The Importance of Maine for Ecoregional Conservation Planning

by Robert F. Baldwin, Stephen C. Trombulak, Karen Beazley, Conrad Reining, Gillian Woolmer, John R. Nordgren, and Mark Anderson

Ecoregional conservation planning aims at protecting biodiversity within a realistic social and economic framework. The authors of this article suggest that Maine's forests are the ecological core of the entire Northern Appalachian/Acadian ecoregion, which spans four states and five Canadian provinces. Using mapping and mathematical models of the "human footprint," they note that Maine has a large, contiguous, undeveloped and unfragmented forest compared with neighboring states and provinces. However, compared with its neighbors Maine also has the largest proportion of unprotected forest. The authors conclude with the hope that land use policy and planning can be better informed through the active integration of recent ecoregional conservation mapping models.

As with many places around the globe rich in natural resources, Maine's diverse ecosystems have attracted the attention of many conservationists from both inside and outside of the state. A plethora of conservation groups has periodically proposed strategies for protecting the state's forests, waters, plants, and animals. Some of these proposals and projects represent successful public-private partnerships and are the result of careful, science-based planning. For example, several recent large-scale conservation easements strategically protect vulnerable landscapes and allow sustainable forestry and recreational access. On the other hand, proposals for large-scale wilderness have been viewed by residents of the state as threats to Maine's culture and values, not to mention its economic stability. For example, a proposal for the Maine Woods National Park met broad opposition because the planning process was viewed as arbitrary and exclusive of many points of view (Baldwin 2006).

Threats are gathering for the Maine landscape, and new conservation action is needed if large swaths of forestland are going to be prevented from slipping to paved roads, housing, and other elements of a developed landscape. In recent years large-scale land conservation has become an urgent priority for the people of the state. Changes in the timber industry have weakened its position as a dominant and stable economic force. Forestland ownership is shifting to companies that are more interested in short-term economic returns, threatening an end to the comfortable assumption that forest management would keep both local economies chugging and forest plants and animals in well-managed habitat (Hagan et al. 2005). Today there is increasing concern that amenity development infrastructure—roads, housing, and services focused on lakes, ponds, ski areas, and other aesthetically pleasing spots—will gradually come to dominate the landscape.

The emerging field of conservation planning suggests that only systematic, science-based planning provides the kind of decision-making tool that stakeholders (i.e., resource users and managers, residents, and scientists) respect. The scientific basis for conservation planning has been developed over several decades. The basic approach is to map (using digital Geographic Information Systems [GIS]) areas with the greatest ecological value relative to where the greatest threats to those values are (Groves et al. 2002). Threats include current and projected roads, housing, human population, and other elements of human influence. Mapped information is combined in mathematical models, and the resulting information can then support decision-making by conservation groups and others concerned with the future of the forest. Ultimately, these mapping models will assist decision makers at multiple scales (local, state, regional, national, and global) to identify appropriate land management and conservation strategies.

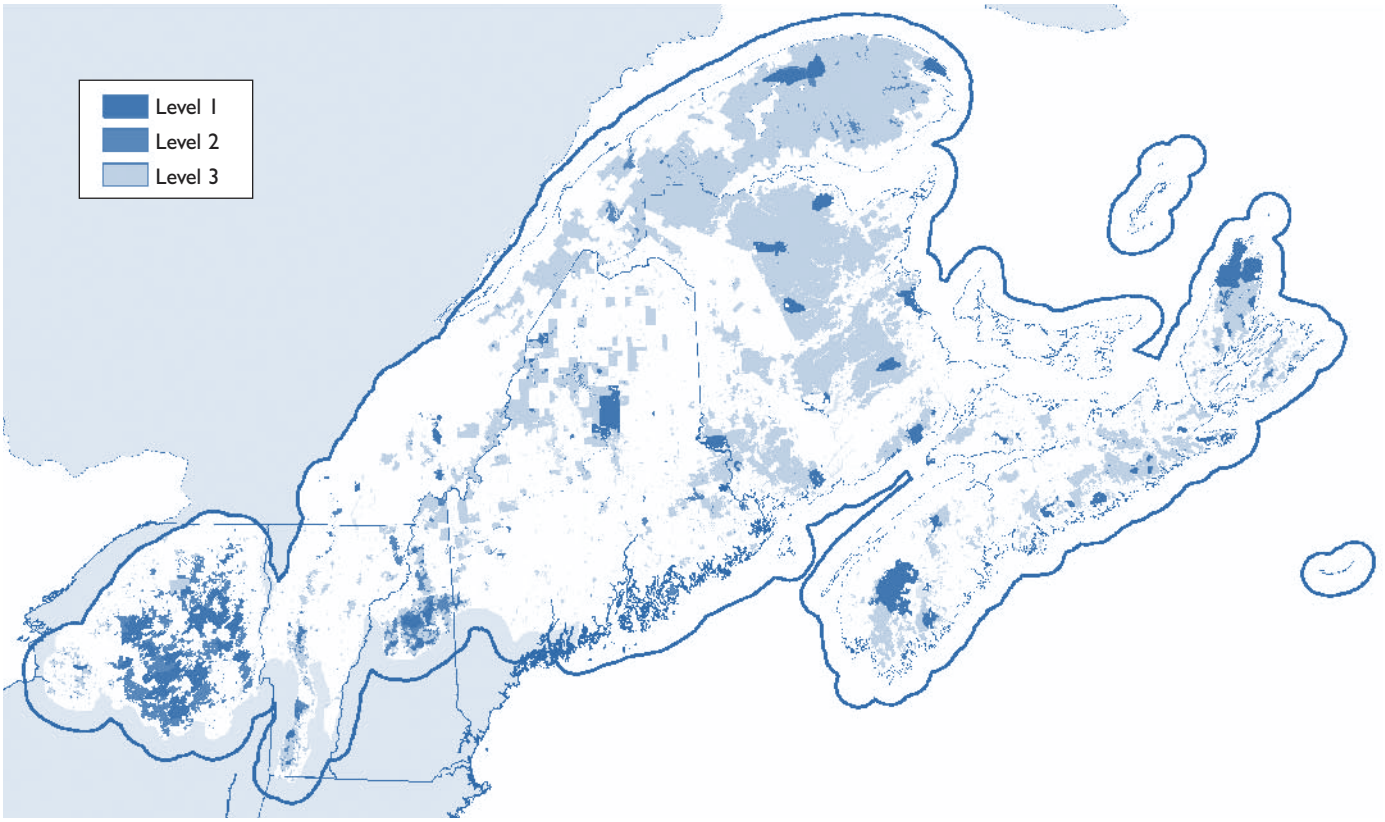
In recent years, large-scale conservation planning has become a priority for the people of the state.

Through broad collaborations among the nongovernmental organizations (NGOs), government agencies, and scholarly communities, this approach provides valuable resources for making conservation decisions. One such collaboration described here has focused on the Northern Appalachian/Acadian ecoregion in which the state of Maine is embedded (Figure 1, p. 68). This collaboration is organized under the auspices of the Canada-based Two Countries, One Forest (2C1Forest) enterprise. This umbrella group includes dozens of regional conservation and academic institutions and features an international team of conservation scientists that has recently completed a detailed analysis of natural and human-built aspects of this transboundary landscape. One of the most striking results of this analysis is the emergence of Maine's forests as the ecological core of the entire region, a compelling finding because these forests also are the least protected—not from the effects of forest management but from conversion to development. In this essay we profile how the 2C1Forest collaboration has come to understand the importance of Maine's forests in the context of the larger region.

THE NORTHERN APPALACHIAN/ACADIAN ECOREGION (NAP)

Most of Maine (90 percent) is a part of the Northern Appalachian/Acadian ecoregion,

FIGURE 1: **Protection Status of Lands Permanently Secured from Development in the Northern Appalachian Ecoregion**



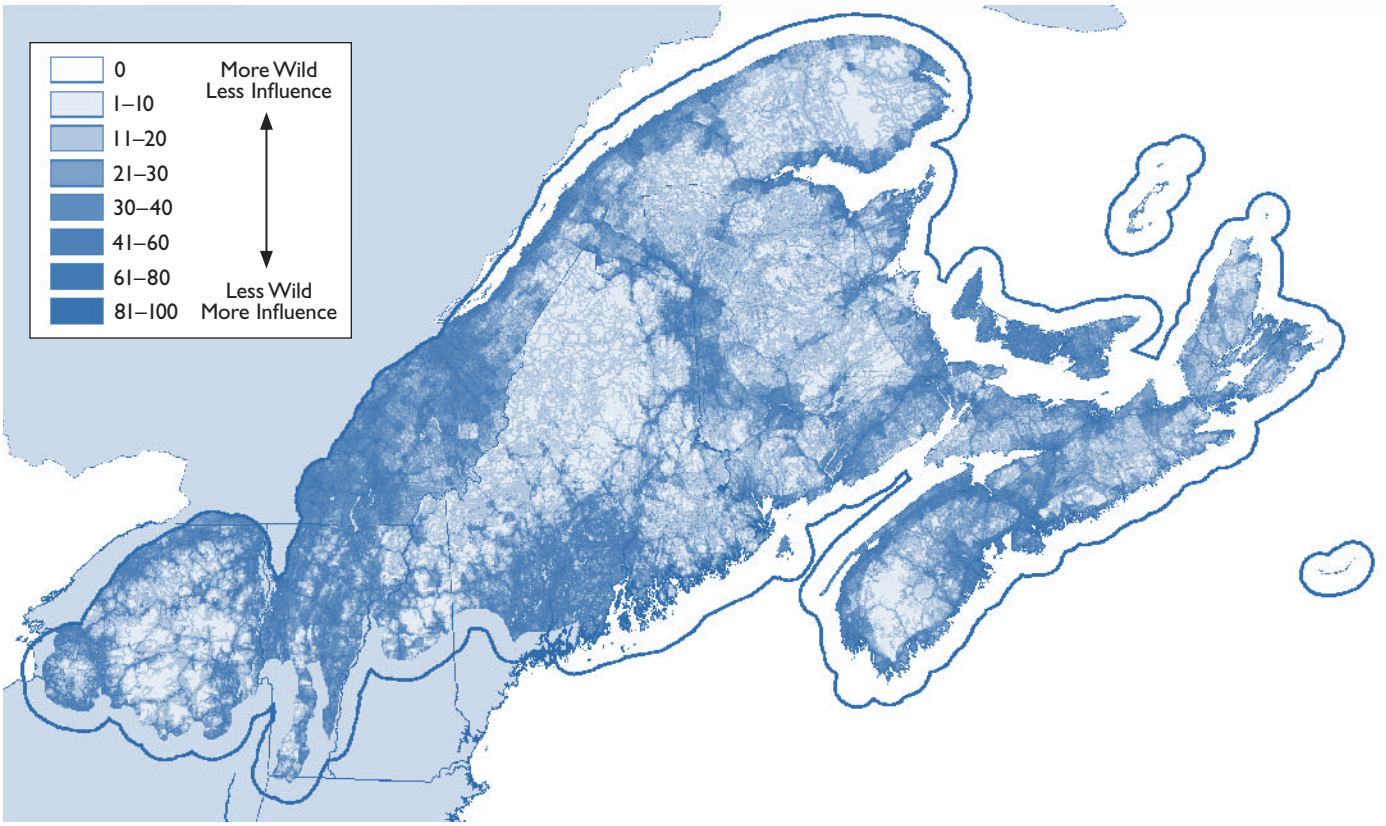
Protection status is derived from the U.S. National Gap Analysis Program and essentially categorizes levels 1 and 2 as protected primarily for nature conservation (i.e., reserves but for 2 including some more intensive uses), and gap level 3 as protected for multiple uses (e.g., National Forest land with extensive or intensive forest harvesting).

defined by similarity of landforms and ecosystems (Figure 1). The ecoregion encompasses the cool, spruce- and hardwood-clad northern extent of the Appalachian Mountains, which along with the marine and coastal influences have helped to define the ecological history of the Northeast. From the Tug Hill plateau of New York, the ecoregion extends eastward across the Adirondack Mountains, the Green Mountains of Vermont, the White Mountains of New Hampshire, and most of Maine. Northward, it includes the Appalachian complex of eastern Quebec extending to the Gaspé Peninsula and the Îles-de-la-Madeleine (Magdalene Islands), New Brunswick, Nova Scotia, and Prince Edward Island. The Northern Appalachian/Acadian ecoregion is the second-richest ecoregion for vertebrate diversity within the temperate broadleaf and mixed forest regions of North America (Ricketts et al. 1999). The geographic boundaries of the ecoregion were derived and modified by an international team of scientists from standard ecological land classification frameworks in Canada and the U.S., coordinated by The Nature Conservancy Eastern Resource Office (Anderson et al. 2006).

THE BIODIVERSITY VALUES OF MAINE RELATIVE TO THE ECOREGION

When viewed in relation to the entire ecoregion, northern Maine (for our purposes inclusive of the Western Mountains, North Woods, and Downeast regions) appears as a vast expanse of forestland surrounded by more settled agricultural, rural, urban,

FIGURE 2: **The WCS Human Footprint for the Northern Appalachian/Acadian Ecoregion**

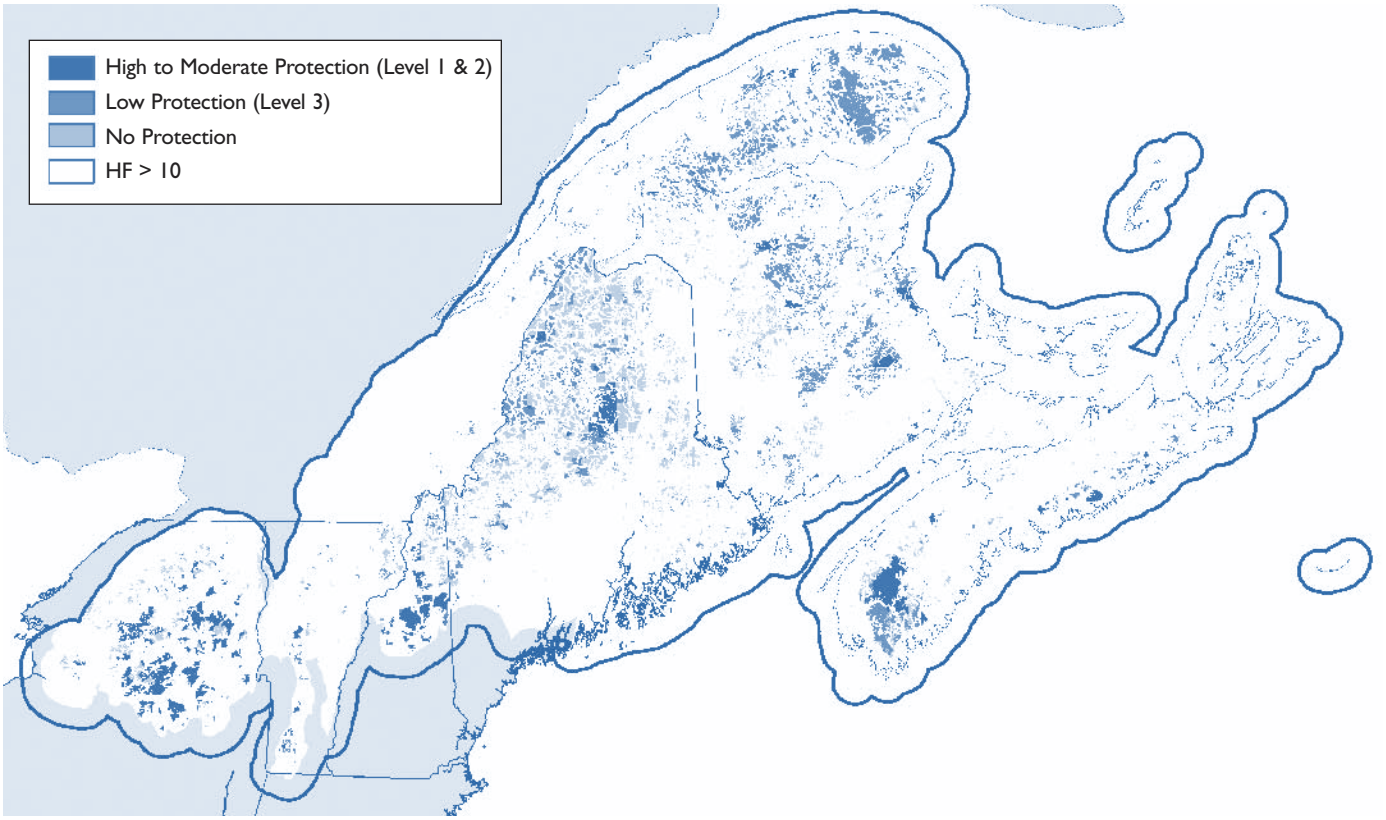


The human footprint methodology is simple: overlay as many land uses as possible. Each land use is assigned a specific score reflecting its relative influence on ecosystems: the Human Influence Index. The most recently calculated human footprint shown here includes human population and housing density, roads of many classes as well as road influence zones, rail systems, land cover, dams, and the electrical power grid, at a 90 m^2 resolution. Details may be found at http://www.wcscanada.org/

and exurban landscapes. This land use pattern is mapped as the "human footprint" and is displayed in Figure 2.

While southern Maine is biogeographically similar to central New England (Foster 1992), northern Maine has more ecological similarity with eastern Canada, the Adirondacks, and northern New England. Plant and animal diversity is relatively higher in southern than northern Maine because southern Maine represents the northern range limits for many well-known species (e.g., Blanding's turtle, *Emydoidea blandingii*, and sassafras, *Sassafras albidum*). By contrast, the northern regions of Maine host alpine habitats, vast bog systems, spruce-fir forest, fishless ponds, and numbers of lakes and streams. This habitat supports species diversity that may not be imperiled at the Maine scale, but is a valuable ecoregional resource. For example, the extensive forested wetland habitat supports globally imperiled amphibians (Golet et al. 1993), a shifting mosaic of forest types supports neotropical migrant birds (Hagan et al. 2005), and abundant streams support anadramous fish (Owen et al. 1997). Finally, the vast, forested landscape of northern Maine provides the greatest remaining opportunity in eastern North America for re-establishment of viable populations of wide-ranging predators including wolves (*Canis lupus*), lynx (*Lynx canadensis*), and marten (*Martes americana*), and these trends are currently visible (e.g., lynx have reached their highest population levels in 30 years) (Carroll 2005). Northern Maine is now recognized for its potential to

FIGURE 3: **How Protected Is the Remaining Wild of the Northern Appalachian/Acadian Ecoregion?**



Wild is defined as the land with the lowest score from the WCS human footprint (HF ≤10) and is shown here classified by protection status (levels 1 [highest] through 3 [lowest]). See also Figure 2 note.

represent and connect ecoregional habitats in the larger landscape. Strategic conservation planning at the ecoregion scale seeks to maintain Maine's valued biodiversity while also ensuring access to and sustainable use of forest resources where those uses are most appropriate based on the arrangement of land uses and habitat systems currently on the landscape.

THREAT AND OPPORTUNITY: CHANGING LAND USE

Historically in northern New England, private industry was the land's steward—overseen by state agencies with varying degrees of rigor (Dobbs and Ober 1995). Maine's forests were managed for timber and pulp extraction and were largely open to the public for recreation (Irland 1999). Until recently, the companies or families that owned the land had little interest in converting the land from timber production to any kind of permanent human development, simply because land was most valued for its future timber production (Hagan et al. 2005). Likewise, most Mainers felt secure in their jobs in the forests and mills and in their access to land for hunting, fishing, and other recreational opportunities.

Despite this history, research by the Brunswick-based Manomet Center for Conservation Science has demonstrated with clarity that forestland ownership patterns have been changing rapidly over recent decades, following a nationwide trend in "parcelization" (subdivision) of privately held forestlands for recreational or "amenity" development (Hagan et al. 2005). These developments range from exclusive gated communities bordering lakes, rivers, and ski areas to individual homes ("mini-kingdoms") on remote parcels. This trend now threatens to take a quantum leap

forward, as is evidenced by the Plum Creek Company's development plans for the Moosehead Lake region of Maine (Austin 2005) and similar projects elsewhere in North America.

Such large-scale changes in land use have permanent ecological effects. For example, houses and roads are permanent installations and their ecological effects are less reversible than inappropriate forest-management practices. There is the real possibility that within 20 to 40 years what now appears as a mostly forested, unsettled landscape will be increasingly fragmented by paved roadways and clusters of housing and other developments.

Expansion of road networks is a particularly devastating ecological change. Today, roads proliferate throughout the North Woods region. As new houses and resorts are built in remote locations, there will be more paved roads and greater traffic volume at greater speeds, placing neighboring ecosystems at risk. Slow-moving animals with long-distance patterns of movement (e.g., many turtles, amphibians) will become more vulnerable (Gibbs and Shriver 2002) and even fast-moving, wide-ranging species including lynx are susceptible to road mortality (Kramer-Schadt et al. 2004). Roads have secondary effects on adjacent ecosystems including salt spray that kills amphibians and stunts plant growth, increased random access for ATVs, and introduction of invasive species, effects that may extend as much as 1 km from the roadway (reviewed in Trombulak and Frissell 2000).

The change in land use from forest management to amenity development in Maine lends a sense of urgency to conservation planning efforts in the entire Northern Appalachian/Acadian ecoregion. Those areas most threatened by new infrastructure must be identified and, if they represent important ecological values, secured from conversion to what planners call "a built environment" via working forest or development easements or acquisition.

In our ecoregion, when those remote forestlands that are not secured from development are mapped and compared with neighboring states and provinces, we see that there is a comparatively large amount of contiguous, undeveloped, and unfragmented forest in Maine that remains in private ownership with no guarantee of protection from future development.

TABLE 1: **Contributions of Constituent States and Provinces to the Remaining Conservation Opportunity in the Northern Appalachian Ecoregion[a]**

State or Province	Percentage Unprotected Wild
Prince Edward Island	0.1%
Nova Scotia	7.5%
New Brunswick	12.5%
Quebec	3.8%
Maine	63.0%
Massachusetts	0.0%
New Hampshire	2.2%
New York	8.8%
Vermont	2.1%

(a) Percentage of this ecoregion's unprotected wild is measured by the lowest score of the WCS human footprint (≤10)].

Specifically, a majority (63 percent) of the forestlands in the ecoregion that are currently unprotected in any form (public land or private land in easement) occur within the boundaries of Maine (Table 1; Figure 3).

While approximately one-third, or 37 percent of the entire northern Appalachians is presently secured from development (e.g., as public land, or private land in conservation easement), Maine—which makes up 20 percent of the ecoregion—contains only 14.8 percent of these conserved lands (Table 2, p. 72). One way to look at this is that no other single political jurisdiction within the five-state, four-province ecoregion has retained such a high proportion of its unprotected forestlands. We believe that the private forest industry is to be praised for this. At the same time, we must recognize the global forces and regional economic realities that drive land use decisions are changing.

THE FUTURE OF MAINE'S NORTH WOODS: ECOREGIONAL ISLAND OR CORE HABITAT AREA?

On its simplest level, landscape-scale conservation is based on the principle of interconnected core habitat areas—areas of large enough to protect source (surplus) populations of plants and animals that may disperse to surrounding habitats. Cores and corridors can and must exist in a managed matrix of human-

TABLE 2: **Protected Areas of Maine Compared to the Entire Ecoregion**[a]

	km^2	Acres	Percentage of Ecoregion	Percentage of Maine
Area of Maine in ecoregion	76,680	18,948,122	19.7%	90.0%
Maine status 1 and 2 lands	2,199	543,421	0.6%	2.9%
Maine status 3 lands	9,109	2,250,979	2.3%	11.9%

(a) For explanation of how protection status is defined, see Figure 1 note. Status 3 figures do not include recently concluded easement projects (e.g., Downeast Lakes).

dominated land uses—where habitat quality can vary widely by species—for this principle to be realized. Clearly, we need to consider the concepts of scale and space. Ecoregional planning by definition thinks big, but many species are capable of using high-quality habitat in areas too small to even be shown on maps represented here (for example, a local population of pool-breeding amphibians)—and, as ecologists well know, *everything* is habitat for *something*. For this reason, at every step of the way planners must seek to engage local expertise so that the coarse filter of ecoregional planning does not miss important, known local features including rare species, vulnerable habitat types (e.g., floodplains), or specific threats.

By connecting core areas using corridors (also known as habitat "linkages"), conservation planners aim to avoid isolation of plant and animal populations inside core areas (habitat "islands") (Noss 1983). The field of conservation biology has shown that as these islands become smaller and more isolated from one another in a "sea" of development, local extinctions increase. Even national parks can effectively become islands if dispersal and migration of organisms is limited by roads and other development (Newmark 1987). In fact, despite the appearance of the region having vast forested landscapes, scientists predict that mammal species here have "latent extinction risk" due to gathering threats from land use and climate change (Cardillo et al. 2006).

What constitutes a core area? Core areas typically are reserves, with complete or restored ecosystems and critical structural elements such as coarse woody debris, old trees, complex understories and soil microfauna that are attained with age (Anderson et al. 2006). However, in our region it is entirely reasonable to consider core areas containing multiple uses including recreation and sustainable forestry. What is a corridor? Corridors are tricky to precisely define because each dispersing species has different requirements, conditions change, and behavior of individual organisms is variable (Berger 2004). However, the important thing is that core areas are interconnected with permeable habitat corridors—habitat that may not be optimal in quality for any given species but meets requirements for movements. Again, it is important to note that a core area need not be protected as a "reserve." Private forestland that is managed sustainably and protects habitat quality does meet the criterion of core in many cases. Likewise, "corridor" or linkage areas may include many land uses, including agricultural landscapes.

From a regional ecological perspective, working forests do not represent a terminal threat. In fact, forest management has protected valuable forest habitat in Maine, neighboring New Brunswick, Quebec, and northern New Hampshire. Vigorous forest-harvesting practices are in many cases a challenge to conservation planning. By contrast, conversion to a built environment—buildings, parking lots and roads—is terminal (meaning it cannot be reversed) and is a potential that exists for broad stretches of Maine's North Woods. There is concern that this broad expanse of relatively unfragmented forest currently stretching across northern Maine could become a habitat island, cut off from surrounding forested areas in neighboring states and provinces by intensifying human settlement outside of cities and towns (exurban growth), while at the same time, within northern Maine the trend towards "wilderness development"—roads, houses, gated communities, and resorts—could cut off within-state core habitat areas from each other. Ecoregional planning is proactive in that it aims to identify important core areas and key areas of connectivity among them, so as to retain options for wildlife in such future development scenarios.

THE GOALS OF CONSERVATION PLANNING IN THE NORTHERN APPALACHIAN/ACADIAN ECOREGION

The goals of conservation planning are three-fold. First, we seek to ensure that a viable portion of each type of ecosystem is represented in areas secured from development. Again, this does not mean that all ecosystems are protected in entirety—only portions necessary to represent their occurrence in areas of habitat extensive enough to ensure viability. Second, we seek to protect habitat for rare species. Third, we seek to ensure adequate habitat for carefully selected "focal species" whose broad spatial requirements serve as umbrellas protecting habitat for many other species and ecosystems (Lambeck 1997).

Generally speaking, The Nature Conservancy (TNC), U.S., and the Nature Conservancy of Canada (NCC) are focused on the first goal, representation. In this region, their goal has been "to maintain all of the region's native species, ecosystems and dynamic processes using a small, but strategically chosen, portion of the landscape" (Anderson et al. 2006: 6). As an example of the wide net that TNC throws, their plan focused on 72 forest types, 20 groups of upland, wetland and tidal ecosystems, and 108 vulnerable species. Through collaboration between TNC and NCC in our region, more than 100,000 sites were reviewed by state and provincial experts and more than 16,000 ground inventory points were contributed by the U.S. Natural Heritage Programs and Canadian Conservation Data Centers (Anderson et al. 2006).

To accomplish similar goals but also include sufficiently connected habitat for wide-ranging and other non-rare species, other conservation groups have championed the "focal species approach." With this approach, the habitat requirements of functionally important, wide-ranging, and other carefully selected species can serve as an "umbrella," capturing an array of habitats that also harbor many other, equally important species. Because medium- to large-bodied mammalian carnivores typically follow prey abundances in multiple habitats and require large amounts of space, they are considered "umbrella" species by conservation organizations. The basic idea is that if you identify and protect enough habitat for a carefully selected suite of wide-ranging carnivores, you will ultimately protect many other species with similar yet smaller habitat requirements. For example, in our region the Wildlands Project (a 2C1Forest partner) has funded, promoted, and conducted research to identify strategies that would include enough habitat for the population processes of wide-ranging focal species (Carroll 2005, 2007; Reining et al. 2006).

COMBINING BIOLOGICAL VALUES AND LEVELS OF THREAT FOR CONSERVATION PLANNING

On the flip side of mapping the biological values described above (the measure of irreplaceability or importance of one given point on the map relative to another) is the task of mapping the levels of threat (e.g., level of protection, likelihood of conversion to development). To map threats, the human footprint developed by the Wildlife Conservation Society (WCS) creates a human influence index by cataloguing a cumulative score of current human activities on the landscape. Human influences such as roads, rail, population, dwellings, energy infrastructure, agriculture, forestry, dams, and mines are assigned scores that are then combined to map the "human influence index" across a region. Wild areas (defined as areas of low human influence) are considered to have a human footprint value of ≤10 on a scale of 0 to 100. Wild areas that are not already protected or secured from development are considered the best opportunity for large-scale biodiversity conservation. Scenarios are then developed to project alternative futures, what we have termed the "future human footprint." The future human footprint projects the future growth of population, roads, and dwellings using trends and geographical analyses. Among other things, it has forecast a doubling of public, residential roads in the ecoregion over the coming 20 years (Baldwin et al. 2007). Further, it has suggested that nearly 1,000 km^2 of pristine lakeshores are likely to be developed.

Under the auspices of 2C1Forest, these strands of research—representation, rare species, focal species, and threats—are being woven together to produce a synthetic, ecoregion-wide conservation plan. It is beyond the scope of this essay to present the results

of this ecoregional planning initiative. Elements have been published in Anderson et al. (2006), Reining et al. (2006) and Baldwin et al. (2007). An interactive mapping Web site for disseminating this information, the Northern Appalachian Conservation Atlas, is online at www.2c1forest.org. Likewise, an ecoregional planning conference to engage stakeholders was held in Montreal in November 2007. For the first time, the ecoregional landscape is being systematically prioritized for conservation action through a broad, collaborative planning initiative.

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What kind of conservation action is envisioned as a consequence of this planning? There are many potential conservation solutions in Maine. The aim is for a future landscape that will look something like the landscape today. Most likely, it will have an expanded, scientifically selected set of reserves connected with each other and with similar reserves outside of Maine. Concurrently, the landscapes in which the reserves are embedded will be managed under the principles of sustainable forestry. All of this will be regulated by the state government, most likely through an expanded and more active role of the Land Use Regulatory Commission. The role of conservation easements will be greatly expanded, through the actions of groups such as the Forest Society of Maine, The Nature Conservancy, and the Maine Coast Heritage Trust. Easements will, by necessity and design, include active forest management.

Our goal is for information to flow from local ecoregional science groups to help guide strategic decisions about where and when to act to have the greatest impact, more proactively and less opportunistically. Because the forests of Maine represent so many of the best ecoregional conservation opportunities, this information will help Maine groups to consolidate political support and raise funds for conservation. For example, these efforts may help Maine groups to expand upon their nationally recognized conservation easement projects, including the West Branch of the Penobscot River, Downeast Lakes, Upper St. John River watershed, and the 100-Mile Wilderness. Groups involved in these successful conservation easement projects have included the Forest Society of Maine, New England Forestry Foundation, Sierra Club, The Appalachian Mountain Club, The Nature Conservancy, state, federal and tribal entities, and private industry. We see these successful collaborations as models of cooperation among diverse stakeholders, which can be expanded to the ecoregional scale (Ginn 2005). The old divides between conservation groups, industry, and government have melted away in the face of mounting threats from global economic forces.

Despite these recent conservation successes, our research to date has illustrated that Maine has a vast amount of land with high conservation value that is not permanently secured from development, whether through public ownership or easements on private lands. Only 2.9 percent of Maine is in reserves secured primarily for nature (highest levels of protection under GAP classifications). An additional 11.9 percent is in lands secured from development, but open to multiple uses including resource extraction (Table 2, p. 72).

It is important to note that none of the groups that are part of this ecoregional planning effort is advocating for Maine being a national park. Ultimately, we want to ensure that the vast forests of the Gaspé, Maine, New Brunswick, and the White, Green, Sutton, and Adirondack mountains are maintained primarily as forests. To achieve this, all management options for maintaining these forestlands are on the table. Realistically, reserves managed only for biodiversity will remain a relatively small portion of the landscape, while multiple use and sound management will prevail throughout under various ownership regimes. Most likely, in Maine, the conservation easement—a partnership between a landowner and the public—will remain the most widely applied tool.

CONCLUSION: WHY MAINE? THE GREATEST CONSERVATION OPPORTUNITIES IN THE ECOREGION

This essay has argued that the state of Maine has the greatest and most strategically located conservation opportunities in the Northern Appalachian/Acadian ecoregion. We are able to say with confidence that in the context of the whole ecoregion, conserving the contiguity and integrity of Maine's forests is among the most important conservation goals in the Northern Appalachian/Acadian ecoregion. Nearly two-thirds (63 percent) of the unprotected forests with lowest human footprint scores (HF score ≤10) in the 4 million km^2 ecoregion occur in Maine (Table 1, p. 71).

For more than a century, the forest-products industry has acted as steward of Maine's forests. Today, these forests and the way of life of people who live and work there are threatened: global pressures on forest-products industry and local economies have forced land use changes threatening, in turn, biological diversity and local control of land use decisions. Such changes have necessitated that entities concerned with the future of the forest set aside differences and come to the table to discuss how best to conserve vibrant ecological and economic communities. Ecoregional conservation planning is a tool for bringing people together to review the science and set specific conservation goals. Our process is an example of this. In 2007 we met with representatives of more than 20 agencies and NGOs in Maine (and more in the other states and provinces) to discuss this research and its implications for their ongoing efforts. If anything, our results support the critical importance of state-level conservation planning work being carried out already in Maine and suggest that many more resources be poured into the state, even from surrounding states and provinces.

Ecoregional conservation planning is about protecting biodiversity within a realistic social and economic framework. Land use management, planning, and policy decisions cannot and will not be based on science alone, but can and must be made better by the application of scientific information and principles. The implementation of a vision this broad and complex will require the participation of many people and institutions. Ultimately, what is needed is an active integration of conservation science within established, or perhaps new, social processes that incorporates the needs of the many stakeholders in the entire four-state, five-province ecoregion in which the state of Maine and its ecological processes are embedded.

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