

Resource Management Plan Acadia National Park

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INTRODUCTION

This Resource Management Plan (RMP) for Acadia National Park (ACAD) documents the area's diverse natural and cultural resources, identifies threats to these resources, and prescribes action programs designed to manage and protect them. A variety of activities, including baseline inventories, long-term monitoring, research, maintenance, and visitor education, management and enforcement are integrated into a comprehensive resource management program. The RMP serves as the primary plan for addressing critical resource issues and problems at ACAD and in effect is the action plan for other more general Park planning documents.

ACAD was originally established as Sieur de Monts National Monument by presidential proclamation (# 1339) on July 8, 1916. Enduring name changes (Lafayette National Park - 1919, Acadia National Park - 1929) and a constantly changing boundary reflecting sporadic land acquisitions, Public Law 99-420 (1986) finally established the Park's legislative boundary and outlined the Park's role in acquiring further lands and conservation easements. Most of ACAD's land has been acquired through donation, juxtaposing public with private lands and creating a noncontiguous boundary.

ACAD preserves approximately 16,500 hectares in Hancock and Knox Counties, located along the Maine coast in the northeastern United States. It consists of land on Mount Desert Island (MDI) plus portions of and entire outlying smaller islands, a portion of Isle au Haut to the southwest of MDI, and the tip of the Schoodic Peninsula located on Maine's mainland to the east of MDI. In addition, the Park holds over 150 conservation easements in the Penobscot and Frenchman Bay areas. The Park was created to protect the natural beauty of the highest rocky headlands along the Atlantic shore of the United States, and the enabling legislation specifically mentioning the "historic significance" of the area and the unique natural resources which were of great "scientific interest".

Based on the 1997 Park Strategic Plan (National Park Service 1997), the Park mission Statement is: "The National Park Service at Acadia National Park protects and conserves outstanding scenic, natural, and cultural resources for present and future generations. These resources include a glaciated coastal and island landscape, biological diversity, clean air and water, and a rich cultural heritage. Acadia National Park also offers opportunities for high-quality non-consumptive recreation, education, and scientific research."

The ACAD General Management Plan ([GMP] National Park Service 1992) describes the Park's significance as a mix of islands and ocean unequaled along the Atlantic coast of the United States. Natural resources, as described within the GMP, emphasize the Park's unique location as a transition zone between temperate, deciduous, and northern coniferous forests overlaying glacially sculptured granite mountains with interspersed glacially scoured lakebeds and bounded by high rocky headlands. Noteworthy natural resources within the Park include old-growth forests, sub-alpine communities, heaths and marshes, an exceptionally diverse flora, over 40 species of mammals, and documented sightings of over 300 bird species. Significant cultural resources include light stations, 19th century frame buildings, a 80 km carriage road system with 17 stone bridges, and the Islesford Historical Museum.

This RMP was developed through a variety of discussions with Park staff, NPS resource management specialists, federal and State scientists, and faculty at the University of Maine. Earlier versions of this plan (1988, 1991, and 1993) served as the basis for this updated plan. In addition, a Park-scoping meeting was held in November 1995 to review the existing resource management program. Based on that and subsequent internal reviews, the Division of Resource Management developed a 5-year work plan which has now been incorporated into this 1998 RMP. In addition, the NPS has recently completed a strategic plan for ACAD in order to comply with the Government Performance and Results Act (GPRA). A core group of twenty managers and staff at ACAD worked during the summer of 1997 to draft the various components of the Park strategic plan. This updated RMP reflects the long-term goals and action items contained in the Park's most recent strategic plan.

Resource Management at ACAD is focused on protecting the integrity of natural resources, preserving cultural heritage, and maintaining quality visitor experiences. Consistent with current Park strategic planning documents, resource management program activities emphasize: a) development of knowledge about and the identification of threats to Park ecosystems, cultural resources, and visitor experiences; b) application of scientific study in formulating solutions to Park issues; c) participation with other entities in the implementation of appropriate management actions to meet Park stewardship responsibilities; d) compliance with applicable federal, State, and local laws, and; e) communication of the results of our work with others to achieve the Park's mission.

PRESENT RESOURCE STATUS

A. Natural Resource Baseline Information

This overview describes present baseline information for ACAD's important natural resources. Levels of completeness of baseline data are discussed below in reference to standards identified in NPS-75, *Natural Resources Inventory and Monitoring Guidelines* (NPS 1991). A summary of available information for ACAD's major resource groups against these standards is provided in Table 1. Green et al (1992a), summarized the status of knowledge about Park natural resources into a comprehensive report. In addition, the NPS has spent considerable effort to maintain an annotated bibliography of all ACAD published research and natural resource inventory and monitoring reports; this database is computerized, updated annually and available at the Park using Procite software. It is the definitive source for data on the status of the Park's natural resources, and the following summaries are taken from information contained in the most recent update (1998) of the database.

Vegetation Resources

The Park's flora has been described in several publications and voucher specimens exist in both the Park (located at College of the Atlantic) and university herbariums around the country (e.g., University of Maine at Orono, University of Minnesota, Harvard University). Over 1200 vascular species are known from the Park. Terrestrial and aquatic Park-wide rare plant inventories have been completed (Greene 1990; Green et al 1997). Because ACAD is situated along the Maine's coast at the intersection of two major biogeographic regions and contains a topographically diverse landscape, the Park's flora includes many species of international, national, and regional significance. Six plant species at the Park are listed as globally rare. Additionally, nearly 23% of ACAD's vascular plants have been designated as locally rare or State-listed.

Baseline data meeting the Level I Standards for the NPS Inventory and Monitoring program exist for vascular plants through various investigator reports and the greater than 5000 specimen ACAD herbarium. Numerous floral investigations in the area that is now ACAD have been conducted since the 1890's; Greene (1990) compiled a comprehensive species list based on a review of the literature and field surveys. Additional plant research at ACAD has been initiated to determine the effects of air pollutants on various vascular plants (Kohut et al 1997), assess the effects of trampling on sub-alpine species (Foley, in preparation), and fuels and community changes in Park forests (Patterson, in preparation).

The Park's current vegetation maps were developed from aerial photography flown in 1979; these have been digitized and are now available on the Park's GIS. Updated digital vegetation maps, based on color infra-red photographs taken in 1997, are currently being prepared by the Biological Resources Division of the U.S. Geological Survey, as part of the NPS's Inventory and Monitoring program. When this current vegetation map initiative is completed in 1999, the Park will have met the Level I standards identified in the NPS Inventory and Monitoring guidelines.

Level I Standards have not been met for non-vascular plants and on the distribution and abundance of both vascular and non-vascular species.

Fire. Recent research examined fire history for ACAD and MDI dating back 6000 years and found that large fires occurred at 100-150 year intervals. This research creates an extensive database illustrating MDI's fire occurrence for the last several thousand years. Also, the information documents plant communities and fire's role in the ecology of island vegetation communities. The work was completed using pollen and charcoal analyses (see Patterson and Backman 1988). Other historical data on fire occurrence exists (Patterson et al. 1983) including a large fire that burned approximately 1/3 of MDI in 1947; since that time all fires have been suppressed. General fuel inventories for the Park have been completed (Patterson et al. 1983) and permanent vegetative and fuel monitoring programs have been established. Site specific inventories are currently underway and will continue at various locations within the Park. Fire behavior for northeastern plant communities and the utility of certain fuel reduction methods (i.e., role of prescribed fire) is largely unknown. On-going research is addressing these questions.

A Fire Management Officer directs fire management activities in the Park according to the 1993 approved ACAD Fire Management Plan. This plan describes how detailed fuel load information will be incorporated into prescriptions for small scale research burns using recent research data and the excellent long-term (> 50 years) records of climatic data to determine island fuel burning models, vegetative response, and the viability of fire as a management tool. The current level of information, with the exception of short-term fire history, does not yet meet the Level I Standards. This information is necessary for a proactive fire management program.

Threatened Endangered, and Rare Plant Species. As noted above, inventories of terrestrial and aquatic rare vascular plants have recently been completed. Existing information on the presence of rare vascular plants at ACAD meets the Level 1 Standards; however, distribution and abundance data are lacking.

Exotic Plant Species. Nearly a third of all vascular species in the Park are non-native. Purple loosestrife has historically been the principal species of concern within the Park and monitoring and control actions are implemented annually to manage this species. A peer review of the Park's purple loosestrife management program was recently completed (Hiebert et al 1997). Except for this species, very limited data exist on the abundance and distribution of other invasive exotic plants in the Park. In 1998, the University of Texas, El Paso will initiate a NPS funded study to evaluate the relative threat to Park ecosystems from other Park exotic plants.

Animal Resources

Mammals. Baseline data meeting Level 1 Standards exist for most large mammals. Since the 1980s, extensive research on white-tailed deer, coyote, snowshoe hare, river otter, and beaver have been conducted (Dubuc 1987, Harrison et al in preparation, Long 1995, Saeki 1991, Winter 1990). Small mammal populations have been recently inventoried on the Schoodic Peninsula and Park-owned islands (Connery and Mittlehauser in preparation; Mittlehauser et al 1995). While Coman (1987) presents the most up-to-date mammal information on MDI, it still does not meet Level 1 Standards.

Birds. For most groups of birds, baseline data meets the Level 1 Standards; over 330 birds have been sighted in the Park. Birds are now being regularly counted at ACAD during the annual volunteer fall hawk migration and Christmas Bird Counts. Since 1994, breeding landbirds have also been surveyed on MDI. The NPS at ACAD is also a cooperating member of the Maine's Partner's in Flight Program. Park staff annually monitor peregrine falcon reproduction following the extensive reintroduction program of the mid 1980's. In 1997, three pairs of nesting peregrines successfully fledged a total of seven chicks. The location of bald eagle nesting sites within the Park is monitored cooperatively with the Maine Department of Inland Fisheries and Wildlife (IFW). Very limited data exist for forest nesting owls and hawks.

Fish. Only limited information exists about freshwater fish species found at ACAD. While considerable fisheries work has occurred in the Park over the last 100 years, it has been coordinated and implemented by the IFW. Fisheries management has focused on enhancing fish production and harvest and providing recreational fishing opportunities. Stocking records and data from fish inventories and creel surveys are maintained by the MDIFW, but have not been consistently forwarded to the Park. Because the focus of past and present management has been on sport species, baseline data on non-game fish species is virtually non-existent. An NPS funded study to survey freshwater fish in the Park will start in 1998. There is also a paucity of data about estuarine fish species inhabiting the Park. Most recently Doering et al (1995) surveyed adult and juvenile fish in Bass Harbor Marsh, documenting 23 species. Baseline data about anadromous and catadromous species is unknown. In summary, current information about fish do not meet Level I Standards.

Amphibians and Reptiles. A Statewide inventory of reptiles and amphibians has been completed but no comprehensive field survey has been conducted specifically within the Park or on MDI. Coman (1987) summarized herptile field observations and reports for MDI and surrounding islands. Herptile inventories on Park owned islands and the Schoodic Peninsula have documented reptiles and amphibians (Connery and Mittlehauser in preparation; Mittlehauser et al 1995). In addition, a volunteer MDI backyard frog and toad survey has been initiated and is annually collecting baseline data on these taxa (Ressel and Connery 1996). Current information does not meet Level 1 Standards.

Invertebrates. Although baseline data about invertebrates is not required to meet Level I Standards, information about the current status of these animals is important to ACAD. Unlike most units of the national Park system, the Park has a wealth of knowledge about its historic insect fauna. Johnson (1927) and Proctor (1946) conducted invertebrate surveys in the Park for over 27 years and their collection of over 6,500 species represents a very significant database. This collection uniquely documents the invertebrate community at ACAD during the early part of this century. In addition, the Park contains a diversity of Odonates of national significance. White (1986; personal communication, 1997) has documented 101 species on MDI, one of the most diverse Odonate faunas in the world for such a small area so far north.

Aquatic Resources

A variety of water quality data have been collected within the Park and on MDI by Park staff, local universities and private individuals. Park staff have compiled and

computerized data from these studies and monitoring efforts into a historical database for ACAD. Data meet Level I Standards for surface waters, but are deficient for Park groundwater.

The most comprehensive assessment of MDI lake and stream chemistry was conducted by the University of Maine (Kahl 1996; Kahl et al, 1985, Heath et al 1994). In the late 1970's, Park staff in cooperation with the Maine Department of Environmental Protection (DEP), began collecting transparency and surface temperature data for five lakes during summer months in an effort to characterize baseline conditions. Beginning in 1993, the Park expanded the program to a larger subset of lakes to include measurements on pH, specific conductance, oxygen and temperature profiles, alkalinity, color, chlorophyll a, and total phosphorus and total nitrogen (Gawley and Breen 1996). In 1997, the Park received NPS funding to develop a freshwater resource monitoring program. Efforts are currently underway to field test the proposed long-term monitoring methods.

Between 1993 and 1995, the Park conducted weekly summer bacteriological monitoring at Acadia National Park swim beaches (Breen 1995). Monitoring no longer continues, as the results of this baseline study showed that no public health problems existed.

Research to document baseline water quality conditions in Park estuaries have recently been completed for Somes Sound (Doering and Roman 1994) and Bass Harbor Marsh (Doering et al 1995). Habitat mapping, nutrient loading, and water quality monitoring of the Northeast Creek/Fresh Meadow Marsh is planned to begin in 1998.

Since 1995, the NPS has funded research on the presence and ecological effects of mercury in Park aquatic habitats. Baseline data have been collected on mercury concentrations in water, sediment, invertebrates and fish of Park lakes and bogs (Norton et al 1997; Burgess 1997).

Limited data exist on the quality of Park groundwater. As part of the planning for major Park utility improvements, some groundwater monitoring was conducted at Park wellheads and water systems; results indicated that drinking water quality exceeded State regulatory requirements. Data on the hydrogeology of subsurface waters in the Park is virtually non-existent.

A Water Resources Scoping Report for the Park was completed in 1991 and a Water Resources Management Plan will be completed in 1998. These documents, while not providing all the pertinent baseline information, synthesize the most important water resource data and issues for the Park.

Air Resources

ACAD is a Class 1 area under the Clean Air Act and the only NPS Class 1 area in the northeast. The air resources management program at the Park began in the early 1980's and includes monitoring, research, and regulatory interaction with State and federal agencies. The core program includes long-term monitoring for meteorology, ozone, sulfur dioxide, nitrogen oxides, volatile organic compounds (VOC's), fine particulates, visibility, mercury deposition and acid precipitation. This monitoring effort is conducted in cooperation with the NPS, Maine DEP, National Atmospheric Deposition Network, Mercury Deposition Network, Environment Canada, and others. Overall, the

Park has accumulated a significant database for its air resources and this information exceeds the Level 1 Standards.

Due to its status as an area of significant national interest and unique location downwind of major air pollution sources, the Park has been a focal point in regional and State research and monitoring efforts aimed at verifying and quantifying present air quality conditions. The Park has participated in regional air quality research studies with the U.S. Environmental Protection Agency, several northeastern State air resource agencies, Northeast States for Coordinated Air Use Management (NESAUM), and Canadian agencies. Examples of air related research at the Park includes: effects of ozone on native vegetation (Kohut et al 1997), lichens and air quality (Sullivan 1986), water resource baseline data and analysis of acid deposition impacts Kahl et al 1992), acid fog impacts to red spruce (Jagels et al 1989), and mercury contamination in freshwater habitats (Norton et al 1997; Burgess 1997).

Geologic Resources

Geological processes that have influenced the Park landscapes include marine erosion, glaciation, igneous activity, and sedimentation. A variety of academic oriented geological research has been conducted at the Park and relatively good baseline data exists; information meets the Level 1 Standards. Some of the noteworthy studies that have been conducted include Chadwick (1939), Metzger (1979), and Raisz (1929.)

The U.S. Natural Resource and Conservation Service have completed a complete soil survey for MDI. It is part of work conducted to update soils data for Hancock County, Maine. A digital form of these data are included in the Park GIS.

Aesthetic Resources

Jacobson and Dominie (1988) identified historic, scenic vistas and viewsheds from numerous locations in the Park. However, many of these vistas have become overgrown due to lack of maintenance and have degraded the visitor experience. Since the early 1990's, the NPS has begun to document and restore a number of the more high priority historic vistas. The greatest effort to date has focused on the Park's carriage roads. Rieley's (1989) comprehensive work identified the location and description of vistas located along the carriage roads. Approximately, 10 of the most significant identified vistas on the carriage roads have been restored using Park maintenance staff and students from the University of Maine's forestry camp. Some additional vistas along the Park Loop Road have also been restored. The development of a vista management plan is slated for completion in 1998.

B. Natural Resources Condition and Threats to the Resources

Located within a day's drive from many large cities within the northeastern United States and Canada, over three million people visit the Park annually. ACAD has increasingly become identified as a outdoor recreation destination in Maine. This intense demand for public use at ACAD threatens many sensitive habitats in the Park and compromises high quality visitor experiences. Increasing residential development abutting the Park's boundary and air pollution from upwind sources also pose significant risks to natural resources. The following sections describe the condition of ACAD's natural resources and discuss the nature and severity of these and other threats.

Vegetation Resources

No federally listed vascular plants are known to occur at the Park, however, 183 species are either State listed or designated as locally rare (Greene 1990). Six of these are identified as globally rare (New England Wildflower Society, in press). The Park flora includes coastal and sub-alpine endemics, species with disjunct distributions, species at the edge of their range, and species with very narrow habitat preferences. Other than surveys to locate these species, no efforts have been undertaken to monitor or protect these species.

Exotic plants pose a significant risk to native species and ecosystems at the Park. Nearly 35% (283) of the Park's vascular flora are non-native. A number of these species are known to be extremely invasive (e.g., oriental bittersweet, Japanese knotweed, alder buckthorn); other weedy species have recently appeared. All pose direct threats to native plants and communities. At present, the Park is only managing purple loosestrife. Failure to manage other high priority exotic plants could result in major ecosystem impacts. Long-term monitoring and management will need to be implemented for those species posing the greatest risks to Park natural resources.

Increasing visitor use in the Park is impacting vegetation. Plants in sub-alpine habitats on mountain summits and offshore islands and Park bogs and wetlands are particularly sensitive to trampling. Soil compaction and/or erosion, destruction of vegetation, and development of social trails have all been observed in these fragile habitats. Habitat restoration, long-term monitoring and visitor management is needed to protect these areas.

Concentrated visitor use in the front country is also having a negative impact on vegetation. Trampling of soils and plants is occurring along roadside and Parking areas due to crowded overflow conditions in summer. Social trails have also developed at many heavily visited sites. Habitat restoration and visitor management is critically needed to repair degraded conditions.

Park development also impacts Park vegetation. Advance planning is currently underway to upgrade Park utility systems, improve campgrounds, and rehabilitate roads. Rare species surveys and wetland delineations are needed in the project areas to minimize development impacts on vegetation. Landscaping and site restoration using native plants will be needed once construction activities are completed.

Forest succession is eliminating significant Park vistas. Many national register cultural landscapes that had outstanding views of the surrounding countryside and Acadian Archipelago are no longer present. For example, many of the integral vistas originally designed into the Park Loop and Carriage Roads have been blocked by woody vegetation. In order to protect these scenic and in some cases, historic resources, a comprehensive vista management program is needed that incorporates the identification, restoration and long-term maintenance of key viewsheds.

Park watersheds receive some of the highest levels of atmospheric air pollutants in the northeastern United States. Elevated inputs of ozone, nitrogen, and other anthropogenic compounds can profoundly effect forested ecosystems in the Park. For example, changes in nitrogen cycling may shift ecosystem function in nitrogen-limited forests, resulting in changes in forest productivity, composition and health (Vitousek et al 1997). Research on the effects of ozone on native plants at Acadia National Park has documented six species that were injured at ambient ozone concentrations. (Kohut et al 1997). While some work has been conducted at the Park, additional research is needed to fully understand the ecological consequences of nitrogen deposition, ozone, and other air pollutants on Park resources, including vegetation.

The Park contains several communities and assemblages of plants that will be particularly sensitive to global change, in particular the anticipated atmospheric warming. ACAD is at a prime mid-latitude location to exhibit the largest climate-related changes. In Maine, 28% of the woody taxa in the State and many herbaceous species reach either their northern or southern range limits in a broad band that extends through the Park. By being located in this "tension zone", the Park includes a rare mix of plant species unique to the East Coast of North America. The occurrence of northern and southern species at the same location offers the opportunity to evaluate the effects of changes in climate.

ACAD's relatively small size, fire history, the high degree of interface with private lands, and increasing forest fragmentation caused by development outside the Park boundary, may influence browsing effects on Park vegetation. Both white-tailed deer and snowshoe hare reside in the Park, and have the potential to alter plant productivity, succession, composition, and structure. Periodic assessment of herbivore-plant interactions is needed to detect changes in browse availability and utilization by deer and hare and to understand the long-term effects of browsing on plant succession in a post-fire forest environment.

The Park contains a number of plant communities that are considered rare by the Maine Natural Heritage Program and are State Critical Areas. These include old growth pine and red spruce stands, a northern white cedar forests, heaths, and sub-alpine communities. While these communities are not in immediate danger, baseline ecological data on these areas is lacking. Without additional information about these communities, the NPS will not be able to evaluate potential changes in species composition and productivity from acid deposition, air pollution, climate change and increasing Park visitation.

The 1947 fire dramatically altered Park vegetation on MDI. This fire burned approximately 6,880 hectares and removed the dominant spruce forest and provided the disturbance necessary to establish today's birch and aspen forest. It also consumed

much of the thin soils that clung to the mountain slopes and exposed large areas of bare rockface. In order to assess the effects of the fire on Park vegetation and fuels, long-term monitoring is needed.

Wetland plants have been well inventoried; however, baseline data on wetland communities is lacking. Long-term monitoring of wetland species composition, structure, and diversity is needed to evaluate the effects of exotic species, habitat fragmentation, and changing hydrological patterns outside the Park boundary. Without a monitoring program in place, Park managers will never know baseline conditions or what changes if any will be occurring in wetland vegetative communities.

Animal Resources

The large numbers of visitors that are using the Park in summer threatens federally endangered peregrine falcons and bald eagles nesting in ACAD. These species can be negatively effected by human activities and birds in the Park have traditionally nested in heavily used areas (e.g., Precipice). In order to protect the birds, Park staff monitors reproductive activity, closes adjacent hiking trails to public use, and conducts a variety of interpretive programs. The NPS is planning to close offshore islands used by nesting bald eagles and other nesting seabirds during the breeding season. Additional patrols will be necessary to educate the public and enforce these regulations in order to protect these species.

Parklands on the southern shore of Isle au Haut are a major wintering area for the western Atlantic population of harlequin ducks. The duck's status is unknown, but recent surveys indicate that the western Atlantic population is declining from the estimated 1989 population of 400 (Mittlehauser 1991). A petition to list the eastern North American harlequin duck population as threatened or endangered is currently being reviewed by the U.S. Fish and Wildlife Service (USFWS). Research on the ecology of wintering harlequin ducks and a long-term cooperative monitoring effort with the State and USFWS is needed to help protect this species.

Beaver water impoundments have been an ongoing problem at the Park since the 1960s; their activities flood and undermine roads (some of these are historic), flood private property, and in some cases create safety hazards. Although beaver populations at the Park may be declining (due to reduced habitat associated with changes in forest composition following the 1947 fire on MDI), incidents of flooding Park facilities and historic structures remain a significant problem. A large investment by Park staff and resources is annually required to protect roads and trails by installing water control devices (e.g., "beaver dam-foolers"), maintaining culverts, and monitoring beaver activity. A beaver monitoring plan is needed to serve as a guide for managing nuisance beaver in the future. Additional beaver research and monitoring is also warranted to provide the basic ecological information necessary to successfully resolve ongoing conflicts.

Panhandling raccoons and foxes pose ongoing problems along the Park Loop Road and at the Blackwoods Campground. Individual animals have unfortunately learned to associate Park visitors as a source of food and beg, steal, and occasionally threaten them to obtain human food. Easily accessible trash cans, local merchants promoting wildlife feeding, campers leaving food unattended, and inadequate Park staffing all

exacerbate the problem. No visitor injuries have occurred to date, but incidents of damage to tents and coolers are annually reported in the campground. Given that raccoon and fox rabies is rapidly approaching the Park, increases the immediacy and need for active management and resolution of this ongoing problem.

Habitat fragmentation is now recognized as a major threat to wildlife around the globe. Given that Park lands consist mainly of islands, are small in acreage, contain a highly irregular boundary, and are surrounded by private land that is increasingly becoming developed, habitat fragmentation may pose a threat to the viability of some Park animals. With the exception of one study on forest birds, no research on this subject has been conducted at the Park. Without more information, Park managers cannot assess the significance of this issue and what if any actions would be necessary to protect Park animals.

Natural forest succession may also be affecting wildlife populations. After the 1947 MDI fire, white-tailed deer and beaver populations dramatically increased. Since that time, however, both species are at much lower densities in the Park. If forest succession continues toward a mature spruce-fir community, it is possible that deer and beaver populations may decline even further. While these changes are not considered a problem to the NPS, both species are charismatic and extremely popular with the public. Declining or very low populations of these animals may generate some concern from visitors and residents.

Hunting and trapping are prohibited within Acadia National Park. However, these activities do occur on the Great Ponds and at intertidal areas within the Park. Under a 1641-1647 Colonial Ordinance of the Massachusetts Bay Colony, and now codified in Maine Statute, the public has a right to "fish and fowl" on Great Ponds and intertidal areas regardless of ownership. Great Ponds are defined by Maine law as any inland body of water, which in its natural State has a surface area in excess of 10 acres, or any impoundment with an area greater than 30 acres. Because of the complexity and potential controversy over jurisdiction on Great Ponds and intertidal areas within the Park, the NPS has not taken action to stop hunting and trapping on these areas. While management concerns over hunting and trapping primarily focus on visitor safety, visitor experiences and aesthetics, the effects of these activities on harvested species (in particular, furbearers and waterfowl) are unknown. Baseline ecological data on the species subjected to harvesting are also not generally available. While hunting and trapping activity is limited in the Park, no data exist about harvest rates or hunter effort.

Native fish and aquatic biota are threatened by stocking programs and self-reproducing populations of exotic and hatchery reared native fish. The Maine IFW regulates and manages freshwater fishing at the Park with the goal of promoting sport fish production. In addition to stocking, State biologists have also manipulated prey species as a management tool to enhance populations of game fish. To date, the NPS has had limited involvement in fisheries management programs at the Park. The effects of stocking and non-native species on native aquatic organisms are not known. There is also a paucity of information about non-game fish, native sea-run brook trout, and other anadromous and catadromous species. Such information is critical to preserve and protect native aquatic ecosystems for current and future generations.

Sea caves are among the most geologically and ecologically unique resources at Acadia National Park; they likely contain species and assemblages of organisms found nowhere else within the Park. Biological data specific to intertidal communities at the Park are limited. Sea cave organisms face threats from visitors, because these areas are accessible at low tide. With annual visitation at three million and increasing at a rate nearing 7%, recreational use of the Park's rocky shoreline is expected to expand with unknown consequences. Trampling and collecting by humans is suspected as a major factor leading to the decline of some species in Anemone Cave. The National Park Service stopped promoting visitation to the area in 1970. Other possible disturbances, such as oil spills, also threaten these habitats and communities. In order to protect these important and sensitive resources, baseline data about sea cave organisms is needed and methods developed to be used to evaluate their status and condition in the future.

The status of other native animal species (i.e., amphibians, fish and insects) is largely unknown. Baseline surveys have been conducted for most of the large mammals and birds, but inventories remain to be completed for most of the other animal taxa. The absence of inventory data for these groups makes many management decisions difficult. In addition, recommended long-term monitoring of those species where inventories and/or research have been completed has generally not been implemented due to Park staffing and funding constraints.

Integrated Pest Management

A number of forest insect pests and diseases have affected Park forests. Gypsy moths have had only minimal impacts on Park vegetation in the early 1980's, although their populations during the early 1990's were monitored in cooperation with the U. S. Forest Service. Native forest insect pests, such as spruce bark beetle, spruce budworm, and hemlock looper have had periodic outbreaks within the Park and caused some injury to trees. Only limited qualitative data is available about these infestations, so accurate assessments of their ecological impact are unknown. Many Park historic structures are infested with carpenter ants and mice. These are treated in accordance with NPS policies and follow IPM principles. Yellowjackets, honeybees, bald-faced hornets, and paper wasps are an annual summer nuisance to Park employees and visitors. Biting flies are a nuisance throughout summer and are managed with fly repellants.

Air Resources

Based on years of data on fog chemistry, annual ozone and mercury health advisories, and 15 years of NADP precipitation chemistry, it is clear that ACAD is the recipient of some of the highest levels of atmospheric inputs in the northeastern United States. Modeling of regional emission source data and back trajectory analysis, indicate that airborne pollutants carried from the eastern mid-Atlantic and coastal New England States and northern Midwestern/Great Lakes (including Canada) industrial corridors significantly affect Park's ecosystems. Nitrogen, ozone and mercury are among the pollutants of most immediate concern to the Park. The imminent deregulation of the electric utility industry raises the additional concern that deposition of nitrogen compounds and mercury may increase in the future. New EPA regulations will possibly favor operation of dirtier coal-fired power plants in the midwest and mid-Atlantic States, leading to more long-range transport of pollutants to northern New England.

Park ecosystems are extremely vulnerable to change from chemical environmental perturbations. Strong marine chemical and meteorological influences, thin soils, low natural buffering capacity, frequent bedrock exposure and cold climate contribute to the highly fragile and sensitive character of the Park. Atmospheric inputs are deposited in both wet and dry form, with a significant contribution from coastal fogs. Air pollutants are currently affecting Park surface waters, native plants, fish, and bald eagles.

The average rainfall pH at the Park is 4.6; fog pH commonly ranges below 4. These values are among the most acidic of any national Park. Episodic acidification of Park streams has been documented. However, little is known about the actual effects of increased acidity on aquatic systems and organisms at the Park. Research elsewhere has documented that acid deposition may deplete soil nutrients and promote soil acidification and increase the concentration of strong acid anions and ionic aluminum in soil solution. These processes can lead to an increase in the incidence and severity of soil aluminum toxicity and nutrient imbalances in forest tree species. Eutrophication of estuaries and coastal waters is also a well-documented and understood consequence of increased deposition of nitrogen compounds.

Elevated levels of ozone are known to cause human health problems. In response to high ozone concentrations at the Park during summer (greater than .081 ppm), the NPS has routinely issued public health advisories for visitors and local residents. Recent research at the Park identified six native plant species injured by ambient conditions of ozone. Although these species exhibited visible symptoms to ozone exposure, no information is known about the genetic and community effects of long-term ozone stress.

Mercury concentrations in aquatic biota at the Park are among the highest in the nation. This discovery eventually led to the release of a mercury human health advisory for the State of Maine. Atmospheric deposition is believed to be the important source of mercury in the northern United States. Although the Park is located in rural Maine, accumulation rates of mercury in sediment at the Park are comparable to those reported from urban lakes. Presumably these high concentrations reflect deposition of mercury from upwind sources. Given that limited research and monitoring have been conducted at the Park, the full ecological and public health ramifications of elevated mercury contamination are not known. Information is critically needed about mercury cycling in terrestrial and aquatic habitats, food chain transfer and magnification of mercury, and the ecological responses of wildlife that feed on mercury contaminated organisms.

Sulfur dioxide/sulfate emissions contribute significantly to visibility impairment and to acid deposition. Visibility data collected since the early 1980's indicate visual air quality at the Park is among the poorest in the national Park system. Although this time period is too short to determine a trend, it is generally believed that standard visual range at Acadia has been reduced dramatically over the past several decades and thus represents an existing adverse impact.

In addition to impacts from the long range transport of pollutants several hundred miles away, there is concern with the continued development of major and secondary emission sources within the State. The possible development or modification of fossil fuel or biomass electrical power plants and large paper mills, within 100 km of the Park has been proposed for different areas of central Maine. The Park needs to continue working closely with the NPS Air Resources Division and the Maine DEP to evaluate

these proposals and their potential effect on Park resources, as required in the Clean Air Act's regulatory authority for Class I areas.

Aquatic Resources

Concern for the protection of drinking water sources and the ecological, aesthetic and recreational attributes of water resources on MDI and at the Park has been a dominant theme for Park managers, State agencies and local communities for nearly a century. Today, air pollution and nutrient loading associated with waste water systems and atmospheric deposition of nitrogen pose the greatest threats to Acadia National Park water resources.

As described in the preceding section, the Park's water resources and watersheds are threatened by an array of atmospheric inputs: acids, sulfur, nitrogen, and toxic contaminants such as mercury, lead, and chlorinated organics. These chemicals are deposited in both and wet dry form, with a significant contribution from coastal fogs. Air pollutants are undoubtedly affecting Park surface waters. Episodic acidification has been documented in Park streams, with the causes known to be both anthropogenic (sulfur and nitrogen compounds), and natural (coastal marine influences that flush compounds into streams). However, the effect of these acidic events on aquatic biota are unknown. Toxic air contaminants and their bioaccumulation in the food chain are also of major concern. With the exception of mercury, which is under investigation, the magnitude and ecological consequences of other atmospherically derived contaminants in Park waters is unknown. Additional research and monitoring is needed to better understand lake and watershed ecosystem conditions with respect to potential stress from continued atmospheric deposition of both acidic and toxic substances.

The dilute clearwater, low alkalinity Park lakes are susceptible to eutrophication from only modest increases in phosphorus and from modest increases in acidity. Both changes would be detrimental for biological communities, aesthetics, and the visitor experience. Human introductions of "extra-watershed" phosphorus occur as septic wastes, yard fertilizer, and as runoff from disturbed shoreline soils. With increasing residential development outside the Park boundary, there is a potential for additional introductions of phosphorus to lake and pond nutrient budgets. Park estuaries (Bass Harbor Marsh and Northeast Creek/Fresh Meadow Marsh) and other nearshore coastal waters are also threatened by human-altered nitrogen cycling. In these waters, primary production and eutrophication are controlled by nitrogen inputs. Given existing air pollution levels and expanding residential development outside the Park boundary, anthropogenic nitrogen loading from atmospheric deposition and septic systems represents a significant threat to Park marine waters. Eutrophication can have substantial effects on ecosystem function and composition in estuaries, resulting in oxygen depletions, loss of biodiversity, and increases in nuisance algae.

For over 20 years, the Park has been concerned about the impacts of the Worcester landfill in Southwest Harbor on the Bass Harbor Marsh. Recent research by Doering et al (1995) found that there are some indications that this estuary may be tending toward eutrophied conditions. The investigators quantified relatively dense zones of macroalgae containing low abundance of fish communities, benthic species that are indicative of nutrient-rich conditions, and high nitrogen loading from the Marshall Brook freshwater sources (which are downstream of the landfill). Given that these data represent the only

comprehensive baseline for this system, future monitoring will be necessary to determine additional ecological trends.

Five of the Park lakes serve as public water supplies for local communities and need to be managed to protect water quality and public health. Potential threats to these waters are from nutrient loading (associated with increased development in the watersheds of these lakes), chemical contamination (vehicle and motor boat fuel spills), bacterial contamination (inadequate or failing human waste disposal facilities), and sedimentation (soil erosion from shoreline trails).

There are no point sources which discharge upstream of or directly to, freshwaters within Park boundaries. However, at least eight point sources on MDI discharge treated wastewater to marine and estuarine waters in close proximity to Park boundaries: Bar Harbor (3), Otter Creek, Northeast Harbor, Somesville, Seal Harbor, and Southwest Harbor. These discharges contribute to shellfish flat closures over most of the southern and eastern sides of MDI and may affect aquatic ecosystems. Some Park wastes are tied into municipal treatment facilities and therefore may be contributing to these problems.

Geologic Resources

In general, coastal geological processes do not pose problems to the Park because most visitor facilities are located outside the immediate coastal zone and shorelines are comprised of parent material that is not susceptible to significant erosion from coastal storms. Sand Beach, a small calcareous beach has fluctuated in width due to prevailing climatic and marine hydrologic events; however, there has been little change in beach structure and dynamics during the last twenty years.

The greatest immediate threat to Park geological resources is soil erosion caused by visitors. With approximately three million people annually visiting the Park, soils and vegetation at a number of facilities, Park trails, and sensitive habitats have been disturbed. For example, social trails have developed and soil erosion has occurred at Cadillac Mountain, Otter Cliffs, Compass Harbor, and Little Moose Island.

The shallow soils which overlay MDI's unique geology offer relatively little buffering capacity from acid precipitation. The continuing deposition of various atmospheric inputs could adversely impact soil buffering capabilities and lead to changes in soil biogeochemical processes and nutrient cycling in forested watersheds of the Park. In addition, the fires of 1947 burned entire watersheds in the Park, likely resulting in dramatic decreases in soil organic matter in many areas, and nearly complete consumption of standing biomass. The fate of various atmospherically derived pollutants prior to the fire (e.g., mercury and lead) may be affected differently in burned and unburned cachmentents. The resulting changes in soil chemistry would also likely alter the chemistry and mobility of chemicals deposited since the fire. Further research on the effects of the 1947 could help to explain patterns of toxic burdens in Park soils, watersheds and biota.

Global change represents a more long-term issue of concern to Park managers. ACAD is located in the region, where models unanimously predict the largest climate change to be exhibited in the future. Climate change may result in altered moisture and chemical

regimes, potentially leading to changes in forest communities and to altered nutrient cycling. These changes may also lead to shifts in species distributions. As noted earlier in this chapter, numerous plant species are at the edge of their northern or southern ranges in the Park and could be negatively affected by global warming. In response to global warming, predictions of future sea level rise are variable. Intensely used landforms at the Park, such as Sand Beach, may be particularly sensitive to accelerated sea level rise. Given that sediment supply at the Park is limited, the pocket beaches may be lost. Salt marshes may also be similarly effected, because they may not have enough time or capability to respond to rapid (in geological terms) changes in sea level.

Aesthetic Resources

Crowding, traffic congestion, conflicts among user-groups, and degradation of natural resources are threatening the quality of visitor experiences at Acadia National Park. With annual visitation close to three million, the Park has increasingly become identified as a mecca for outdoor recreation. Visitation to the Park has increased dramatically over the last 20 years and some visitors have reported altering their use patterns to avoid the crowds. Protecting high quality visitor experiences in the frontcountry and backcountry, given the increasing demand for recreation, is one of the Park's most significant challenges.

Development activities outside the boundary also pose risks to the quality of the scenic landscape visible from within the Park. Given that the area within the permanent Park boundary falls within 11 communities, it is imperative that Park managers work cooperatively with surrounding jurisdictions and other partners to protect scenic resources. The Park's discontinuous parcels and easements, irregularly shaped boundary, and lack of adequately surveyed and marked boundary lines further complicate the pressures placed upon Park resources by developers and adjacent landowners.

C. Cultural Resource Baseline Information

The charts on the following pages summarize the status of Cultural Resource Baseline information for ACAD. The Cultural Landscapes and Ethnographic Resources charts have been left blank because no study has ever been conducted at the Park in these two areas. Please refer to the NPS Cultural Resource Management Guideline (NPS-28), Chapter 2, Pages 3 through 22 for a complete discussion of the purpose and contents of these documents.

RESOURCE MANAGEMENT PROGRAM

Overview Of Current Programs And Needs

Acadia National Park's resource management program faces a number of increasingly complex and challenging issues. These include: 1) air pollution; 2) accelerated rates of freshwater and coastal marine eutrophication; 3) impacts of recreation on visitor experiences and natural resources; 4) protection of Federal and/or State listed rare species and communities; 5) restoration of disturbed habitats and cultural landscapes; 6) exotic plants; 7) nuisance wildlife; 8) increasing habitat fragmentation adjacent to the Park; 9) poor condition of historic facilities, roads, and trails, 10) significant cataloging backlog of natural and cultural history museum objects and, 11) lack of baseline information about Park natural and cultural resources.

Given these issues and the legislative mandates of the NPS to maintain native ecosystems and protect cultural heritage for the present and future enjoyment and education of the public, ACAD's resource management program will focus on the following fundamental tasks:

- 1) inventory Park natural and cultural resources sufficient to serve as a baseline of information about the historic and current status and condition of the resources that the NPS is charged with protecting.
- 2) develop and institutionalize a program of long-term natural resource monitoring sufficient to understand natural processes and detect and clarify human-induced factors that may be contributing to changes in ecosystem structure and function.
- 3) develop and institutionalize a long-term visitor monitoring program sufficient to detect and understand changes in numbers and patterns of visitor use and visitor behaviors, and identify changes that are inappropriate or degrade visitor experiences.
- 4) establish an active research program that characterizes the function and structure of Park ecosystems, identifies threats to natural processes and visitor experiences, and evaluates alternative management actions to resolve natural resource and recreational issues.
- 5) create an information management system that allows Park staff, the scientific community, and other interested parties to easily retrieve data about Park natural resources and visitor use.
- 6) implement scientifically-based and NPS policy derived mitigation actions to resolve issues and threats, improve degraded conditions, and maintain Park ecosystems, cultural landscapes, and appropriate visitor experiences.
- 7) catalog, curate, and make available to researchers objects in the Park's museum collection.

- 8) develop and institutionalize an in-house capability to monitor the condition and repair historic structures, roads, and trails.
- 9) Implement and institutionalize a resource protection and education program to reduce visitor impacts on Park natural and cultural resources.

The resource management program at the Park has expanded considerably over the last decade and is now guided by a professional staff (see Table xxx). Natural and cultural resources management have been combined within the last year into a separate Division reporting directly to the Deputy Superintendent. The 1998 base-operating program of the Division is approximately \$400,000. Staff working in other Park Divisions also conducts resource protection, maintenance and education activities.

Yet despite many accomplishments and program growth, current funding levels at the Park do not provide for the resolution of critical resource threats. Important baseline studies remain to be completed, research recommendations cannot be implemented, and except for air quality, no long-term natural resource monitoring has been institutionalized. Despite having diverse nationally significant cultural resources, the Park does not have a professional cultural resource specialist on staff; only a museum curator serves to protect part of the valued cultural heritage at ACAD. In addition, funding and FTE constraints have limited a number of key natural professional staff to only part-time status (e.g., GIS specialist, compliance biologist). The Park also does not have a water resource subject-matter expert on staff. Given the complexity and significance of water-related issues and threats at the Park, a full-time aquatic biologist or hydrologist is needed. Funding constraints also hamper the implementation of a proactive and more effective resource protection and education program.

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