

THE CONSERVATION POTENTIAL OF THE FRONTENAC AXIS: LINKING ALGONQUIN PARK TO THE ADIRONDACKS



Published by:

**The Canadian Parks and Wilderness Society
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THE CONSERVATION POTENTIAL OF THE FRONTENAC AXIS:

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1.0 INTRODUCTION

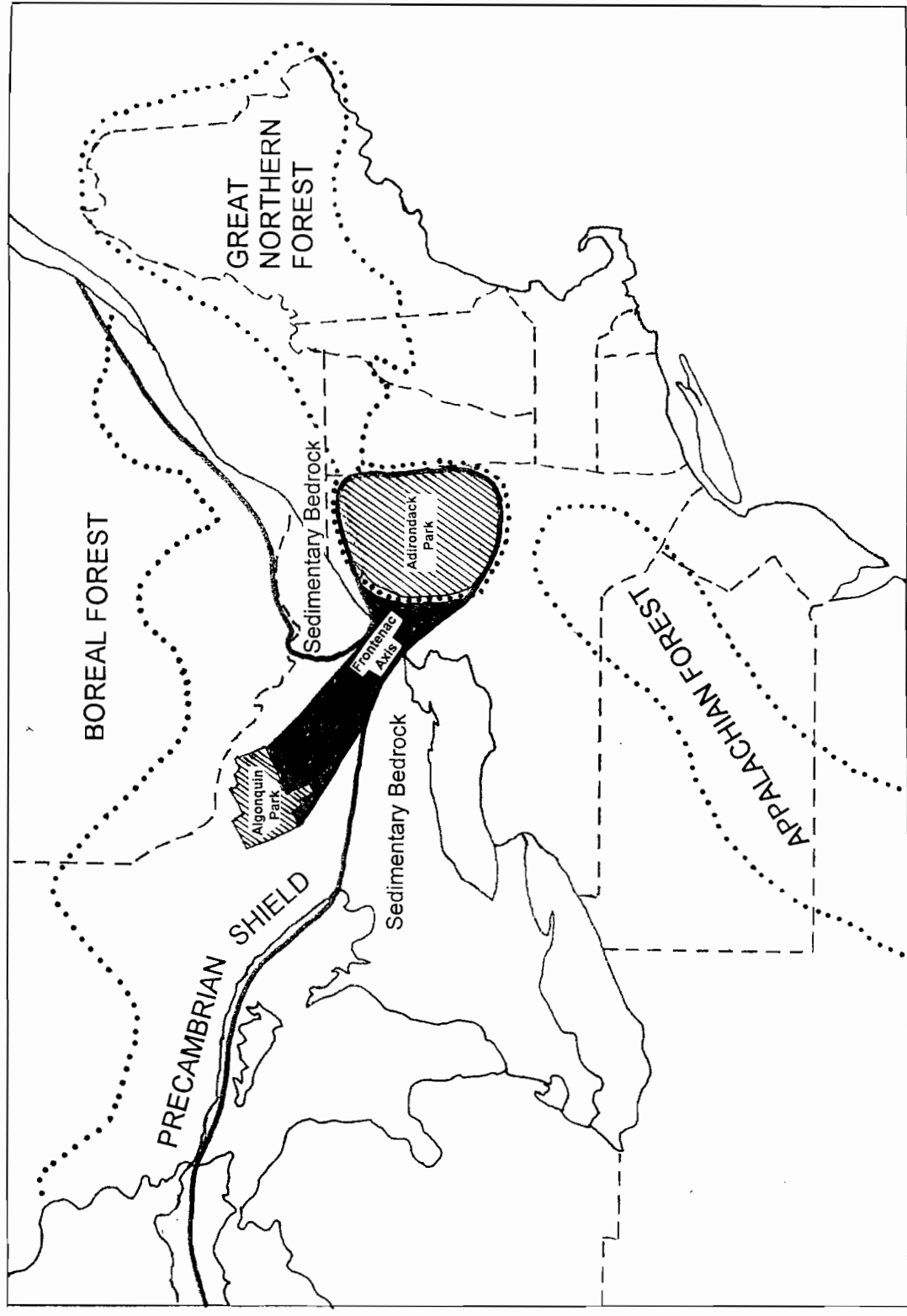
The Frontenac Axis is a band of precambrian bedrock that joins the Precambrian Shield in Ontario with the Adirondack Mountains in New York (Fig. 1). It links related biological communities on a major geographical scale and is the most extensive, least degraded north-south corridor across the St. Lawrence River. This natural land unit is significant at a continental scale and a large scale strategy is needed to sustain its significant conservation value.

The Frontenac Axis is a fragile link. It is a sparsely populated, narrow bridge flanked by broad areas of agricultural land over sedimentary Paleozoic bedrock. The use of this land for agriculture and urbanization has severely altered its characteristics and landscape patterns. This has limited its ability to carry out many functions and processes, typical of natural environments, upon which our quality of life and economic well-being depend. While the less disturbed, more wooded landscape of the Frontenac Axis makes it stand out in sharp contrast to this landscape, the deterioration of its function as a significant ecological linkage due to threats from the major highway corridors, cottage and urban development and pollution of the St. Lawrence River, is currently of great concern. Thus a comprehensive land use strategy is required to maintain and enhance the ecological integrity of the Frontenac Axis and its role in facilitating biogeographic dispersal. Conservation of the Axis will also contribute to protecting integrity at the biosphere scale.

Given the present condition of the Axis and the extensions that anchor it to Algonquin Provincial Park in Ontario and Adirondack State Park in New York (both world class parks), the Canadian Parks and Wilderness Society recognized the urgency and excellent opportunity for designing and implementing a successful conservation strategy for the Axis. To achieve this goal, a comprehensive strategy that incorporates information distribution, scientific studies and the involvement of land use decision-makers, landowners and the public will have to be implemented.

To initiate the development of this conservation strategy, CPAWS formed a working group and sponsored the preparation of this report. The purpose of this document is to provide information on the natural features of the Frontenac Axis and its extensions, review complementary topics related to strategy development (e.g., scientific foundation, government commitments, conservation initiatives, public participation, stakeholders) and provide a framework that will assist

Figure 1. The continental view of the Frontenac Link (shaded area).



CPAWS in establishing a strategy for conserving the Axis. The goal of this conservation strategy will be to:

Work cooperatively with government and nongovernment organizations to develop a long-term, international conservation strategy for the Frontenac Link between Algonquin Provincial Park and Adirondack State Park that will maintain and restore the ecological integrity of the natural landscape and integrate cultural development with processes that sustain the natural environment.

This project to conserve the Frontenac Axis should serve as a catalyst and model to inspire other conservation projects at comparable scales.

1.1 Report Contents

This report will first provide you with a geographical picture of the Frontenac Link between Algonquin Park and Adirondack Park, highlighting its significant continental context and the regional setting. The next part of the report describes the natural environment of the link, covering natural regions, and the physical and biological qualities that characterize the link and make it special. This is followed by a brief discussion of the nature of human interactions with the link landscape. Following this focus on the link, a broader scientific context and foundation for developing a conservation strategy is provided. Other elements that should be reviewed in establishing the conservation strategy such as government commitments, other conservation initiatives, public participation, land stewardship tools, and critical stakeholders are then discussed. Finally, a framework for developing a conservation strategy for the link is proposed, consisting of a goal, subgoals and objectives. The report concludes with brief recommendations and conclusions, then literature cited.

Because the two parks that anchor the link have long histories of study and considerable information is readily available for them, this report concentrates on providing background information on the area that links them. The link spans a large geographical area, covering many jurisdictional units of many agencies in two different countries! Thus while it was often a considerable challenge to piece together a comprehensive picture for a topic for the Ontario portion of the link, it was not always possible to provide complementary information for the NY portion, given the monetary and time constraints limiting the scope of this project. The concentration effort on obtaining information for the Ontario portion of the link is a reasonable approach since it comprises the majority of the link. The provision of additional details for the NY portion should be facilitated through the establishment of American partners in this conservation strategy.

2.0 GEOGRAPHICAL SETTING OF THE FRONTENAC LINK

2.1 A Continental Link

The “underlying basis” of the Frontenac Link is the Precambrian Shield, an igneous bedrock that dominates much of the landscape of eastern and central Canada. In the region of the St. Lawrence River, it funnels down to a narrow bridge, called the Frontenac Axis (centred on Frontenac Co., Ontario) which links the southern Adirondack precambrian dome to the vast northern Shield (Fig. 1). The Niagara Escarpment, which links New York to Ontario via Niagara Falls and extends northward, can be thought of as its sedimentary counterpart.

The Frontenac Axis also provides biogeographic links between the Boreal Forest of North America and the Great Northern Forest of the northeastern United States and the Appalachian Forests that extend south along the mountains (Fig. 1). This link is of biogeographic interest for so many reasons. For example, southern species extend their distributions north along the Axis, northern species extend their distributions south along the Axis, widespread species concentrate on the Axis, forest-dependent species use the Axis as a migration route and breeding habitat, and the high diversity of environmental conditions, in turn, supports high species diversity and numerous rare species. See section 3.0 for more details.

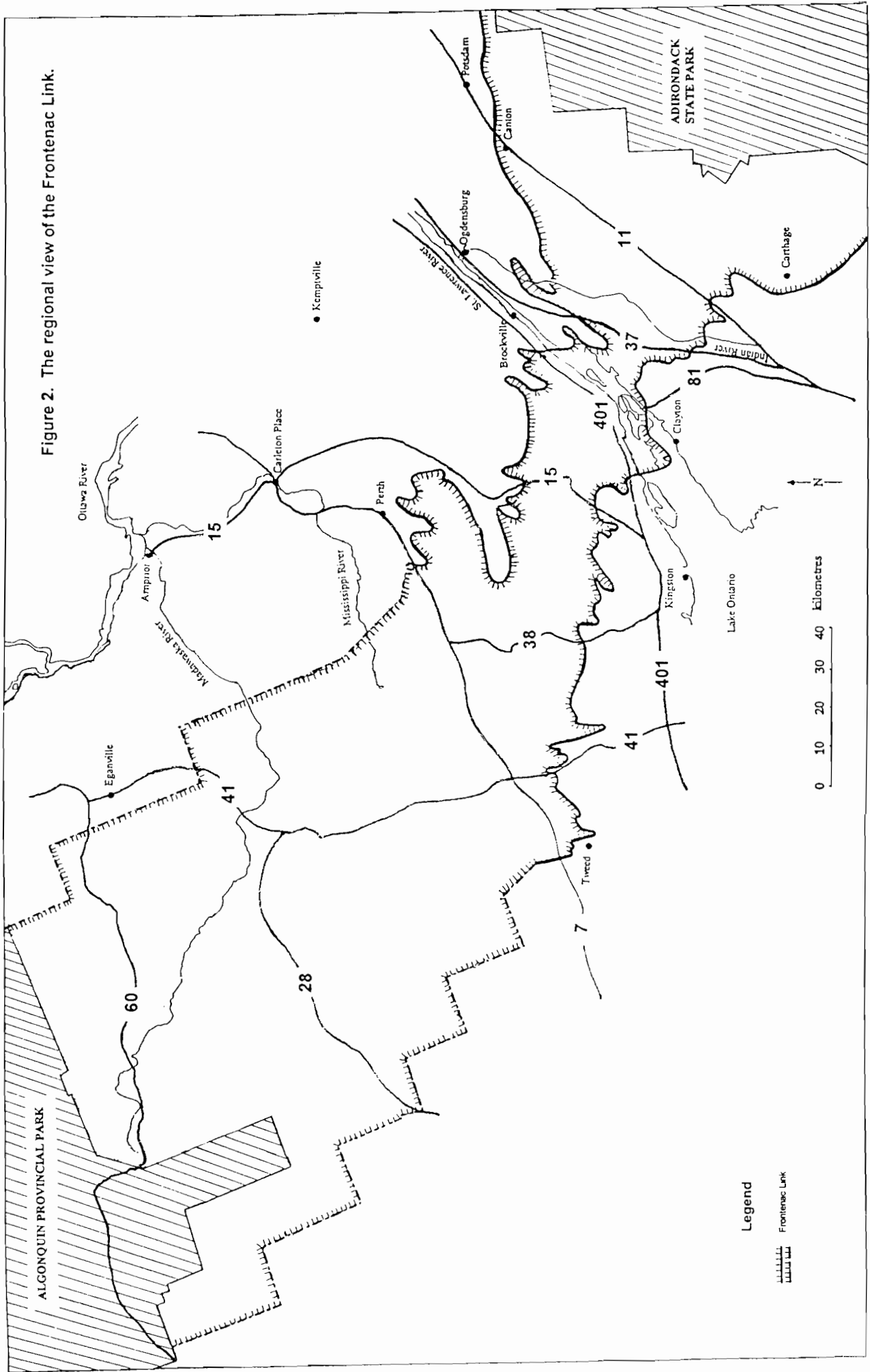
Conservation of this continentally significant land unit requires more than consideration of the Axis itself. Its value depends on its continued connection to the Great Northern and Appalachian forests as well as to the Boreal Forest. The focus of the conservation strategy will thus be on the **Frontenac Link (FL)**. It includes the Frontenac Axis and the areas that link it to Algonquin Provincial Park to the north and Adirondack State Park to the south.

2.2 The View from the Regional Scale

2.2.1 Defining the Frontenac Link

The Frontenac Link (FL), which is the focus of the conservation strategy (see 2.1), can be easily defined in the vicinity of the St. Lawrence R. and around Adirondack Park as the limit of the Precambrian Shield (Fig. 2). North of the Axis, around Highway 7, where the Shield begins to broaden and cover the width of Ontario, there are no obvious natural ecological or physical features to use in establishing boundaries for the link between the Axis and Algonquin Park. In the absence of these features, existing jurisdictional boundaries (township boundaries) were used to establish preliminary boundaries essential for providing a focal area for documenting background information for this report.

Figure 2. The regional view of the Frontenac Link.



To set these boundaries, a straight line was drawn from the northeast corner of the Axis to the southeast corner of Algonquin Park. The eastern boundary of the FL was set as the line following township boundaries that most closely followed the straight line, but remained east of it. The western boundary of the area between the Axis and Algonquin Park was established in a similar way. The resulting area of conservation interest was established as far as possible on the basis of boundaries of a natural land unit and is of an appropriate size for developing a regional conservation strategy and maintaining ecological integrity of the land unit.

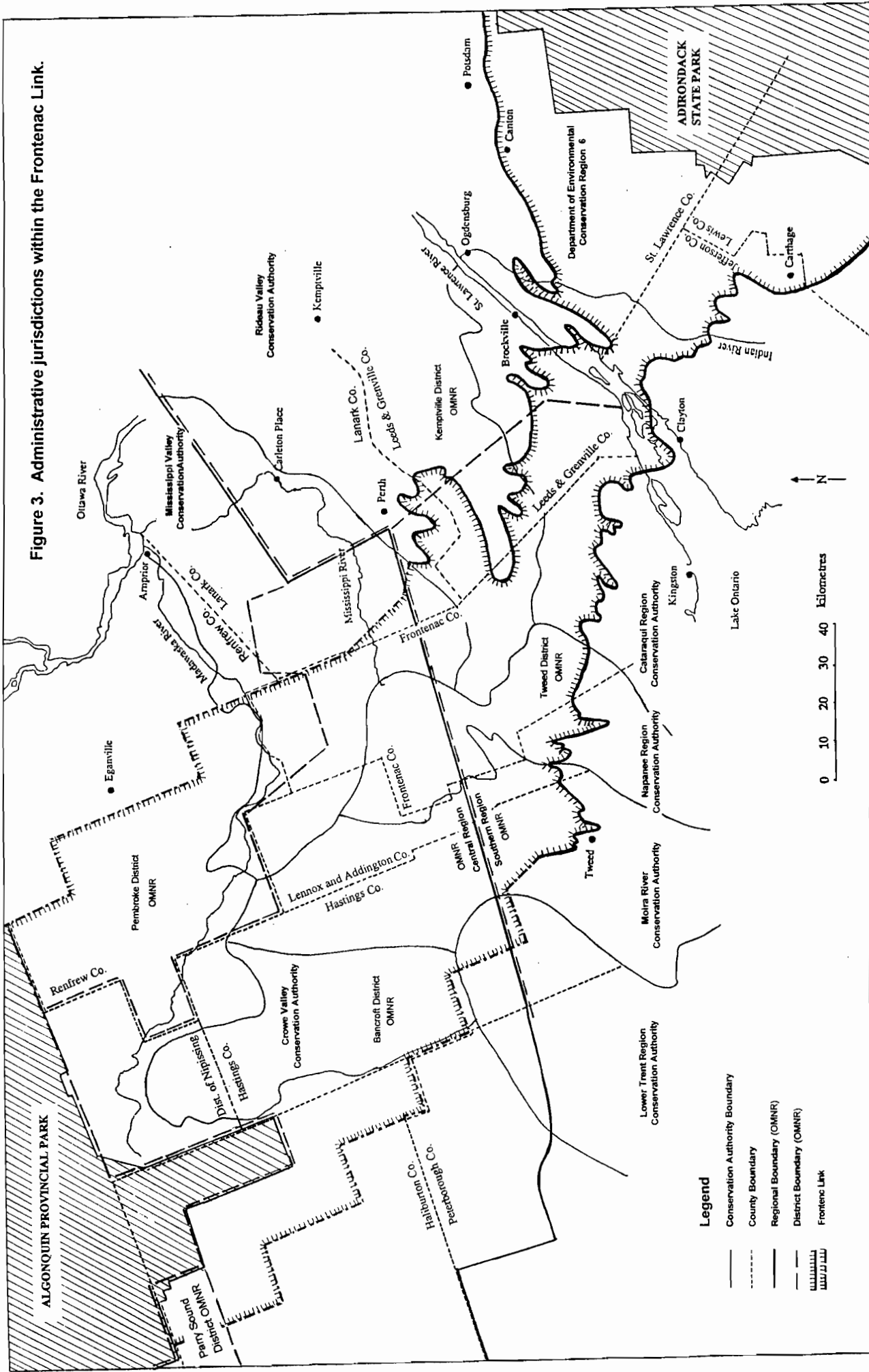
The boundaries defined on the basis of the Precambrian Shield are shown as a solid line in Figure 2, while those based on jurisdictional boundaries are indicated by dashed lines. Revision of these preliminary boundaries will be required and should reflect the weakness of the link at its narrowest point, the potential effects of development on Paleozoic intrusions reaching far into the Precambrian FL and the importance of the Madawaska area in making connections with Algonquin Park.

2.2.2 Administrative Jurisdictions

A successful conservation strategy will require the cooperation and support of the many land management agencies and decision-makers within the FL. Figure 3 puts the FL in context for several major land management agencies by showing the administrative boundaries of these agencies. Not only can each agency relate the FL to its own authority, but relationships among agencies, the potential for cooperation and the administrative complexity of land management on the FL become clear.

In summary, Figure 3 shows two administrative regions (Southern, Central) and five administrative districts (Kemptville, Pembroke, Tweed, Bancroft, Parry Sound; 1994 boundaries) of the Ministry of Natural Resources, 7 conservation authorities and 8 counties (Haliburton, Nipissing, Hastings, Lennox and Addington, Frontenac, Leeds and Grenville, Lanark, Renfrew) compose the FL. South of the St. Lawrence River, three counties are represented (Jefferson, Lewis, St. Lawrence) and the entire area falls within Region 6 of the NY State Department of Environmental Conservation. Additional jurisdictions, not mapped, include 75 townships composing the Ontario portion of the FL, one region of Parks Canada (Ontario Region) and the Golden Lake Indian Reservation just inside the boundary, west of Eganville.

Figure 3. Administrative jurisdictions within the Frontenac Link.



3.0 NATURAL ENVIRONMENT OF THE FRONTENAC LINK

3.1 Natural Regions

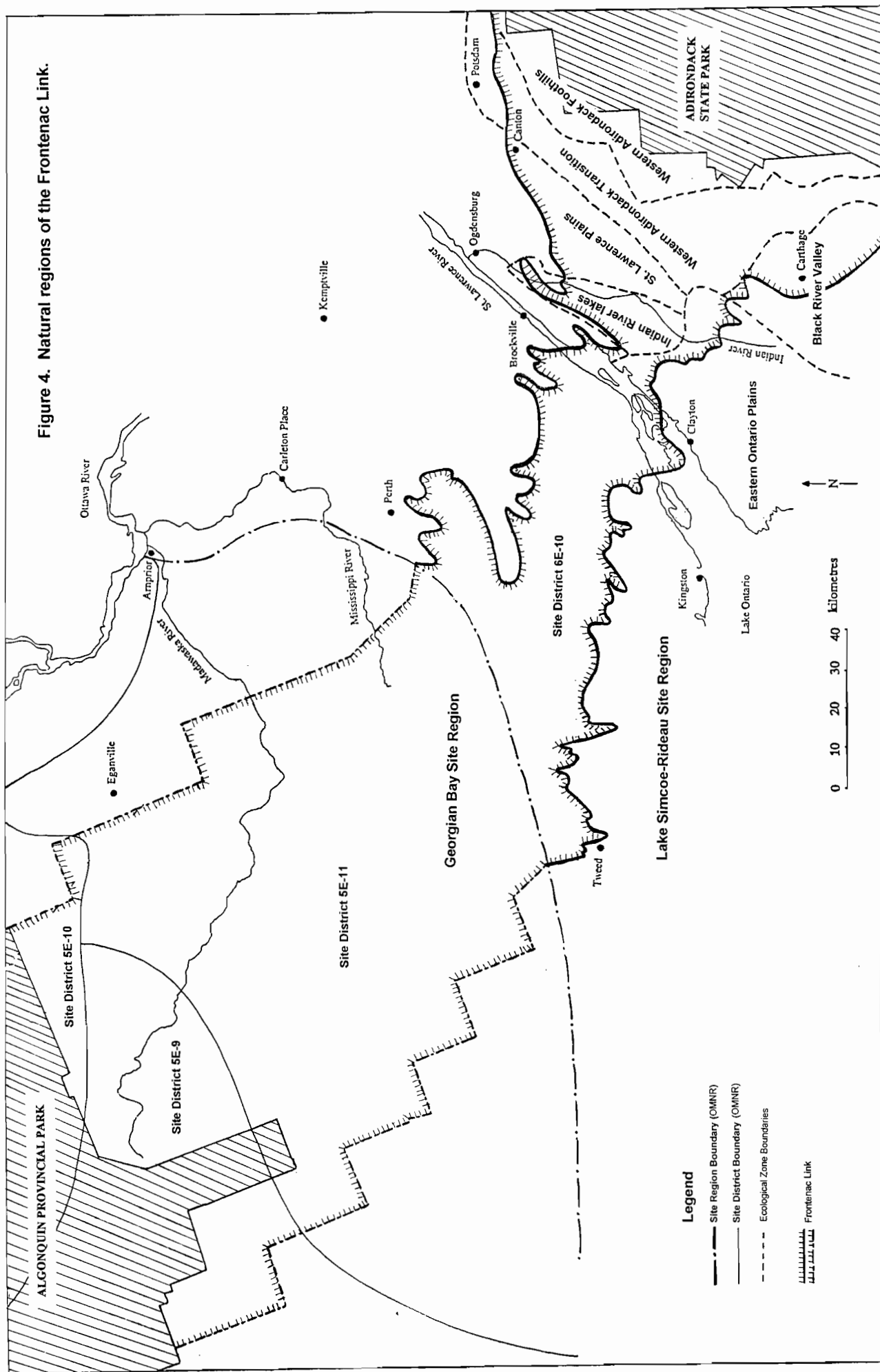
Under the natural region classification scheme used by the Ontario Ministry of Natural Resources (Hills 1959), Ontario is divided into 12 Site Regions on the basis of the response of vegetation to landform features and characteristic patterns of plant species succession. The FL represents two of these regions-- the Georgian Bay Site Region (5E) and the Lake Simcoe-Rideau Site Region (6E) (Figure 4). These Site Regions are further divided into landform units called Site Districts that express a uniform set of interrelationships between vegetation and physiographic characteristics of the land. The majority of the FL is composed of Site District 6E-10 (Westport Site District-- the Axis itself) and Site District 5E-11 (Bancroft Site District). Small portions of site districts 5E-9 and 5E-10 compose the northern portion of the FL. Although other natural regions are discussed below, only those of OMNR and those for New York State are mapped in Figure 4 because they are likely to provide the most useful framework for the conservation strategy.

Characteristic of the rugged landscape of the Westport Site District are the humpbacked, igneous rock ridges and alternating valley troughs. The ridges may form rock barrens or be covered with thin, sandy soil that supports mostly mixed forest and some deciduous forest. Drainage is often impeded and numerous wetlands and many lakes are found in the site district (White 1993).

The Bancroft Site District has a rolling landscape underlain mostly by igneous bedrock with thin soil cover. Lakes and rivers abound and extensive rock barrens are found in the southern portion. It also contains a large area of marble bedrock which supports a rich representation of marble-influenced wetland and upland habitats (Brunton 1989). The climate is generally more boreal than in the Westport Site District.

The rock barrens of these natural regions are the largest, relatively undisturbed granite rock barren areas in southern Ontario (see report cover). They have resulted from glacial scouring and subsequent soil loss as a result of fire, wind and rain. These barrens are characterized by blue berry-juniper thickets with extensive stands of Red Oak and poplar-pine-oak forest and some White Pine forest. Unusual species from upland areas include provincially rare species such as the little Prickly Pear Cactus, Shining Sumach, Pitch Pine, *Bulbostylis*, Forked Panic Grass, Black Rat Snake and Prairie Warbler. Others of regional significance include Poke Milkweed, Northern Downy Violet, Bicknell's Panic Grass, Hoary Vervain, Pink Polygala and the only lizard in the province (Five-lined Skink, see report cover). In the wetland areas among the rock ridges, provincially rare species such as Bladderwort, Carey's Knotweed, Small Beggarticks, Southern Twayblade and Spotted Turtles may be found.

Figure 4. Natural regions of the Frontenac Link.



South of the St. Lawrence River, the FL is composed of six ecological zones (Fig. 4) which are described by Will *et al.* (1982). The Eastern Ontario Plains is a nearly level area where the soils are mostly lake sediments over limestone bedrock. White Elm-Red Maple and northern hardwoods are the dominant forest types.

The Indian River Lakes zone is another lowland area consisting primarily of rolling hills and granite outcrops. Precambrian granite and intruding sedimentary sandstones underlie the shallow, poorly drained soils. Forests are a transitional type between northern hardwoods and oak-hickory forests of more southern affinity.

In the St. Lawrence Plains, an area of flat and rolling plain, northern hardwoods are dominant in small woodlots, often in low swampy areas. Soils of moderate capability for agriculture overlie limestone and sandstone bedrock.

The Black River Valley zone is largely an agricultural area with some woodlots of northern hardwoods. Rich loam soils cover the limestone bedrock.

In the Western Adirondack Transition zone, poor soils cover the rough topography underlain by Precambrian bedrock. A mixture of old fields, successional forests and farms occurs in this area.

The topography and soils of the Western Adirondack Foothills zone are much like the previous zone. Spruce and Balsam Fir forests of northern affinity and northern hardwoods as well as shrubland occupy about 85% of the area. Wetlands are characteristic of the floodplains adjacent to many rivers and streams.

In terms of the national natural region classification scheme described by Environment Canada and Agriculture Canada (Ecological Stratification Working Group 1993, Centre for Land and Biological Resources and State of the Environment Reporting 1994), the FL represents two (Boreal Shield, Mixedwood Plain) of the 15 ecozones that comprise Canada. Within these ecozones, the FL represents the Frontenac Axis and Algonquin-Lake Nipissing ecoregions, respectively.

The entire FL occurs within one of the natural regions in Parks Canada's classification framework-- 19b, the Central Great Lakes-St. Lawrence Precambrian Region (Canadian Environmental Advisory Council 1991).

3.2 Geology and Physiography

As briefly mentioned in section 2.1, the main basis for defining the FL is geological (Figs. 1, 2). The FL is within the Grenville geological province of the Precambrian Shield for which assignments of rocks are tentative because they are based on broad lithological and structural characteristics (Geological Survey of Canada 1971). This bedrock is largely composed of undifferentiated igneous and metamorphic precambrian bedrock, exposed at the surface or covered by a discontinuous, thin layer of drift (Barnett *et al.* 1991). The FL also contains large expanses of more easily erodible marble bedrock (White 1993). Where tilted and alternating layers of igneous and marble bedrock occur, a 'ridge and valley' topography, consisting of humpbacked igneous ridges alternating with eroded marble valleys, characterizes the landscape. In contrast, the relatively flat area off the Precambrian Shield is underlain by Paleozoic bedrock composed of sandstones and limestones (Fig. 1; Chapman and Putnam 1984).

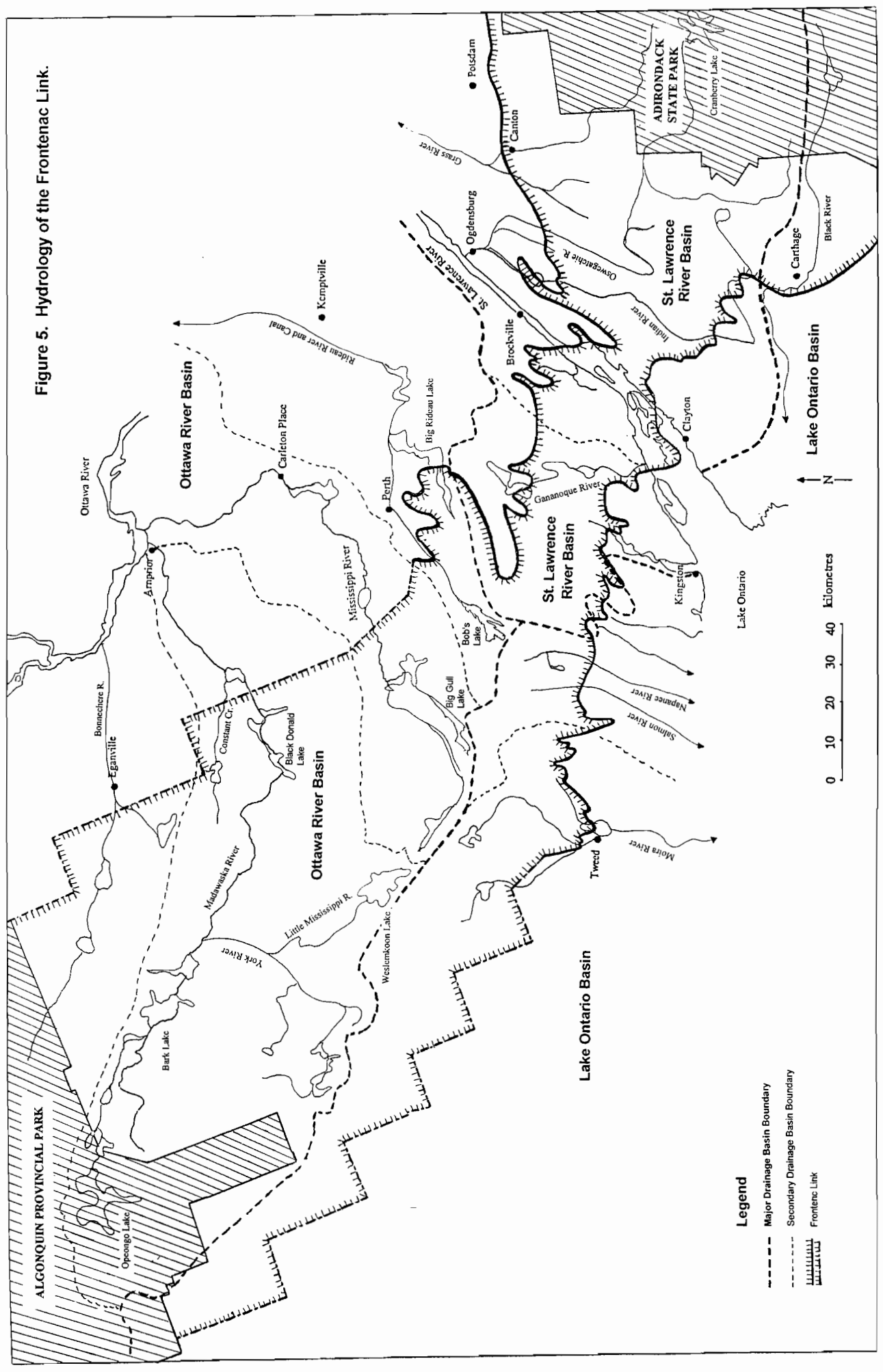
Glacial activity has had a major influence on the landscape of the FL. Most of the surface material was removed from the uplands through scouring by the Wisconsin ice sheet and extensive rock barrens (with associated significant plant species, see section 3.1) are found in the central portion of the FL (Brunton 1989, White 1993). The southern portion was inundated by glacial Lake Iroquois (Chapman and Putnam 1984). Glacial and post glacial processes have left a variety of restricted inland deposits in the FL such as clay plains, sand plains, kame moraines, drumlins and eskers. Clay plains are mostly found in the southern part of the FL where igneous rock knobs protrude through the clay deposits to form the Leeds 'knobs and flats' described by Chapman and Putnam (1984). Thus the geological history and geomorphology of the FL have combined to make the area largely unsuitable for agriculture and this is the reason that it exists today as a somewhat natural link.

In the NY portion of the FL, lake sediments with scattered drumlins and kame deposits occur over the lowlying areas between Adirondack Park and the St. Lawrence River (van Diver 1985). The 'ridge and valley' topography resulting from alternating igneous and marble bedrock, common in the FL in Ontario, is also typical of the central part of the FL in NY. The geology of the state has been mapped in detail by the New York State Museum and Science Service (1970) and a technical discussion of the Quaternary geology of the state can be found in Wright and Fry (1965).

3.3 Hydrology

The FL is a height of land from which rivers flow east to the Ottawa R., west to Lake Ontario and south or north to the St. Lawrence R. (Fig. 5). Most of the link drains to the Ottawa River basin (Ontario Ministry of the Environment 1973).

Figure 5. Hydrology of the Frontenac Link.



Major rivers crossing the FL in Ontario include the Bonnechere (175 km), Madawaska (225 km), Mississippi (100 km), and Moira (165 km). The Indian River (75 km) is the largest draining the New York portion of the FL. Water flow in the majority of these large rivers has been restricted by dams installed for hydroelectric power generation.

The irregular topography of the FL, combined with beaver activity, results in restricted drainage, numerous wetlands and numerous oligotrophic lakes as well as marl-based ponds and lakes. The lakes on the FL range from beaver ponds to those several kilometers long and about 80 km². The five largest lakes, from north to south are: Bark L., Black Donald L., Weslemkoon L., Big Gull L., and Bob's L. The highly convoluted shorelines and numerous islands of these lakes are typical of the FL.

A diverse array of wetland types occurs on the FL. Commonly associated with wet basins, rivers and shallow lakes are emergent, aquatic, and open water marshes. Emergent marshes are often dominated by cattails and may contain sedges. Water-lilies and Bullhead are typical of floating-leaved marshes while species such as Bladderwort are common in submerged marshes.

Four main types of swamps are found on the FL. Numerous, relatively undisturbed examples of mixed swamps dominated by White Cedar and Black Ash exist, but few are extensive. Deciduous swamps, dominated by Red Maple and Black Ash also commonly occur in association with wet basins, shallow lake margins and river floodplains. Coniferous swamps are uncommonly associated with wet basins. Although several undisturbed examples of these swamps, typically dominated by White Cedar and Larch, can be found, few are large. Typically dominated by White Cedar and Larch, several undisturbed examples can be found and few are large. Thicket swamps, dominated by shrubs such as Speckled Alder and Willows, are very common, but often not extensive.

Small fens, are rare in the FL and dominated by sedges. They are associated with wet basins, small lakes and streams as are open bogs. The latter are common, but most are small. Low shrubs such as Labrador Tea and Leatherleaf are often dominant in these open bogs. Rarely, treed bogs form in wet basins and they are dominated by Black Spruce, Balsam Fir and White Cedar. Generally, the size and significance of bogs increases towards the northern, more boreal, end of the FL.

3.4 Vegetation

3.4.1 From the Ice Age On...

On the basis of pollen analysis of lake sediments, the general pattern of vegetation development on the FL since the last ice age is described by Anderson (1989) and summarized below:

12,000 B.P. portions near the present St. Lawrence river were covered by a glacial lake while the remainder, further north, was tundra

10,500 B.P. the majority of the FL was covered by spruce forest while a small area in the northeast corner had poplar forest

9,500 B.P. the southern two-thirds was dominated by pine forest and the northern part by spruce forest

6,500 B.P. the majority of the FL was covered by Eastern Hemlock and hardwoods while a small area in the northeast corner had pine forest

3,000 B.P. the entire FL was covered by Eastern Hemlock, White Pine and mixed hardwoods.

3.4.2 Present Vegetation Cover

The FL lies near the northern limit of the deciduous forest region of North America (Barnes 1991, Braun 1950). Along the alignment of the FL, the vegetation undergoes a transition from deciduous forest of Carolinian affinity in the south (e.g., oak-hickory in NY) to mixed forest (northern hardwoods with Spruce and Balsam Fir) with boreal affinities in the north.

Eyre (1980) generally characterizes the forest in the NY portion of the FL as northern hardwoods (maple-beech-birch) with pockets of spruce-fir. A closer look shows that in the lowlying plains areas (Fig. 4), maple-beech-birch, oak-hickory and White Elm-Red Maple forests are found. As one moves to the foothills of the Adirondacks, spruce and Balsam Fir forests, of more northern affinity, become mixed with the northern hardwoods.

According to Rowe (1972), the Ontario portion of the FL occurs within the Great-Lakes- St. Lawrence Forest Region. More specifically, the southern three-quarters of this area falls within the Middle Ottawa Forest Section. The upland forests here are typically composed of Sugar Maple, Beech, Yellow Birch, Red Maple and Eastern Hemlock along with White Pine and Red Pine. The last two species, along with Jack Pine, are characteristic of dry ridges and sand flats.

White Spruce, Balsam Fir, Trembling Aspen, White Birch, Red Oak and Basswood occur throughout. Hardwood and mixedwood swamps are common and composed of White Cedar, Tamarack, Black Spruce, Black Ash, Red Maple and White Elm. Less common are species of southern affinity such as Butternut, Bitternut Hickory, White Oak, White Ash and Black Cherry.

The northern quarter of the Ontario portion of the FL falls within the Algonquin-Pontiac Forest Section which shows affinity with the Boreal Forest Region. Typical upland forest is composed of Sugar Maple, Red Maple, Yellow Birch, Eastern Hemlock, and White Pine, and they often occur in association with boreal conifers. Hardwoods tend to be dominant on warm slopes and hilltops. Red Spruce enters in the eastern portion of the section. Balsam Fir is common, White Spruce has a moderate distribution and Jack Pine again occurs in dry sites. American Beech, White Cedar, White Birch and Trembling Aspen also occur in the section. Large stands of White and Red Pine occurred historically but are now rare due to logging and fires.

White (1990) examined a limited number of forest stands in the FL in Ontario and found only a few (hemlock-red spruce, maple-beech, red oak-white pine), ranging in size from 8 to 60 ha, that had the potential to develop or were nearing conditions characteristic of old growth forests. This uncommon habitat type requires attention during strategy development. Additional information on the nature of forests and significant examples in the FL can be found in various reports prepared for the Ontario Ministry of Natural Resources (Brunton 1989, White 1993, White 1990).

Wetland vegetation cover of the FL was described in more detail in section 3.3.

3.4.3 Significant Plant Species

The FL provides habitat for species of biogeographic interest as well as many species considered rare. For example, in the rock barrens in the central portion of the FL, one finds Little Prickly Pear, a cactus that is disjunct from the main part of its range (western Canada and U.S.) by about 1000km. Other species such as Balsam Willow and Three-leaved Cinquefoil are northern species that reach their southern limit on the FL. Shining Sumach, Dryland Blueberry, Prostrate Tick-trefoil and Deerberry are a few of the many southern species that occur in the Carolinian zone of Ontario (south of Hamilton), south of L. Ontario, and manage to extend around the eastern end of the lake onto the southern end of Frontenac Axis where they reach their northern limit.

The FL supports many plant species of significance in Canada, Ontario and New York State. The 48 species rare in Ontario represent 28 different plant families (Argus *et al.* 1987). This diverse array of species includes, for example, sedges,

orchids, cacti, legumes, asters, gentians and ferns. Five of these provincially rare species have not been seen in the FL since 1925 and three have not been seen since 1949. On a Canadian scale, 33 plant species found on the FL are considered rare (Argus and Pryer 1990). For some of these, such as Pitch Pine, the FL supports important centres of distribution. Status reports have been prepared for four species and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has assigned vulnerable status to one species (Broad Beech Fern) and threatened status to three species (Blunt-lobed Woodsia, Deerberry, Ginseng; COSEWIC 1994). About half of Canada's remaining wild population of Ginseng occurs within the FL.

South of the St. Lawrence R., the FL supports eight species that are rare, eight species that are threatened and three species that are endangered within the State of New York (Nick Conrad, NY State Dept. of Environmental Conservation, pers. comm.)

White *et al.* (1993) provide accounts of many alien plant species that have been found on the FL and are potential invaders of natural habitats and could reduce ecological integrity. Among these, four wetland species currently pose major threats to natural habitats (Purple Loosestrife, Eurasian Watermilfoil, European Frog-bit, Reed Canary Grass) and one species threatens the integrity of upland habitats (Common Buckthorn).

3.5 Fauna

3.5.1 Mammals

In the FL, a total of about 54 mammal species occur (Banfield 1974). Some of the animals included in this diverse group are opossums, shrews, bats, hares, rodents, beaver, porcupines, coyotes, weasels, cats and deer. Of these, four (Wolf, Marten, Lynx, Moose) have become extirpated from the southern third of the FL in Ontario and three (Cougar, Wolverine, Wapiti) have become extirpated from the entire FL. Projects at the University of Waterloo are being conducted to investigate the current distribution of wolves, the potential for populations to be restored and move south along the FL (J. Theberge pers. comm.). The European Hare and Norwegian Rat have been introduced to the FL.

COSEWIC (1994) considers two of the species occurring on the FL (Grey Fox, Southern Flying Squirrel) vulnerable in Canada. Both these species have southern affinities and reach northern limits on the FL. South of the St. Lawrence R., the FL does not support any mammals that are of concern in New York State (Nick Conrad, NY State Dept. of Environmental Conservation, pers.

comm.). The Lynx has been reintroduced into Adirondack State Park (Brocke and Gustafson 1992, Brocke *et al.* 1990).

3.5.2 Birds

Breeding bird atlases have been completed for both Ontario (Cadman *et al.* 1987) and New York (Andrle and Carroll 1988). According to these atlases, 185 native species of birds may breed in the FL (165 confirmed, 11 probably and 9 possibly). The Ontario Atlas also shows that the diversity of breeding birds in the FL is generally high (relative to other areas of the province) as 60% of the squares (10x10 km) surveyed fell into the highest class for number of species (>104 species/square). Further analysis of breeding birds in the main (Ontario) portion of the link showed that a distinct group of species had affinities to the southern Shield (southern 3/4 of the FL in Ontario) while another group had affinities with the northern Shield (northern 1/4 of FL). The high diversity of species, particularly in the southern Shield group (mean of 105/square; the highest for all groups examined), is probably due to the variety of habitats present, the availability of wetlands and overlap of species of southern and northern affinity in this transition zone.

For the New York portion of the link, where 5x5 km squares were surveyed, the diversity of breeding bird species was similar to most of the rest of the state. Only 16% of the 155 squares in the link had more than 75+ species (the highest density category used in the NY atlas).

The FL plays an important role in maintaining and facilitating the distribution of breeding bird species which show many interesting patterns. This area links the major concentrations of northern species to their southern range extensions. Typically these species extend down the FL, jump the lowlands near the St. Lawrence R., then reappear in boreal habitats of Adirondack Park where they reach their southern limit. They form the largest group of geographic interest and include the Boreal Chickadee, Spruce Grouse, Gray Jay, Black-backed Woodpecker, Tennessee Warbler, and Rusty Blackbird. Four species have a similar distribution (Swainson's Thrush, Olive-sided Flycatcher, Common Raven, Yellow-bellied Flycatcher), but they reach their southern limit in the Catskill Mountains of New York, just south of Adirondack Park. The unusual distribution of the boreal Three-toed Woodpecker is also noteworthy. The limit of its main distribution occurs around Sudbury, but it has two disjunct locations within the Ontario portion of the FL and it occurs in Adirondack Park!

At the other end of the spectrum, some southern species reach their northern distribution limits on the FL. Four of these breed in Adirondack Park and extend up along the FL. They include the Cerulean Warbler, Louisiana Waterthrush, Orchard Oriole and Blue-winged Warbler. Two others (Yellow-breasted Chat,

Kentucky Warbler) occur only within the Ontario portion of the FL. One species (Wilson's Phalarope), with its main distribution in western North America, also breeds just in this portion of the FL.

Some more widespread birds appear to have regionally (Ontario-NY context) significant centres of abundance on the FL. Examples of species with concentrations in the Ontario portion of the FL include the Yellow-throated Vireo, Golden-winged Warbler, Cerulean Warbler and Prairie Warbler. Few species (e.g., Sedge Wren, Pine Warbler) have centres of abundance in the NY portion of the FL. Other widespread species appear particularly common on the FL: Pine Warblers and Whip-poor-wills have distributions that appear to follow the rocky open forests; Hooded Mergansers seem to use the many small ponds of the FL in Ontario for breeding.

Considering the area composed of the FL and the two anchoring parks, no species are found only within Algonquin Park. A dozen species are found only in Adirondack Park. Some are southern species that reach their northern limit in the Park (e.g., Red-bellied Woodpecker, Carolina Wren, White-eyed Vireo, Hooded Warbler). These also occur in the Carolinian zone of Ontario. Two northern species (Gray-cheeked Thrush, Blackpoll Warbler) are typically found around James Bay, yet they have disjunct locations only in Adirondack Park (and the Catskills), over 1,000km from their main range! The remaining species found only in Adirondack Park are the Bald Eagle and Golden Eagle. Two species (Common Goldeneye, Palm Warbler) occur only within the two parks and not in the FL.

Unlike the surrounding farmland, the FL provides significant interior forest habitat that is required by many neotropical migrants such as the Scarlet Tanager, Canada Warbler, Cerulean Warbler, Louisiana Waterthrush, Veery, Northern Waterthrush, Nashville Warbler and Ovenbird. The latter four species have shown more than 50% decline in Ontario between 1961 and 1988 (Riley and Mohr 1994). Significant habitat is also provided by the FL for neotemperate migrants that breed in the forest interior such as Red-shouldered Hawks and Yellow-bellied Sapsuckers. During the winter, the forests of the FL provide significant habitat for finches and support the largest concentration of Great Grey Owls in southern Ontario (R. Weir pers. comm.).

Where clearing for agriculture has occurred, prairie-like conditions have been created in some areas of the FL. Birds of open areas have likely increased in abundance since settlement as a result. Species such as Bobolinks, Eastern Meadowlarks and Upland Sandpipers are examples. Where human activities increase forest fragmentation and forest interior habitat is reduced, the incidence of parasitism of forest nesting species by the Brown-headed Cowbird (formerly an occasional species of the eastern prairies, now abundant on the FL) increases.

Not included in the species counts above are four species that have been introduced to the FL (Gray Partridge, Ring-necked Pheasant, European Starling, House Finch). The latter is expanding its distribution rapidly, mainly in association with urban centres and areas disturbed through agriculture.

Of the nearly 200 species that may breed on the FL, COSEWIC has designated eight vulnerable (Cerulean Warbler, Short-eared Owl, Cooper's Hawk, Red-shouldered Hawk, Prairie Warbler, Yellow-breasted Chat, Least Bittern, Louisiana Waterthrush), two endangered (Loggerhead Shrike, Henslow's Sparrow). The Bald Eagle is protected under Ontario's Endangered Species Act. Bald Eagles, formerly common nesters in the FL are gradually returning. The Passenger Pigeon, which formerly bred on the FL, is now extinct.

South of the St. Lawrence R., the FL supports five protected species (Great Blue Heron, Short-eared Owl, Black Tern, Cliff Swallow, Common Loon), four threatened species (Northern Harrier, Osprey, Common Tern, Red-shouldered Hawk) and two endangered species (Loggerhead Shrike, Bald Eagle) in New York State (Nick Conrad, NY State Dept. of Environmental Conservation, pers. comm.). In the U.S., the Bald Eagle is formally listed as endangered in some parts of its range and threatened in others.

3.5.3 Amphibians and Reptiles

According to a preliminary version of the amphibian and reptile atlas being prepared by the New York State Department of Environmental Conservation (1995), most of the portion of the FL in this state is not rich in these species. Only one of the approximately 10x10km² survey squares contained more than 20 species. The New York portion of the FL supports 27 species while the Ontario portion of the FL supports 34 species (M. Oldham, Natural Heritage Information Centre, pers. comm.; 1989 data).

The FL provides habitat for 17 species of amphibians, two of which are uncommon in Ontario (Two-lined Salamander, Four-toed Salamander). On the FL, the Four-toed Salamander is found only in Ontario and the Mink Frog reaches its northern limit.

A total of 17 reptile species is also found on the FL. Of these, five are found only on the Ontario portion of the FL (Map Turtle, Blandings Turtle, Ring-neck Snake, Sinkpot Turtle, Spotted Turtle). The latter two species reach their northern distribution limits on the FL. The Stinkpot Turtle, Map Turtle, Spotted Turtle (vulnerable in Canada according to COSEWIC 1994), Five-lined Skink (only lizard in the province) and Black Rat Snake (most arboreal snake in the

province) are uncommon in Ontario. The majority of the Canadian population of the last species is found on the FL.

3.5.4 Fish

Ninety native species of fish occur in the FL (Scott and Crossman 1973). These species have re-invaded the area since glacial times from two major refugia. Species such as Northern Pike, Muskellunge, and Central Mudminnow survived glaciation in the Mississippi refugium (McAllister and Coad 1974). Species such as Silvery Minnow, Golden Shiner and Northern Redbelly Dace likely survived in an Atlantic coastal refugium. For the Silvery Minnow, the FL represents a significant portion of its Canadian range.

Three species have been intentionally introduced to the FL: Brown Trout, Rainbow Trout and Carp. The influence of the Ontario Ministry of Natural Resources fish stocking program on fish distributions on the FL should be determined.

The Pugnose Shiner is considered vulnerable and two species (Margined Madtom, Channel Darter) are considered threatened in Canada by COSEWIC (1994). One fish species (Lake Sturgeon) is considered threatened and one is considered endangered (Pugnose Shiner) in New York State (Nick Conrad, NY State Dept. of Environmental Conservation, pers. comm.).

3.6 Protected Areas

The forests of Adirondack State Park anchor the western edge of the Great Northern Forest (see Fig. 1 and section 7.3) and are joined by the FL to Algonquin Provincial Park. These two world class parks will be briefly described, followed by protected areas within the FL.

3.6.1 Algonquin Provincial Park

Algonquin Park is the largest (772,500 ha) and oldest (established 1893) provincial park in Ontario (Strickland 1989). It is located on the top and eastern slopes of a dome of Precambrian Shield bedrock from which 19 rivers originate. Because Algonquin Park lies in the transition zone between the southern deciduous and northern coniferous forests, it supports high biodiversity. Over half of the park is subject to timber management.

On the west side of the park, the upland forests consist mainly of hardwoods such as Sugar Maple, Yellow Birch and American Beech with Eastern Hemlock,

Black Cherry and Ironwood as secondary components. Good examples of Red Spruce forest, once more common in the province, can be found in the park. Black Spruce and Speckled Alder dominate in many low-lying areas. The forests on the west side of the park have been altered by human activities in a major way. Pioneer loggers in the area removed giant white pines (many over 120 cm diameter) and, today, only two of the original hardwood-pine stands remain. The vegetation of the east side of the park is more diverse as a result of the warmer climate, presence of rocks enriched in calcium carbonate and the presence of river valleys which serve as routes for plant migration from the Ottawa valley. Forests are dominated by White, Red and Jack Pine. The predominant hardwoods are early successional species- Trembling Aspen, White Birch. In total, 1,042 plant species are found in the park (Brunton and Crins 1992).

Among the 44 species of mammals in the park, the largest include Moose, Black Bear, Wolf, Lynx and White-tailed Deer. The latter is not native to the park, but migrated there when logging began on the Shield. This has had detrimental consequences for Moose populations because the deer carry a parasite which causes death to Moose.

The park harbours 14 species of reptiles and 16 species of amphibians. The Wood Turtle and Pickerel Frog populations appear to be some of the most significant remaining in the province (Strickland 1989). A total of 246 bird species have been recorded for the park, of which 128 are known to breed. Checklists for lichens (165 species), bryophytes (257 species), fungi (1,070 conspicuous species) and butterflies (77 species) have also been prepared for the park (R. Tozer, Algonquin Park, pers. comm.).

3.6.2 Adirondack State Park

The park is the largest park in the lower 48 states. Its 2.5 million ha could hold the combined areas of Yellowstone, Yosemite, Grand Canyon and Olympic national parks. This park includes 90% of all designated wilderness in the northeastern U.S. (*i.e.*, east of the Mississippi River and north of the Great Smoky Mountains). Adirondack Park is part of the 4 million ha Champlain-Adirondack International Biosphere Reserve (Gibson 1994). Only 42% of the park is owned and protected by the State as Adirondack Forest Preserve and half of this is classified as wilderness where commercial use and motor vehicles are prohibited. The remainder is private land.

Like Algonquin Park, Adirondack is a dome of Precambrian Shield. It harbours the headwaters of 30 major rivers including the Hudson R. and tributaries of the St. Lawrence R.

Mixed woods and hardwoods dominate the park forests. The upper slopes support Balsam Fir and Mountain Paper Birch, below which Red Spruce and Balsam Fir, with occasional Yellow Birch, are found. The mid-slopes support the richest hardwoods of Sugar Maple, American Beech and Yellow Birch. Where drainage is poor, in the more level areas of the northwest, Red Spruce and Balsam Fir dominate. Ridges in lowland areas support White Pine (McMartin 1994). Ninety per cent of the plant and animal species found in the northeastern U.S. occur in the park.

Of the 291 bird species that have been seen in the park, 187 breed there (DiNunzio 1984). Species such as the Spruce Grouse, Common Goldeneye, Golden Eagle, Three-toed Woodpecker, Black-backed Woodpecker, Gray Jay, Boreal Chickadee, Ruby-crowned Kinglet, Tennessee Warbler, Cape May Warbler and Palm Warbler are unique in the State to Adirondack Park. Fourteen species are of special concern, three are threatened and four are endangered in the state (E. Reid, NY State Dept. of Environmental Conservation, pers. comm.).

The park fauna also includes 57 species of mammals, 79 native fish species, 19 amphibians and 16 reptiles (DiNunzio 1984).

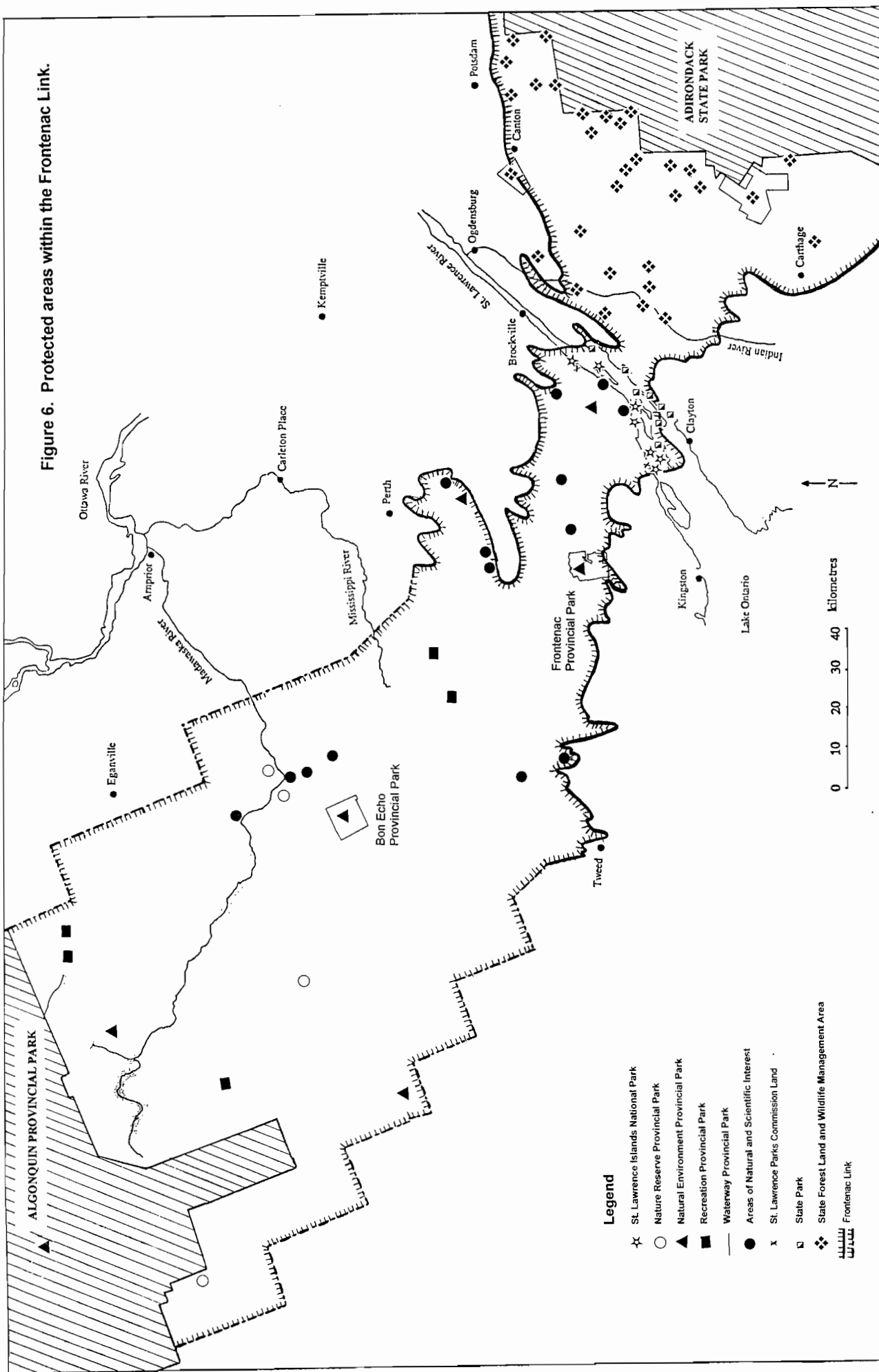
Although Adirondack Park lies far south of Algonquin Park, elevation and drainage conditions have combined to create habitats in the Adirondacks that resemble those typical of Algonquin Park and more northern areas. This provides the ground for the ecological and biogeographical connection between these two parks and the FL provides the link.

2.6.3 The Frontenac Link

A diversity of protected areas is found within the FL. They include the following types (numbers of areas indicated in brackets) which are mapped in Figure 6:

- national parks (1)
- provincial parks (19)
 - nature reserve parks (4)
 - natural environment parks (6)
 - recreation parks (5)
 - waterway parks (4)
- areas of natural and scientific interest (ANSI, 11)
- regional parks (St. Lawrence Parks Commission) (1)
- state parks (8)
- state forest land and wildlife management areas (31)

Figure 6. Protected areas within the Frontenac Link.



Legend

- ★ St. Lawrence Islands National Park
- Nature Reserve Provincial Park
- ▲ Natural Environment Provincial Park
- Recreation Provincial Park
- Waterway Provincial Park
- Areas of Natural and Scientific Interest
- x St. Lawrence Parks Commission Land
- ◻ State Park
- ◊ State Forest Land and Wildlife Management Area
- Frontenac Link

Each type of area offers differing degrees of protection to the natural resources within. Only ANSIs officially designated by OMNR are shown in Figure 6. Candidate ANSIs proposed for the Ontario portion of the FL are described in relevant Site District reports (White 1993, Brunton 1989, 1991a,b). These 71 areas of natural significance comprise only a small portion of the total area of the FL and are widely scattered within it. In addition to these areas protected by government agencies, holdings by nongovernmental organizations such as the Kingston Field Naturalists, Queens University and Hewlett-Packard also contribute to area protection. These areas could be considered as a nucleus which (with the addition of other areas) could form the core of a natural areas network within the FL (see section 5.2).

Gap analysis by World Wildlife Fund (1995) of the portion of the FL in Ontario showed that natural features found in Site District 6-10 (the Frontenac Axis) were moderately represented by the protected areas in Figure 6. The northern portion of the FL (Site District 5-11) is only partially represented (up to 50% of the major enduring features are either moderately or adequately captured and at least 50% of the remaining features are partially captured; and at least 80% of all features are partially captured) by the protected areas within it. Additional detail concerning the degree of protection (adequate, moderate, partial, not protected) of each of the enduring features of each site district can be obtained from WWF (T. Iacobelli, pers. comm.).

4.0 THE HUMAN ELEMENT

4.1 Land Capability

Had our ancestors understood the nature of FL and its land capability, patterns of land use and disturbance of the FL would probably have been very different today. Table 1 shows the capability of the FL for agriculture, forestry, outdoor recreation, ungulate production, and waterfowl production. Percentages of the FL in different capability classes were obtained by laying a clear plastic sheet with a grid of 587 dots over 1:1,000,000 land capability maps (prepared in the mid 1970s jointly by the Ontario Ministry of Natural Resources, Environment Canada, Agriculture Canada) and determining the proportion of dots in each class. From this table, it can be clearly seen that the lands of the FL are unsuitable for agriculture and most suitable for forestry, outdoor recreation and wildlife production.

For comparison, Table 1 also lists the first, second and third most common class (determined by visual inspection) for each land use capability in the areas east and the west of the Axis. It is the poor capability for agriculture (contrasting with the areas to the east and west) that now gives us the opportunity to enhance and restore the ecological integrity of the FL.

Table 1. (a) Relative extent (% FL covered) of land capability classes in the FL for agriculture, outdoor recreation, forestry, ungulates and waterfowl based on the Canada Land Inventory (the lower the number, the higher the capability; see text for details) and (b) the three most common capability classes for lands east and west of the Frontenac Axis.

(a)

Capability Class	Agriculture	Outdoor Recreation	Forestry	Ungulates	Waterfowl
1	1	3	0	0	1
2	0	9	3	1	0
3	1	32	23	2	1
4	3	56	21	87	2
5	3		34	10	96
6	3		14		
7	87		5		
organic	2				

(b)

Capability Class	Agriculture	Outdoor Recreation	Forestry	Ungulates	Waterfowl
EAST					
1st	6	4	5	4	5
2nd	1	3	4	3	1
3rd	3	2	6	2	3
WEST					
1st	6	4	4	3	5
2nd	3	3	3	2	1
3rd	2	2	2	4	4

4.2 Settlement and its Effects

In Ontario, the FL was surveyed for settlement before 1830 (southern third) and between 1850 and 1874 (northern two-thirds) (Parson 1983). The Rideau Canal, which traverses the southern portion of the FL was built between 1826 and 1832 to link Bytown (presently Ottawa) with Kingston. By 1869, a major road network totaling 800 km had been constructed within the FL (Parson 1983). In 1857, one railway line crossed the FL along the St. Lawrence River. By 1888 a north-south line from Kingston to Renfrew had been added and by 1898, a good network had been constructed in the lower third of the FL (Gentilcore and Head 1983). The rugged nature and limited land use capabilities of the Canadian Shield landscape inhibited settlement progress and the development of agriculture.

In the 1800s, pine sawlogs and square timber were important products of the FL (Head 1975). The abundant forest cover of the FL led land surveyors to believe that the soil was of reasonable quality for agriculture. For this reason and because of pressure from lumbermen anxious to reduce the expenses of transporting food and fodder to the remote shield shanties by having farmers locate near the lumbering areas, settlement of the land and the development of agriculture was actively encouraged by government from the mid 1800s.

For the Ontario portion of the FL, Kelly (1974) indicates (or the area for which data were available-- about 60% of the townships) that in 1880 approximately 75% of the FL had \geq 50% forest cover, 7% had 40 to 49.9% cover, 2% had 10 to 19.9% cover and 12% had $<$ 10 % forest cover. A century later, Riley and Mohr (1994) show that about 10% of the FL has 20-40% forest cover while the remainder has $>$ 40% forest cover. Comparison of these figures suggests that forest cover has increased slightly since the turn of the century probably as a result of abandonment of farmland and fire suppression. Lands off the Precambrian Shield on either side of the FL, by contrast, typically have only 20-40% forest cover (Riley and Mohr 1994).

In addition to loss of forest cover, landscape fragmentation is also associated with human settlement of the area. Fragmentation results from forestry operations, urbanization, cottage development and the severing of the FL by highway and utility corridors. Based on an examination of the most recent (1979-94) and historical (1925-45) 1:50,000 topographic maps for six large lakes in the FL (Bark, Weslemkoon, Crotch, Bob's, Newboro, Charleston), cottage development (as indicated by the number of cottages along the same stretch of shoreline) has increased by one and a half to seven times over this period. The contribution of other land uses to fragmentation remains to be determined.

A recent analysis of fragmentation of the Canadian landscape was conducted by Rubec *et al.* (1993). Human activities were assigned a weighting based on the severity of their impact on landscape fragmentation. For each ecodistrict in

Canada, the human activities performed and the relative area they affected were then determined. By combining activity types and areas with impact severities, a measure of per cent fragmentation was obtained. Their results showed that the landscape in the very southernmost portion near the St. Lawrence River is 75-100% fragmented. The majority of the FL, however, is only moderately fragmented (50-75%) and the northern most portion of the FL near Algonquin Park (and the park) has a fragmentation value of 25-50%. Thus the FL contrasts sharply with adjacent lands off the Precambrian Shield which are typically highly fragmented. Changes in land cover can readily be assessed over time using satellite images and about half of the FL has already been classified by land cover based on a 1992 image.

Today, no major urban centres are found within the FL. The largest town and village are Gananoque (population 4,988) and Bancroft (population 2,335), respectively (Ontario Ministry of Municipal Affairs 1993b; 1991 data). In Ontario, population densities typically range from 0.004 to 0.05 people/ha on the FL, except in the extreme southern end where they 0.11 to 0.33 people/ha. By contrast, the land adjacent to the FL has population densities ranging from 0.09 to 4.13 people/ha.

Specifically, human activities and natural features have combined to create the following obstacles to biogeographic movement along the FL:

- landscape fragmentation through land use patterns and cutting of the corridor by transportation routes and utility rights-of ways
- habitat loss and modification through urbanization and agricultural use of area adjacent to St. Lawrence R.
- highway barriers (particularly highway 401)
- the deep and wide St. Lawrence R.

These obstacles act at different scales and thus have different levels of significance for different groups of organisms.

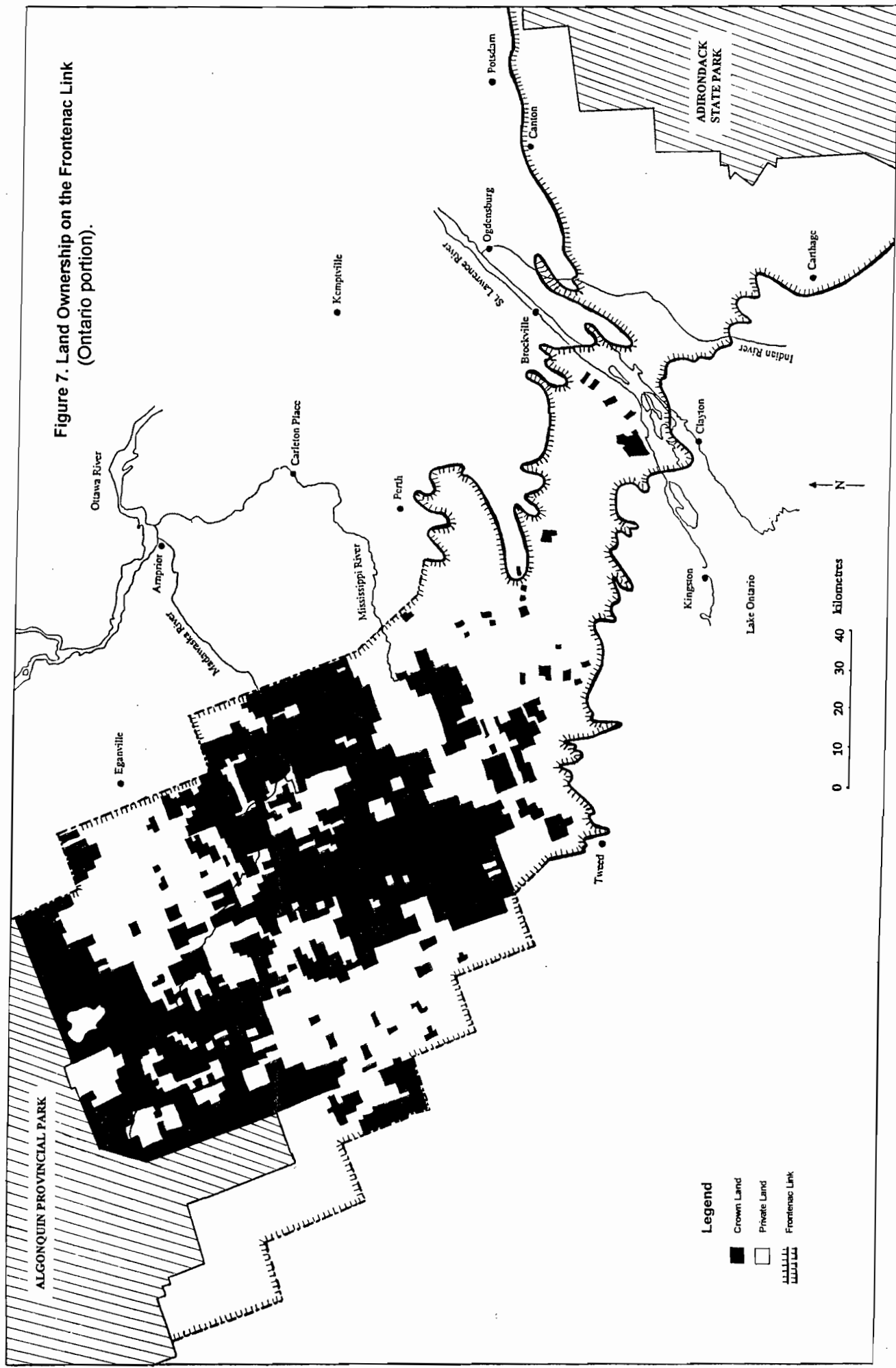
4.3 Land Ownership

Land use and land ownership for the Ontario portion of the FL is summarized in Table 2. This information (and those used to prepare Fig. 7) are taken from land tenure maps prepared by the Ontario Ministry of Natural Resources for each of their administrative districts and are typically current as of the early 1990s (e.g., OMNR 1993). Note that the Site Districts referred to in Table 2 do not correspond with those in Figure 3 since the latter are based on revised boundaries as of 1994. As shown in Figure 7, the lower third of the FL is predominantly private land while the mid and northern portions still have

Table 2. Land use for the entire Ontario portion of the FL (column 2) and for the OMNR administrative districts (boundaries prior to 1994) for which land use maps were obtained.

	AREA (km ²)	Pembroke	Brockville	Bancroft	Twesed	Carleton Place	Haliburton	Aigouquin	Napanee
Area in Link	14941	3142	981	3148	5011	244	732	1006	677
Land Use in Link									
Crown	5421	1100	34	1000	2400	6		860	21
Private	9233	2010	920	2118	2480	230	732	143	600
Prov. park	161	2	8	26	65	1		3	56
County Forest	37	30	1		6				
Agreement Forest	7					7			
Game Preserve	4			4					
Conservation Authority property	66		6		60				
Conservation Authority forest -crown managed	2		2						
St. Lawrence Parks Commission	10		10						

Figure 7. Land Ownership on the Frontenac Link
(Ontario portion).



Legend

- Crown Land
- Private Land
- ==== Frontenac Link

significant areas of crown land. It will be important to recognize this difference in developing the conservation strategy.

5.0 SCIENTIFIC CONTEXT AND FOUNDATIONS FOR STRATEGY DEVELOPMENT

The scientific foundation for this strategy is the discipline of ecology and, more specifically, conservation biology. Although this is an area of active scientific endeavor, a few basic principles are well-documented, and provide a primer for work in the FL. Two excellent reviews are Noss (1995) and Grumbine (1994). In this part of the report, ecosystem management is discussed as the basis for strategy development, environmental components of a conservation strategy are outlined, and considerations for selecting and managing these components are discussed.

5.1 Ecosystem Management

An ecosystem management approach must be taken in the establishment of a conservation strategy in order for it to be successful. Ecosystem management is a collaborative approach to natural and cultural resource management that integrates scientific knowledge of ecological relationships, values and resource stewardship practices in order to sustain long term ecological integrity and human use (U.S. National Park Service 1994, Pell 1995).

Ecosystems change naturally over a variety of temporal and spatial scales; many processes such as evolution, disturbance, immigration, occur at temporal and spatial scales much longer than humans tend to consider (Grumbine 1994). For example, one fire a century may be necessary to retain conifer forests in the FL. From a purely local point of view, a fire may appear to be a catastrophe, but from the point of view of a longer time scale, it is merely a short term event that maintains long term ecosystem processes. Similarly, a population of rare birds such as Cerulean Warblers may attract great attention, but from the larger scale perspective we need to consider whether the population is self-sustaining, whether there are adequate migration routes, and whether the habitat is sustainable over time. In general, managers and citizens must both become accustomed to thinking in terms of landscapes and centuries rather than stands and years. Maintaining the ecosystem management perspective (Grumbine 1994, Noss 1995) will be an ongoing challenge in conserving the natural resources of the FL.

We must begin to view ourselves as part of nature rather than the master of nature. Our viability rests on bringing our social and economic needs into alignment with ecological capabilities and the success of incorporating

ecological principles of sustainability in management decisions (Kaufman *et al.* 1994). The practice of ecosystem management requires that we reconnect with the land at many scales and develop the wild heart within us.

Ecosystem management is a relatively easy concept to understand at a conceptual level, but exceedingly difficult to put into practice. Grumbine (1994) recognized 10 attributes of ecosystem management:

- 1. Hierarchical context:** Problems at any scale must be examined in a hierarchical context in terms of other scales in the biodiversity hierarchy (from genes to populations to landscapes).
- 2. Ecological boundaries:** Ecosystem management requires ecological boundaries to be defined at appropriate scales and working across administrative and political boundaries.
- 3. Ecological integrity:** Managing for ecological integrity involves protecting the total native diversity (species, populations, ecosystems) and the ecological (e.g., herbivory, predation, pollination, decomposition) and evolutionary (e.g., mutation, gene flow, differentiation of populations) processes that maintain this diversity.
- 4. Data collection:** Additional research and data collection (e.g., habitat inventory, disturbance regime dynamics) is required as well as better management and use of existing data.
- 5. Monitoring:** Monitoring tells us whether we are meeting our ecosystem management goals and objectives and directs further management decisions.
- 6. Adaptive management:** Management is regarded as a learning process or a continuous experiment where the results of previous actions are used to guide current practices. It assumes that the scientific knowledge we use a basis for management is provisional.
- 7. Interagency cooperation:** Cooperation among land management agencies is essential for management within ecological boundaries.
- 8. Organizational change:** Implementing ecosystem management requires changes in the structure of land management agencies ranging from participating in interagency committees to restructuring internally.
- 9. Humans imbedded in nature:** People are a fundamental influence on ecological patterns and processes and are in turn affected by them.

10. Values: Regardless of the role of scientific knowledge, human values play a major role in establishing ecosystem goals.

Lets further consider ecological integrity. Two recent definitions of integrity are provided below:

When a community is dominated by native species, is relatively stable, and shows other attributes of "health," it is often said to have integrity.
(Noss 1990)

Biological integrity - The capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition and functional organization comparable to that of natural habitat of the region.
(Karr and Dudley 1981)

We perceive the highest degree of ecological integrity to be represented by pristine ecosystems untouched by modern technological humans. While such areas are rare or nonexistent on earth, this level can, however, serve as a goal to provide direction. Conservation of the ecological integrity of the FL is the basis for developing the conservation strategy.

Areas with high ecological integrity have a number of characteristics in common (taken in part from Noss 1990):

1. the ability to recover from perturbation, natural and non-natural, even if catastrophic
2. the need for a minimal level of human maintenance for long term persistence
3. long term stability as an ecosystem
4. a structure composed of native flora and fauna
5. communities, diversity and functional organization comparable to the natural habitat of the region given the same site conditions.

The greater the fulfillment of these attributes, the greater ecological integrity an ecosystem has. (One notable consequence of this is that individual habitats that compose seral stages of a larger natural system may seem to have little ecological integrity. They are, in fact, expected to be continuously present, although transient at any specific location.)

A conservation strategy designed around the following four objectives, consistent with the goal of maintaining ecological integrity (Noss 1992), is required for the FL:

- 1) represent, in a system of protected natural areas, all native ecosystem types and seral stages across their natural range of variation
- 2) maintain viable populations of all native species in natural patterns of abundance and distribution
- 3) maintain ecological and evolutionary processes, such as disturbance regimes, hydrological processes, nutrient cycles, and biotic interactions including predation
- 4) design and manage the system to be responsive to short-term and long-term environmental change and to maintain the evolutionary potential of lineages.

5.2 Environmental Components of a Conservation Strategy

A general conservation strategy, consisting of three components (cores, corridors and buffers) designed to meet the four objectives outlined above, is suggested by Noss (1992, 1995).

5.2.1 Cores

Core areas, managed to maintain or restore their natural values, form the backbone of the conservation strategy. They are selected to meet the strategy objectives outlined in section 5.1, given the considerations discussed in section 5.3. Unless core areas are very large, they will not be able to maintain viable populations of large animals and evolutionary processes in isolation. In order to maintain their ecological integrity, core areas must thus be interconnected in an ecologically functional way. This enhancement of connectivity is the antidote to landscape fragmentation.

5.2.2 Linkages

Linkages are connecting elements between core areas or with other linkages which are particularly important in the conservation strategy, where the natural areas are too small to support viable populations of native species (Noss 1992). Linkages may serve as habitat, allow daily and seasonal movements, and

function to facilitate regional dispersal and long-distance range shifts (Noss 1993). Particularly in fragmented landscapes, where species are restricted to remnant patches of habitat, the provision of linkages for movement of individuals among patches is essential for balancing periodic extirpation from local patches (as a result of demographic effects, extreme weather, environmental disturbances, etc.). A species distributed as a system of local populations linked by dispersal is termed a *metapopulation*.

Habitat quality within linkages will determine their utility for species in the FL. The more a linkage resembles good quality habitat for a species, the more likely it will be used by the species. What dimensions such linkages must meet are still unclear and the topic is still one of active research (e.g., Merriam and Saunders 1993). It is obvious that narrow linkages such as fence rows may be sufficient for rodents, whereas larger forested linkages are necessary for Wolves, Fishers and Moose. Appropriate widths for linkages in the FL conservation strategy will need to be set based on the particular ecological functions we wish them to perform.

5.2.3 Buffers

The third component of a conservation strategy would be buffers which include the area that is adjacent to the network of cores and linkages. Buffers are managed in an environmentally sensitive way to insulate the natural areas network from the effects of high intensity land uses. This results in supplementing habitat for native species, thereby increasing the conservation potential of the network. Buffers can also serve to block or slow the invasion of alien species into the natural area network and protect developed areas from large predators dwelling in core areas. In order to maintain species sensitive to human disturbance, such as large carnivores, buffer areas must have low road densities.

5.3 Considerations for Selecting Components of the Conservation Strategy

The selection of cores, corridors and buffers in the design of the conservation strategy for the FL should be guided by considerations such as area size, landscape heterogeneity, the dynamic nature of ecosystems.

5.3.1 Size

There is a well-documented relationship between the number of species in a protected area and its size. In general, the larger the size, the more species that can be sustained. Recent work has sought numerical values: how big is

enough? Nudds (1993) provides evidence that 75 ha of forest are necessary to protect an intact passerine bird fauna (and at least 3,000 ha may be necessary to include some, small rare species), whereas 100,000 ha are necessary to preserve an intact mammalian fauna. Most existing protected areas are thus too small to protect mammals, particularly large carnivores such as Wolves.

5.3.2 Heterogeneity

Landscapes contain different habits, and this is what determines the biological diversity of a region (e.g., Scott *et al.* 1987, Kavanagh and Iacobelli 1995). In the FL one can find ecosystem types including mature deciduous forest, open rock ridges, and peat bogs. Within each of these is smaller scale variation. For example, within forests, there is marked variation with respect to soil depth, soil moisture, aspect, rock type and fire history. The concept of centrifugal organization provides a theoretical understanding of forest gradients on the FL (Keddy and MacLellan 1990). Any conservation strategy must include representation of all these habitat types. The World Wildlife Fund has recently provided preliminary criteria for judging representivity (Kavanagh and Iacobelli 1995). This would provide a solid foundation for representing the natural heterogeneity of the FL as part of the conservation strategy.

5.3.3 Dynamic Nature of Ecosystems

Natural disturbances (e.g., fire, floods, insect outbreaks, storms) have long been active in North American ecosystems (Pickett and White 1985) and any natural areas network has to incorporate these processes. This is another reason why small fragments of landscape are at risk. For example, past storms undoubtedly leveled large areas of deciduous forest, providing a patchwork of old growth and younger forests. However, today's old growth stands in the FL are so small and isolated (White 1990) that storms could eliminate the few that are left. Similarly, many of the vegetation types in the FL are obviously the result of past fires. Thus natural area conservation should address the reintroduction of natural fires. In summary, we need to provide a natural areas network that is resilient to these natural dynamic process. This leads to a consideration of adaptive management and indicators.

5.4 Considerations for Managing Environmental Components of the Conservation Strategy

5.4.1 Adaptive Management

It is impossible to think of every problem that will arise in the future. This is why Holling (1978) introduced the concept of adaptive assessment and management. There are several key parts to adaptive management. These include a clear statement of *goals* and *objectives* as well as an implementation plan that lays out the *tasks* necessary to accomplish these objectives (Schroeder and Keller 1990). Thirdly, a *monitoring* program is set in place; this monitoring program provides feedback to the managers so that they can assess whether their activities are enhancing progress towards the goals. Finally, there is a clear mechanism for *feedback* so that if the tasks are not achieving the goals, the management program can be modified. Thus the task of management is one of continually adapting to changing circumstances and improving scientific knowledge.

5.4.2 Indicators

Owing to the number of species involved, the array of habitats, and the limitations on current scientific knowledge, we cannot hope to study each and every rare species in the FL. An alternative that is less costly and therefore more efficient is to choose indicators of ecosystem integrity (Keddy 1991, Noss 1995). The problem of selecting indicators for entire pieces of landscape is discussed in Keddy (1991), and the application of indicators to maintaining ecological integrity in reserve networks is reviewed in Noss (1995). An early step in the management of the FL will be to select such indicators. They could include populations of key species (*e.g.*, Cerulean Warblers, Fishers), critical habitats (*e.g.*, forests greater than 100 years old, rock barrens burned within the past decade), human use (*e.g.*, number of cottages per km of lakeshore, hectares of habitat more than a given no. of kilometers from a road), or properties of particular ecosystems (*e.g.*, pH of lakes, coarse woody debris of forests). Such indicators should be selected both with consideration of existing databases and with consideration of future needs. Since much of the FL is forested, indicators for the evaluation of eastern Ontario Forests may be particularly relevant (Keddy and Drummond 1995).

6.0 GOVERNMENT POLICIES, LEGISLATION, COMMITMENTS

Government policies related to conservation biology and natural area management that are relevant to conserving the natural heritage of the FL are described below. They include documents of international, national, state and

provincial relevance that suggest opportunities for obtaining verbal and financial support as well as long term commitment to this initiative. They provide a basis for working within existing institutions and from which to seek additional information at more detailed levels within government structures. Detailed examination of the complexity of federal and provincial government programs is beyond the scope of this review.

North American Agreement on Environmental Cooperation (1993)

This agreement (Canada 1993) concerns Canada, the United States and Mexico. It covers (among others) commitments to make available state-of-the-environment reports, promote education in environmental matters, further scientific research and technology development in respect of environmental matters and promote the use of economic instruments for the efficient achievement of environmental goals.

Wildlife Policy for Canada (1990)

This is a national policy that provides a framework for federal, territorial and nongovernmental policies and programs that affect wildlife (Wildlife Ministers' Council of Canada 1990). The goal of this policy is to maintain and enhance the health and diversity of Canada's wildlife, for its own sake, and for the benefit of future generations. The policy recognizes three important issues: maintaining and restoring ecological processes, maintaining and restoring biodiversity, and ensuring that all uses of wildlife are sustainable.

Canadian Biodiversity Strategy (1995)

The Government of Canada, with support from the provincial and territorial governments, signed and ratified the United Nations Convention on Biological Diversity in 1992. In order to meet the obligations of the Convention, the federal government prepared a strategy for maintaining biodiversity in Canada (Biodiversity Convention Office 1995) which has five goals: to conserve biodiversity and the sustainable use biological resources, enhance our understanding of ecosystems and our resource management capability, promote an understanding of the need to conserve biodiversity and sustainably use biological resources, provide incentives and legislation that support the conservation of biodiversity and the sustainable use of biological resources, and lastly to work with countries to conserve biodiversity, use biological resources sustainably, and share equitably the benefits that arise from the utilization of genetic resources. The strategy also describes a series of mechanisms for achieving the goals.

Federal Policy on Wetland Conservation (1991)

The objective of this policy is to promote the conservation of Canada's wetlands to sustain their ecological and socio-economic functions, now and in the future (Canadian Wildlife Service 1991). More specifically, the goals of the policy are: to maintain the functions and values derived from wetlands throughout Canada; achieve no net loss of wetland functions on federal lands and waters; enhance and rehabilitate wetlands in areas where continuing loss or degradation of wetlands or their functions have reached critical levels; recognize wetland functions in resource planning, management, and economic decision-making with regard to all federal programs, policies and activities; secure wetlands of significance to Canadians; recognize sound, sustainable management practices in sectors such as agriculture and forestry; and utilize wetlands in a manner that enhances prospects for their sustained use by future generations. Seven strategies to achieve these goals are presented.

Canada Forest Accord (1992)

This accord, involving federal and provincial ministers responsible for forests, as well as forest industry and non-government organization representatives, makes reference to wildlife conservation (cited in Canadian Nature Federation and Canadian Wildlife Service 1994). It refers to forests that will be managed on an integrated basis, supporting a full range of uses and values including timber production, habitat for wildlife, and areas allocated for parks and wilderness.

Statement to Complete Canada's Networks of Protected Areas (1992)

Canada's ministers of wildlife, parks and environment endorsed this statement and forest ministers and national aboriginal groups gave verbal support for the statement (CCMOE, CPMC and WMCC 1992). It established the Endangered Spaces goal (completion of a protected areas network that represents the ecological diversity in each of Canada's natural regions by the year 2000) as the public policy of the federal, provincial and territorial governments across Canada. Among the five commitments in the statement were: to accelerate the identification and protection of Canada's critical wildlife habitats, and to continue to cooperate in the protection of ecosystems, landscapes and wildlife habitats.

Parks Canada Policy (1994)

Guiding principles and operational policies related to natural area and cultural conservation are described in Parks Canada (1994). These policies cover responsibilities for sustaining the integrity of park ecosystems and practicing ecosystem management. Recognition is given to the need to base ecosystem management on credible research, collaborate with all those whose activities influence the integrity of the park, demonstrate leadership by working closely with other land management agencies to develop a better understanding of the relationship between existing land use practices and their effects on the natural environment, participate in regional land use planning and management initiatives sponsored by others, relate messages concerning environmental issues to the public to provide them with opportunities and skills to make environmentally responsible decisions.

Endangered Species Legislation (1995)

A proposal for an endangered species act has been prepared by Environment Canada (1995) as the federal component of a federal-provincial approach to endangered species protection. It is currently under discussion and will be the focus of a national workshop in December 1995.

Liberal Party of Canada Policies (1993)

In general, the Party contends that preventative environmental care is the foundation of the Liberal approach to sustainable development and that integrating economic with environmental goals fits in their tradition of social investment as sound economic policy. The Party has committed itself to work towards protecting representative examples of Canada's natural regions, amounting to at least 12% of Canada and to complete the national parks system by 2000 (Liberal Party of Canada 1993).

Ontario Wetlands Policy (1992)

Under the Planning Act, the goals of this policy are to ensure that wetlands are identified and adequately protected through the land use planning process and to achieve no loss of provincially significant wetlands (Ontario Ministry of Municipal Affairs and Ontario Ministry of Natural Resources 1992). Specifically related to the FL, the objectives are to ensure no loss in area or function in provincially significant wetlands in the Great Lakes-St. Lawrence Region and encourage the conservation of other wetlands.

Comprehensive Set of Policy Statements (1994)

These are statements of the Ontario government under the province's Planning Act. Policies A.1.2 and A.1.4 address natural heritage and environmental protection, the goals of which are to protect the quality and integrity of natural ecosystems in Ontario (Ontario Ministry of Municipal Affairs 1994). The policy covers natural landforms, ecosystems, species in the environment and their environmental and social values as a legacy of natural or restored ecosystems on the landscape. More specifically it includes natural areas and natural restored corridors, significant portions of endangered species habitat, threatened and vulnerable species, significant natural corridors, significant woodlands *off* the Precambrian Shield (*i.e.*, *not* applicable to any woodlots within the FL), areas of natural and scientific interest, shorelines of lakes, rivers and streams, and significant wildlife habitat. The policy applies to all municipalities in Ontario and requests planning agencies to evaluate the significance and extent of each natural heritage component. It also recognizes that definition and maintenance of a natural areas network is important in maintaining overall health and integrity of ecosystems. Currently this policy is under review.

Conservation Reserves Policy (1995)

Conservation reserves were established as a new category of protection of natural heritage areas under Ontario's Public Lands Act and a draft policy for these areas is under review. Conservation Reserves are managed to protect important natural features on public land while permitting traditional land uses and activities that are compatible with resource protection. Commercial forestry, mining (including aggregate extraction) and hydroelectric development are not permitted. Conservation Reserves are permanently protected by their establishment and regulation under the Act. A statement of conservation interest guides the management of reserves (Ontario Ministry of Natural Resources 1995). In the FL, for example, one Conservation Reserve is under consideration- Kaladar Jack Pine Barrens.

Forest Policy for Ontario (1996?)

A proposal for a comprehensive forest policy framework for Ontario was prepared by the Ontario Forests Policy Panel (1993). The goal of this policy is to ensure the long term health of forest ecosystems for the benefit of the local and global environment, while enabling present and future generations to meet their material and social needs. It recognizes the importance of maintaining large, healthy, diverse forests, conserving biodiversity and ecological processes essential for maintaining a functional biosphere, maintaining representative protected forest lands, and the need to adopt an adaptive ecosystem

management approach to forest management. Following this framework, a new forest policy for the province is being prepared.

Biological Diversity Bill (1993)

The State of New York recently passed an act related to the identification, research and conservation of biological diversity in the State (New York State 1993). A Biodiversity Research Institute is created within the State Museum to coordinate the State's research and inventory work with regard to biodiversity and requires the State Department of Environmental Conservation and the Office of Parks, Recreation and Historic Preservation to identify, manage and conserve rare plants, animals and ecological communities on State-owned lands within their jurisdiction.

7.0 OTHER CONSERVATION INITIATIVES

Before preparing a conservation strategy for the FL, it is important to review initiatives currently underway within the FL, in close proximity to it, or of interest because they have similarities to the FL initiative. This will assist in enhancing project coordination, avoiding duplication of effort and resources, identifying potential collaborators, and building upon previous experience. Relevant projects reviewed are briefly described and contacts provided. This is followed by a list of key points synthesized from documents and conversations with people involved with these projects that provides guidance for establishing the FL initiative. Additional projects with features in common with the FL initiative are discussed in a special issue of Wild Earth (The Wildlands Project 1992).

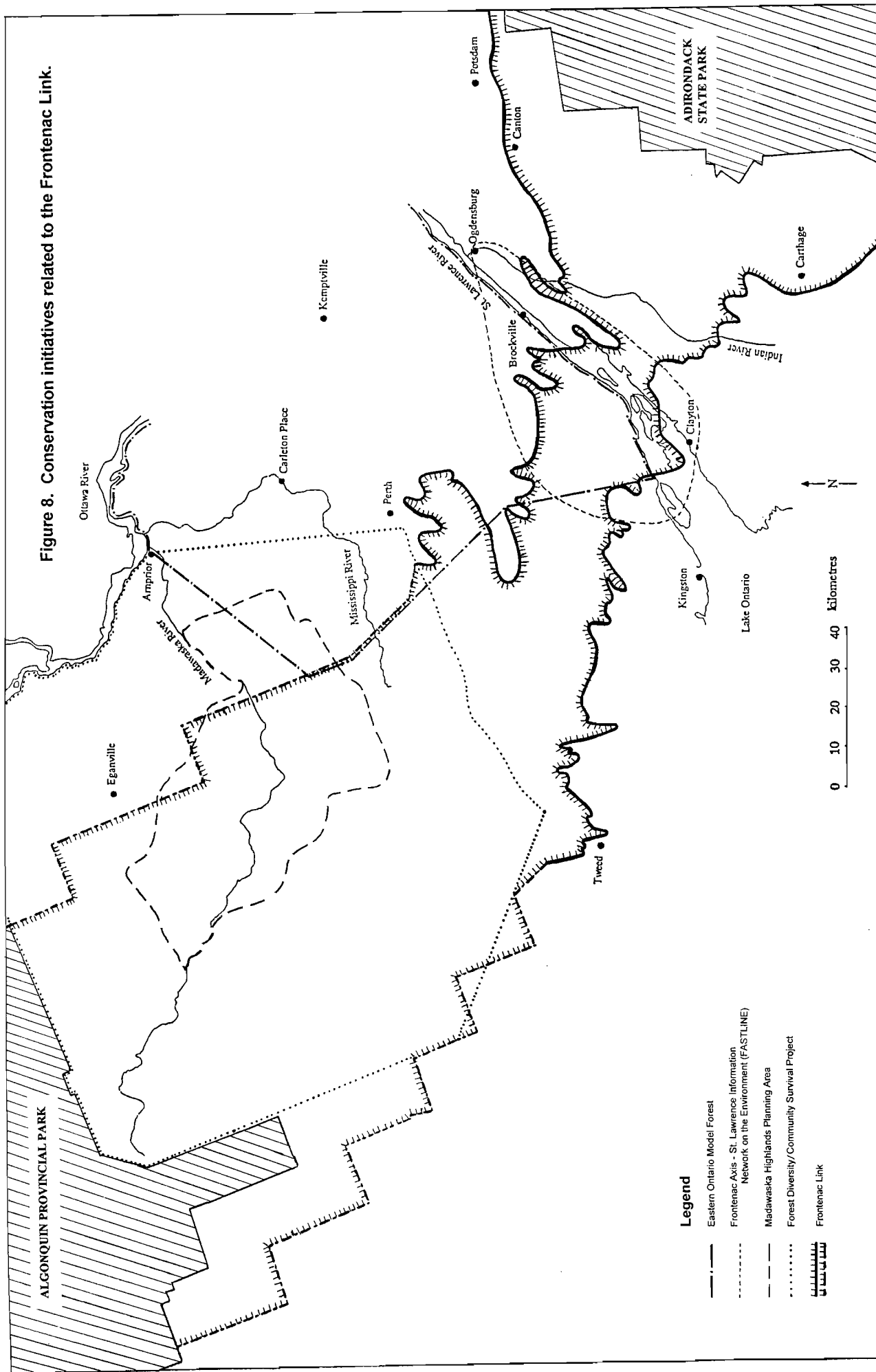
7.1 Projects Overlapping With the FL

FASTLINE

The Frontenac Axis-St. Lawrence Information Network (FASTLINE) is a project initiated by Parks Canada. The goal is to establish an international, multi-partner group with diverse backgrounds and responsibilities that is dedicated to developing and applying an ecological approach to natural and cultural heritage conservation in an area of cooperation around the St. Lawrence River (Fig. 8). The network will pool and disseminate information to ensure that natural and cultural heritage resources are adequately considered in resource management and better land use decisions are made (Snetsinger 1994).

An inventory of information and data sources for the FASTLINE area was developed (and is periodically updated; Hansen 1995) that provides information

Figure 8. Conservation initiatives related to the Frontenac Link.



- Legend**
- Eastern Ontario Model Forest
 - - - Frontenac Axis - St. Lawrence Information Network on the Environment (FASTLINE)
 - · - Madawaska Highlands Planning Area
 - · · · Forest Diversity/Community Survival Project
 - Frontenac Link

on potential partners with work summarizes and contacts, reports and publications for the area by subject, digital files available, protected areas and potential partner hardware and software capabilities. A communication strategy has also been prepared for the project (B. Stephenson, Parks Canada, pers. comm.).

As part of this project, Parks Canada sponsored a symposium that addressed recent research that is relevant to the FL in October 1995. It could form the basis for developing an agenda for research needed on the FL (see section 10.0).

The goal of this project overlaps significantly with that of the FL. Many of the cooperative partners have jurisdiction beyond the FASTLINE area and would likely be interested an extension to a Greater FASTLINE area (the FL). For further information concerning this initiative contact Mary Alice Snetsinger, St. Lawrence Islands National Park, Mallorytown.

Eastern Ontario Model Forest

Under Forestry Canada's Partners in Sustainable Development of Forests Program, the Eastern Ontario Model Forest project was initiated in 1992 by a diverse array of twenty-three partners (Eastern Ontario Forest Resources Stewardship Council 1992). The goal of this project is to develop a world-class model for sustainable forestry based on community partnerships. This project overlaps slightly with the FL as shown in Figure 8.

There are numerous projects underway as part of this initiative, with the following being most relevant to FL conservation (Story 1994):

- integrated resource management (IRM) planning which involves the identification of resource management issues and targets, collection of data required to support management targets, and the development of strategies for implementing the information systems and analysis tools in resource management and municipal planning processes; two pilot project areas were chosen for application of the IRM strategy developed
- land owner survey to determine their interests, concerns, and priorities concerning land use issues, natural resource management and public programs.

Further discussion of the state (successes and problems) of these projects would provide additional direction to the FL project. Both an active public participation and education program as well as a lengthy, annotated mailing list (Hopson 1994) is associated with this project. For additional detailed information

on this initiative contact Steve Virc or Patti Story, Eastern Ontario Model Forest, Kemptville.

Forest Diversity\Community Survival

The goals of this two-year project, being undertaken by the Wildlands League (Toronto), are to recognize on a provincial level the social and economic impacts of the current approach to forest use and to develop broad community-level support for a new approach to sustainable forest management which would include protection of representative forest areas and sustainable use of the surrounding landscape (Wildlands League 1994). The provincial campaign will involve the preparation of fact sheets, two case study reports, educational materials and a workshop. The community outreach component is designed to help initiate effective working relationships in cooperative problem solving by bridging political, cultural and other differences in resource-dependent communities.

The case study area, within which expertise will be developed for application to other areas, is the Mississippi-Madawaska Watershed (Fig. 8). This area was selected because candidate forest areas have been identified by the Ontario government for protection, identifiable native and non-native communities are interested in the issue, opportunities for developing community support for protected areas establishment exist, and the Wildlands League is currently in the process of developing an extensive information base on economic and natural values in the region. Additional details concerning this project can be obtained from Nancy Bailey, Wildlands League, Toronto.

Madawaska Highlands

A land use plan for the crown land in the Madawaska Highlands (Fig. 8) is being developed by the Ontario Ministry of Natural Resources with the assistance of an advisory committee. A tabloid was prepared that presented planning issues identified by the public through a circulated questionnaire and means for addressing these issues in the plan. The areas of interest included forestry, aggregates, off-road vehicles, mining, ecosystem protection, access, hunting, angling, trapping, tourism, cottaging, motorboating, snowmobiling and hiking/canoeing/camping. Based on feedback from information open houses, a draft plan is being prepared for public comment. Following this review, a final plan will be prepared. For more information on this initiative contact Monique Rolf von den Baumen, Ontario Ministry of Natural Resources, Pembroke.

7.2 Other Projects in Canada

In addition to those projects currently underway in a portion of the FL, there are others in Ontario of a comparable geographical scale to the FL and from which relevant lessons can be learned. Of particular interest is the Niagara Escarpment Planning process (NE) and Carolinian Canada (CC).

The Niagara Escarpment, like the FL is a natural international linkage that stretches from New York to central Ontario. The ongoing planning process is addressing multiple jurisdictions and ownership as well as resource extraction issues on one hand and the conservation of this continentally significant natural feature on the other. Initially the strategy for land use of this area was formulated and presented to the public for comment in a top down approach that was met with hostility. Although a plan was agreed upon, the initial approach caused considerable delay in implementation. Recently a program to monitor cumulative environmental effects on the escarpment was prepared to guide landscape management (MacViro Consultants 1993).

The focus of Carolinian Canada, a project in southern Ontario, was land acquisition to protect significant natural areas, rather than influencing land management, and it did not include a linkage concept. It included a significant private landowner/stewardship program as well. Points raised through discussions with people who had involvement with these projects are included in project synthesis. Further information on these two projects can be obtained from World Wildlife Fund, Toronto (CC) and K. McNamee (Canadian Nature Federation, NE).

Kootenay Land Use Plans

Comprehensive land use plans were recently developed for the Kootenay area of British Columbia (1995a, b) by a negotiation table, representing a variety of interests, with the assistance of public participation. In the East Kootenay area, for example, consensus was reached on 27 land use policy recommendations, a social and economic transition strategy and recommendations for implementation and monitoring. General agreement was also reached on land use in about 90% of the area. In the East Kootenay area, 16.5% of the land was designated as protected areas and 11.3% was identified as special resource management where resource use will take into account sensitive natural and cultural features. In the West Kootenay-boundary area, 11.3% of the land was designated as protected areas and 17.6% was identified as special resource management where resource use will take into account sensitive natural and cultural features.

7.3 Projects in the United States

Northern Forest Lands

The northern forest lands are 10 million ha of forested area stretching from northern Maine to Adirondack Park (Great Northern Forest of Fig. 1; Trombulak 1995). In 1990, State senators in Vermont and New Hampshire got Congress to initiate the Northern Forest Lands Study, undertaken by the USDA Forest Service. The purpose was to assess the impacts of change on the region and its people, and set out possible ways to maintain the northern forest, traditional uses and quality of life dependent upon the forest. The Northern Forest Lands Council was then established to develop specific recommendations for land management through conducting studies on biological resources, conservation strategies, land conversion, local forest-based economies, property taxation, recreation and tourism and by obtaining extensive public input concerning the problems of the region and implications for the future. The Council facilitated the development of the Northern Forest Resource Inventory and published a technical appendix of all its research and forum proceedings. Its report on recommendations was released in 1994 (Northern Forest Lands Council 1994a, b). This report contains a vision of the region's future, principles and concepts upon which the Council based its work and recommendations with background information and justification.

Of particular interest for the FL are recommendations related to creating state forest roundtables to discuss and implement the recommendations; continuing dialogue among local, state and federal governments on natural resource issues that affect the Northern Forest; providing leadership and support through state natural resource agencies to implement the recommendations; increasing the involvement of state universities in implementing recommendations, enacting of legislation to implement recommendations beginning in 1995; and giving priority to directing state and federal funds towards programs that support the recommendations.

This project covered a large geographical area which is directly connected to the FL via Adirondack Park. Thus not only does the FL link two parks, it links Ontario forests with those of Maine! For further information contact the New York State Department of Environmental Conservation, Albany.

As a result of this project, a coalition of 24 environmental groups (e.g., Sierra Club, National Audubon, National Wildlife, Appalachian Mountain Club) called the Northern Forest Alliance, with headquarters in Mont Pelier, Vermont, was formed to oversee the evolution of land management within northern forest lands area (The North Woods).

Other Projects in the Northeast

Within the area of The North Woods, there are subcomponent conservation projects. For example, the organization RESTORE: The North Woods (Concord, MA) has proposed a significant extension of Baxter State Park in Maine to create Maine Woods National Park (Restore: the North Woods 1994).

Within New York, natural area networks linking the Adirondacks, Catskills and upper Hudson area are being developed. As well, a proposal for a natural area linkage between the Adirondacks and Green Mountains of Vermont is being developed. Steve Trombulak, Resource Director Greater Laurentian Region (including the FL) of the Wildlands Project and staff at Middlebury College, Middlebury, Vermont should be contacted for further information on these projects.

7.4 International Projects

Yellowstone to Yukon

This project focuses on developing a framework for land management for the area of the Rocky Mountains from Wyoming to the southern boundary of the Yukon Territory (Locke 1994). A document is now in circulation that discusses research required for corridor identification and a concept plan will be prepared soon. Eventually critical corridors among protected areas and buffers around these areas will be mapped using GIS. Ecological management plans for corridors and buffer areas will then receive attention. To date, most of the areas considered in this initiative are on public land. The issue of private land ownership has not yet been addressed.

For further information concerning this project contact Harvey Locke, National President of CPAWS, Calgary.

Crown of the Continent

The product of this project will be an electronic data atlas for the Rocky Mountains stretching between Wyoming and Banff National Park (B.C.). It is designed to promote improved management of this ecosystem by making better information more readily accessible to those responsible for making land use decisions (Crown of the Continent Project Steering Committee 1995). The exchange of information and cooperation among stakeholders will be encouraged through information gathering, cataloguing, correcting, updating and dissemination as well as ecosystem monitoring, education, and research in the Crown of the Continent ecosystem. This project will provide support for the

Yukon to Yellowstone project. It will encourage partnership building among agencies and the public to facilitate conflict resolution, solution development and ecosystem management. For further information contact Denis Gourdeau, Chairperson Calgary/Banff Chapter CPAWS, Calgary.

7.5 Project Synthesis

The following general principles concerning the development of conservation strategies emerged from project review and discussions with project coordinators. They are put in order of significance based on the number of contacts who mentioned they were important. These guidance recommendations, in addition to the background information, were used to develop the strategy framework presented in section 10.0.

1. make sure your concept has the verbal and written support of key conservation agencies before publishing ideas or educating others to solicit support
2. education and awareness is the key to support; before asking for support, provide numerous audiences with documentation of the significance of the FL
3. obtain letters of support from participating partners at project start up
4. before going to public have things well thought out (e.g., final strategy based on section 10.0)
5. keep your mind at the scale of the project (large, open)
6. identify pro and con organizations; seek supportive individuals within; include both types of groups in project strategy development from the beginning to appreciate fully and minimize hurdles
7. work within existing institutions (for implementation and communication) and modify them rather than trying to add another layer of complexity
8. find supporting individuals within existing groups/agencies to relay information, messages
9. identify a focal centre for information (person, organization, phone number)

10. when soliciting agency support demonstrate how they will obtain local, national and international exposure and be affiliated with a project that none of the affiliated organizations could do alone, that state of the art capabilities will be used to establish a model for environmental work, and that they will be on the ground floor of this
11. establish concrete goals and objectives
12. use other organizations with charitable status to draw upon for funding
13. do not rush; important to establish solid basis for long-term strategy beginning with education that involves adaptive management; on the one hand there is a sense of urgency to start the conservation program, but at the same time it should be recognized that it involves changing values and long term processes (for example, the gestation period for the project to re-establish lynx in Adirondack Park spanned almost 10 yr; Brocke *et al.* 1990)
14. political reality has as much weight as the scientific reality and the former can change any time
15. present plans and information at existing activities (e.g., community fairs, meetings of existing organizations)
16. develop local working groups to carry on project once it is firmly established
17. process should be viewed as non-partisan and independent of agencies involved (e.g., use of independent institutions such as universities) to improve credibility of products and stakeholder acceptance
18. steering committee should have one seat for each partner (a contributor in terms of money or in kind)
19. establish a diverse steering committee to limit bias
20. need for government to show support (but not necessarily appear as a proponent), provide a backbone for the project
21. emphasize information provision rather than the organization and don't use works implying control like management, resources, zoning
22. give out consistent information throughout (need to stay up to date on related issues)
23. do not tie the FL project to any other; maintain distinct identity

24. develop own logo and letterhead
25. land acquisition is not the way to go, rather to influence land use indirectly through education of both management and decision-making agencies and landowners
26. identify big institution landowners and bring onside before talking to small landowners
27. land management focus (long term) view vs. short term land acquisition; need both but the former is an integrated ecosystem management approach
28. remember that cores and linkages are tools, but the objective is wildland protection
29. use media before, during and after
30. total top down approach is not acceptable to the public

8.0 PUBLIC PARTICIPATION IN ESTABLISHING THE FUTURE OF THE FL

Human social and economic values are part of the environment and all of these (environment, community, economy) are intricately linked to ecosystem integrity. The direction of evolution of the FL, reflecting humans embedded in nature, should thus be determined through an inclusive, multi-stakeholder approach for guiding conservation decision-making processes.

Potential government participation in establishing a strategy for ecosystem management of the FL was outlined in section 6.0 in relation to policies, legislation and commitments relevant at municipal, provincial, national and international levels. Other major stakeholders to consider are listed in section 9.0. This section of the report will focus on the public as a stakeholder and address public participation in the process of determining the future of the FL and land stewardship. These discussions will provide input for developing a comprehensive public involvement plan as part of the strategy (section 10.0).

The importance of developing a public education program about the significance of the FL and its natural resources cannot be overemphasized. It is essential for forming a solid foundation for obtaining informed public participation in the process of developing a long-term conservation strategy for the FL. Education will follow a standard path from awareness to understanding to acceptance which leads to action.

Related to public education is media education. It is through the media that most people are educated about issues. Media education has played a significant role in public education concerning endangered species. By contrast, the issue of biodiversity is still reported in a political context rather than an ecological context because media education is lacking. (The Canadian Coalition for Biodiversity is currently embarking on a multi-year program to educate the media and the public about biodiversity.)

8.1 Public Participation Approaches

Public involvement in directing the future of the FL will range from general participation in strategy formulation (at a variety of geographical scales and through numerous methods) to the management activities of individual landowners. Effective participation begins with education, as discussed above. The approach(es) for involving the public also depend on the audiences to be addressed and the corresponding appropriate methods to facilitate their participation, as well as the objectives of participation (related to, for example, stage of the project, type of issue, geographical area of interest).

The communications strategy for the Eastern Ontario Model Forest (Hopson 1994) characterized general conditions and trends related to their audience, based on informal focus groups, that influence their audience approach and are somewhat relevant to the FL including:

- people are largely preoccupied with economy and jobs
- environment has slipped from no. 1 on the list, although it is still high on the list of concerns
- health issues such as water quality are emerging as concerns of the next decade
- there is a perceptible environmental backlash among members of the public, particularly among males over 50 years of age, many of whom tend to be the decision-makers
- awareness and interest are highest among the country's youth

Throughout the life of the FI project, it is important maintain public participation through the variety of means available. Public participation is required for obtaining public support which is essential for achieving the goals of the project. As well it is important for enhancing the public's ability to influence decision-makers. Public participation (under the appropriate forms) will also provide the steering committee with information that will assist it in assessing project progress and developing the strategy.

Public participation will involve both consultation and involvement. Public consultation and public involvement are on a continuum in terms of the degree to which responsibilities for addressing issues are shared between the project organizers and others in the community (Ontario Ministry of Municipal Affairs 1993a). Public consultation gives people an opportunity to voice their opinions and influence decision-makers. Through public involvement, others would be included in an ongoing way in the process of strategy development and implementation. In this case, all sectors share a commitment to the strategy and are prepared to act on that commitment.

Both public consultation and public involvement will be appropriate at different times, depending upon the particular objectives of public participation. Public consultation is appropriate when proponents of the FL strategy want to communicate with the public in a meaningful way but have the final responsibility of making decisions and implementing them. This approach to public participation is typically used to obtain reaction to a plan in its early stages. Public involvement, on the other hand, is appropriate when there is a desire to include the broader public and other community partners in making these choices. A common vision is held by all groups. While public consultation can lead to better decision-making and consensus in the FL in support of the conservation strategy, the broader approach of public involvement provides opportunities for all groups to benefit from combining their resources to achieve the goal. The same means for bringing groups together for public consultation can be used for public involvement, but the difference is that the groups are committed to the results and jointly carry out the actions decided upon.

Approaches to public consultation or public involvement include public meetings, open houses, workshops, targeted briefings, public seminars, conferences/symposia, public advisory committees, focus group sessions, advertising/information distribution and informal communications. The role of each of these methods, when it is appropriate to use them, case studies and additional references concerning public participation are described in detail by the Ontario Ministry of Municipal Affairs (1993a) and so will not be repeated in this report. May (1994) also tabled suggestions for approaches in relation to audience type.

The location of sites selected for soliciting public participation is also a significant determinant of the quantity and quality of participation. Opportunities for participation should include verbal and written means. While there is a need for a public participation plan, it must be adaptive. The appropriateness of methods and location may change over time as the audience within the FL becomes better acquainted with the area and project. Because finding the appropriate approaches to participation are crucial to the success of the project, this area requires the attention of a specialist who should be part of or consulted by the steering committee.

Guidance for developing the communications plan, a part of which covers public involvement, is provided in sections 7.5 and 10.0 as well as in the case study described by Trombulak (1994).

8.2 Land Stewardship Tools

Complementary to the actions and policies of land management agencies are public and private partnerships to facilitate land stewardship. As part of the evolution of the project strategy, direct consultation with agencies specializing in or having experience with land stewardship (e.g., Federation of Ontario Naturalists, The Nature Conservancy, Bruce Trail Association, Wildlife Habitat Canada) should be pursued.

Figure 7 showed that much of the southern portion of the FL in Ontario is privately owned, indicating that private land stewardship can play a major role in conserving the natural features of the FL. Stewardship may be encouraged through education, tax incentives, conservation easements and the development of land trusts discussed briefly below. Education of the public (sections 7.5 and 10.0), including landowners, about the natural features of the FL and the need for conservation is the first step towards stewardship of the FL.

In the recent budget plan (Martin 1995), a federal tax credit for donating ecologically sensitive land for conservation may claim a tax credit of 29% (on donations exceeding \$200). While initially claims were limited to 20% of an individual's net income in a year, for five years, they are now exempted from this limitation. Currently, a property tax rebate is available to owners of provincially significant wetlands and ANSIs as well as to nonprofit groups owning lands for conservation purposes in Ontario. The rebate for woodlands was recently eliminated, but there is currently discussion concerning its revitalization.

The role and use of conservation easements and covenants was thoroughly described by Trombetti and Cox (1990). These mechanisms involve placing partial or complete restrictions on land use to protect natural features. In Ontario, the *Ontario Heritage Act* is the piece of legislation that enables the Ontario Heritage Foundation and nonprofit organizations to enter into agreements, covenants and easements with property owners. While agencies that administer conservation easements may have to conduct baseline surveys, monitor and enforce the easement and pay management costs, there are many advantages to easements. The cost of acquiring an easement is likely to be much less than outright purchase. As well, landowners are little disturbed since they can remain on their land and easements can be written to meet the exact requirements of both the landowner and the site.

Land trusts, particularly well developed in the U.S., can be set up to facilitate land stewardship. They may be involved in a variety of areas including land purchase, providing advice to land owners, carrying out evaluations to identify priorities for protection, acquiring easements to protect land, raising funds and providing environmental education programs. The development of land trusts in Ontario is reviewed in detail by Hilts and Reid (1993). Where existing community groups do not already fulfill these roles, the establishment of land trusts may enhance land stewardship in the FL. Currently one land trust (Thousand Islands Trust) exists within the Ontario portion of the FL and others occur within the Adirondacks. The number of land trusts in Ontario is steadily growing, with 17 to date (A. McLeod, Parks Canada, pers. comm.).

8.3 Land Acquisition

Land acquisition should be used as another tool to achieve the conservation objectives for the FL, but should not be considered an end unto itself. A land acquisition strategy should be developed as a component of the overall conservation strategy for the FL.

9.0 STAKEHOLDERS

Stakeholders in this project are those who own (particularly large landowners) or administer land in the area as well as those who use (both consumptive and nonconsumptive) the resources. A list of stakeholders has been prepared by May (1994) as part of the ecosystem communication strategy for St. Lawrence Islands National Park. As well the FASTLINE project and the Eastern Ontario Model Forest have identified their stakeholders, many of whom they will have in common with the FL project. A composite list from these three projects with the addition of stakeholders for the other two regional projects (Madawaska Highlands, Forest Diversity/Community Survival), would form a good preliminary list for the FL. The following stakeholders should be included in the FL project:

- forest industry (for example Domtar owns forest within Adirondack Park and is already working with the Adirondack Council with respect to sustainable forestry practices); contacts John Iverson (Domtar), Mike DiNunzio (AC)
- Adirondack Council- advocacy group for Adirondack Park, Mike DiNunzio (Director); author of *Adirondack Wildguide, a Natural History of Adirondack Park*; (518) 873-2240
- Wildlands Greater Laurentian Region- promotes and assists with wildlands projects in the northeastern U.S., Canadian Maritimes, southern Quebec and southeastern Ontario, Steve Trombulak (Director; (802) 388-3711)

- Adirondack Mountain Club; (518) 668-4447
- Adirondack Park Agency- a NY State agency that oversees the management of private land within Adirondack Park, John Banta (Director of Planning; 518-891-4050)
- Northern Forest Alliance- overseeing implementation of land management recommendations made by Northern Forest Lands Council (see section 7.3); (802) 223-5256
- St. Lawrence Co. (NY)- John Montan (Planner)
- Hewlett-Packard owns land in the FL (Ontario) and is already a supporter of the Crown of the Continent atlas project
- Queens University- large landowner considering buying more land, representing institutional community
- Golden Lake Band
- Conservation Authorities (see Fig. 3)
- "Friends" organizations associated with provincial parks (e.g., Frontenac, Murphy's Point, Bon Echo) and other parks
- Hiking organizations- Rideau Trail Association (Rideau Trail), Hastings Heritage Trail Association (Hastings Rail Trail); trail associations in NY (call NY Office of Parks, Recreation and Historic Preservation; (518) 474-0456); relevant trails include Adirondack Trail, Seaway Trail, see Cobb (1994) for more information
- Other recreational organizations (e.g., Ontario Federation of Anglers and Hunters)
- Cottage owner associations
- All municipalities in FL
- Natural history societies: Haliburton Highlands Field Naturalists (705-286-2203), Kingston FN (own land in vicinity of Frontenac Provincial Park), Quinte FN (613- 962-4648), Rideau Valley FN, Ottawa FN, Pembroke and Area Bird Club, Huntsville Nature Club

- Agricultural and Rural Property Owners Association: a large, vocal group of landowners united in opposition to government control over property use decisions; originally formed to lobby against wetlands policy, but with aspirations of tackling all such government directives; (613) 826-2315
- Forest Sustainability Stewardship Councils: these councils, sponsored by the Ontario Ministry of Natural Resources, are in the process of being established in each county to address priorities for land management and implementation of means to achieve their land management goals.
- Historical societies

10.0 A FRAMEWORK FOR THE FL CONSERVATION STRATEGY

This section provides a framework for developing a conservation strategy for the FL. It consists of a goal, subgoals and objectives. Clearly, the first step is to establish a cohesive, representative steering committee. Within each sub-goal, the objectives are essentially listed in a time sequence. While the sub-goals are presented as a linear sequence here on paper, it is obvious that they and their associated objectives are interdependent and work should begin on several simultaneously. The exact sequence in which they should be attended to will be based on a multitude of circumstances including the current information holdings, programs, funding and level of support of the partners selected to be involved; the level of funding obtained from other sources; and the progress, compatibility and contribution of other conservation initiatives. Thus it must be the cooperative responsibility of the strategy steering committee to establish specific tasks, mechanisms, agency responsibilities and a timeline to meet the objectives in the strategy framework.

This project is a catalyst for changing society's ideas about conservation and ecosystem management and thus sustained participation by major stakeholders is essential for strategy implementation. The strategy designed should remain adaptive so that it reflects current attitudes and conditions.

The benefits of this strategy to stakeholders will include:

- establishment of a profile for the region
- maintenance of ecosystem integrity
- creation of a data pool for research, conservation
- fostering cooperation and partnerships among agencies and communities
- sharing of economic resources
- developing common ground for land use decisions

Benefits to specific stakeholders should be addressed in advance of soliciting their support (see Snetsinger 1994).

GOAL:

To work cooperatively with government and nongovernment organizations to develop a long-term, international conservation strategy for the Frontenac Link between Algonquin Provincial Park and Adirondack State Park that will maintain and restore the ecological integrity of the natural landscape and integrate cultural development with processes that sustain the natural environment. This project should serve as a catalyst and model to inspire other conservation projects at comparable scales.

Subgoal A: Establish an Organizational Framework

Objectives:

A1 review and refine the boundaries of the FL

A2 establish a steering committee of representatives of major stakeholders including American representatives who are eligible for additional funding sources (particularly sources in the US) to complete the strategy and direct the project

A3 establish subcommittees, as required, to guide the development of elements of the strategy such as research, communication, funding

A4 select a project coordinator and contact person in an office within the FL in a neutral location (no political/environmental bias) to provide information concerning the FL and the project, maintain communication linkages with other activities/projects that have a bearing on the FL project

A5 develop a communications plan and schedule for the FL organization

A6 develop a project length workplan and annual plans (identifying a sequence of goals, objectives, tasks and costs) that integrate all the objectives presented in this draft strategy and provide a basis for soliciting resources, including funds; plan for a project that will be gradually adopted by organizations within the FL at the end of a five-year period

A7 establish a mechanism to annually evaluate the performance of the project in relation to operational criteria (e.g., stakeholder benefits and contributions, extent to which project is becoming integrated into organizations within the FL)

A9 establish relationships between project needs (funds, volunteers, communications, database management, equipment, etc.) and stakeholder capabilities

A8 maintain an annotated mailing list for the project

Subgoal B: Develop a Communications Strategy

Objectives:

B1 identify major stakeholders and obtain letters of general support from a diverse array (interests and jurisdictional levels) before dealing with the public

B2 develop a brief document (project rationale, goals, objectives) for soliciting initial funding

B3 develop and coordinate an initial intensive and extensive publicity campaign concerning FL description and significance, general principles (see B5) and planned progress for the project (include articles in major national and international magazines (Equinox, Canadian Geographic) by professional writers, major newspapers, cable TV and radio)

B4 establish a slogan (e.g., The Frontenac Link, Link the Lynx, Frontenac-Our Link to the Future), logo (stylistic/representing relevant natural feature unique to Axis), letterhead and key messages for the project

B5 prepare short brochure of project highlights including goal, a set of principles (desires rather than objectives, specific problems we are trying to address through project such as fragmentation, loss of particular habitat types, retaining habitat, providing options for the future), benefits and 3-4 major tasks for wide dissemination

B6 prepare a strategic, long-term communications plan with the assistance of a specialist in communications that address audiences, sub-messages within the overall basic project message, media, budget and an evaluation of the effectiveness of the methods used

B7 establish formal communication linkages with other projects in the FL or influential on the FL

B8 identify target audiences for communication concerning general education and project development (researchers, bureaucrats, conservation related organizations, recreation organizations, forest users, other industries,

municipalities, institutions, school children, general public) and develop an appropriate approach for each (e.g., publications, conferences, individual contacts)

B9 develop mechanisms to maintain regular communication with all target audiences concerning the project

B10 prepare press releases, updates concerning success stories (remember to use the media constantly- before, during and after the project takes place)

B11 following the development of a conservation concept for the FL (in cooperation with stakeholders, including the public), develop a means to solicit and analyze public response and incorporate it into the concept.

B12 having laid down an educational basis and concept groundwork (B11), develop a landowner stewardship program jointly with organizations and individuals that already have extensive expertise in this area (e.g., Stu Hilts, Bruce Trail Association, Nature Conservancy, Federation of Ontario Naturalists)

Subgoal C: Develop a Database for Conservation Decision Support

Objectives:

C1 develop an information management system and GIS database for the FL to support conservation decisions (consider compatibility with the FASTLINE, OMNR and Natural Heritage Information Centre databases and their technical and scientific requirements)

C2 identify data needs for conservation decision making (e.g., natural and cultural resource distribution, land ownership) that would permit the identification of opportunities and constraints for developing a conservation strategy

C3 assess existing data extent and quality for use in conservation decisions, building on other data management and collection initiatives (FASTLINE inventory and results of symposium in October will provide part of the basis for this and the following objective)

C4 identify data gaps (extent of information, significance assessment, functional understanding) between C2 and C3 that are critical in developing a conservation strategy for the FL

C5 identify potential contributions of stakeholders in data gathering, management, analysis, updating database (expand upon Snetsinger 1994 and May 1994)

C6 assign priorities for data collection based on utility for making conservation decisions and stakeholder/partner capabilities

C7 develop a research strategy and conduct research to complete the database

Subgoal D: Develop a Regional Conservation Strategy

Objectives:

D1 having developed a supporting database for the FL (subgoal C), determine opportunities and constraints related to developing the conservation strategy

D2 prepare a draft conservation strategy (including maps) based on the ecological principles described in section 5.0 in consultation with major stakeholders

D3 solicit broad public comment on the proposed strategy using a variety of approaches appropriate for the target audiences identified (B8)

D4 prepare a final long-term conservation strategy incorporating comments from D3, the implementation of which will be carried on by stakeholders of the FL

Subgoal E: Establish a Monitoring Program to Determine Whether the Goals and Objectives of the Project are Being Met and Target Areas for Attention

Objectives:

E1 determine the degree to which planning decisions in the FL incorporate principles of ecosystem management

E2 develop a suite of indicators to assess ecological integrity of the FL including targets and threshold values

E3 determine responsibilities for data collection, management and analysis

E4 establish reporting procedures related to indicators and a mechanism for initiating adaptive management in light of the findings reported

Subgoal F: Develop a Strategy for Funding

Objectives:

F1 obtain initial funding for coordinator and initial publicity

F2 develop a funding strategy (project length and annual) to support the other strategy subgoals

11.0 CONCLUSIONS AND RECOMMENDATIONS

The Frontenac Axis, which links Adirondack State Park ecologically with Algonquin Provincial Park, is a fragile, narrow bridge. It provides major biogeographical connections between the Boreal Forest to the north and the Great Northern Forests of the northeastern U.S., and between the Appalachian forests to the south and the Boreal Forest. In this north-south transition zone, the Axis provides a wide array of natural habitats from those of southern affinity to those common in the Boreal Forest. The Axis thus supports unusually high species richness including major populations of species significant at provincial, state and national scales. With increasing threats to the ecological integrity of the Axis from major highway corridors, cottage and urban development, and pollution of the St. Lawrence R., a strategy to maintain and restore its environmental value is urgently needed. Under current environmental conditions we still have the opportunity to achieve this conservation goal.

Conservation of this continentally significant land unit requires more than consideration of the Axis itself because its value depends on its continued connection to the Great Northern, Boreal and Appalachian forests. The strategy should thus focus on the Axis as well as the lands that anchor it to Adirondack State Park in the south and Algonquin Provincial Park in the north.

As a first step in developing a strategy, CPAWS should create a steering committee composed of representatives of major land management agencies in the FL in Ontario and New York, large conservation organizations, and other stakeholder groups, to finalize the boundaries of the area of conservation interest, formulate an initial strategy and oversee its implementation. A project coordinator needs to be hired to facilitate task implementation, integration of the strategy components and liaison with stakeholders. The coordinator would act as a focal point for the project.

The preparation of a communications strategy covering education of a wide range of audiences as well as needs for funding support would be the initial priority of the coordinator. Parallel to this initiative, the development of a database for supporting conservation decisions is required. This will require an

assessment of the utility of all sources of data on hand, an analysis of data needs (environmental and social) for developing an ecologically sound conservation strategy for conservation and the establishment of means to obtain the required information.

The environmental and social information gathered would be interwoven to formulate, with public participation, a strategy for conserving the FL. The progress and achievements of all aspects of the strategy (from management operations to ecological integrity) should be assessed through monitoring and comparison to predetermined targets. This will allow us to maximize our progress toward our goal of maintaining and restoring the ecological integrity of the FL.

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