The Greater Fundy Ecosystem Project: Toward Ecosystem Management

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Introduction

THE GREATER FUNDY ECOSYSTEM (GFE) PROJECT IS AN ATTEMPT to design and implement a plan to manage a landscape on an ecologically sustainable basis. The overall aim is to protect ecological structures, functions, and processes while providing a sustainable flow of goods and services for people. A key element of the GFE project is the integration of a protected area into its regional landscape as a single greater ecosystem. At the core of the GFE project is Fundy National Park, a small (206 sq km) national park located on the upper Bay of Fundy in New Brunswick, Canada.

The Greater Fundy Ecosystem project grew out of concerns, mainly by park managers and academics, that the ecological values of the park were not being adequately protected by managing the park in isolation from surrounding lands. A study of the ecological integrity of the park (Woodley, 1993) documented a history of losses of native species, invasions by exotic species, habitat fragmentation and conversion, and significant doubts that species associated with old-growth coniferous forests, such as American marten (*Martes americana*), would survive in the area.

The problems faced by Fundy National Park occur in many of the world's protected areas. Parks and equivalent reserves are often too small to protect viable populations of many species, especially large vertebrates and seasonal migrants. Most reserves are also too small to accommodate the dynamics of large-scale ecological processes, such as wildfire or insect epidemics. As a result, the integrity of many community types is at risk. In addition, protected areas are subject to a host of other stresses, including edge effects in highly fragmented landscapes; disease transmission from domestic animals, or other effects of introduced species; long-range transport of pollutants; and the effects of tourism, poaching and global climate change (Machlis and Tichnell, 1985; Woodley, 1992).

Character of the Greater Fundy Ecosystem

The Greater Fundy Ecosystem study area has known history of human use since the arrival of European settlers, circa 1750 (West and Sinclair, 1985). Although the area lies within the general area inhabited by the Micmac and Malecite nations, there is no evidence of any intensive human use of the area prior to circa 1750 (West and Sinclair, 1985). It was not until the 1830s that the area was intensively settled. Since that time, most of the GFE area has been logged or converted to agriculture. By 1870, a peak population of 1,262 people was recorded in the Alma Parish, which

comprises the core of the study area. At that time, there were five towns, many farms, dams, and sawmills. After 1870, the area began to decline economically and the population of Alma Parish decreased to 600 by the 1940s (West and Sinclair, 1985). The study area currently has one village, Alma, of 350 residents, with a few farms and cottages scattered through outlying areas. Most of the farms have reverted back to forest, although several old-field sites remain in the area.

Fundy National Park receives approximately 200,000 visitors per year, and has a tourism-related infrastructure of roads and trails, three campgrounds, a golf course, and other facilities. The park is surrounded by crown and privately owned land, used primarily for intensive forestry. Presently, the only other major human activities in the area are tourism developments, and a small amount of agriculture, including intensively managed blueberry plantations. The forestry practice is mainly clearcutting, followed primarily by conversion to single-species plantations of black spruce (*Picea mariana*) or jack pine (*Pinus banksiana*). The plantations are harvested on short-rotation (40-50 years) for pulpwood. An extensive network of forestry roads is now established throughout the area.

There is no absolutely determined size for the Greater Fundy Ecosystem. A detailed biophysical data base exists for an area of 1,050 sq km, but this is a working area and does not define the size of the GFE. The project is an approach to integrating an ecological reserve into its larger surrounding landscape, and the ecosystem approach is the context for it all. There is no attempt to draw a boundary around the 1,050-sq-km area that either limits institutional partnerships or ecological understanding.

Institutional Arrangements

The Greater Fundy Ecosystem project was established in 1991. From the beginning, the project was conceived as a research and monitoring effort to provide the science support necessary to manage an ecologically sustainable landscape. This early research focus was essential to bring all parties together under a common, non-threatening agenda. The project was always conceived as multi-disciplinary, with members from industry, government, and academia. The aim of the GFE project is to be inclusive, and not to be interpreted as aligned with the aspirations of a particular group or agency.

The project is run on an *ad hoc* basis, without a formal constitution. Decisions are reached on a consensus basis, and management is accomplished by a chairperson and management committee. An office for organization and administration of the project was established in 1993, in the Faculty of Forestry at the University of New Brunswick. Funding for the office and a project coordinator comes from Parks Canada and the University. Research funds come from a variety of sources and granting agencies.

The GFE project was instrumental in applying for, and receiving, a "Model Forest grant" from the Government of Canada. The Model Forest program is a large national and international effort by Canada to promote research and demonstrate sustainable forestry. The achievement of a Model Forest grant led the GFE project into a partnership with over 20 other groups to form the Fundy Model Forest partnership. The other groups include forest companies, private woodlot owners, federal and provincial government agencies, universities, and non-government agencies such as environmental groups and clubs. The area of the Fundy Model Forest extends north and west of Fundy National Park to encompass approx-

imately 500,000 hectares. A key partner in the Fundy Model Forest is the Southern New Brunswick Wood Producers Co-op, a cooperative of small private woodlot owners, who collectively own half of the forest lands in the Model Forest.

The ecological research agenda developed for the GFE project was adopted in full by the Fundy Model Forest. The Fundy Model Forest now acts as a key sponsor for research in the GFE and will use the results to develop a larger management plan, expected by 1996.

An Exercise in Ecosystem Management

The Greater Fundy Ecosystem project is an attempt to manage a reserve as part of a larger ecosystem. Ecosystem management is not a new idea. It has origins in a call to integrate biological, physical, and sociological information. Ecosystem management in protected areas was discussed as early as 1932, with the Committee for the Study of Plant and Animal Communities of the Ecological Society of America (Shelford, 1932). Committee members recognized that a comprehensive system of sanctuaries in the United States must protect ecosystems as well as particular species, represent a wide range of ecosystem types, manage for ecological fluctuations (i.e., natural disturbances), and employ a core reserve and buffer approach. The committee also discussed the need for interagency cooperation and public education to make the approach successful. These components remain as foundations for more recent approaches toward ecosystem management. More recently, Agee and Johnson (1988) published an edited volume on ecosystem management in protected areas. The modern application of ecosystem management was pioneered in Yellowstone National Park, and the Greater Yellowstone Ecosystem has been the subject of much literature and debate (see Keiter and Boyce, 1991). In Canadian national parks, the concept developed from the extensive use of biophysical land-use inventories in the 1970s. These biophysical inventories were an integrated examination of the natural world, including wildlife, topography, soils, and vegetation.

"Ecosystem management" is a term applied to the activities of many different agencies, and has been interpreted in a variety of ways. The following principles of ecosystem management are thought to apply to the GFE project. After each statement of principle, the related actions of the GFE project are given:

1. An integrated partnership. Institutional boundaries are never the same as ecological boundaries (Newmark, 1985). Thus, if management is to proceed on the basis of ecological boundaries, interagency cooperation is essential and not simply a desirable thing to do. Interagency cooperation implies some mechanism of joint decisionmaking and some mechanism to allow those decisions to be implemented.

The GFE project is explicitly organized to cross institutional boundaries and not let institutional frameworks influence ecological thinking. Membership in the group includes parks managers and researchers, academics from several universities, government research scientists, biologists from commercial forest companies, and provincial forest managers.

2. The importance of scale. All management issues are scale-dependent, with hierarchically related levels that include genes, organisms, populations, communities, and landscapes. For example, the management of a viable arthropod population may occur at a much smaller scale than management of the long-range transport of atmospheric pollutants. The choice of the appropriate scale at which an issue is to be managed is critical. Fur-

thermore, scales must be constantly related to each other if issues are to be resolved successfully.

The GFE research group attempts to reflect issues of scale through its research agenda (see below), which ultimately will be translated into recommendations for management actions. Research projects are designed around a stress–response framework for several levels in the ecological hierarchy. These levels include gene, organism, population, community, and landscape.

3. A range of land uses over a broad scale. Over the longer term, ecosystem management must accommodate multiple uses at a regional scale, and restricted uses at a site or unit scale. Simply put, this implies that human activities may not be ecologically sustainable if spread over the entire landscape. Our best approach to conserving nature is to plan for a range of land uses: from concentrated human activity, such as towns or plantations, to large areas where humans have little impact, such as ecological reserves. The gradients between these extremes are critical to the conservation of natural areas and ecological integrity.

Parks and other protected areas must be managed as the extreme preservation end of the conservation gradient, and should not be compromised by other land uses. Moreover, all land uses external to protected areas must be compatible or the protection role will not be possible. At the heart of the GFE project is a core protected area, Fundy National Park. The GFE project aims to ensure that management actions on the surrounding landscape are compatible with the protection of the ecological values of the park.

4. A systems context for decisions. Social, political, and environmental issues must be viewed in a systems context and not as isolated issues. This is a basic principle of ecosystem management and it implies that actions, programs, and policies cannot be based on narrow sectoral perspectives.

The GFE research project is a partner in a larger institutional arrangement, the Fundy Model Forest. The Fundy Model Forest contains more than 20 partners, representing a broad cross-section of the community. Issues in the Fundy Model Forest span the range from the ecological to the economic and social.

5. Ecological boundaries are contextual. Ecosystem boundaries are elastic over time. This characteristic can be seasonal, as is found in migratory ungulates moving from summer to winter range, or longer term, such as the distribution of mature-growth forest, beaver ponds, and retreating glacial outwashes.

We have deliberately not drawn fixed boundaries around the GFE. Specific issues must be managed in their own dynamic context. For example, the park has two rivers with runs of Atlantic salmon (*Salmo salar*). One of the rivers was subject to a salmon reintroduction program, in which an old logging dam was removed and juvenile salmon were introduced. For that issue, the spatial boundary is the river basin. However, the adult salmon runs are far smaller than historical levels, possibly due to a fishery by-catch. For this issue of low returns, the ecosystem management boundary is much larger. It includes the Bay of Fundy and Gulf of Maine, where Fundy salmon stock are known to spend time.

6. Integration of data bases. Decisions in the context of ecosystem management are best made from common, integrated data bases. The term "data base" is used in the largest sense and includes the commonly used spatial information on vegetation, geology, landforms, soils, land use, animal movements and rare features. However, the data base should not be limited to biophysical data. It should also include information on cultural fea-

tures, institutional arrangements, economics, and human living patterns. The use of an integrated data base puts all partners in ecosystem management on an equal footing.

For the GFE project, a common biophysical data base exists in a geographic information system, to which all members have unlimited access. A detailed protocol for data storage, acquisition, and cataloguing is being developed. This data base is housed in the GFE office at the University of New Brunswick.

7. Clear and appropriate goals are necessary. Ecosystem management best develops where there are clear objectives for the ecosystem. The setting of appropriate goals is one of the most difficult hurdles faced by groups attempting ecosystem management, in part because of the need to consider humans as part of nature. Human values and needs must be expressed clearly, and the implications then considered if ecosystem management is to be successful. The goals for the GFE project are as follows:

- To identify strategies to maintain viable populations of native species within the Greater Fundy Ecosystem by focusing on species whose population levels are perceived to be at risk.
- To quantify species–habitat relationships for select species in the Greater Fundy Ecosystem so that the information can be used in land-management decisions.
- To examine the environmental stresses in the GFE and understand how they affect valued resources.
- To identify operational management options that will ensure the ongoing sustainability of the Greater Fundy Ecosystem.

8. Monitoring is necessary. For ecosystem management to be successful in protected areas, a comprehensive monitoring plan must be established that examines the state of ecological integrity of the system on a regular basis. Results of the monitoring must be built into a management system so that management practices can be adaptively changed. Despite a general call for monitoring in the recent literature, it is difficult to find ecosystem management projects, in protected areas or elsewhere, where good ecological monitoring programs are in place.

The GFE project is part of a national program coordinated by Environment Canada to monitor the status of ecosystems on an ecozone basis. The first "state of the ecozone report" for the Fundy region is under preparation for release in March 1995. We hope that having an institutionalized requirement to prepare regular reports will provide the necessary impetus to conduct regular monitoring. We recognize the many failures that have occurred in attempts to carry out long-term monitoring.

9. Management must be adaptive. All management involving ecosystems is a long-term experiment that must be continually adapting to changing conditions and new knowledge. Our fundamental understanding of ecosystems is weak and our ability to predict cause-and-effect relationships in ecosystems is imprecise. Therefore, decisions regarding ecosystems must be open to modification on a short time horizon, and management structures must be designed to reflect this necessity.

The above is a management philosophy that we are attempting to instill in the management of the GFE and Fundy Model Forest projects. This will be difficult and will require substantial changes in the approaches to management taken by all partners.

Research Agenda

The GFE research agenda is based upon (1) a fundamental need to first characterize the ecosystem; (2) a stress–response framework that

accounts for specific stressors, such as stand conversion or forestry roads, so they can be mitigated or the impacts avoided; and (3) the need to design a research program that accounts for the inherent hierarchical nature of ecosystems. These factors were used to design a research agenda through consensus, using a series of workshops. The basic elements of the agenda are given below.

Characterization of the Greater Fundy Ecosystem

The consideration of any ecosystem must begin with a basic understanding of the components and dynamics. Good existing data characterizing parts of the Greater Fundy Ecosystem already exist. For example, Fundy National Park has good data on vegetation and bird-habitat relationships. Outside the park, the Province of New Brunswick has a data base used to manage timber resources. In other cases, new data are being collected or data need to be collected at a finer resolution. In all cases, data characterizing the Greater Fundy Ecosystem need to be kept on a common up-datable data base. The main needs for ecosystem characterization are perceived as follows:

- Characterization of past and future landscapes and the dynamics of change, at both the community and landscape levels.
- At a community level, chronosequences of both natural and anthropogenic origin should be determined. This may be done for forest communities, including plantations, thinned stands, and budworm-origin stands as well as non-forest communities such as streams. The purpose of understanding community and landscape dynamics must be to forecast both temporally and spatially.

Research on Mitigation and Avoidance of Known Stressors

In some cases, research needs to be conducted on specific mitigation and avoidance techniques required to ensure that forest management, tourism, and other activities on the landscape are compatible with a sustainable landscape and the maintenance of ecological integrity. General descriptions of such research, with some specific examples, are as follows:

- A common mitigation for forest harvesting now used on the landscape is buffer strips around watercourses. However, there are few concrete data on the best configuration of buffer strips. How can buffer strips be managed to ensure that the integrity of stream communities is protected, including fish habitat? Questions remain on the required width of buffer strips and the types of forest management activities that might be compatible within the buffers.
- What are the specific ecological requirements to support viable populations associated with mature or old-growth forests? These requirements need to be quantified as both structural and functional elements. In some cases, it may be possible to duplicate certain habitat needs by modifying forest harvest techniques, for example by providing cavity trees, brush piles, or understory vegetation.
- Paleoecological studies may be used to reconstruct the past disturbance regime in the Greater Fundy Ecosystem.
- What are the effects of different disturbance regimes on nutrient cycling? The disturbance regimes should include budworm-affected forest, plantations, thinned stands, and mature reference forest. Nutrient input and output studies should be conducted on higher-order

streams and their watersheds, in addition to stand types.

- What patterns of forest harvest on the landscape are best suited to the maintenance of native biodiversity in the Greater Fundy Ecosystem? Because many native populations cannot be maintained in all stand types and ages, their sustainability must be considered at the landscape level.
- What are suitable indicators of environmental quality in the Greater Fundy Ecosystem, including indicators relevant to ecological and resource sustainability, ecological integrity, and biodiversity?
- What are the differences in carbon storage and dynamics in natural versus silvicultural forests and streams in the Greater Fundy Ecosystem, and what are the implications for long-term productivity and the survival of specific populations?
- What are suitable population-habitat models for selected game and indicator species? Experiments should be conducted on the relationships between populations and habitat. For example, forestry could be conducted to manage for a range of stand types and conditions. These conditions should be specified as part of an experiment to provide habitat for selected species at risk.
- What are the implications of increased access allowed by forestry roads on game and wildlife populations within the larger context of exploitation?
- What are the ecological implications of edges created by intensive forestry? How deeply do edge effects penetrate into the unharvested reference forest and what are the implications for habitat quality and quantity.

This general research agenda led to the development of more than 20 research projects. The first formal presentation of the initial results of these projects was given at a workshop in the fall of 1994.

Lessons Learned to Date and Future Directions

The GFE project has been successful in bringing parties together that previously had little dialogue or even an adversarial relationship. Most partners now agree that there has been an enormous increase in the common level of understanding and appreciation of each others' problems and contexts. The use of a research focus and an office in the non-aligned atmosphere of a university was an effective tool in bringing parties together. This accomplishment might have been impossible if left to bureaucracies to develop similar arrangements. The project has also been successful in bringing a research focus to the GFE and the Fundy Model Forest. With the publication of newsletters and word of mouth, there has been an increasing interest in research in the area. The research activity presently occurring has exceeded early expectations.

Despite the widespread adoption of the ecosystem approach to management, it should be recognized there are problems associated with it. First and foremost is the very idea that ecosystems can or should be managed. Ecosystems are complex, self-organizing entities that are dynamic in time and space. They respond to external and internal forces in both predictable and unpredictable ways. To say that humans can manage something as complex as an ecosystem, something of which they are part, is an expression of arrogance. Ecosystem management should be viewed as an effort to think holistically, to understand a range of interactions, and to be unconstrained by institutional boundaries. We can destroy ecosys-

tems, or protect them from destruction, or even moderately influence them. However, managing ecosystems, in the sense of full control, is not possible.

Because the GFE project is only three years old, there is little to report in actual changes to management actions. However, there is an expectation within the GFE and the Fundy Model Forest that the comprehensive management plan under preparation will result in significant changes in the nature of human use of the region. Ultimately, the success of ecosystem management and the GFE project will be judged by what happens on the ground. Most operating examples of ecosystem management have had a difficult time pointing to actual changes in land-based operations that have taken place. We are hopeful that our efforts will result in a long-term management strategy that is adaptive and ecosystem-based, and which will provide a working example of humans living in harmony with the ecosystem that must sustain them forever.

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