.4	4	18.2	1	1		1
Snowshoe hare		4.6	20.4	6	20.7	1	1	1	1

Notes: Bold type indicates species with the ten highest rates of affirmative responses; toned areas indicate species with the five highest rates of affirmative responses.

Appendix 9.2.2: Affirmative response rates by data source and assessment type

Assessment Type	Identified by experts in survey	Affirmative response rate				No. of categories in which sps. scored within 5 highest affirmative response rates			
Data source		Average		Consensus		Average		Consensus	
Reptiles & Amphibians		#	%	#	%	#	%	#	%^
Snapping turtle		11.8	57.6	7	31.8	3	2	2	2
Wood turtle	6	15	77.7	11	55	4	4	4	5
Blanding's turtle	9	14.3	71.8	11	45.8	3	3	3	3
Eastern painted turtle		7	56.5	5	22.7				1
Maritime garter snake		5.6	32.6	4	16.7		1	1	2
Northern ribbon snake	6	13	83.3	11	57.9	2	4	3	5
Northern ringneck snake		8.6	52.1	7	31.8	1	1	2	3
E. smooth green snake		7.5	48.1	6	26.1	1	1	2	3
Northern redbelly snake		6.4	43.2	4	17.4		1		1
Eastern American toad	1	6.1	39.1	6	25	2	2	2	2
Northern spring peeper	1	6	37	6	25	1	1	1	2
Bullfrog		9.1	53.8	9	39	3	4	3	4
Green frog	1	7.2	43.9	8	32	2	2	2	2
Mink frog	1	7.2	44.4	7	30.4	2	2	2	2
Northern leopard frog	1	8.9	47.6	9	33.3	3	3	3	3
Pickerel frog	1	8.9	58.9	9	37.5	3	4	3	3
Wood frog	1	6.3	38.2	7	28	2	2	2	2
Yellow-spot. salamander	1	4.6	39.3	6	25	1	1	1	1
Blue-spotted salamander	4	8.8	62.4	9	41	2	2	2	3
Red-spotted newt	1	7.2	57.6	8	33.3	1	2	2	3
Red-backed salamander	1	7.5	57.7	8	33	2	2	2	2
Four-toed salamander	4	11.2	70.4	12	50	4	4	4	4

Notes:
Bold type indicates species with the ten highest rates of affirmative responses; toned areas indicate species with the five highest rates of affirmative responses.

Appendix 9.2.3: Affirmative response rates by data source and assessment type

Assessment Type	Identified by experts in survey	Total affirmative response rate				No. of categories in which sps. scored within 5 highest affirmative response rates			
Data source		Average		Consensus		Average		Consensus	
Freshwater fishes		#	%	#	%	#	%	#	%^
Sea lamprey		4.3	33.1	3	25		2	1	1
Atlantic sturgeon		**6.3**	**45.7**	5	38.5	2	2	2	2
American eel		4	26.1	3	21.4		1	1	1
Blueback herring		**8**	**59.3**	**6**	**50**	2	2	3	3
Gaspereau, Alewife		**7**	**44.6**	5	**41.7**	1	3	2	4
American shad		**7.8**	43.8	7	41.1	3	1	3	2
Atlantic whitefish	3	**14.7**	**90.2**	**12**	**92.3**	3	4	3	2
Lake whitefish		**8.3**	**65.4**	**7**	**63.6**	2	4	2	3
Atlantic salmon	1	**13**	**69.1**	**14**	**64**	4	3	4	3
Brook trout		**7.7**	**44.5**	**9**	39.1	2	2	4	2
Lake trout		**8.8**	**60**	**8**	**72.7**	2	5	4	6
Rainbow smelt		**6.5**	**43.9**	**6**	**42.9**	2	2	3	2
Northern redbelly dace		4.3	32.3	4	30.8		2	1	3
Lake chub		4.3	40.2	4	40		1	2	2
Golden shiner		4.8	34.8	3	27.3	2	2	1	2
Common shiner		3	30.9	3	33.3		1	1	2
Blacknose shiner		5	35	5	35.7		1	1	3
Blacknose dace		5.3	**45.3**	**6**	**50**	1	1	2	3
Creek chub		3.5	25.9	2	16.7	1	2		1
Fallfish		4.3	44.3	5	**50**	1	1	1	2
Pearl dace		4.3	38.1	5	**41.7**		1	1	3
White sucker		4	29	2	18.2	1	1		2
Brown bullhead		3.3	20.6	2	14.3	1	1		1
Atlantic tomcod		2	18.2	2	18.2		1		1
Banded killifish		4.3	27.7	3	21.4	2	1	1	1
Mummichog		2.3	17.7	2	16.7		1		2
Fourspine stickleback		0	0	1	10				1
Brook stickleback		**5**	**50**	**6**	**60**	1	1	1	3
Threespine stickleback		1.3	10.6	2	16.7			1	2
Ninespine stickleback		2.3	17.3	2	15.4	2	2	1	2
White perch		3.5	22.9	3	25			1	2
Striped bass		5	37.6	4	30.8		2	2	2
Yellow perch		4.8	30	5	38.5	1		2	2

Notes:
Bold type indicates species with the ten highest rates of affirmative responses; toned areas indicate species with the five highest rates of affirmative responses.

Appendix 9.3: High affirmative response rates

9.3.1: High percentage affirmative response rate by family

Mammals		Reptiles and amphibians	
Average	**Consensus**	**Average**	**Consensus**
Cats (55%)	Cats (46%)	Semi-aquatic, pond and marsh turtles (69%)	Lungless salamanders (42%)
Bats (52%)	Bats (38%)	Lungless salamanders (64%)	Semi-aquatic, pond and marsh turtles (41%)
Moles (45%)	Moles (35%)	Typical snakes (52%)	Typical frogs (34%)
Shrews (43%)	Shrews (34%).	Mole salamanders (51%)	
Beaver (41%)		Typical frogs (48%)	
Mustelids (39%)		Toads (48%)	

Freshwater fishes	
Average	**Consensus**
Salmonids/trouts (70%)	Salmonids/trouts (66%)
Herrings (49%)	Herrings (44%)
Sturgeon (46%)	Smelt (43%)
Smelt (44%)	Sturgeon (39%)
Minnows and carps (36%)	Perches (39%)

9.3.2: Species with highest total affirmative response rates by assessment types:
Total affirmative response rates and High response rates in several categories

9.3.2.1 Species with 10 highest total affirmative response rates by assessment type

Average affirmative response rate		Consensus affirmative response rate	
#	%	#	%
Mammals			
Eastern cougar (16.2)	E. cougar (64.5%)	Gaspé shrew (13)	E. pipistrelle (52%)
Lynx (16.1)	Gaspé shrew (63.4%)	Lynx (13)	Gaspé shrew (54.2%)
Amer. marten (14.9)	Sil.-hair. bat (60.3%)	E. pipistrelle (11)	Lynx (54%)
Sil.-haired bat (14.6)	Lynx (60.1%)	Eastern cougar (11)	Eastern cougar (50%)
E. pipistrell (14)	E. pipistrelle (58.3%)	L.-tailed shrew (10)	L.-tail. shrew (47.6)
Gaspé shrew (13.7)	L.-tail. shrew (57.5%)	N. long-eared Bat (9)	Sil.-hair. bat (45%)
Fisher (13.4)	N. l.-ear. bat (56.3%)	Sil.-haired bat (9)	N. long-ear. bat (41%)
N. long-ear. bat (12.1)	Fisher (53.6%)	Arctic shrew (8)	Arctic shrew (40%)
Hoary bat (12)	Arctic shrew (53.4%)	Bobcat (8)	S. fly. squirrel (36.4%)
Long-t. shrew (11.5)	Amer. marten (53.4%)	S. flying squirrel (8)	Star-nose mole (35%)
Reptiles and Amphibians			
Wood turtle (15)	N. rib. snake (83.3%)	Four-toed sal. (12)	N. rib. snake (57.9%)
Bland. turtle (14.3)	Wood turtle (77.7%)	Wood turtle (11)	Wood turtle (55%)
N. ribbon snake (13)	Bland. turtle (71.8%)	Blanding's turtle (11)	Four-toed sal. (50%)
Snap. turtle (11.8)	Four-toed sal. (70.4%)	N. ribbon snake (11)	Bland. turtle (45.8%)
Four-toed sala. (11.2)	Bl.-spot. sal. (62.4%)	Bullfrog (9)	Blue-spot.sal. (41%)
Bullfrog (9.1)	Red-bck. sal. (57.7%)	N. leopard frog (9)	Bullfrog (39%)
N. leopard frog (8.9)	Snapping turtle (57.6)	Pickerel frog (9)	Pickerel frog (37.5%)
Pickerel frog (8.9)	Rd.-spt. newt (57.6%)	Blue-spot. sal. (9)	N. leop. frog (33.3%)
Blue-spot. sal. (8.8)	E. paint. turtle (56.5%)	Green frog (8)	Rd-spot. newt (33.3%)
N. ring. snake (8.6)		Red-spot. newt (8)	Red-back. sal. (33%)
		Red.-backed sal. (8)	

Appendix 9.3.2.1 (continued)

Average affirmative response rate		Consensus affirmative response rate	
#	%	#	%
Freshwater fishes			
A. whitefish (14.7)	A. whitefish (90.2%)	Atlantic salmon (14)	A. whitefish (92.3%)
Atlantic salmon (13)	Lake trout (80%)	A. whitefish (12)	Lake trout (72.7%)
Lake trout (8.8)	A. salmon (69.1%)	Brook trout (9)	Atlantic salmon (64%)
Lake whitefish (8.3)	Lk. whitefish (65.4%)	Lake trout (8)	Lk. whitefish (63.6%)
Blueback herring (8)	Blbck. herring (59.3%)	American shad (7)	Brk. stickleback (60%)
American shad (7.8)	Brk. stickleback (50%)	Lake whitefish (7)	Blbck. herring (50%)
Brook trout (7.7)	Atl. sturgeon (45.7%)	Blueback herring (6)	Blckns. dace (50%)
Gaspereau (7)	Blckns. dace (45.3%)	Rainbow smelt (6)	Fallfish (50%)
Rainbow smelt (6.5)	Gaspereau (44.6%)	Blacknose dace (6)	Rain. smelt (42.9%)
Atlantic sturgeon (6.3)	Brk. trout (44.5%)	Brook stickleback (6)	Gaspereau (44.6%)
			Pearl dace (41.7%)

9.3.2.2: Species with consistently high total affirmative response rates

Mammals	**Reptiles and amphibians**	**Freshwater fishes***
Gaspé shrew Eastern pipistrelle Eastern cougar Lynx	Wood turtle Blanding's turtle Northern ribbon snake Four-toed salamander	Atlantic whitefish Atlantic salmon Lake trout
Silver-haired bat Long-tailed shrew Northern long-eared bat	Blue-spotted salamander	Lake whitefish Blueback herring
Arctic shrew	Bullfrog Pickerel frog Northern leopard frog Red-backed salamander Red-spotted newt	Brook trout Gaspereau Rainbow smelt Brook stickleback Blacknose dace
American marten Fisher Southern flying squirrel	Snapping turtle	Atlantic sturgeon American shad

Note: Table cells represent a rough cluster analysis ranging from consistency of highest affirmative response rates to lower affirmative response rates, from top to bottom. Species within each cell received similar scores and are listed in the order they appear on species lists throughout the thesis.

9.3.3: High response rates in several categories

9.3.3.1: Mammal species with highest response rates in several categories

Average		Consensus	
#	%	#	%
Eastern cougar (5)	Long-tailed shrew (4)	Lynx (4)	Long-tailed shrew (4)
Lynx (5)	Silver-haired bat (4)	Gaspé shrew (3)	Eastern cougar (4)
Eastern pipistrelle (4)	Arctic shrew (3)	Eastern pipistrelle (3)	Bobcat (4)
American marten (4)	Common shrew (3)	Eastern cougar (3)	Gaspé shrew (3)
Gaspé shrew (3)	Star-nosed mole (3)	Arctic shrew (2)	Eastern pipistrelle (3)
Long-tailed shrew (3)	Eastern pipistrelle (3)	Long-tailed shrew (2)	American marten (3)
Short-tailed shrew (3)	N. long-eared bat (3)	Star-nosed mole (2)	River otter (3)
Silver-haired bat (3)	American marten (3)	N. long-eared bat (2)	Lynx (3)
River otter (3)	Fisher (3)	Silver-haired bat (2)	American moose (3)
Arctic shrew (2)	Eastern cougar (3)	Red bat (2)	S. flying squirrel (3)
Little brown bat (2)	Lynx (3)	American marten (2)	Arctic shrew (2)
Red bat (2)	Bobcat (3)	Fisher (2)	Common shrew (2)
Fisher (2)	S. flying squirrel (3)	River otter (2)	Smokey shrew (2)
Bobcat (2)	Gaspé shrew (2)	Bobcat (2)	Star-nosed mole (2)
Rock vole (2)	Smokey shrew (2)	S. flying squirrel (2)	Silver-haired bat (2)
	Little brown bat (2)		Red bat (2)
	Hoary bat (2)		Red fox (2)
	River otter (2)		Fisher (2)
	Am. black bear (2)		Ermine/weasel (2)
	White-foot. mouse (2)		American mink (2)
			White-foot. mouse (2)
			Muskrat (2)
			Rock vole (2)

Note: Numbers in brackets indicate number of categories in which species scored within top ten.

9.3.3.2: Herpetofauna with highest response rates in several categories

Average		Consensus	
#	%	#	%
Wood turtle (4)	Wood turtle (4)	Wood turtle (4)	Wood turtle (5)
Fr-td. salamander (4)	N. ribbon snake (4)	Fr.-td. salamander (4)	N. ribbon snake (5)
Snapping turtle (3)	Bullfrog (4)	Blanding's turtle (3)	Bullfrog (4)
Blanding's turtle (3)	Pickerel frog (4)	N.ribbon snake (3)	Fr.-td. salamander (4)
Bullfrog (3)	Fr.-td. salamander (4)	N. leopard frog (3)	Blanding's turtle (3)
N. leopard frog (3)	Blandings turtle (3)	Pickerel frog (3)	N. ringneck snake (3)
Pickerel frog (3)	N. leopard frog (3)	Snapping turtle (2)	E. sm. grn. snake (3)
N. ribbon snake (2)	Snapping turtle (2)	N. ringneck snake (2)	N. leopard frog (3)
E. American toad (2)	E. American toad (2)	E. sm. grn. snake (2)	Pickerel frog (3)
Green frog (2)	Green frog (2)	E. American toad (2)	Bl.-sp. salamander (3)
Mink frog (2)	Mink frog (2)	Bullfrog (2)	Red-spotted newt (3)
Wood frog (2)	Wood frog (2)	Green frog (2)	
Bl.-sp. salamander (2)	Bl.-sp. salamander (2)	Mink frog (2)	
Rd.-b. salamander (2)	Red-spoted newt (2)	Wood frog (2)	
	Rd.-b. salamander (2)	Bl.-sp. salamander (2)	
		Red-spoted newt (2)	
		Rd.-b. salamander (2)	

Note: Numbers in brackets indicate number of categories in which species scored within top ten.

9.3.3.3: Freshwater fishes with highest response rates in several categories

Average		Consensus	
#	%	#	%
Atlantic salmon (4)	Lake trout (5)	Atlantic salmon (4)	Lake trout (6)
American shad (3)	Atlantic whitefish (4)	Brook trout (4)	Gaspereau/Alewife (4)
Atlantic whitefish (3)	Lake whitefish (4)	Lake trout (4)	Blueback herring (3)
Atl. sturgeon (2)	Gaspereau/Alewife (3)	Blueback herring (3)	Lake whitefish (3)
Blueback herring (2)	Atlantic salmon (3)	American shad (3)	Atlantic salmon (3)
Lake whitefish (2)	Sea lamprey (2)	Atlantic whitefish (3)	N. redbelly dace (3)
Brook trout (2)	Atlantic sturgeon (2)	Rainbow smelt (3)	Blacknose shiner (3)
Lake trout (2)	Blueback herring (2)	Atl. sturgeon (2)	Blacknose dace (3)
Rainbow smelt (2)	Brook trout (2)	Gaspereau/Alewife (2)	Pearl dace (3)
Banded killifish (2)	Rainbow smelt (2)	Lake whitefish (2)	Brook stickleback (3)
Ninesp. stickleback (2)	N. redbelly dace (2)	Lake chub (2)	Atlantic whitefish (2)
	Golden shiner (2)	Striped bass (2)	Atlantic sturgeon (2)
	Creek chub (2)	Yellow perch (2)	American shad (2)
	Ninesp. stickleback (2)		Brook trout (2)
			Rainbow smelt (2)
			Lake chub (2)
			Golden shiner (2)
			Fallfish (2)
			White sucker (2)
			Mummichog (2)
			Threesp. sticklbck. (2)
			Ninesp. stickleback (2)
			White perch (2)
			Striped bass (2)
			Yellow perch (2)

Note: Numbers in brackets indicate number of categories in which species scored within top ten.

9.3.3.4: Species with consistently high response rates in several categories

Mammals	Reptiles and amphibians	Freshwater fishes
Eastern pipistrelle Eastern cougar Lynx	Wood turtle Four-toed salamander	Lake trout Atlantic salmon
Gaspe shrew American marten	Blanding's turtle	
Long-tailed shrew	Northern ribbon snake Pickerel frog Northern leopard frog	Blueback herring Atlantic whitefish
	Bullfrog	
Arctic shrew Silver-haired bat Fisher River otter Bobcat	Blue-spotted salamander	Atlantic sturgeon Brook trout Lake whitefish
		Rainbow smelt

Note: Table cells represent a rough cluster analysis ranging from consistency of highest affirmative response rates to lower affirmative response rates, from top to bottom. Species within each cell received similar scores and are listed in the order they appear on species lists throughout the thesis.

Appendix 10

Sample of
Summary of Questionnaire and Matrix Survey Responses and Assessment

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10.1: List of contents

10.2: Sample of cover letter for *Summary of Questionnaire and Matrix Survey Responses and Assessment* as distributed to respondents

10.3: Sample pages from *Summary of Questionnaire and Matrix Survey Responses and Assessment*, including title page, list of tables and introductory pages for appendices, as distributed to respondents for comments

<u>10.2: Sample of cover letter for *Summary of Questionnaire and Matrix Survey Responses and Assessment* as distributed to respondents:</u>

July 25, 1997

Dear,

Thank you for participating in my research. I received 13 full and 9 partial responses, for a total of 22 responses to 32 questionnaires and matrices sent out. Your participation is greatly appreciated. Enclosed is a summary of the results as promised. I have included a copy of a paper I presented at the Science and the Management of Protected Areas (SAMPA) conference in May in Calgary. The paper describes the purpose, context and methodology of the research and assessment, as well as some preliminary findings and other applications of the approach and information.

Several tables are also enclosed (see List of Tables in <u>Summary of Questionnaire and Matrix Survey Responses and Assessment</u>). The enclosed tables have been selected to show how responses to the questionnaire and the matrices were compiled and assessed. The tables include "consensus" tables showing areas of expert agreement in the responses, as well as summary tables of the results of assessments. Both questionnaire and matrix responses were assessed.

To finalize this phase of the research, <u>I particularly request that you examine the "consensus response" tables to ensure that there is no response with which you disagree, or no serious omission of a response which you know to be true</u> (please provide a reference in this case if possible). You will find the consensus response tables in Appendices 3 (mammals), 4 (reptiles and amphibians), and 5 (freshwater fishes) (see highlighted items in List of Tables, enclosed). <u>Please submit any comments by the end of August</u>. Revisions arising from this review will be circulated.

Additional information and tables are available upon request. The full assortment of tables and results will be presented in my thesis, estimated to be completed in late 1997 or early 1998. Invitations to the thesis defense will be extended to the respondents.

Finally, many participants noted that they would like to fill-in the information in cooperation or with discussion with other experts. Many believe that the information would be useful for management/planning decision-making. Upon completion of my thesis, I would be willing to convene a workshop to facilitate this discussion and confirm and supplement the information if sufficient interest is expressed. Please let me know if you or your organization are interested in participating in such a workshop, and whether you are willing to contribute funding or know of a potential funding source. If sufficient interest is expressed, I will also explore other avenues of research funding.

Thank-you once again for your participation.

Sincerely,

Karen Beazley, B.L.A., M.A.

Appendix 10.3: Sample pages from *Summary of Questionnaire and Matrix Survey Responses and Assessment*, including title page, list of tables and introductory pages for Appendices 1-5, as distributed to respondents for comments:

Summary of Questionnaire and Matrix Survey Responses and Assessment

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Identifying focus-species for biodiversity management in Nova Scotia

DRAFT
For discussion purposes only

Do not duplicate or quote without permission of the author.

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JULY 1997

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Appendix 10.3 (continued):

Summary of Questionnaire and Matrix Survey Responses and Assessment

Identifying focus-species for biodiversity management in Nova Scotia

A selection of tables is provided in the following appendices. These tables represent a sampling of tables developed to summarize responses to both the questionnaire (Appendix 1) and the matrices (Appendices 2-5). Tables include "consensus response" tables showing areas of expert agreement, and summary tables showing the results of assessments. I particularly request that you examine the "consensus response" tables to ensure that there is no response with which you disagree, or no serious omission of a response which you know to be true (please provide a reference in this case if possible). You will find the consensus response tables in Appendices 3 (mammals), 4 (reptiles and amphibians), and 5 (freshwater fishes) (see *highlighted items** on the List of Tables below and on the following page). Please submit any comments by the end of August 1988. Revisions arising from this review will be circulated.

Matrix responses were assessed in terms of both the degree or level of total (√ and X) responses (indicating the level of knowledge) (Appendix 2) and the number of affirmative (√) responses (indicating characteristics which define a species as potentially more vulnerable than other species or warranting special biodiversity management attention) (Appendices 3-5). Assessments were done at the group, family, and species level, and from the average of all responses, as well as from the "consensus responses" derived from responses. Assessments were completed with all variables as a single group as well as with variables separated into the six variable categories. Total responses were calculated as a simple number and as a percentage of possible responses or total cells. Affirmative responses were also calculated as a simple number and as a percentage of total responses. These various assessments are summarized in the respective tables and columns. Please refer to the accompanying paper, Focus-species approach for trans-boundary biodiversity management in Nova Scotia, for a summary of the research and preliminary findings.

List of Tables

Appendix 1: Tables Summarizing Responses from Questionnaire

- Identification of most and least important variables by respondents
- Suggested variables to be added that are not easily included in existing variables
- Most vulnerable species identified from questionnaire

Appendix 2: Tables Summarizing Total Response Rates from Matrices

- Response rates for mammals, reptiles and amphibians, and freshwater fishes [by class]
- Percent response rate by species group [class] and category
- Total response rates for mammal species from average and consensus
- Total response rates for reptiles and amphibians from average and consensus
- Total response rates for freshwater fishes from average and consensus
- Percentage of total (affirmative and negative) responses by family and category from consensus

Appendix 10.3 (continued):

Appendix 3: Tables Summarizing Responses, Consensus, and Affirmative Responses to Matrices - *Mammals*

- Comparison of matrix responses on a per-species basis - Fisher [sample]
- *Mammal matrix with consensus responses** derived from expert survey matrices
- Number of affirmative responses by species and respondent
- Affirmative response rates by category and by data source and assessment type for mammal species
- Affirmative response rates for mammals by data source and assessment type

Appendix 4: Tables Summarizing Responses, Consensus, and Affirmative Responses to Matrices - *Reptiles and Amphibians*

- Comparison of matrix responses on a per-species basis - Wood turtle
- *Reptile matrix with consensus responses* *derived from expert survey matrices
- *Amphibian matrix with consensus responses** derived from expert survey matrices
- Affirmative response rates by category and by data source and assessment type for reptile and amphibian species
- Affirmative response rates by data source and assessment type

Appendix 5: Tables Summarizing Responses, Consensus, and Affirmative Responses to Matrices - *Freshwater fishes*

- Comparison of matrix responses on a per-species basis - Atlantic salmon
- *Freshwater fishes matrix with consensus responses* *derived from expert survey matrices
- Affirmative response rates by category and by data source and assessment type for freshwater fishes
- Affirmative response rates by data source and assessment type

Appendix 10.3 (continued):

Appendix 1: Tables Summarizing Responses from Questionnaire

The tables in Appendix 1 summarize the comments participants provided in response to the questions asked in the questionnaire; they do not include information derived from the matrices. Responses to the matrices are summarized in Appendices 2 through 5.

Tables included in Appendix 1 are listed below. A summary of other responses to the questionnaire is provided in the accompanying paper: Focus-species approach for trans-boundary biodiversity management in Nova Scotia (Beazley 1997). Additional and more detailed text and tables are available upon request.

List of tables - Appendix 1

- **Identification of most and least important variables by respondents**
- **Suggested variables to be added that are not easily included in existing variables**
- **Most vulnerable species identified from questionnaire**

Appendix 10.3 (continued):

Appendix 2: Tables Summarizing Total Response Rates from Matrices

The following tables summarize the total number of both affirmative (√) and negative (X) responses included in the matrices returned by the participants. The purpose of this assessment is to determine the relative state or level of knowledge about the various classes, families and species, as well as in relation to the various categories of variables. Assessments were done by averaging all of the responses as well as from the "consensus" derived from the responses (see Appendices 3 through 5). A brief discussion of this assessment is included in the accompanying paper: Focus-species approach for trans-boundary biodiversity management in Nova Scotia (Beazley 1997). Tables included in Appendix 2 are listed below; additional and more detailed text and tables are available upon request.

List of tables - Appendix 2

- **Response rates for mammals, reptiles and amphibians, and freshwater fishes [by class]**
- **Percent response rate by species group [class] and category**
- **Total response rates for mammal species from average and consensus**
- **Total response rates for reptiles and amphibians from average and consensus**
- **Total response rates for freshwater fishes from average and consensus**
- **Percentage of total (affirmative and negative) responses by family and category from consensus**

Appendix 10.3 (continued):

Appendix 3: Tables Summarizing Responses, Consensus, and Affirmative Responses to Matrices - *Mammals*

The following tables summarize the responses included in the mammal matrices returned by the participants (one example), consensus responses derived from these responses, the number of affirmative (√) responses per-species and by category of variables, and a comparison of results from the various assessments. The purpose of this assessment is to determine the relative vulnerability or need of special management attention of the various species, as well as in relation to the various categories of variables. Assessments were done by averaging all of the responses as well as from the "consensus" derived from the responses. Affirmative responses were calculated as a simple number and as a percentage of total (√ + X) responses. A brief discussion of this assessment is included in the accompanying paper: Focus-species approach for trans-boundary biodiversity management in Nova Scotia (Beazley 1997). Tables included in Appendix 3 are listed below; additional and more detailed text and tables are available upon request. Tables for reptiles and amphibians and freshwater fishes are included in Appendices 4 and 5.

List of tables - Appendix 3

- **Comparison of matrix responses on a per-species basis - Fisher**
- **Mammal matrix with consensus responses derived from expert survey matrices**
- **Number of affirmative responses by species and respondent**
- **Affirmative response rates by category and by data source and assessment type for mammal species**
- **Affirmative response rates for mammals by data source and assessment type**

Appendix 10.3 (continued):

Appendix 4: Tables Summarizing Responses, Consensus, and Affirmative Responses to Matrices - *Reptiles and Amphibians*

The following tables summarize the responses included in the reptile and amphibian matrices returned by the participants (one example), consensus responses derived from these responses, the number of affirmative (√) responses per-species and by category of variables, and a comparison of results from the various assessments. The purpose of this assessment is to determine the relative vulnerability or need of special management attention of the various species, as well as in relation to the various categories of variables. Assessments were done by averaging all of the responses as well as from the "consensus" derived from the responses. Affirmative responses were calculated as a simple number and as a percentage of total (√ + X) responses. A brief discussion of this assessment is included in the accompanying paper: Focus-species approach for trans-boundary biodiversity management in Nova Scotia (Beazley 1997). Tables included in Appendix 4 are listed below; additional and more detailed text and tables are available upon request. Tables for mammals and freshwater fishes are included in Appendices 3 and 5.

List of tables - Appendix 4

- **Comparison of matrix responses on a per-species basis - Wood turtle** [sample]
- **Reptile matrix with consensus responses derived from expert survey matrices**
- **Amphibian matrix with consensus responses derived from expert survey matrices**
- **Affirmative response rates by category and by data source and assessment type for reptile and amphibian species**
- **Affirmative response rates by data source and assessment type**

Appendix 10.3 (continued):

Appendix 5: Tables Summarizing Responses, Consensus, and Affirmative Responses to Matrices - *Freshwater fishes*

The following tables summarize the responses included in the freshwater fishes matrices returned by the participants (one example), consensus responses derived from these responses, the number of affirmative (√) responses per-species and by category of variables, and a comparison of results from the various assessments. The purpose of this assessment is to determine the relative vulnerability or need of special management attention of the various species, as well as in relation to the various categories of variables. Assessments were done by averaging all of the responses as well as from the "consensus" derived from the responses. Affirmative responses were calculated as a simple number and as a percentage of total (√ + X) responses. A brief discussion of this assessment is included in the accompanying paper: Focus-species approach for trans-boundary biodiversity management in Nova Scotia (Beazley 1997). Tables included in Appendix 5 are listed below; additional and more detailed text and tables are available upon request. Tables for mammals and reptiles and amphibians are included in Appendices 3 and 4.

List of tables - Appendix 5

- **Comparison of matrix responses on a per-species basis - Atlantic salmon** [sample]
- **Freshwater fishes matrix with consensus responses derived from expert survey matrices**
- **Affirmative response rates by category and by data source and assessment type for freshwater fishes**
- **Affirmative response rates by data source and assessment type**

Appendix 11: Survey of experts by taxonomic group

11.1 List of contents

11.2 List of participants

11.3 Sample of cover letter

11.4 Sample of survey

11.5 Compilation of responses

11.6 Summary assessment of "expertise" relative to taxonomic groups

Notes:

1. A total of 132 surveys were distributed; 64 surveys were completed and returned.
2. The method was of a "snowball" type:

- an preliminary list of contacts was developed in consultation with M. Willison (Nov. 5, 1996);
- an initial mail-out took place January 20, 1997;
- a subsequent mail-out took place January 27 and Feb. 3-5, 1997, to inividuals mentioned in the first group of survey returns;
- a final mail-out occurred June 4, 5 and 12 in response to subsequent survey returns.

3. Surveys were not distributed to pontential experts identified in surveys returned after June 12, 1997. However, potential experts identified in this final group of returned surveys are included in the compilation of results, as "experts identified by others" (Appendix 11.5: refer to column with heading, "Experts identified by others"). Additional sources for identification of experts mentioned in the final surveys returned include:

- Canadian Society of Zoologists;
- Entymology Society of Canada;
- Office of the Regional Director of Science, Department of Fisheries and Oceans; and,
- 24 individuals not previously contacted.

Appendix 11.2: List of participants

Note: * Asterisk symbol indicates respondent that completed and returned the survey

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Appendix 11.3: Sample of cover letter

January 20, 1997

Dear

As part of my Interdisciplinary Ph.D. research I would like to get a sense of the expertise available regarding particular groups of species found within the province of Nova Scotia. Toward this end, I am compiling a list of experts associated with the various taxonomic groups or orders, primarily through recommendation or word-of-mouth, and expert consensus. The research is being supervised by Martin Willison, Biology Department, Dalhousie University.

I am asking each "expert" that is identified to confirm her or his "expert status", as well as to identify other "experts" of whom they are aware. The newly identified experts will, in turn, be asked the same, so that the survey proceeds in a snowball-like fashion. The purpose of the exercise is to identify the areas of knowledge of species groups or classes in Nova Scotia. This information may be useful for assessing the strengths and weaknesses of our scientific- or natural history-knowledge base for conservation planning towards, for example, maintaining native biological diversity.

You have been identified as an expert or as someone having knowledge of the expertise available in Nova Scotia. As such, I request that you use your best professional judgment in confirming or denying your own expertise and suggesting other potential experts. Please use the attached form. Some uncertainty is to be expected in identifying other potential "experts", however, each person identified will be contacted to confirm her or his expert status.

I recognize that defining "expertise" can be difficult. For this reason, I put forward the following tentative guideline: *an expert is one who has considerable academic training: has published in academic, peer-reviewed or other journals; is recognized as an expert by his or her peers; and/or, has extensive and relatively recent field and/or management experience in the relevant taxonomic group in Nova Scotia.*

Thank-you, in advance, for your time. Your assistance is greatly appreciated. A summary of the findings will be circulated to all participants.

Sincerely,

Karen Beazley

Appendix 11.4: Sample of survey of expertise relative to taxonomic groups in Nova Scotia

List of Experts

Name:________________________ **Date:** ________________________

1. (a) Do you consider yourself to be an expert ecologist, biologist, or natural historian?
Yes (circle most appropriate term, above) ______ No ______

(b) Do you consider yourself to be an "expert"* in one or more of the following taxonomic groups?
Yes ______ No ______

(c) Which group(s)? Please print your name beside the appropriate categories below.

2. Please identify other potential experts* in Nova Scotia of whom you are aware. Print names and addresses beside the appropriate categories. Attach additional sheets if necessary. Please include postal and e-mail addresses, telephone numbers, and/or other means of contact, if known.

* For the purposes of this survey, the following tentative guideline is suggested:
an expert is one who has considerable formal training; has published in academic, peer-reviewed or other journals; is recognized as an expert by his or her peers; and/or, has extensive and relatively recent field and/or management experience in the relevant taxonomic group in Nova Scotia.

Taxonomic Group, Class or Order	Expert Name And Address
Fauna	
Vertebrates	
Mammals Order insectivora (shrews, moles) Order chiroptera (bats) Order carnivora (carnivores) Order cetacea (whales, dolphins, porpoises) Order perissodactyla (odd-toed ungulates) Order arctiodactyla (even-toed ungulates) Order rodentia (rodents) Order lagomorpha (pikas, hares, rabbits)	

Amphibians Frogs Toads Salamanders	
Reptiles Snakes Turtles	
Birds	
Fish Freshwater Marine	
Lower chordates	

Invertebrates	
Chaetognaths Hemichordates Pogonophorans Echinoderms	
Insects	
Crustaceans Chilopods Diplopods	
Chelicerata	
Molluscs	
Annelids	
Nematodes	
Coelenterates Stenophores Platyhelminths Rhynchocoels Aschelminthes Other pseudocoelomates	
Protozoans Mesozoans Poriferans	

Flora	
Algae	
Fungi	
Lichens	
Lower vascular plants	
Higher vascular plants	
General Ecologists	
General Biologists	
Natural Historians	

(Sources: Scott 1996; Willison 1996 pers. comm.) K.Beazley / January 1997

Appendix 11.5: Compilation of responses

Taxonomic Group, Class or Order	Number of self-identified experts (may also have been identified by others)	Number of experts identified by others (not self-identified)*	Total
Fauna			
Vertebrates			
Mammals (General)	3	2	5
Order insectivora (shrews, moles)	1		1
Order chiroptera (bats)		2	2
Order carnivora (carnivores)	3	4	7
Order cetacea (whales, dolphins, porpoises)	1	4	5
Order perissodactyla (odd-toed ungulates)		2	2
Order arctiodactyla (even-toed ungulates)	2	4	6
Order rodentia (rodents)	3	1	4
Order lagomorpha (pikas, hares, rabbits)	2	1	3
Amphibians (General)	4	3	8
Frogs	1	3	3
Toads	1	1	1
Salamanders	1		1
Reptiles (General)	4	3	7
Snakes	2	5	7
Turtles	3	4	7
Birds	14	25	39
Fish (General)	4	4	8
Freshwater	7	4	11
Marine	6	2	8
Lower chordates			

Invertebrates			
Chaetognaths			
Hemichordates			
Pogonophorans			
Echinoderms	1		1
Insects	8	9	17
Crustaceans	5	1	6
Chilopods	1		1
Diplopods	1		1
Chelicerata	2	1	3
Molluscs	5	8	13
Annelids	2	1	3
Nematodes		2	2
Coelenterates		1	1
Stenophores		1	1
Platyhelminths	1	1	2
Rhynchocoels			
Ascheiminthes		1	1
Other pseudocoelomates (myxozoa)	1		1
Protozoans			
Mesozoans		1	1
Poriferans			
Flora			
Algae	5	7	12
Fungi	7	6	13
Lichens	3	1	4
Lower vascular plants	5	6	11
Higher vascular plants	9	12	21

General			
Ecologists	19	16	35
General Biologists	30	4	33
Natural Historians	14	11	25

Notes:
1. Group, class and order divisions derived from Scott 1996; Willison 1996 pers. comm.
2. Level of detail in mammal, reptile and amphibian divisions reflect focus of the thesis
3. * Individuals who were identified by others *and* were self-identified were excluded from the calculation of number of experts identified by others; only those individuals *who did not send in a survey* but were identified by others are included in this category
4. Surveys were not distributed to pontential experts identified in surveys returned after June 12, 1997. However, potential experts identified in this final group of returned surveys are included in the compilation of results, as "experts identified by others"

Appendix 11.6: Summary assessment of expertise relative to taxonomic group

Taxonomic Group	Sub-total: Number of self-identified experts	Sub-total: Number of experts identified by others (not self-identified)*	Total
Fauna			
Vertebrates			
Mammals	9	19	28
Amphibians	5	9	14
Reptiles	7	12	19
Birds	14	25	39
Fish	12	10	22
Lower chordates	0	0	0
Invertebrates			
Chaetognaths Hemichordates Pogonophorans Echinoderms	1	0	1
Insects	8	9	17
Crustaceans Chilopods Diplopods	5	1	6
Chelicerata	2	1	3
Molluscs	5	8	13
Annelids	2	1	3
Nematodes	0	2	2
Coelenterates Stenophores Platyhelminths Rhynchocoels Aschelminthes Other pseudocoelomates (myxozoa)	1	3	4
Protozoans Mesozoans Poriferans	0	1	1

Flora			
Algae	5	7	12
Fungi	7	6	13
Lichens	3	1	4
Lower vascular plants	5	6	11
Higher vascular plants	9	12	21
General			
General Ecologists, Biologists and Natural Historians	53	26	79

Notes:
1. Totals presented within this table are derived from Appendix 11.5: Compilation of Responses. The totals differ from Appendix 11.5 because experts that may have been identified within more than one area of expertise have only been counted once within each taxonomic class for the purposes of this summary assessment.
2. * Individuals who were identified by others *and* were self-identified were excluded from the calculation of number of experts identified by others; only those individuals *who did not send in a survey* but were identified by others are included in this category
3. Surveys were not distributed to pontential experts identified in surveys returned after June 12, 1997. However, potential experts identified in this final group of returned surveys are included in the compilation of results, as "experts identified by others"

IMAGE EVALUATION TEST TARGET (QA-3)

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