Opportunities for Wildlife Habitat Connectivity between Algonquin Provincial Park and the Adirondack Park

by Peter Quinby, Steve Trombulak, Thomas Lee, Robert Long, Paula MacKay, Jeff Lane, and Michael Henry

EXECUTIVE SUMMARY

The Frontenac Link, an area characterized by its distinctive band of Precambrian bedrock, offers a unique opportunity for restoring a binational, ecological linkage between two of northeastern North America's oldest and largest parks: Algonquin Provincial Park in Ontario and the Adirondack Park in New York. This study is the product of two analyses that, collectively, identify the best path for a priority conservation zone between the two parks (a distance of approximately 270 kilometers), with the overriding goal of reestablishing natural connectivity of wildlife habitats. Using the eastern timber wolf (*Canis lupus lycaon)* as a focal species, the first analysis identified and characterized a corridor between the Adirondack Park and the Thousand Islands region (Trombulak and Lane 1996); the second, between the latter and Algonquin Provincial Park (Quinby et al. 1998). The area of the proposed Priority Conservation Corridor is approximately 8,600 square kilometers, with its width varying according to the quality of selected habitat at any given point. Protected and restored, this corridor would not only provide connectivity between these parks for wolves and other large, wide-ranging species, but would also provide secure habitat for the myriad other species inhabiting this region.

Adirondack landscape by Bill Amadon

No Park Is an Island

That existing parks and Wilderness Areas alone are too small and isolated to protect biodiversity is dramatically illustrated by current trends in species loss. Even our largest parks may not sustain viable populations of large carnivores (Newmark 1985, Soulé 1987, Grumbine 1990) and are part of an ecological mosaic that incorporates the land surrounding and between them (Merriam 1995). When connections between suitable habitat are severed, the resulting fragmentation may have dire consequences for small, isolated animal populations subjected to genetic and demographic effects (Brown and Kodric-Brown 1997). Furthermore, fragmentation invites a host of other problems for wildlife, including increased human disturbance of species and habitats (Noss et al. 1997). For example, a recent study found that conflict with people on reserve borders is the major cause of mortality for large carnivores inhabiting parks and protected areas (Woodroffe and Ginsberg 1998). At Algonquin Park, Théberge et al. (1996) found that 50% of resident wolf packs have territories extending beyond park boundaries. Anthropogenic effects are a significant threat to these wolves, with 75% of human-induced deaths occurring outside of the park (Forbes and Théberge 1995).

The restoration of functional connectivity between protected areas is essential to prevent or mitigate deleterious population effects associated with fragmentation, and to ensure the viability of wide-ranging species that require ample habitat for foraging, seasonal movement, and other needs (Noss 1983, Harris 1984, Noss and Harris 1986, Soulé 1987). Noss et al. (1997) suggest four specific guidelines arising from the connectivity principle:

- All else being equal, wide swaths of suitable habitat are better than narrow corridors.
- Corridors longer than normal dispersal distances for a target species should be sufficiently wide or have enough "stepping stone" habitat patches to provide for resident individual home ranges.
- Animals usually follow a path of least resistance when moving through a landscape.
- Planners should base connectivity designs on the needs of species most sensitive to fragmentation.

These guidelines are fundamental to the methodology used in the current study.

The Frontenac Link

The Frontenac Link is a broad swath of land connecting Ontario's Algonquin Park to the Adirondacks (Fig. 1), and includes the Frontenac Axis, the least degraded north-south corridor across the St. Lawrence River (Keddy 1995). Approximately 12,000 years ago, the present St. Lawrence River region was covered by a glacial lake, while the more northern portion was tundra (Anderson 1989). Today, the

Fig. 1. Greater Laurentian region showing the Frontenac Link

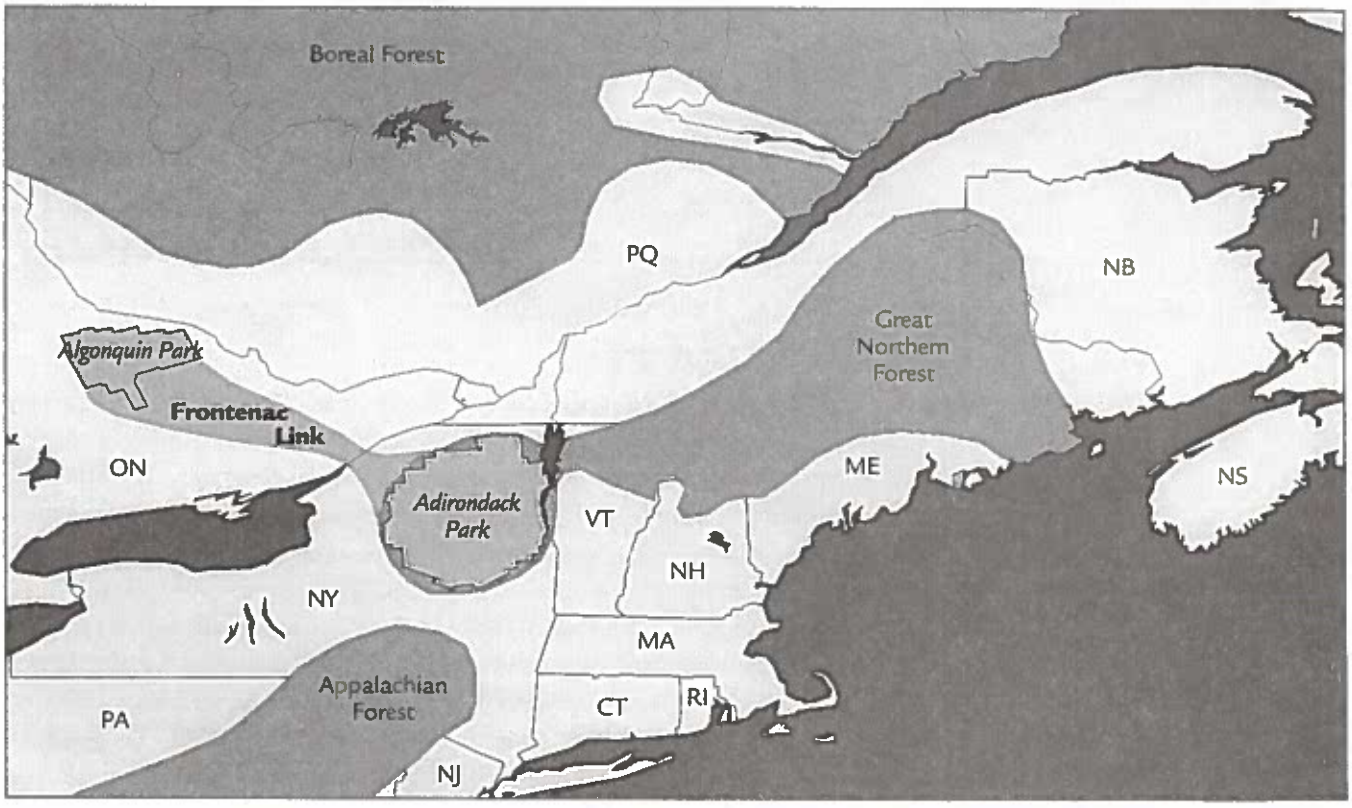
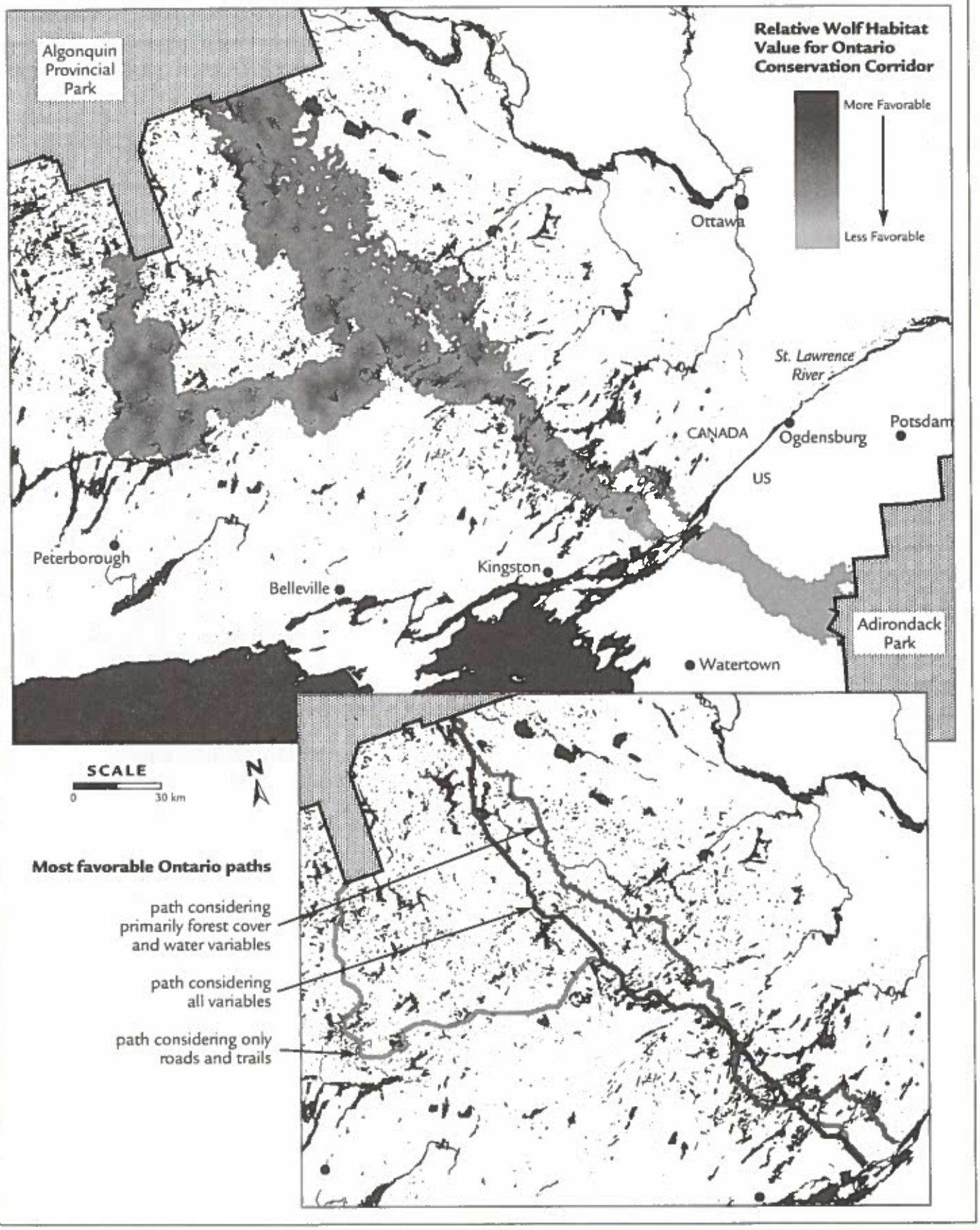


Fig. 2. Priority conservation corridors

based on the top 5% of wolf habitat along most favorable corridor paths



Frontenac Link lies near the continent's northeastern limit of deciduous forest, thus providing a critical biogeographical connection between Canada's boreal forest and the northern forest of the US. The wide array of environmental conditions and habitats, including interior forest, rock barrens, and numerous wetland types, supports a rich and diverse range of species—many of which are rare. More than 50 mammal species occur in this region, with at least five (timber wolf, cougar, marten, lynx, and moose) having been extirpated or reduced to very small numbers in the southeastern part of the Link. Nearly 200 bird species may breed here, with the Frontenac Link serving for many as a connection between their breeding and wintering ranges (Keddy 1995).

The importance of protecting the primarily forested Frontenac Link is magnified by the destructive effects of human settlement on its periphery. Deforestation, agriculture, commercial fishing, mining, water mills, and urbanization have transformed the natural ecosystem of the region, interfering with ecological processes (Osborne 1995). Keddy (1995) states: "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." Anchored by two world-class parks, the Frontenac Link presents a strategically situated and ecologically valuable opportunity for reestablishing wildlife connectivity.

Why the Wolf?

To perform an assessment of the study area based on the habitat requirements of all native species was clearly impractical. Rather, we evaluated the region in terms of its potential ability to fulfill selected needs of a single species—the eastern timber wolf (*Canis lupus lycaon*). A wide-ranging top predator, *C. l. lycaon* requires extensive core areas of forested habitat for foraging and dispersal (Jensen et al. 1986, Fuller et al. 1992, Mladenoff et al. 1995, Harrison and Chapin 1997, 1998). Habitat security is crucial to the long-term viability of wolf populations, with low road density (Thiel 1985, Jensen et al. 1986, Fuller 1989, USFWS 1992, Thurber et al. 1994, Paquet et al. 1997, Mladenoff et al. 1995, Corsi et al. 1999) and human population density (Fuller et al. 1992, USFWS 1992, Mladenoff et al. 1995) considered critical factors affecting their distribution and survival. Furthermore, providing ample habitat to assure a viable population of wolves should benefit many other species with more restricted habitat and area needs (Miller et al. 1998). In the Frontenac Link region, for example, bird species such as the threatened cerulean warbler *(Dendroica cerulea)* (Oliarnyk and Robertson 1995), red-shouldered hawks *(Asturina lineata),* and others (see Keddy 1995) require interior forest habitat for breeding.

C. l. lycaon is currently of major conservation concern in the Frontenac Link region. Wolves were historically present throughout the study area, but were extirpated from the southern portion by 1900 (Harrison and Chapin 1997). Wolf recovery in the northeastern US has been the focus of increasing interest, especially since the US Fish & Wildlife Service recently announced its intention to design a recovery plan for the species in this region. Although potential habitat for recovery has been identified in the Adirondacks (USFWS 1992, Mladenoff and Sickley 1998, Paquet et al. 1999) and Algonquin Park is the most significant stronghold for wolves in southern Ontario (Théberge et al. 1996), there are expansive areas between the two parks that do not meet the criteria for either core or dispersal habitat (Harrison and Chapin 1997, 1998, Mladenoff and Sickley 1998, Paquet et al. 1999). Thus, recent attempts to model connectivity for wolves between southeastern Canada and the northeastern US have failed to identify a contiguous biotic corridor in the Frontenac Link region. Our study attempts to answer the question: If wolves were to move between the Adirondacks and Algonquin Park, what would be their path of least resistance?

Methods

The Priority Conservation Corridor was identified using a number of descriptive models and geographic information system (GIS) analyses. The models were used to assess and integrate variables that have been shown to influence wolf movement and the integrity of wolf populations. These variables included road density, presence of major roads, human population density, land use, and proximity to water. Within the GIS, the study area was divided into 90 meter by 90 meter cells, and each cell was weighted based on its "favorability" in relation to each of the above variables. Path analysis (ESRI 1996) was then used to identify the most favorable paths (cell by cell) between the parks (Fig. 2).

Results and Conclusions

By qualitatively evaluating corridors of various widths, it was decided that the top 5% of identified cells along the best single path provided better corridor designs than those based on other percentages. This model minimizes bottlenecks in northwestern New York and provides continuous corridors throughout the remainder of the study area. Within the 5% corridor for New York, the road density is 0.31 km/km^2—well below the threshold for suitable wolf habitat (0.45–0.70 km/km^2) (Fuller et al. 1992, Jensen et al. 1986, Mech et al. 1988, Mladenoff et al. 1995, Thiel 1985, Thurber et al. 1994). This model described an area of 977 km^2, which was chosen as the Priority Conservation Corridor in New York. Using the 5% level and similar but slightly different methods, we identified a Priority Conservation Corridor for the Ontario study area comprising 7,622 km^2. (See Fig. 2.)

Additional analyses of natural aquatic ecosystems in the New York study area indicate that the Priority Conservation Corridor provides good representation of this element relative to the entire study region. This suggests that the wolf may be

an effective umbrella species for aquatic ecosystems. The corridor does not, however, adequately represent some of the less common plant community types (e.g., oak-hickory, white-red-jack pine) found in the region. Further analyses using other techniques would be necessary to address the protection of these community types.

Habitat suitability is a measure of habitat productivity (food resources) and habitat security (safety). It is important to note that the current study is not a rigorous habitat suitability analysis, but primarily addresses habitat security. Other research suggests that the main factor limiting wolves *where they are tolerated by humans* is prey density (Fuller et al. 1992). In our study, prey availability was considered only insofar as it is related to forest cover and distance to water bodies. Further examination of prey density is necessary to analyze habitat suitability for wolves in the Frontenac Link.

Based on current conditions, the likelihood of individual wolves dispersing from extant populations in Ontario into the northeastern US is uncertain because of potentially significant physical barriers (e.g., the St. Lawrence River) and isolation of suitable habitat (Harrison and Chapin 1998, Wydeven et al. 1998). Furthermore, a recent study examining the feasibility of wolf reintroduction in the Adirondack Park found that, although prey density and habitat within the park are likely sufficient to support a small population of wolves, linkages between the park and other subpopulations of wolves are inadequate to ensure the long-term persistence of the population (Paquet et al. 1999). This study concluded that "emphasis needs to be placed on identifying landscape connections with other nearby reserves."

While our analyses point to the best potential linkage between the Adirondacks and Algonquin Park, the challenges to establishing on-the-ground wildlife connectivity are formidable. Habitat fragmentation due to human development is severe in some areas, especially along the St. Lawrence River, and icebreaking activities on the river further hinder the potential for wildlife movement. Any efforts toward carnivore restoration must also overcome pervasive negative human attitudes within the recovery region. Nonetheless, this region presents a unique opportunity for restoring a vital linkage between the northeastern US and southern Ontario. Such a corridor would allow for movement and genetic exchange within populations of *many* species, including black bear, lynx, moose, and a variety of smaller mammals, birds, and invertebrates (Wydeven et al. 1998). Opportunities for such large-scale connectivity should not be overlooked.

The restoration of this linkage will require binational, visionary, and pragmatic conservation efforts involving both public and private lands. For example, the Algonquin to Adirondacks (A2A) Conservation Initiative seeks to involve private landowners in restoring and maintaining connectivity through private land stewardship (see sidebar). The protection of core areas will also be essential: A2A supporters recently helped secure over 259,000 acres of new protected areas in the

About the Algonquin to Adirondacks Conservation Initiative

The Algonquin to Adirondacks Conservation Initiative (A2A) presents a bold new vision of cooperative conservation on a grand scale. Spearheaded by the Canadian Parks and Wilderness Society (CPAWS), A2A is a binational effort to preserve ecological connectivity between Algonquin Provincial Park in Ontario and Adirondack Park in New York. At a regional scale, the landscape between the two parks affords a rare opportunity in eastern North America to maintain and protect habitat and movement potential for native plants and animals along a north-south axis.

Centered on the rugged terrain of the Frontenac Axis, the A2A vision is one of an ecologically sustainable home place that provides for the well being of both its wild and human inhabitants. A place where...

- natural areas, whether privately or publicly maintained, provide functional connectivity across the landscape.
- ecological linkages, anchored by the two great parks, extend across highlands, valleys, rivers, and political boundaries.
- the essential natural movement of organisms, water, and nutrients occurs seamlessly at local, regional, and international scales.
- the traditions, scenic beauty, and biological diversity of the region are maintained for their inherent value and for the life-support and enrichment of future generations.

As the majority of land between the two parks is owned privately, individual landowners have a key role to play in preserving the habitat that supports people, plants, and animals. Of course, public land also plays a vital role. Two years of advocacy work by CPAWS and others culminated in last year's designation of more than 259,000 acres of new protected areas in the A2A region of Ontario.

A2A is a vision shared by a society that recognizes the importance of natural areas and is resolved to maintain them. Our success will depend on the cooperative efforts of a broad diversity of organizations and individual landowners. The current focus of A2A in Ontario is to support private land stewardship. For more information, please contact

CPAWS Ottawa Valley Chapter
PO Box 3072, Station D
Ottawa, Ontario, Canada KIP 6H6
www.AtoA.org

region via Ontario's "Lands for Life" land-use planning process. Movement barriers resulting from roads will need to be creatively addressed using tools such as overpasses and underpasses, reduced speed limits, road closures where possible, and by reducing the number of new roads. A strategy must also be developed to restore the ice "bridge" historically afforded by the frozen St. Lawrence, but severed by today's ice-breakers. Most importantly, extensive public outreach will be necessary to foster more positive attitudes toward predators and biodiversity conservation as a whole.

Given the current pattern of human settlement and the dearth of truly large, protected wildlands, connectivity zones are integral to the maintenance of ecological integrity across the landscape. Our results identify a Priority Conservation Corridor that, if restored and protected, could provide functional connectivity for wolves and many other species, as well as a starting point for protecting selected special elements and natural communities. Future studies should be undertaken to fully examine potential values provided by the corridor, and to adapt it as appropriate. Meanwhile, these preliminary findings may help to guide managers, landowners, educators, municipalities, and land trusts in focusing land protection strategies where they are most likely to benefit biodiversity in the long term.

Acknowledgements We would like to thank the Geraldine R. Dodge Foundation for their financial support of this project. In addition, we thank the many individuals who contributed valuable skills, time, and knowledge to the project, including Kathleen Fitzgerald, Jonathan Lee, Caleb McClennen, Cheryl Veary, and Chad Weiner.

Peter Quinby *(Department of Natural Resources, Paul Smith's College, PO Box 265, Paul Smiths, NY 12970) is Assistant Dean of Natural Resources, Sciences, and Liberal Arts at Paul Smith's College, New York, and Research Scientist for Ancient Forest Exploration and Research, Powassan, Ontario.* ■ **Steve Trombulak** *Department of Biology, Middlebury College, Middlebury, VT 05753* ■ **Thomas Lee** *Ancient Forest Exploration & Research, 3486 Memorial Park Drive, RR #4, Powassan, Ontario POH 1Z0 Canada* ■ **Robert Long, Paula MacKay** *Greater Laurentian Wildlands Project (GLWP), 4 Laurel Hill Drive, South Burlington, VT 05403* ■ **Jeff Lane** *Department of Geography, Middlebury College, Middlebury, VT 05753* ■ **Michael Henry** *Ancient Forest Exploration & Research, 3486 Memorial Park Drive, RR #4, Powassan, Ontario POH 1Z0 Canada* ➤ *Contact GLWP for a full report on this work.*

Literature Cited

Anderson, T.W. 1989. Vegetation changes over 12,000 years. *GEOS* 18: 39–47.

Brown, J.H., and A. Kodric-Brown. 1997. Turnover rates in insular biogeography: Effect of immigration on extinction. *Ecology* 58: 445–449.

Corsi, F., E. Dupre, and L. Boitani. 1999. A large-scale model of wolf distribution in Italy for conservation planning. *Conservation Biology* 13: 150–159.

ESRI, Inc. 1996. ArcView Spatial Analyst Version 1.1. Environmental Systems Research Institute, Inc. Redlands, CA.

Forbes, G.J. and J.B. Théberge. 1995. Influences of a migratory deer herd on wolf movements and mortality in and near Algonquin Park, Ontario. Pages 303–314 *in* L.N. Carbyn, S.H. Fritts, and D.R. Seip, eds. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, Occasional Publication Number 35.

Fuller, T.K. 1989. Population dynamics of wolves in north-central Minnesota. *Wildlife Monographs* 105: 1–41.

Fuller, T.K., W.E. Berg, G.I. Radde, M.S. Lenarz, and G.B. Joselyn. 1992. A history and current estimate of wolf distribution and numbers in Minnesota. *Wildlife Society Bulletin* 20: 42–55.

Grumbine, R.E. 1990. Protecting biological diversity through the greater ecosystem concept. *Natural Areas Journal* 10: 114–120.

Harris, L.D. 1984. *The Fragmented Forest: Island Biogeography Theory and the Preservation of Biotic Diversity*. Chicago: University of Chicago Press.

Harrison, D.J. and T.G. Chapin. 1998. Extent and connectivity of habitat for wolves in eastern North America. *Wildlife Society Bulletin* 26(4): 767–775.

Harrison, D.J. and T.G. Chapin. 1997. An assessment of potential habitat for eastern timber wolves in the northeastern United States and connectivity with occupied habitat in southeastern Canada. Wildlife Conservation Society, Working Paper 7, New York, New York.

Jensen, W.F., T.K. Fuller, and W.L. Robinson. 1986. Wolf (*Canis lupus*) distribution on the Ontario Michigan border near Sault Ste. Marie. *Canadian Field Naturalist* 100: 363–366.

Keddy, C. 1995. *The Conservation Potential of the Frontenac Axis: Linking Algonquin Park to the Adirondacks*. Ottawa, Ontario: The Canadian Parks and Wilderness Society, Ottawa Valley Chapter.

Mech, L.D., S.H. Fritts, G.L. Radde, and W.J. Paul. 1988. Wolf distribution and road density in Minnesota. *Wildlife Society Bulletin* 16: 85–87.

Merriam, G. 1995. Algonquin Adirondacks Landscape Linkage (AALL): Roots of the idea. Proceedings of the Frontenac Axis Research Needs Symposium, October 10–12, 1995, Kingston, Ontario, Parks Canada/FASTLINE.

Miller, B., R. Reading, J. Strittholt, C. Carroll, R. Noss, M. Soulé, O. Sanchez, J. Terborgh, D. Brightsmith, T. Cheeseman, and D. Foreman. 1998. Using focal species in the design of nature reserve networks. *Wild Earth* 8(4): 81–92.

Mladenoff, D.J. and T.A. Sickley. 1998. Assessing potential gray wolf restoration in the northeastern United States: A spatial prediction of favorable habitat and potential population levels. *Journal of Wildlife Management* 62: 1–10.

Mladenoff, D.J., T.A. Sickley, R.G. Haight, and A.P. Wydeven. 1995. A regional landscape analysis and prediction of favorable gray wolf habitat in the northern Great Lakes Region. *Conservation Biology* 9: 279–294.

Newmark, W.D. 1985. Legal and biotic boundaries of western North American national parks: A problem of congruence. *Biological Conservation* 33: 197–208.

Noss, R. 1983. A regional landscape approach to maintain diversity. *BioScience* 33(11): 700–707.

Noss, R.F. and L.D. Harris. 1986. Nodes, networks, and MUM's: Preserving diversity at all scales. *Environmental Management* 10: 299–309.

Noss, R.F., M.A. O'Connell, and D.D. Murphy. 1997. *The Science of Conservation Planning: Habitat Conservation under the Endangered Species Act*. Washington, DC: Island Press.

Oliarnyk, C., and R.J. Robertson. 1995. Breeding success of cerulean warblers *(Dendroica cerulea)* in habitats undergoing differing management schemes. Proceedings of the Frontenac Axis Research Needs Symposium, October 10–12, 1995, Kingston, Ontario, Parks Canada/FASTLINE.

Osborne, B.S. 1995. The "nature" of the Frontenac Axis: An evolving concept in a dynamic world. Proceedings of the Frontenac Axis Research Needs Symposium, October 10–12, 1995, Kingston, Ontario, Parks Canada/FASTLINE.

Paquet, P.C., J.R. Strittholt, and N.L. Staus. 1999. Wolf reintroduction feasibility in the Adirondack Park. Unpublished report prepared by the Conservation Biology Institute for the Adirondack Citizens Advisory Committee on the Feasibility of Wolf Reintroduction.

Paquet, P.C., J. Wierzchhowski, and C. Callaghan. 1997. Assessing reserve designs using a predictive habitat suitability and movement model. Oral presentation, 1997 Annual Meeting of the Society for Conservation Biology, Victoria, Canada.

Quinby, P.A., T. Lee, and M. Henry. 1998. Identifying a priority conservation zone in eastern Ontario. Unpublished report prepared by Ancient Forest Exploration & Research, Powassan and Toronto, Ontario; prepared for the Greater Laurentian Wildlands Project, South Burlington, Vermont.

Soulé, M.E., ed. 1987. *Viable Populations for Conservation*. Cambridge, UK: Cambridge University Press.

Théberge, J.B., M.T. Théberge, and G. Forbes. 1996. What Algonquin Park wolf research has to instruct about recovery in the northeastern United States. Pages 34–40 *in* Wolves of America Conference Proceedings. November 14–16, 1996, Albany, New York, Defenders of Wildlife.

Thiel, R.P. 1985. The relationship between road density and wolf habitat suitability in Wisconsin. *American Midland Naturalist* 113: 404–407.

Thurber, J.M., R.O. Peterson, T.D. Drummer and S.A. Thomasma. 1994. Gray wolf response to refuge boundaries and roads in Alaska. *Wildlife Society Bulletin* 22: 61–68.

Trombulak S. and J. Lane. 1996. A proposal for a priority conservation zone in northern New York. Unpublished report prepared for the Greater Laurentian Wildlands Project, South Burlington, Vermont.

US Fish and Wildlife Service. 1992. *Recovery Plan for the Eastern Timber Wolf*. Twin Cities, Minnesota.

Woodroffe, R. and J.R. Ginsberg. 1998. Edge effects and the extinction of populations inside protected areas. *Science* 280: 2126–2128.

Wydeven, A.P., T.K Fuller, W. Weber, K. MacDonald. 1998. The potential for wolf recovery in the northeastern United States via dispersal from southeastern Canada. *Wildlife Society Bulletin* 26(4): 776–784.