

INVENTORIES OF SELECTED FLORA AND FAUNA ON 10 ISLANDS OF ACADIA NATIONAL PARK, MAINE



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Inventories of Selected Flora and Fauna on 10 Islands of Acadia National Park, Maine

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Introduction

Current, accurate, and comparable resource inventories are fundamental to understanding the intricacies of biological diversity (Wilson 1988, Heyer et al. 1994) and are a necessary component for successful stewardship of protected areas (Johnson et al. 1984, Likens 1989, van Riper et al. 1990, Goldsmith 1991, Williams 1994). This need for knowledge regarding the condition of natural resources has long been recognized (National Park Service 1992a) and has been reflected in legal mandates and management policies since the inception of the National Park Service (NPS). Despite these longstanding directives the NPS has acquired only limited information about the natural resources under its stewardship (Ruggiero et al. 1992). The lack of basic inventory information prevents natural resource managers from measuring population or environmental changes (Heyer et al. 1994).

In 1992, the NPS began to address the need for increased efforts in inventory and monitoring of natural resources by publishing the Natural Resources Inventory and Monitoring Guidelines (NPS-75) (National Park Service 1992a). A partnership was formed between the NPS and the Center for Field Research (Earthwatch) to improve the understanding of park resources. The objectives were to provide the NPS with a labor force of Earthwatch volunteers to facilitate inventory and monitoring projects, and to provide field research experience to elementary and secondary school teachers serving as volunteers to help broaden and enliven their science teaching. Acadia National Park (ANP) was the first park to participate in this partnership.

Acadia National Park preserves approximately 14,000 ha and is composed of lands in Hancock and Knox Counties in mid-coastal Maine (Figure 1). The majority of the park consists of lands on Mount Desert Island (MDI) (12,000 ha), with lesser amounts on Isle au Haut (1,200 ha), Schoodic Peninsula (800 ha), and 12 small islands (300 ha) in the Gulf of Maine.

Considerable research has been conducted in ANP and the associated region since the late 1800s. A summary of scientific work (Greene et al. 1992) conducted within the park identifies available inventory information and identifies gaps in knowledge for many natural resources. Whereas much is known about Mount Desert Island, the flora and fauna on small park islands was unknown. In fact, many of these islands had never been visited by park biologists before this study. This lack of information was of particular concern to managers because islands often have unique physiography, habitats, and ecological isolation, and may harbor rare species, species of concern to management, and sensitive ecological zones deserving special protection (Lack 1971). The popularity of sea kayaking and small boating in the waters near the park, and the lack of information regarding visitor use, also has generated concern among park managers about the vulnerability of these islands to the effects of humans.

The goal of this project was to provide park managers with resource information to facilitate informed management of park islands.

Objectives of this island inventory project were to:

1. Develop species lists of vascular plants and non-avian terrestrial vertebrates, quantitatively describe forests, and provide photographic documentation of the islands' vegetation and landscapes;
2. Identify state or federally listed endangered or threatened species, non-native species, and other species or habitats of management concern;
3. Qualitatively assess effects of humans; and,
4. Design and implement methods that will facilitate expanded future inventory efforts.

STUDY AREA

Our inventory focused on 10 small islands on which over 95% of each island is federally owned and administered by the NPS (Figure 1, Table 1). Historic and incidental information for Bar Island in Frenchman Bay is included in selected sections of this report, although minimal field work was conducted on this island during this study.

Thousands of islands are scattered along the Maine coast and many share common names. To differentiate between islands with identical names, the state has assigned each a unique Maine Island Registry number (MIR#). Throughout this report we use these numbers to differentiate between Bar Island in Somes Sound (MIR# 59-265), and Bar Island in Frenchman's Bay (MIR# 59-194). Other park islands are referred to by name.

The geographic position of the study islands in relation to the mainland and other islands varied greatly (Figure 1). Little Moose and Pond Islands are attached to the mainland by tidal bars; both Bar Islands (MIR# 59-265 and 59-194) are attached to MDI; Baker Island, The Hop, and Western Ear are attached to other islands by tidal bars; Heron, Schoodic, Bald Porcupine, and Sheep Porcupine Islands are isolated from other lands.

Sand beaches are rare on the islands, with cobbles, ledges, and cliffs predominating. Soils are primarily glacial in origin, thin and acidic. Maximum elevations range from 9 to 58 m.

ANP has a cool, moist, maritime climate, with temperatures ranging from a high of 41°C in summer to a low of -9°C in the winter and a mean annual temperature during 1941 to 1980 of 8°C. Precipitation during this period averaged 123 cm annually, with snowfall averaging 1.5 m (Patterson et al. 1983). Compared to the mainland, island temperatures are cooler in summer and warmer in winter, and snowfall is reduced because of the moderating effect of the ocean. In summer the islands are frequently shrouded in thick fog. Constant dampness, combined with the effect of cold ocean water, creates conditions on the islands similar to those in more arctic regions and affords a habitat for arctic plants (Hill 1919).

DESCRIPTIONS OF ISLANDS

Maps of each island are located in Appendix A (Figures A1 through A10).

Baker Island

Baker Island, nearly circular with a 0.8 km diameter, encompasses 68 ha. and is located 5 km south of MDI. At extremely low tides, the island is connected to neighboring Little Cranberry Island by a bar approximately 1.6 km long. The northern portion of the island contains extensive fields. Most of the island is forested with dense red and white spruce (*Picea rubrum*, *P. glauca*). Brackish ponds are on the southwest and northeast corners of the island and are surrounded by wetlands. The interior of the island contains a few temporary streams, and areas of small, forested wetlands are common on the western side.

The Baker Island Lighthouse, built in 1828, sits at the island's center and is still operational. Four other buildings constructed in the mid-1800s are on the island, including one private summer residence. Foundations of additional structures, a cemetery, and remnants of stone walls can be found throughout the island, reflecting its history of human use.

The park's General Management Plan (National Park Service 1992b) designates that the middle of the island surrounding the lighthouse will be managed to protect cultural resource values. The remainder of the island is to be managed to preserve natural resources and ecological processes. A cultural landscape report for Baker Island is currently being developed (I. Mancinelli, College of the Atlantic, pers. comm.). Danskin (1994) identifies management alternatives for maintaining the cultural landscape surrounding the lighthouse and historic residence.

The rocky shoreline lacks a good harbor; however, a safe anchorage and landing site exists on the north side of the island. The NPS conducts daily tours of the island in the summer.

Bald Porcupine Island

Bald Porcupine Island is 12.8 ha and is located in Frenchman Bay 1.6 km south-southeast of Bar Harbor. A breakwater extends from the western shore. The island is densely forested with spruce and contains patches of eastern hemlock (*Tsuga canadensis*) and northern white cedar (*Thuja occidentalis*) as well as mixed hardwoods at the inland summit. The island has been designated as a Maine critical area because a sea cave on the island supports an unusual luminescent moss (*Schistostega pennati*) found only in a few locations in Maine, and because the forests on Bald Porcupine Island have been designated as a research natural area by the Society of American Foresters (Maine Natural Areas Program 1994a). Bald Porcupine is a steep island with sheer 30-40 m cliffs marking the south and east sides. These cliffs are used for nesting and perching by black guillemots (*Cepphus grylle*) (Folger 1986). The cliffs also may provide suitable nesting habitat for federally endangered peregrine falcons. A pair of federally threatened bald eagles (*Haliaeetus leucocephalus*) nested on the island from the 1960s to 1984. The nest reportedly fell from the tree in 1985 and the pair moved to nearby Sheep Porcupine Island (Jacobi 1994).

Access to the island is difficult. When wind is light and from the south or southeast, access can be gained by landing in the lee of the breakwater and passengers can scramble up a steep trail onto the island. At high tide, no flat shoreline is exposed and securing a small boat on shore is extremely difficult.

Bar Island (MIR# 59-194)

Bar Island, a 27 ha island connected to MDI at low tide by a gravel bar, is 0.5 km north of Bar Harbor. The gravel bar provides easy access to the island at low tide, and many people and vehicles cross daily. A dirt road connects the bar with a meadow in the center of the island. The remainder of the island is dominated by a diverse conifer forest.

One private residence is located on the south side of the island and is occupied year-round. Scattered bricks on the southwest side of the island suggest historic human occupation.

Bar Island (MIR# 59-265)

Bar Island is a 2.7 ha island in the northern end of Somes Sound and is connected to MDI at low tide by a gravel bar. The island supports a number of large, old, eastern white pines (*Pinus strobus*) and has been part of a bald eagle nesting territory since, at least, 1969. It supported an active eagle nest in 1969, 1992, and 1993. Thick shrubs grow along the southern perimeter of the island; the central portions are forested with mixed hardwood-conifer forest.

Evidence of historic human habitation is in the form of a cement cistern and pipes that extend from the center of the island. Access to the island can be gained by the sand bar at the northern end of the island or via boat at a number of sites.

Heron Island

Heron Island is a low, flat, and treeless island 7 km southwest of Swans Island and 1.6 km southeast of Marshall Island in Jericho Bay. Vegetation on this 21 ha island is composed primarily of grasses, low shrubs, and herbs. A wet depression occurs on the southern end of the island.

Heron Island is a registered Maine critical area (Maine Natural Areas Program 1994a) for nesting common eider (*Somateria mollissima*) and historically has been used as a nesting site for great blue herons (*Ardea herodias*), black-crowned night herons (*Nycticorax nycticorax*), ravens (*Corvus corax*), and osprey (*Pandion haliaetus*) (Norton 1907, Allen and Norton 1931, Townsend 1975). Now many species of seabirds nest on the island, including herring gulls (*Larus argentatus*), great black-backed gulls (*Larus marinus*), common eider, black guillemots, and Leach's storm-petrels (*Oceanodroma leucorhoa*). Harlequin ducks (*Histrionicus histrionicus*), a candidate species for federal listing, winter around the island (Mittelhauser 1991).

Anchorage and landing options are poor. The best landing sites are on the north and west sides of the island on cobble beaches.

The Hop

The Hop is a small, 3.3 ha island in Frenchman Bay that is connected at low tide by a gravel bar to Long Porcupine Island. Dense spruce forest covers the northern half of the island, the mid-section consists of dense patches of shrubs, and the south is covered with tall grasses dotted with occasional clumps of spruce. The island was used by nesting seagulls in the 1930s (Allen and Norton 1931, Mendall 1934, Gross 1945) and currently is used as a perching site for bald eagles. High cliffs mark the south and eastern shores.

Landings are best made on the northern side of the tidal bar connecting The Hop to Long Porcupine Island.

Little Moose Island

Little Moose Island is a 22 ha island that lies on the southern point of Schoodic Peninsula and is connected to the mainland at low tide by a gravel bar. Exclusive of the forested areas of spruce, balsam fir (*Abies balsamea*), and jack pine (*Pinus banksiana*) that grow along the

northern section, the island is predominantly covered with low shrubs and matted herbs. Only meager amounts of fresh water are on the island in scattered pools and depressions. The island is a registered Maine critical area (Maine Natural Areas Program 1994a) as a rare plant station supporting many state-listed rare species.

Access to the island from the southeast end of the Schoodic Peninsula is easily attained by foot via the tidal bar at low tide. Many protected coves along the north side offer safe passage by canoe or small boat over the shallow flats.

Pond Island

Pond Island is a small island, 5.8 ha, located 0.5 km west of Schoodic Peninsula, thickly forested with spruce and fir and small patches of paper birch (*Betula papyrifera*) that surround a sphagnum bog in the central portion of the island. The island is connected to the mainland by a cobble bar at low water on the southern end of the island. A partial bar exists to the east, however, a strong current often rips through this area creating a fast, deep stream, which can make crossing difficult. Protected coves on the southeastern shore facilitate easy landings by small boat or canoe during most tides.

Schoodic Island

Schoodic Island is a long, thin, 27 ha island, located 1.2 km southeast of Schoodic Peninsula. Three-quarters of the island is covered by shrubs and herbaceous vegetation. A small white spruce forest at the southern end of the island covers approximately one-quarter of the island. The island is a mix of hills on the northern end, brackish wetlands in the middle, and rolling forest to the south. Bald eagles have nested on this island since 1965 (Jacobi 1994). The island has been used as a nesting island by seabirds since at least 1930 and is a designated Maine critical area for common eider (Maine Natural Areas Program 1994a).

No steep cliffs are on this island; however, landings can be difficult because of large, rolling swells. The best landing sites are on the cobble beaches on the north and northwest sides of the island in several relatively protected coves.

Sheep Porcupine Island

Sheep Porcupine Island lies 1.1 km east-northeast of Bar Harbor in Frenchman Bay and encompasses 9 ha. The island is forested with a dense mixture of spruce, birch, poplar (*Populus* spp.), and maple (*Acer* spp.). The topography of Sheep Porcupine Island is typical of glacially formed islands in the area with steep, rocky cliffs on the south and east sides.

Bald eagles have nested on the island since 1965 (Jacobi 1994). The best landing site is on the cobble beach on the western shore.

Western Ear

Western Ear is a 9 ha island in Penobscot Bay, and is connected at low tide by a gravel bar to another much larger island, Isle au Haut (2600 ha). Western Ear is forested with red and white spruce throughout. Small patches of grass and scattered shrubs exist on the northwest corner and in portions of the forest understory. The south shore is sheer cliff, the eastern and western shores are marked with strewn boulders and ledge. The area near Isle au Haut and Western Ear is the most important wintering area of harlequin ducks in the Western Atlantic (Mittelhauser 1991). The best landing site is on the northwest side of the bar that connects Western Ear to Isle au Haut.

BACKGROUND/APPROACH

Before field work we searched the literature to compile available historic information for each study island. Also, we identified inventory methods appropriate for each resource studied, while accounting for the varying abilities of our field assistants. Field work was conducted May-September 1992 and 1993 (Table 1).

We inventoried vascular flora, forest communities, and vertebrate fauna except for birds and bats. We recorded information regarding colonial nesting seabirds on park islands but did not conduct quantitative assessments of population or reproduction. Information regarding nesting seabirds is included in the Effects of Human Use chapter. We did not systematically inventory avian fauna on the islands because it required too much work and it was too difficult to verify identifications made by volunteers.

We recorded all evidence of human use on each island in an effort to obtain preliminary information about effects on the resource caused by visitors. Also we systematically photographed each island to document current conditions. Photographs taken at a minimum of five-year intervals can help document gradual changes otherwise unnoticed and may be useful for detecting effects of changing air quality, visitor effects, land use patterns, changes in the scenery, etc. Photographic monitoring also is a cost-effective and efficient method for long-term monitoring (Magill 1989). To the best of our knowledge, this study was the first to establish permanent photopoints for documenting changes in landscape and vegetation on park islands, and to systematically photograph island shorelines and associated vegetation. We established permanent photopoints, as well as a series of photos taken from the periphery of the islands. Specific information regarding photographs is in Appendix B.

This report is organized into topical chapters for vascular plants, forests, mammals, amphibians and reptiles, and human use and effects. Each chapter includes historic information, dates of field work, methods used, results, and discussion. Results are summarized and management recommendations are repeated in the final chapter, which serves as a synopsis of this study. Field notes, raw data, and slides are stored in the Natural Resource Library at ANP (Mittelhauser et al. 1996).

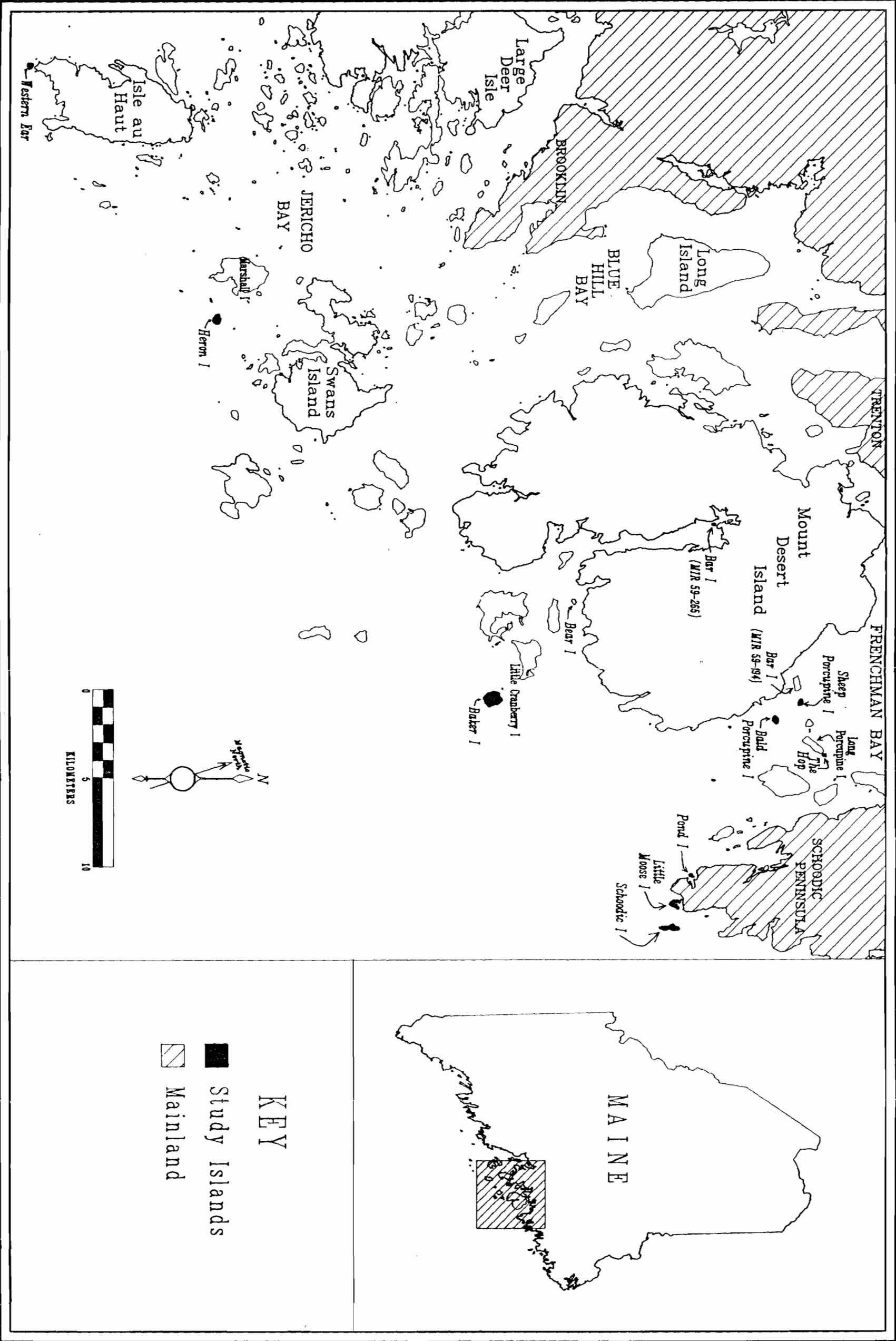


Figure 1. Study area, Acadia National Park, Maine.

Table 1. Study islands with descriptors and dates of field work, 1992 and 1993.

Island Name	Maine Island Registry #	Town, County	Size (Hectares)	Percent Federal Ownership	Date Acquired	Dates of Field Work 1992-1993
Baker Island	59-318	Cranberry Isles Hancock County	68.1	99%	1983 (most recent parcel)	April 29, 1992; May 20-21, 1992; July 7-9, 1992; August 3-6, 1993
Bald Porcupine Island	59-197	Gouldsboro Hancock County	12.8	100%	12/14/56	May 18, 1992; May 14, 1993; June 18, 1993; July 5-9, 1993; September 2, 7, 8, 13, 17, 27, 1993
Bar Island	59-265	Mount Desert Hancock County	2.7	100%	12/3/25	June 8, 1992; September 1, 15-17, 19-20, 1993
Bar Island	59-194	Gouldsboro Hancock County	27.3	82%	1989 (most recent parcel)	June 16, 1992; May 31, 1993
Heron Island	59-480	Swans Island Hancock County	21.0	100%	8/15/68	May 29, 1992; May 13, 1993; June 17, 1993; July 12-14, 1993; August 31, 1993
The Hop	59-200	Gouldsboro Hancock County	3.3	100%	12/15/89	May 12, 1993; June 7-10, 1993; August 9-10, 1993; September 14, 1993
Little Moose Island	59-063	Winter Harbor Hancock County	22.1	100%	2/9/29	May 11, 20, 21, 25-27, 1993; June 1-4, 1993; August 11, 1993; September 13, 15, 21, 22, 1993
Pond Island	59-064	Winter Harbor Hancock County	5.8	100%	2/9/29	June 4, 30, 1992; July 1-3, 6, 1992; September 15, 1992; October 2, 1992; August 27, 1993
Schoodic Island	59-062	Winter Harbor Hancock County	27.1	100%	11/3/89	June 8, 19, 1992; July 16, 21-24, 27-30, 1992; August 20, 25-26, 1992; October 9, 1992; June 14, 1993
Sheep Porcupine Island	59-195	Gouldsboro Hancock County	9.0	100%	7/13/60	June 8, 1992; June 14, 1993; September 2, 7-9, 13-14, 24, 1993
Western Ear	63-244	Isle au Haut Knox County	9.0	100%	7/28/89	May 13, 1993; June 25, 1993; June 29-30, 1993; July 1-2, 28, 1993

Before conducting field work, we searched the herbaria at ANP and College of the Atlantic for plant specimens collected from small park islands and used these to augment preliminary lists (Les 1984, Greene 1988, 1992). We did not search other herbaria, although historical collections undoubtedly exist.

We conducted plant searches in all habitats on each island. Habitats were determined by examining aerial photographs followed by ground-truthing. We walked each habitat looking for new plant species. Within each habitat, we searched wet depressions, spray zones, and other microhabitats known to harbor uncommon species. Initial identifications of common species were made in the field; for most of these, voucher specimens were not collected. Specimens in question, or specimens from difficult taxa were collected for identification in the lab. We were assisted with field surveys by C. Greene, Professor of Botany at College of the Atlantic, and L. Gregory, ANP Botanist. They identified most plant specimens collected. Some specimens that were difficult to identify were compared with collections in the herbaria at College of the Atlantic or University of Maine. Specimens from particularly difficult taxa [e.g. *Carex recta*, sandy sedge (*Carex silicea*), orach (*Atriplex* spp.), and blue birch (*Betula x caerulea*)] were sent to specialists for verification.

We carefully planned the timing of our visits to islands to avoid disturbing nesting seabirds or eagles. After preliminary visits to Bar Island (MIR# 59-265) and Sheep Porcupine Island with U.S. Fish and Wildlife Service eagle researchers, we conducted most of our field work in September after eaglets had fledged. We were able to conduct field work without disturbing eagles throughout 1992 on Schoodic Island because the eagle nest failed.

Nomenclature follows that of Kartesz (1994). Common and latin names are provided in Table 3. All collections have been accessioned into the herbarium at the College of the Atlantic. Field notes and data are stored at the Natural Resource Library at ANP (Mittelhauser et al. 1996).

Plant Status

The Maine Natural Areas Program compiles and maintains Maine's official list of threatened and endangered plants. We used this list, which is based on data collected before 1989, to determine rarity status (Maine State Planning Office 1990). The Natural Areas Program tracks recent changes in status of plant populations, and proposes changes to the State list. Proposed listing status was obtained from the Maine Natural Areas Program (1994b).

The following categories are recognized on the official State list:

Endangered: documented once within the past 20 years, or listed as endangered under the Federal Endangered Species Act (ESA).

Threatened: Documented two to four times recently, or listed as threatened under the ESA.

Species not fitting the State criteria for endangered or threatened may be included in one of the above categories if the populations are small, confined to small geographic areas in the State, or the species is clearly and imminently jeopardized as determined by the Maine Botanical Advisory Group.

Special concern: documented by five to 10 recent occurrences. If variables contributing to their decline are not changed, the plant could become threatened within the foreseeable future. This category includes plants that might justifiably be placed in endangered or threatened category but for which recent documentation (within past 20 years) is lacking.

Watch list: documented more than 10 times recently but still of concern; plants removed from one of above categories may be listed here, as may plants proposed for addition to one of the above categories but for which more information is needed.

Possibly extirpated: undocumented in Maine within the last twenty years. If found and documented, the taxon is immediately listed under endangered status.

In addition to state-listed plants, the NPS is concerned with identifying and protecting locally rare species and those that may be potentially useful as indicators of unique habitats (National Park Service 1988). The NPS has not developed criteria to define local rarity. We use Greene (1990) to classify species as locally rare. Greene (1990) determined local rarity based on Rand and Redfield (1894), Stebbins (1929), or as shown by recent field searches to be much less common than previously noted.

A non-native species is a species that occurs in ANP as a result of deliberate or accidental actions by humans (National Park Service 1991). Plants were classified as non-native to Maine using Richards et al. (1983). Non-native plants of management concern in ANP were determined by McInnes (1986).

RESULTS

Based on 1992-1993 field work, searches in herbaria, and previously published inventory efforts (Greenwood 1927, Stebbins 1929, Les 1984, Greene 1988, 1992), we compiled a comprehensive list of all plant species recorded from small park islands (Table 3). The list includes 433 species and 16 varieties and subspecies of vascular plants. No federally-listed endangered or threatened plants have been reported for this coastal region.

State-Listed Species

A total of 10 state-listed (or proposed) endangered, threatened, special concern, or watch list plant species was documented from the islands studied (Table 4).

State Endangered

We found two state endangered plants on Heron Island; *Carex adusta* and *C. recta*. *Carex recta* is proposed for listing in the next version of the state list as possibly extirpated; however, recent findings (S. Gawler, Maine Natural Areas Program, pers. comm.) may result in maintaining its status as endangered or possibly listing it as threatened. Following this study, *C. recta* was collected on Little Moose Island in July, 1994 (L. Gregory, ANP, pers. comm.).

Dwarf rattlesnake root (*Prenanthes nana*), a state endangered species proposed for listing as possibly extirpated, was collected from Little Moose Island in 1955 and 1967 (specimens are stored in the park's herbarium). We found rattlesnake root (*Prenanthes* spp.) on all islands. The taxonomic status of rattlesnake root populations on the coast are uncertain as they appear intermediate between tall rattlesnake root (*P. trifoliata*) and dwarf rattlesnake root (J. Canne-Hilliker, Univ. of Guelph, pers. comm.).

State Threatened

We found *Carex echinata* on Heron Island and Greene (1990) lists it from Baker Island. *Carex echinata* is proposed for deletion from the state list because it occurs in numerous sites in Maine and currently is not considered rare in the state (S. Gawler, Maine Natural Areas Program, pers. comm.).

We collected asters from Western Ear that were intermediate between leafy-bracted aster (*Aster foliaceus*) and New York aster (*A. novi-belgii*), as did Greene on Baker Island (C. Greene, College of the Atlantic, pers. comm.). Final resolution of the status of these specimens will require additional research because the taxonomic status of these coastal populations is questionable (Gleason and Cronquist 1991, C. Greene, College of the Atlantic, pers. comm.).

State Special Concern

Three species of state special concern were collected: blue birch, marsh felwort, and blinks (*Montia fontana*). We found blue birch on Bar Island, The Hop, Little Moose Island, and Western Ear, and relocated the population of marsh felwort on Little Moose Island. We found blinks on Heron Island; Greene (1990) found this species on Little Moose Island.

Possibly Extirpated from State

Sandy sedge was collected from Bald Porcupine Island, Heron Island, The Hop, and Sheep Porcupine Island. Sandy sedge had not been previously listed, however, it was proposed to

be listed as possibly extirpated in the next version of the list (Maine Natural Areas Program 1994b). Based on recent findings, sandy sedge will probably be listed as endangered (S. Gawler, Maine Natural Areas Program, pers. comm.).

State Watch List

Three species, all proposed for removal from the list, were observed by Greene (1988, 1990, 1992). Beachhead iris was found on Baker Island, Little Moose Island, and Schoodic Island. Boreal knotty pearlwort (*Sagina nodosa* ssp. *borealis*) and knotty pearlwort (*S. nodosa* ssp. *nodosa*) were noted from Little Moose Island. We did not relocate these populations.

Locally Rare Species

We noted sixteen locally rare species on the study islands (Tables 3 and 4).

Non-native Species

We observed 111 non-native species (25% of total species) on the study islands (Tables 3 and 3).

Twelve non-native plant species growing in ANP are of management concern (McInnes 1986) because they are invasive or have cultural value. Five of these species occur on the islands we studied (Table 4): Asiatic bittersweet (*Celastrus orbiculatus*); Japanese barberry (*Berberis thunbergii*); common barberry (*Berberis vulgaris*); apple (*Malus sylvestris*); and common lilac (*Syringa vulgaris*). These species all have ornamental or agricultural value and were probably introduced by settlers for plantings around homesteads, thus, they may have some historical value.

DISCUSSION

We prepared species lists for five islands (Bald Porcupine Island, Bar Island (MIR# 59-265) The Hop, Heron Island, and Western Ear) and ammended lists by Greene (1988, 1992) for six additional islands (Baker Island, Bar Island (MIR# 59-194), Little Moose Island, Pond Island, Schoodic Island, and Sheep Porcupine Island).

We searched Sheep Porcupine Island and Bar Island (MIR# 59-265) only briefly in spring, and not at all in the summer, thus, we may have missed species at these times. We recommend additional field searches throughout the growing season on these islands.

Ten state-listed, rare plants were located on park islands. We found that these islands are important refuges for rare plants and should be considered in park management plans. We

recommend monitoring these rare plant populations on all islands at 5-year intervals. At this time, there are no NPS guidelines for identifying what specific monitoring methodology should be used. The park should develop monitoring techniques for rare plant populations by determining what parameters (presence/absence, percent cover, etc.) are appropriate and feasible.

Heron Island and Little Moose Island harbored the greatest number of state-listed, rare plants. Little Moose Island is now registered as a Maine critical area for rare plants. Heron Island supports five rare species, including two state endangered species, and one species previously thought to be extirpated. Heron Island should be nominated as a State critical area to increase awareness of the need for protecting the island's rare flora.

The taxonomic status of coastal populations of leafy-bracted aster and dwarf rattlesnake root, two state-listed species, is in question. Additional research on the taxonomic status of these species is needed.

No specific regulations now protect state-listed species, although some regulations protect special habitats, i.e. wetlands. We recommend that the park participate in partnerships with the New England Plant Conservation Program, the Maine Botanical Advisory Group, The Nature Conservancy, and other conservation groups to enhance protection of rare plants and habitats in the region.

Twenty-five percent of the islands' flora were non-native species; this compares to twenty-two percent found on MDI (National Park Service 1993a). Little Moose Island had the fewest non-native plants; nine percent of the islands' flora. Although few of McInnes' (1986) 12 species of concern to management were found on the study islands, other invasive species such as multiflora rose (*Rosa multiflora*), Canada thistle (*Cirsium arvense*), and tall fescue (*Festuca pratense*) are known to alter native plant communities (Harty 1986), and may be disrupting the ecology of these islands. We recommend that threats to native communities by non-native plant species be reassessed, and, if necessary, management plans to control non-native plants be developed and implemented.

Sheep have been present on many Maine islands (Conkling 1981) and have been proposed for reintroduction on Baker Island to maintain the cultural landscape surrounding historical development (Danskin 1994). Sheep may have adversely affected island ecology by introducing non-native plants or causing local extinction of rare species. In contrast, grazing may have created habitat favoring some rare species. For example, sheep were grazed on Heron Island as recently as 1968 (Sullivan and Favour 1968) and Heron Island supports a number of state-listed meadow species. In the absence of grazing or other active management, these species may disappear. Additional research is needed to determine the role grazing may have on distribution and composition of flora of the islands, and the implications of its use as a management tool.

Table 2. Dates of botanical field work on 10 islands of Acadia National Park, 1992-93.

Island Name	Dates of Botanical Field Work	
	1992	1993
Baker	April 29 May 20-21 July 9	August 3-6
Bald Porcupine	May 18	May 14 June 18 July 5-9 September 8
Bar (MIR# 59-265)	June 8	September 1, 19-20
Heron	May 29	May 13 June 17 July 12-14 August 31
The Hop	No fieldwork	May 12 June 10 August 9-10 September 14
Little Moose	No fieldwork	June 4 August 11, 27 September 13, 15, 21-22
Pond	June 4, 30 July 1-3, 6	August 27
Schoodic	June 8, 19 July 16, 21-24, 27-30 August 20, 25-26	No fieldwork
Sheep Porcupine	June 8	June 14 September 2, 13
Western Ear	No fieldwork	May 13 June 25 July 1-2, 28 October 14

Vascular Flora

HISTORIC INFORMATION

Botanical research on islands in mid-coast Maine has been limited (Greene et al. 1992). The first attempt to create a comprehensive flora list of the ANP region was by Rand and Redfield (1894) who focused on MDI and the Porcupine Islands, with limited work on other nearby islands. Hill (1914, 1919, 1923) qualitatively described plant habitat associations in extensive study of the vegetation of the islands in the Penobscot Bay region. George Rossbach, a retired professor from West Virginia Wesleyan College, collected extensively throughout the state from 1930 to 1986, including many coastal areas; most of this work remains unpublished (Rossbach 1986). Collections from these three studies are stored at herbaria of the University of Maine and the New England Botanical Club, and represent significant information on the distribution of many plants in Maine.

Recent botanical inventories of MDI and surrounding islands were conducted from 1985 through 1989 by Greene (1987, 1988, 1989) focusing on rare vascular plants within ANP (Greene 1990). Greene (1988, 1992) presents preliminary plant lists for Baker Island, Bar Island (MIR# 59-194), Little Moose Island, Pond Island, Schoodic Island, and Sheep Porcupine Island. Les (1984) lists plants found on Little Moose Island. The first comprehensive vascular flora of Isle au Haut was prepared by Wise (1970), building on the published and unpublished work of Kidder (1921, 1923a, 1923b, 1928). Other preliminary floral lists prepared for non-park islands in the region include: Redfield (1885, 1893) and Folger and Wayne (1986), for Great Duck Island; Rappaport and Wesley (1985), for nine seabird-nesting islands in coastal Maine; Gregory (1989), for Wooden Ball Island; and Gregory (1993), for the Eastern Calf Islands Preserve (Black, Sheep, and Eagle Islands in Blue Hill Bay).

Little Moose Island is a Maine critical area (Maine Natural Areas Program 1994a), based on the presence of several unusual and rare plants of arctic-maritime affinity including marsh felwort (*Lomatogonium rotatum*) and beachhead iris (*Iris setosa* var. *canadensis*).

METHODS

Dates of field work on each island are summarized in Table 2. We searched each island for herbaceous plant species at least four times. We scheduled searches, when possible, to include at least one visit in spring, summer, and fall. No botanical field work was conducted on Bar Island (MIR# 59-194).

Table 3. Vascular plant species lists, including species we observed, historical observations we verified, and historical observations not relocated during 1992 and 1993 on 11 islands of Acadia National Park. Key to abbreviations:

Status listings: E = State endangered; T = State threatened; SC = State special concern; PE = possibly extirpated in Maine; WL = State watch list; LR = locally rare (see Greene 1990); I = non-native.

Plant presence: XXS = Voucher specimen; XXH = Voucher specimen from historic work, stored at College of the Atlantic Herbarium; XXA = Voucher specimen from historic work, stored at ANP Herbarium; XX = observed, no voucher specimen collected; q = Identification needs verification; X = reported by Greene (1988, 1992), not relocated. Other historic occurrences not relocated during this study are designated with the original reference.

Islands: Baker = Baker Island; BaldP = Bald Porcupine Island; Bar194 = Bar Island (MIR# 59-194); Bar265 = Bar Island (MIR# 59-265); Heron = Heron Island; Hop = The Hop; LtlMo = Little Moose Island; Pond = Pond Island; Schdc = Schoodic Island; ShpPr = Sheep Porcupine Island; WstEar = Western Ear.

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	WstEar
<i>Abies balsamea</i> (L.) P. Mill.	balsam fir			XX	X	XX		XX	XX	XX	XXS	XX	XX
<i>Acer pensylvanicum</i> L.	striped maple			XX	XXH	XX		XX				XX	
<i>Acer platanoides</i> L.	Norway maple	I		XX									
<i>Acer rubrum</i> L.	red maple		XX	XX		XX		XX			XXS	XX	
<i>Acer saccharum</i> Marsh.	sugar maple			XX	X								
<i>Acer spicatum</i> Lam.	mountain maple		XX	XX	X			XX				XX	
<i>Achillea millefolium</i> L.	yarrow	I	XXH	XX	XXH	XX	XX	XX	XX	XX	XX	XX	XX
<i>Actaea pachypoda</i> Ell.	white baneberry				X								
<i>Agrostis capillaris</i> L.	Rhode Island bentgrass	I			XXH	XXS	XXS						
<i>Agrostis gigantea</i> Roth	redtop		X	XX	X	XX	XXS	XX	XX		XX	XX	XXS
<i>Agrostis scabra</i> Willd.	fly-away grass			XX		XXS	XX		XXS			XX	XXS
<i>Agrostis stolonifera</i> L.	redtop		XXH			XX	XX		XX	XXS			XX
<i>Alnus viridis</i> (Vill.) Lam. & DC. ssp. <i>crispa</i> (Ait.) Turrill	mountain alder		XXS	XXS	X	XXS		XXS	XXS			XX	
<i>Alopecurus pratensis</i> L.	meadow foxtail	I	X		XXH		XXS						
<i>Ambrosia artemisiifolia</i> L.	common ragweed				XXH					XX	XXS		

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	WstEar
<i>Ambrosia artemisiifolia</i> L. var. <i>elator</i> (L.)Descourtils	common ragweed		XXS										
<i>Amelanchier</i> sp.	common shadbush		XX		X	XX						XX	
<i>Amelanchier canadensis</i> (L.)Medik.	swamp shadbush								XXS				
<i>Amelanchier interior</i> Nielsen	shadbush							XXSq					
<i>Amelanchier x intermedia</i> Spach	intermediate shadbush			q							X		
<i>Amelanchier laevis</i> Wieg.	smooth shadbush			XXSq				XXS		XXS	XXS		
<i>Anaphalis margaritacea</i> (L.)Benth. & Hook. f.	pearly everlasting					XX							
<i>Angelica lucida</i> L.	seaside angelica		XXA	XX					XX	XX	XX		XX
<i>Antennaria howellii</i> ssp. <i>canadensis</i> (Greene)Bayer	Canada pussytoes					q							
<i>Anthemis cotula</i> L.	mayweed	I			XXH								
<i>Anthoxanthum odoratum</i> L.	sweet vernal grass	I	XX		X		XXS						
<i>Apocynum androsaemifolium</i> L.	spreading dogbane				X							X	
<i>Aquilegia vulgaris</i> L.	garden columbine	I	X										
<i>Aralia hispida</i> Vent.	bristly sarsaparilla				X	XX			Les (1984)				
<i>Aralia nudicaulis</i> L.	wild sarsaparilla		XX	XX	X	XX			XX	XX	XX	XX	
<i>Arctium minus</i> Bernh.	common burdock	I			XXH								
<i>Arctostaphylos uva-ursi</i> (L.)Spreng.	felted bearberry					XX							
<i>Argentina anserina</i> (L.)Rydb.	silverweed		XXA					XX		XX	XX		XX
<i>Aristolochia macrophylla</i> Lam.	Duchman's pipe	I				XXS							
<i>Aronia melanocarpa</i> (Michx.)Ell.	black chokeberry		X			XX					XX		XX
<i>Aronia x prunifolia</i> (Marsh.)Rehd.	purple chokeberry		XX	XXS					XXS	XXS	XXS		
<i>Artemisia</i> sp.	wormwood	I	X		X								
<i>Asclepias syriaca</i> L.	common milkweed	I			X								

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	WstEar
<i>Aster acuminatus</i> Michx.	whorled aster		XX	XX	XXH			XX	XXA	XX	XX	XX	XX
<i>Aster cordifolius</i> L.	heart-leaved aster	LR			XXH								
<i>Aster foliaceus</i> Lindl. ex DC.	leafy-bracted aster	T	XXHq					q					XXSq
<i>Aster lateriflorus</i> (L.)Britt.	calico aster					XX							
<i>Aster lateriflorus</i> var. <i>hirsuticaulis</i> (Lindl. ex DC.)Porter	calico aster				XXH								
<i>Aster macrophyllus</i> L.	large-leaved aster			XX	XXH							XX	
<i>Aster macrophyllus</i> L. var. <i>velutinus</i> Burgess	large-leaved aster				XXH								
<i>Aster nemoralis</i> Ait.	bog aster		XX						XXA				
<i>Aster novae-angliae</i> L.	New England aster				XXH								
<i>Aster novi-belgii</i> L.	New York aster		XXS	XX		XXS	XX	XXS	XXS	XX	XX	XX	XXS
<i>Aster novi-belgii</i> var. <i>litoreus</i> Gray	New York aster				XXH								
<i>Aster umbellatus</i> P. Mill.	flat-topped aster		XX	XX				XX	XX	XX	XXS	XX	
<i>Athyrium filix-femina</i> (L.)Roth ssp. <i>filix-femina</i>	lady fern				XXH		XXS	XXS					
<i>Athyrium filix-femina</i> ssp. <i>angustum</i> (Willd.)Clausen	lady fern										XXS		
<i>Atriplex glabriuscula</i> Edmondston	orach			XXS			XX		XXS	XXS			XX
<i>Atriplex patula</i> L.	orach							XXS	XXA		XXSq		
<i>Atriplex prostrata</i> Boucher ex DC.	halberd-leaved orach								XXA	XXS			
<i>Barbarea vulgaris</i> Ait. f.	winter cress	I			XXH								
<i>Berberis thunbergii</i> DC.	Japanese barberry	I		XX	XXH							XX	
<i>Berberis vulgaris</i> L.	common barberry	I			XXH							XXS	
<i>Betula alleghaniensis</i> Britt.	yellow birch		X	XX	X						XX	XX	
<i>Betula x caerulea</i> Blanch.	blue birch	SC					XXS		XXS				XXS
<i>Betula papyrifera</i> Marsh.	paper birch		XX	XX	XXH	XX	XX	XX	XX	XX	XXS	XX	XX

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtHMo	Pond	Schdc	ShpPr	WstEar
<i>Betula papyrifera</i> Marsh. var. <i>cordifolia</i> (Regel) Fern.	heart-leaved birch		XX							XXS			
<i>Betula populifolia</i> Marsh.	gray birch			XX		XX				XXS		XX	q
<i>Bidens frondosa</i> L.	beggar ticks									XX	XXS	XX	
<i>Botrychium multifidum</i> (Gmel.) Trev.	leatherleaf grapefern	LR					XXS						
<i>Brassica nigra</i> (L.) W.D.J. Koch	black mustard	I			XXH								
<i>Cakile edentula</i> (Bigelow) Hook.	sea rocket		XXA		XXH		XX	XX	XX	XX	XX	XX	XX
<i>Calamagrostis canadensis</i> (Michx.) Beauv.	Canada bluejoint		X	XX			XXS	XX			XXS	X	XX
<i>Calopogon tuberosus</i> (L.) B.S.P.	grass pink		X										
<i>Calystegia sepium</i> (L.) R. Br.	hedge bindweed		XXA	XX	XXH		XX	XX	XX	XX	XX		XX
<i>Campanula rotundifolia</i> L.	harebell		XX	XX	XXH			XX	XXA		XX	XX	
<i>Capsella bursa-pastoris</i> (L.) Medik.	shepard's purse	I	XX				XXS				XX		
<i>Cardamine parviflora</i> var. <i>arenicola</i> (Britt.) O.E. Schulz	small-flowered bitter cress	LR	XXS	XXS			XX						XX
<i>Carex adusta</i> Boott	sedge	E					XXS						
<i>Carex albicans</i> var <i>emmonsii</i> (Dewey ex Torr.) J. Rettig	Emmons' sedge		XXH										
<i>Carex arctata</i> Boott ex Hook.	drooping wood sedge			XXS	X								
<i>Carex brunneus</i> (Pers.) Poir. var. <i>brunescens</i>	sedge		X					XXS		XXS		XXS	XX
<i>Carex brunneus</i> (Pers.) Poir. ssp. <i>sphaerostachya</i> (Tuckerman) Kalela	sedge			XXS	XXH			XX			XXS		
<i>Carex canescens</i> L.	silvery sedge		XX	XX				XX	q		XX	XX	
<i>Carex canescens</i> ssp. <i>disjuncta</i> (Fern.) Toivonen	sedge					XX	XX						
<i>Carex communis</i> Bailey	fibrous-rooted sedge		XX	XX	XXH	XX		XX	XX	XXH		XXS	

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Barl94	Bar265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	WstEar
<i>Carex crinita</i> Lam.	sickle-grass				X								
<i>Carex debilis</i> Michx.	slender-stalked sedge			q		XX		XX				XX	
<i>Carex disperma</i> Dewey	two-seeded sedge		X	XXS							XX		
<i>Carex echinata</i> Murr.	sedge	T	X				XX						
<i>Carex gracillima</i> Schwein.	graceful sedge											XXH	
<i>Carex hornathodes</i> Fern.	marsh straw sedge		X		XXH		XXS	XX	XX	XXS			XX
<i>Carex lacustris</i> Willd.	sedge						XXS						
<i>Carex magellanica</i> Lam.	bog sedge		X						XXH				
<i>Carex nigra</i> (L.) Reichard	black sedge		XX				XXS	XX	XXS		XXS		
<i>Carex novae-angliae</i> Schwein.	New England sedge												
<i>Carex paleacea</i> Schreb. ex Wahlenb.	seaside sedge			XXS			XXS		XXS				XXS
<i>Carex pallescens</i> L.	pale sedge		X	XXS	X			XX				XX	
<i>Carex pennsylvanica</i> Lam.	Pennsylvania sedge			XXS						q			
<i>Carex recta</i> Boott	sedge	E					XXS		XXS				
<i>Carex rostrata</i> Stokes	sedge		X										
<i>Carex scoparia</i> Schkuhr ex Willd.	rough sedge		X		XXH		XXS	XX	XXS	q			XXS
<i>Carex silicea</i> Olney	sandy sedge			XXS			XXS	XXS				XXS	XXS
<i>Carex stipata</i> Muhl. ex Willd.	awl sedge		X		X		XX		XX				
<i>Carex tenera</i> Dewey	sedge				XXH								
<i>Carex trisperma</i> Dewey	three-seeded sedge		XX	XX					XX	XXS			
<i>Carex viridula</i> Michx.	green sedge		X						XXH	XX			
<i>Carum carvi</i> L.	wild caraway	I	XXH		q								
<i>Celastrus orbiculata</i> Thunb.	Asiatic bittersweet	I		XX	XXH								
<i>Cerastium arvense</i> L.	field chickweed						XXS						
<i>Cerastium fontanum</i> ssp. <i>vulgare</i> (Hartman) Greuter & Burdet	mouse-ear chickweed	I	XX	XX	X		XX	XX	XXA	XX	XX	XX	XX
<i>Chamaedaphne calyculata</i> var. <i>angustifolia</i> (Ait.) Rehd.	leatherleaf								q				

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LulMo	Pond	Schdc	ShpPr	WstEar
<i>Chenopodium album</i> L.	lamb's quarters	I	X				q	q	XXA	XXS			
<i>Cicuta maculata</i> L.	water hemlock										XXS		
<i>Circaea alpina</i> L.	dwarf enchanter's nightshade		XX		X				XX	XX	XX		XX
<i>Cirsium arvense</i> (L.) Scop.	Canada thistle	I			XXH		XX	XX	XXA	XX	XXS	XX	XX
<i>Cirsium muticum</i> Michx.	swamp thistle		XX										XXS
<i>Cirsium vulgare</i> (Savi) Ten.	bull thistle	I	X				XX	XX			XXS	X	XX
<i>Clintonia borealis</i> (Ait.) Raf.	bluebeard lily				X			XX			XX	XX	
<i>Comptonia peregrina</i> (L.) Coult.	sweetfern				XXH	XX			XX			XX	
<i>Conioselinum chinense</i> (L.) B.S.P.	hemlock parsley										XXS		
<i>Coptis trifolia</i> ssp. <i>groenlandica</i> (Oeder) Hultén	goldthread		XXA		X					XXS			XX
<i>Cornus alternifolia</i> L. f.	pagoda dogwood			XX									
<i>Cornus canadensis</i> L.	bunchberry		XXA	XX	X	XX		XX	XX	XX	XX	XX	XX
<i>Cornus sericea</i> L.	red-osier dogwood				X								
<i>Corydalis sempervirens</i> (L.) Pers.	pink corydalis				XX								
<i>Crataegus</i> sp.	hawthorn		X	XX									
<i>Crataegus chrysocarpa</i> Ashe	hawthorn	LR							XXSq				
<i>Crataegus jonesiae</i> Sarg.	Jones' hawthorn				XXH								
<i>Crataegus macrosperma</i> Ashe	hawthorn				XXH				XXSq				
<i>Cuscuta gronovii</i> Willd. ex J.A. Schultes	common dodder		XX				XX	XX	XXH	XXS	XXS		
<i>Dactylis glomerata</i> L.	orchard grass	I	X		X								
<i>Danthonia spicata</i> (L.) Beauv. ex Roemer & J.A. Schultes	poverty grass		X	XX		XX		XX	XX			XX	XX
<i>Daucus carota</i> L.	wild carrot	I			XXH								
<i>Dennstaedtia punctilobula</i> (Michx.) T. Moore	hay-scented fern				X							XX	
<i>Deschampsia flexuosa</i> (L.) Trin.	common hairgrass		XXH	q	XXH	XX		XX	XX	XX		XX	XXS

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	WstEar
<i>Dichanthelium acuminatum</i> var. <i>fasciculatum</i> (Torr.)Freckmann	panic grass		XXH						q			q	
<i>Diervilla lonicera</i> P. Mill.	bush honeysuckle		XX	XX	X			XX					
<i>Drosera intermedia</i> Hayne	spatulate-leaved sundew								XX				
<i>Drosera rotundifolia</i> L.	round-leaved sundew		XX						XX	XXS			XX
<i>Dryopteris campyloptera</i> Clarkson	American spinulose wood fern									XXH			
<i>Dryopteris carthusiana</i> (Vill.)H.P. Fuchs	spinulose wood fern		X	XXS	XXH	XX		XXS	X	XXH	XXS	XX	XXS
<i>Dryopteris cristata</i> (L.)Gray	crested wood fern		XXH										
<i>Dryopteris intermedia</i> (Muhl. ex Willd.)Gray	intermediate wood fern						XXS						
<i>Dryopteris marginalis</i> (L.)Gray	marginal shield fern			XXS	X			XXS				XX	
<i>Dryopteris x triploidea</i> Wherry	spinulose wood fern		Green- wood (1927)										
<i>Eleocharis elliptica</i> Kunth	spike rush						XXS						
<i>Eleocharis halophila</i> (Fern. & Brack.)Fern. & Brack.	spike rush		XXH				XXS						
<i>Elymus trachycaulus</i> (Link)Gould ex ShINNers ssp. <i>trachycaulus</i>	bearded wheatgrass												XXS
<i>Elymus trachycaulus</i> ssp. <i>subsecundus</i> (Link)A. & D. Löve	bearded wheatgrass								XXS			XX	XX
<i>Elymus virginicus</i> L.	Terrell grass		q		XXH	XX	XXS	XXS	XX	XX	XXS		XX
<i>Elytrigia repens</i> (L.)Desv. ex B.D. Jackson	witch grass		X	XX	XXH	XXS	XXS	XXS	q	XXS	XXS	XXH	XXS
<i>Empetrum nigrum</i> L.	black crowberry		XXA	XX	X	XX			XX	XXA	XXS	XX	XX
<i>Epifagus virginiana</i> (L.)W. Bart.	beechdrops				X								
<i>Epilobium angustifolium</i> L.	willow herb		X	XX	X				XX	XXH	XX	XX	

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	WstEar
<i>Epilobium ciliatum</i> Raf.	northern willow herb		XX	XX			XX		XXA	XX	XX	XX	XX
<i>Epilobium leptophyllum</i> Raf.	narrow-leaved willow herb		XX								XXS		
<i>Epipactis helleborine</i> (L.)Crantz	helleborine	I			X								
<i>Equisetum arvense</i> L.	field horsetail		XX		XXH		XXS						
<i>Equisetum sylvaticum</i> L.	plumy horsetail							XX					
<i>Erigeron strigosus</i> Muhl. ex Willd.	daisy fleabane				XXH								
<i>Eriophorum angustifolium</i> Honckeny	tall cotton-grass								XXH	XXS			
<i>Eriophorum virginicum</i> L.	Virginia cotton-grass		X										
<i>Erysimum cheiranthoides</i> L.	wormseed mustard	I	XXH										
<i>Euphrasia nemorosa</i> (Pers.)Wallr.	American eyebright		XXA		XXH		XXS		XXA	XX	XXS		XXS
<i>Euphrasia randii</i> B.L. Robins.	Rand's eyebright		XXS	XXS					XXS	XXS			
<i>Euthamia graminifolia</i> (L.)Nutt.	grass-leaved goldenrod				XXH			XX	XXS			XX	
<i>Fagus grandifolia</i> Ehrh.	American beech			XX	XXH	XX		XX				XX	
<i>Festuca filiformis</i> Pourret	fescue			XX	XXH	XX						XX	
<i>Festuca ovina</i> L.	sheep's fescue	I			XXH								
<i>Festuca pratensis</i> Huds.	taller fescue	I					XXS			XXH			
<i>Festuca rubra</i> L.	red fescue		XX	XX	XXH	XX	XXS	XX	XX	XX	XXS	XX	XXS
<i>Fragaria virginiana</i> Duchesne	wild strawberry		XX	XX	X		XXS	XX	XX	XX	XX	XX	XX
<i>Galeopsis tetrahit</i> L.	hemp nettle	I	XXA		XXH		XX		XXH	XX	XX		
<i>Galinoga quadriradiata</i> Ruiz & Pavon	quickweed	I									q		
<i>Galium aparine</i> L.	cleavers	LR	X					XXS					
<i>Galium asprellum</i> Michx.	rough bedstraw										q		
<i>Galium tinctorium</i> (L.)Scop.	bedstraw								XXH				
<i>Galium trifidum</i> L. ssp. <i>trifidum</i>	bedstraw		X				XXS				XXS		XX

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island											
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	WstEar	
<i>Galium trifidum</i> L. ssp. <i>halophilum</i> (Fern. & Wieg.)Puff	bedstraw										XXS			
<i>Galium triflorum</i> Michx.	sweet-scented bedstraw										XXS	XXS		
<i>Gaultheria hispidula</i> (L.)Muhl. ex Bigelow	creeping snowberry		XX											XX
<i>Gaultheria procumbens</i> L.	wintergreen					XX								
<i>Gaylussacia baccata</i> (Wangenh.)K. Koch	black huckleberry		XX			XX			XX	XXS				
<i>Geranium robertianum</i> L.	herb robert		XXH	XX	XX			XX		XX	XX	XX		
<i>Glaux maritima</i> L.	sea milkwort		XXS						XX		XX			
<i>Glyceria canadensis</i> (Michx.)Trin.	rattlesnake grass		XXH											
<i>Glyceria laxa</i> (Scribn.)Scribn.	mana grass		X											
<i>Gnaphalium uliginosum</i> L.	low cudweed			XX				XXS				XX	XX	XX
<i>Goodyera pubescens</i> (Willd.) R. Br. ex Ait. f.	downy rattlesnake plantain				X									
<i>Gymnocarpium disjunctum</i> (Rupr.)Ching	oak leaf, triplet fern			XX	X								XX	
<i>Hemerocallis fulva</i> (L.)L.	orange daylily	I			X									
<i>Heracleum maximum</i> Battr.	cow parsnip		XXA											
<i>Hieracium aurantiacum</i> L.	orange hawkweed	I	X	XX	XXH									
<i>Hieracium caespitosum</i> Dumort.	field hawkweed	I	XXH	q	XXH	XX			XX		q		XX	
<i>Hieracium canadense</i> Michx.	Canada hawkweed			XX	X				XX	XXA			XX	
<i>Hieracium x floribundum</i> Wimmer & Grab.	pale hawkweed	I							XXS					
<i>Hieracium lachenalii</i> K.C. Gmel.	common hawkweed	I		XXSq					XX				XXS	
<i>Hieracium murorum</i> L.	golden lungwort	I		XXS										
<i>Hieracium pilosella</i> L.	mouse ear	I	XX	XX	X	q		XX	XX				XX	XX
<i>Hieracium piloselloides</i> Vill.	smooth hawkweed	I			XXHq									

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LulMo	Pond	Schdc	ShpPr	WstEar
<i>Hierochloe odorata</i> (L.)Beauv.	sweetgrass		X				XXS		XXH				
<i>Houstonia caerulea</i> L.	blueets								XX				
<i>Hypericum canadense</i> L.	Canada St. Johnswort								XX				
<i>Hypericum perforatum</i> L.	common St. Johnswort	I	q		XXH								
<i>Ilex verticillata</i> (L.)Gray	winterberry			XX	X				XXS	XXS	XXS		
<i>Impatiens capensis</i> Meerb.	jewelweed		X				q		XX	XX	XX		
<i>Iris setosa</i> var. <i>canadensis</i> M. Foster ex B.L. Robins. & Fern.	beach-head iris	WL	X						XXH	q	XX		q
<i>Iris versicolor</i> L.	northern blue flag		XXA					XX	XX	XX	XX		XX
<i>Juncus acuminatus</i> Michx.	sharp-fruited rush									q			
<i>Juncus ambiguus</i> Guss.	toad rush										XXH		
<i>Juncus balticus</i> Willd. var. <i>littoralis</i> Engelm.	shore rush		XXH				XXS		XXS				
<i>Juncus brevicaudatus</i> (Englm.)Fern.	narrow-panicled rush								XXS	XXS			
<i>Juncus bufonius</i> L.	tufted rush		X				XXS	XX	XX	XX	XXS	XX	XXS
<i>Juncus canadensis</i> J. Gay ex Laharpe	marsh rush												XXS
<i>Juncus effusus</i> L. var. <i>conglomeratus</i> (L.)Engelm.	tufted rush		X										
<i>Juncus gerardii</i> Loisel.	black grass		X			XX			XX	XXS	XXS		XXS
<i>Juncus greenei</i> Oakes & Tuckerman	Greene's rush		q										
<i>Juncus tenuis</i> Willd.	yard rush		XXH		XXH								
<i>Juniperus communis</i> L. var. <i>depressa</i> Pursh	ground juniper		XXA	XX	X	XX		XX	XX	XXS	XXS	XX	XX
<i>Juniperus horizontalis</i> Moench	Bar Harbor juniper			XX				XX	XX			XX	XX
<i>Kalmia angustifolia</i> L.	sheep laurel		XX						XXA		XXS		

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	WstEar
<i>Lactuca biennis</i> (Moench) Fern.	tall blue lettuce							XXS					
<i>Lactuca canadensis</i> var. <i>latifolia</i> Kuntze	wild lettuce				XXHq						XXS		
<i>Lactuca sativa</i> L.	prickly lettuce	I		XXSq									
<i>Larix laricina</i> (Du Roi) Koch	larch, tamarack		XX						XX				
<i>Lathyrus japonicus</i> var. <i>maritimus</i> (L.) Kartesz & Gandhi	beach pea		XX		X	XX	XX	XX	XX	XX	XX	XX	XX
<i>Lathyrus palustris</i> L.	marsh vetchling		XXA				XXS			XXS	XXS		
<i>Lathyrus pratensis</i> L.	yellow vetchling	I						XX					XX
<i>Lechea intermedia</i> Leggett ex Britt.	pinweed					XX							
<i>Ledum groenlandicum</i> Oeder	Labrador tea								XXA				
<i>Leontodon autumnalis</i> L.	fall dandelion	I	XXA				XXS	XX			XXS		XX
<i>Leucanthemum vulgare</i> Lam.	oxeye daisy	I	XX	XX	X	XX		XX				XX	
<i>Leymus mollis</i> (Trin.) Hara	sea lyme grass		XX			XX	XX	XX	XXA	XX	XX		XXS
<i>Ligusticum scoticum</i> L.	Scotch lovage		XXA			XX		XX	XX	XX	XX		XX
<i>Ligustrum vulgare</i> L.	amur privet	I		XXS									
<i>Limonium carolinianum</i> (Walt.) Britt.	sea lavender		XX			XX			XXA				
<i>Linaria vulgaris</i> P. Mill.	butter-and-eggs	I			X								
<i>Linnaea borealis</i> ssp. <i>longiflora</i> (Torr.) Hultén	twinsflower			XX	X							XX	XX
<i>Linum catharticum</i> L.	fairy flax	I											XXSq
<i>Lomatogonium rotatum</i> (L.) Fries ex Fern.	marsh felwort	SC							XX				
<i>Lonicera x bella</i> Zabel	honeysuckle	I						XXS					
<i>Lonicera canadensis</i> Bartr. ex Marsh.	American fly honeysuckle			XXS	XXS			XXS				XX	
<i>Lonicera morrowi</i> Gray	Morrow's honeysuckle	I			XXH			XXS					
<i>Lupinus polyphyllus</i> Lindl.	garden lupine	I	XX		XXH								

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LulMo	Pond	Schdc	ShpPr	WstEar
<i>Luzula luzuloides</i> (Lam.)Dandy & Wilmott	woodrush	I	q										
<i>Luzula multiflora</i> (Ehrh.)Lej.	woodrush		X	XXH	XX			XX				XX	XX
<i>Lycopodium annotinum</i> L.	bristly clubmoss											XXS	
<i>Lycopodium clavatum</i> L.	bristly clubmoss			XXH									
<i>Lycopodium obscurum</i> L.	round-branch groundpine			X								XX	
<i>Lycopus uniflorus</i> Michx.	northern bugleweed		XX	XXH			XX		XXA	XX	XXS		XX
<i>Lysimachia quadrifolia</i> L.	whorled loosestrife			X	XX								
<i>Maianthemum canadense</i> Desf.	wild lily-of-the-valley		XXA	XX	X	XX	XX	XX	XX	XX	XX	XX	XX
<i>Maianthemum racemosum</i> (L.)Link	false Solomon's seal			X				XX			XXS		
<i>Maianthemum stellatum</i> (L.)Link	star-flowered Solomon's seal	LR						XXS					
<i>Maianthemum trifolium</i> (L.)Sloboda	three-leaved Solomon's seal		X						XXS				
<i>Malaxis unifolia</i> Michx.	green adder's mouth								XXA				
<i>Malus sargentii</i> Rehd.	Sargent's crabapple	I		XXSq									
<i>Malus sieboldii</i> (Regel)Rehd.	Siebold's crabapple	I						XXS					
<i>Malus sylvestris</i> P.Mill.	apple	I	XX	XX	X			XX				XX	
<i>Matricaria discoidea</i> DC.	pineapple weed	I			XXH						XX		
<i>Medeola virginiana</i> L.	Indian cucumber-root					XX							
<i>Melampyrum lineare</i> Desr.	cowwheat		X			XX			q			X	
<i>Mentha arvensis</i> L.	wild mint		XX	XXH									
<i>Mertensia maritima</i> (L.)S.F. Gray	oysterleaf, sea lungwort	LR	XXA						XXA	XX	XXS		
<i>Moehringia lateriflora</i> (L.)Fenzl	grove sandwort		XXS				XX	XX	XX	XX	XXS	XX	XX
<i>Moneses uniflora</i> (L.)Gray	Indian pipe		XXA							XX			XX
<i>Monotropa hypopithys</i> L.	pinenap					XXS						XX	

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	WstEar
<i>Monotropa uniflora</i> L.	one-flowered pyrola		XX	XX	X	XX				XX		XX	
<i>Montia fontana</i> L. ssp. <i>fontana</i>	blinks	SC					XXS		XXH				
<i>Mycelis muralis</i> (L.)Dumort.	wall lettuce	I		XXS									
<i>Myrica gale</i> L.	sweet gale		XX						XXA				
<i>Myrica pensylvanica</i> Loisel.	bayberry		XX	XX	X	XX		XX	XX	XX	XX	XX	XX
<i>Nemopanthus mucronata</i> (L.)Loes.	mountain holly		X	XX					XX	XXS			
<i>Nuttallanthus canadensis</i> (L.)D.A. Sutton	blue toadflax		XX	XX		XX		XXS				XXH	
<i>Odonites vernus</i> ssp. <i>serotinus</i> (Dumort.)Corb.	red bartsia	I					XXS						
<i>Oenothera biennis</i> L.	common evening primrose	I	XX		XXH	XX		XX	XX	XX		XX	
<i>Onoclea sensibilis</i> L.	sensitive fern						XXS						
<i>Ophioglossum pusillum</i> Raf.	adder's tongue	LR					XXS						
<i>Osmunda cinnamomea</i> L.	cinnamon fern		XXA		X		XX		XXA	XX	XX	XX	
<i>Osmunda regalis</i> L.	royal fern		XX										
<i>Ostrya virginiana</i> (P. Mill.)K. Koch	hop hornbeam	LR			XXS								
<i>Oxalis montana</i> Raf.	common wood sorrel		XXA								XX		
<i>Oxalis stricta</i> L.	yellow wood sorrel						XX			XXS	XX		XX
<i>Phalaris arundinacea</i> L.	reed canary grass		Stebbins (1929)										
<i>Pheum pratense</i> L.	common timothy	I	XX	XX	XXH		XXH	XX					XXS
<i>Picea glauca</i> (Moench)Voss	white spruce		XX	XX	XXH	XX		XX	XX	XX	XXS	XX	XX
<i>Picea rubens</i> Sarg.	red spruce		XX	XX	X	XX		XX	XX	XX		XX	XX
<i>Pinus banksiana</i> Lamb.	jack pine								XX				
<i>Pinus resinosa</i> Soland.	red pine			XX		XX							
<i>Pinus strobus</i> L.	eastern white pine			XX	XXH	XX							
<i>Plantago lanceolata</i> L.	English plantain	I			XXH								

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LulMo	Pond	Schdc	ShpPr	WstEar
<i>Plantago major</i> L.	common plantain	I	XXH		XXH		XX			XX	XX		XX
<i>Plantago maritima</i> var. <i>juncooides</i> (Lam.) Gray	seaside plantain		XXA	XX	XXH	XX	XX	XX	XX	XX	XXS	XX	XX
<i>Platanthera lacera</i> (Michx.) G. Don	green fringed orchis						XXS						
<i>Poa annua</i> L.	annual bluegrass	I	q							q			
<i>Poa compressa</i> L.	Canada bluegrass	I		XXS		XX		XXS				XX	
<i>Poa palustris</i> L.	fowl bluegrass	I	XXH					XXSq					
<i>Poa pratensis</i> L.	Kentucky bluegrass		XXH	XX	XXH		XXS	XXS		XXS	XX		XX
<i>Polygonatum pubescens</i> (Willd.) Pursh	small Solomon's seal				XXH							X	
<i>Polygonum amphibium</i> L. var. <i>stipulaceum</i> Coleman	water smartweed	I					XXS						
<i>Polygonum aviculare</i> L.	common knotgrass	I					XXS				XX		
<i>Polygonum cilinode</i> Michx.	fringed bindweed		X									XX	
<i>Polygonum glaucum</i> Nutt.	seabeach knotweed						XXS						
<i>Polygonum lapathifolium</i> L.	nodding smartweed										XX		
<i>Polygonum persicaria</i> L.	lady's thumb	I			q		XX			XX	XXS		
<i>Polygonum ramosissimum</i> Michx. var. <i>ramosissimum</i>	knotweed										XXH		
<i>Polygonum ramosissimum</i> var. <i>prolificum</i> Small	prolific knotweed										XXS		
<i>Polygonum sagittatum</i> L.	arrow-leaved tearthumb						XX						
<i>Polypodium virginianum</i> L.	rock polypody		XXA	XX		XX		XX					XX
<i>Polystichum acrostichoides</i> (Michx.) Schott	Christmas fern				X	XX							
<i>Populus grandidentata</i> Michx.	big-toothed aspen			XX	XXH	XX						XX	
<i>Populus tremuloides</i> Michx.	quaking aspen			XX	XXH	XX		XX	XX		XX	XX	
<i>Potentilla argentea</i> L.	silvery cinquefoil	I		XX	XXH				q			XX	
<i>Potentilla norvegica</i> L.	rough cinquefoil		XX	XX			XX	XX	XXA	XX	XX	XX	XX

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	WstEar
<i>Potentilla simplex</i> Michx.	common cinquefoil							XX			XXS		
<i>Prenanthes altissima</i> L.	tall white lettuce										XXS		
<i>Prenanthes nana</i> (Bigelow) Torr.	dwarf rattlesnake-root	E							XXA				
<i>Prenanthes trifoliata</i> (Cass.) Fern.	tall rattlesnake-root		XX	XX	X	XX	XX	XXS	XXS	XX	XXS	XX	XXS
<i>Prunus avium</i> (L.) L.	sweet cherry	I		XXS									
<i>Prunus pennsylvanica</i> L. f.	pin cherry			XX	X			XXS				XXS	
<i>Prunus virginiana</i> L.	choke cherry			XX	XXS			XXS			XXS	XX	
<i>Peridium aquilinum</i> (L.) Kuhn var. <i>latiusculum</i>	eastern bracken		X		X	XX							
(Desv.) Underwood ex Heller													
<i>Puccinellia tenella</i> ssp. <i>alascana</i> (Scribn. & Merr.) Tzevelev	alkali grass		XXH				XX	XXS	XX		XX		
<i>Pyrola elliptica</i> Nutt.	shinleaf				X			XXS				XX	
<i>Quercus rubra</i> L.	northern red oak			XX	XXH	XX		XX				XX	
<i>Radiola linoides</i> Roth	thousand seed	LR I											XXS
<i>Ranunculus acris</i> L.	tall buttercup	I	XX	XX	X		XX	XX	XXH	XXS	XX		
<i>Ranunculus cymbalaria</i> Pursh	seaside crowfoot		XX				XX						
<i>Ranunculus repens</i> L.	creeping buttercup	I	XX		q								
<i>Raphanus raphanistrum</i> L.	wild radish	I								XX	XXS		
<i>Rheum rhabarbarum</i> L.	rhubarb	I	XX										
<i>Rhinanthus minor</i> L.	yellow rattle		XX	XX	X	XX	XX	XX	X	XXS	XX	XX	
<i>Rhododendron canadense</i> (L.) Torr.	rhodora		X						XX				
<i>Rhus hirta</i> (L.) Sudworth	staghorn sumac		q	XX	XXH	XX		XX	XXS			XX	
<i>Rhynchospora alba</i> (L.) Vahl	white beak-rush												
<i>Ribes americanum</i> P. Mill.	wild black currant		q										
<i>Ribes glandulosum</i> Grauer	skunk currant			XX			XXS	XX	XX		XXS	XX	
<i>Ribes hirtellum</i> Michx.	gooseberry		XXHq	XX	XX			XX	XXH	XXH	XXS		XX
<i>Ribes lacustre</i> (Pers.) Poir.	bristly black currant	LR	XXHq										

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LulMo	Pond	Schdc	ShpPr	WstEar
<i>Rosa carolina</i> L.	Carolina rose			XXS									
<i>Rosa multiflora</i> Thunb. ex Murr.	multiflora rose	I										XXS	
<i>Rosa nitida</i> Willd.	early swamp rose		q						XXS		q		
<i>Rosa rubrifolia</i> Vill.	redleaf rose	I	q		X								
<i>Rosa rugosa</i> Thunb.	rugosa rose	I	XX		XXH	XX			XX	XX	XXS		
<i>Rosa virginiana</i> P. Mill.	Virginia rose		X	XXS	XXH	XXS	XXS	XX	XX	XX	XXS		XXS
<i>Rubus allegheniensis</i> Porter	common blackberry		X		XXHq				XX	XXSq	XX		
<i>Rubus hispidus</i> L.	swamp dewberry		XXA			XX			XX	XXS			
<i>Rubus idaeus</i> L. ssp. <i>idaeus</i>	wild red raspberry		XXA	XX	XXH	XX	XX	XX	XX	XX	XXS	XX	XX
<i>Rubus idaeus</i> L. ssp. <i>strigosus</i> (Michx.) Focke	wild red raspberry				XXH								
<i>Rubus pubescens</i> Raf.	dwarf raspberry							XXS					
<i>Rudbeckia hirta</i> var. <i>pulcherrima</i> Farw.	black-eyed susan	I			XXH								
<i>Rumex acetosella</i> L.	sheep sorrel	I	XXA	XX	X		XX	XX	X	XX	XX	XX	XX
<i>Rumex crispus</i> L.	curly dock	I	XXA		XXHq							X	XX
<i>Rumex longifolius</i> DC.	dock	I					XXS				XXS		
<i>Rumex obtusifolius</i> L.	dock								XXS				
<i>Rumex orbiculatus</i> Gray	great water dock				XXHq		XXS		XXS	XX	XXS		XX
<i>Rumex pallidus</i> Bigelow	seabeach dock		X							XXH			
<i>Rumex patientia</i> L.	patience dock	I							XX				
<i>Rumex salicifolius</i> var. <i>mexicanus</i> (Meisn.) C. L. Hitchc.	willow dock										XXS		
<i>Ruppia maritima</i> L.	ditch grass		X										
<i>Sagina nodosa</i> (L.) Fenzl ssp. <i>nodosa</i>	knotty pearlwort	WL							XXH				
<i>Sagina nodosa</i> ssp. <i>borealis</i> Crow	knotty pearlwort	WL							XXH				
<i>Sagina procumbens</i> L.	birdseye		XXS				XXS		XXH	XX	XXS	XX	XX
<i>Salicornia maritima</i> Wolff & Jefferies	slender glasswort		X						XXA				

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtMo	Pond	Schdc	ShpPr	WstEar
<i>Salix bebbiana</i> Sarg.	long-beaked willow											XXS	
<i>Salix discolor</i> Muhl.	large pussy willow								XXSq			XXSq	
<i>Salix lucida</i> Muhl.	shining willow												
<i>Sambucus canadensis</i> L.	common elder		XX	X		XX	XX	XX				XX	
<i>Sambucus racemosa</i> var. <i>pubens</i> (Michx.)Koehne	red-berried elder		XXS				XX					XX	
<i>Saxifraga virginiensis</i> Michx.	early saxifrage		XXS									XXS	
<i>Scirpus</i> sp.	bulrush		X										
<i>Scirpus atrocinctus</i> Fern.	bulrush						XXS						
<i>Scirpus cespitosus</i> L.	deer grass								XX				
<i>Scirpus cyperinus</i> (L.)Kunth	wool grass						XX						
<i>Scirpus maritimus</i> L.	salt-marsh bulrush						XX						
<i>Scutellaria galericulata</i> L.	marsh skullcap		XX			XX	XX		XXA	XX	XXS	X	XX
<i>Sedum rosea</i> (L.)Scop.	roseroot stoncrop	LR							XXA	XX	XX		
<i>Senecio sylvaticus</i> L.	wood ragwort	I										XXS	q
<i>Senecio vulgaris</i> L.	common groundsel	I										XXH	
<i>Sibbaldiopsis tridentata</i> (Ait.)Rydb.	three-toothed cinquefoil		XXA			XX			XXA				
<i>Silene vulgaris</i> (Moench)Garcke	bladder campion	I	XXH										
<i>Sisymbrium officinale</i> (L.)Scop.	hedge mustard	I		XXH									
<i>Sisyrinchium montanum</i> Greene var. <i>crebrum</i> Fern.	blue-eyed grass		XXA	XX	X	XX	XX	XXS	XX	XXS	XXS	XXS	XX
<i>Solanum dulcamara</i> L.	deadly nightshade	I	XX	XX	XXH	XX	XX	XX		XX	XX	XX	XX
<i>Solidago bicolor</i> L.	silver-rod			XX	XXH	XX						XX	
<i>Solidago canadensis</i> L.	Canada goldenrod					XX		XX	XX		XXSq	XX	
<i>Solidago gigantea</i> Ait.	late goldenrod												
<i>Solidago puberula</i> Nutt.	downy goldenrod								q	XX		XXS	
<i>Solidago rugosa</i> P. Mill.	rough-stemmed goldenrod		XX	XX	XXH		XX	XX	XX	XX	XX	XX	XX

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtMo	Pond	Schdc	ShpPr	WstEar
<i>Solidago rugosa</i> ssp. <i>rugosa</i> var. <i>villosa</i> (Pursh) Fern.	rough-stemmed goldenrod				XXH								
<i>Solidago sempervirens</i> L.	seaside goldenrod		XX	XX	X	XX	XX	XX	XXA	XX	XX	XX	XX
<i>Solidago simplex</i> var. <i>randii</i> (Porter) Kartesz & Gandhi	Rand's goldenrod		XX	XX		XX		XXS	XXA	XXS		XXS	
<i>Sonchus arvensis</i> L.	field sow thistle	I	X		XXH	XXS		XX	XXS	XX			
<i>Sonchus asper</i> (L.) Hill	spiny-leaved sow thistle	I	X	XX	XXH						XXS	XXH	XXS
<i>Sonchus oleraceus</i> L.	common sow-thistle	I		XXSq			XXSq	XXS					XXS
<i>Sorbus americana</i> Marsh.	American mountain ash		XX	XX	X	XX		XX	XX	XX	XXS	XXS	XX
<i>Sorbus aucuparia</i> L.	European mountain ash	I						XXS				XXS	
<i>Spartina pectinata</i> Link	fresh-water cord grass		XXH				XX						
<i>Spergularia rubra</i> (L.) J. & K. Presl	sand spurry	I	X										
<i>Spergularia salina</i> J. & K. Presl	salt-marsh sand spurry		X				XXS		XXH				
<i>Spiraea alba</i> var. <i>latifolia</i> (Ait.) Dippel	meadowsweet		XX	XX				XX	XXA	XXS	XXS	XX	
<i>Spiraea tomentosa</i> L.	steeplebush								XX				
<i>Spiranthes romanzoffiana</i> Cham.	hooded ladies' tresses	LR							XXA				
<i>Stellaria alsine</i> Grimm	bog chickweed	LR											XX
<i>Stellaria graminea</i> L.	lesser stitchwort	I	XX		XXH		XX						
<i>Stellaria media</i> (L.) Vill.	common chickweed	I	XXH	XX			XX		XXH	q	XX		XX
<i>Streptopus amplexifolius</i> (L.) DC.	white mandarin				q								
<i>Streptopus roseus</i> var. <i>perspectus</i> Fassett	rose mandarin			XX	X			XX		XXH	XXS	XX	
<i>Suaeda maritima</i> (L.) Dumort.	low sea blite		XX		X	XX			XXA	XXS	XX		

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	WstEar
<i>Syringa chinensis</i> Willd.	Chinese lilac	I			XXS								
<i>Syringa vulgaris</i> L.	common lilac	I			X								
<i>Taraxacum officinale</i> G.H. Weber ex Wiggers	common dandelion	I	X	XX	X		XX	XX		X	XXS		
<i>Teucrium canadense</i> L.	American germander												XX
<i>Thalictrum pubescens</i> Pursh	tall meadow rue						XX			XX	XXS	q	
<i>Thelypteris noveboracensis</i> (L.)Nieuwl.	New York fern											q	
<i>Thelypteris palustris</i> var. <i>pubescens</i> (Lawson) Fern.	marsh fern								q			X	
<i>Thuja occidentalis</i> L.	northern white cedar			XX		XX			XX			XX	
<i>Triadenum fraseri</i> (Spach) Gleason	marsh St. Johnswort								XXS				
<i>Triadenum virginicum</i> (L.) Raf.	marsh St. Johnswort		XX						XX	XX	XXS		XXS
<i>Trientalis borealis</i> Raf.	starflower		XXA	XX	X	XX		XX	XX	XX	XX	XX	XX
<i>Trifolium arvense</i> L.	rabbit-foot clover	I						XX	XXA			X	
<i>Trifolium aureum</i> Pollich	hop clover	I	XX					XX	q	XX		XX	
<i>Trifolium campestre</i> Schreb.	low hop clover	I			XXH								
<i>Trifolium pratense</i> L.	red clover	I	XX	XX	XXH		XX	XX				XX	
<i>Trifolium repens</i> L.	white clover	I	XX	XX	XXH	XX	XX	XX	XXA		XX	XX	XX
<i>Triglochin maritimum</i> L.	seaside arrowgrass		XXS						XX	XXS	XXS		
<i>Triglochin palustre</i> L.	northern arrowgrass	LR	Stebbins (1929)										
<i>Tsuga canadensis</i> (L.) Carr.	eastern hemlock			XX		XX							
<i>Typha latifolia</i> L.	common cattail									XX			XX
<i>Urtica dioica</i> L.	stinging nettle	I	X				XX				XXS		
<i>Uvularia sessilifolia</i> L.	wild oats				q								
<i>Vaccinium angustifolium</i> Ait.	low blueberry		XX	XX	XXH	XX			XX	XX	XXS	XX	XX
<i>Vaccinium corymbosum</i> L.	highbush blueberry									XX			
<i>Vaccinium macrocarpon</i> Ait.	large cranberry		XXH	XX					XXH	XX	XXS		XX
<i>Vaccinium myrtilloides</i> Michx.	velvetleaf blueberry		XX						X			XX	

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtMo	Pond	Schdc	ShpPr	WstEar
<i>Vaccinium oxycoccus</i> L.	small cranberry		XX						XX	XX	XX		XX
<i>Vaccinium vitis-idaea</i> ssp. <i>minus</i> (Lodd.)Hultén	mountain cranberry		XXA	XX	X	XX		XX	XX	XX	XX	XX	XX
<i>Valeriana officinalis</i> L.	garden valerian	I					XX						
<i>Verbascum thapsus</i> L.	common mullein	I			XXH	XX		XX		XX		XX	
<i>Veronica arvensis</i> L.	corn speedwell	I					XX						
<i>Veronica officinalis</i> L.	common speedwell			XX	XXH								
<i>Veronica serpyllifolia</i> L.	thyme-leaved speedwell	I			X								
<i>Viburnum acerifolium</i> L.	maple-leaved viburnum				X							XX	
<i>Viburnum dentatum</i> L. var. <i>dentatum</i>	southern arrowwood	I		XXS	X							XX	
<i>Viburnum dentatum</i> var. <i>lucidum</i> Ait.	northern arrowwood	LR		XX	X							XX	
<i>Viburnum lantanoides</i> Michx.	hobble bush			XX									
<i>Viburnum nudum</i> var. <i>cassinoides</i> (L.)Torr. & Gray	wild raisin		XX	XX	X			XX	XXS	XXS	XXS	XX	
<i>Viburnum opulus</i> L. var. <i>opulus</i>	European highbush cranberry	I			XXH							XXS	
<i>Viburnum opulus</i> var. <i>americanum</i> Ait.	American highbush cranberry			XX	XXS			XX					
<i>Vicia cracca</i> L.	cow vetch	I	XXA		X	XX	XX	XX		XX	XXS		
<i>Vicia sativa</i> ssp. <i>nigra</i> (L.)Ehrh.	narrow-leaved vetch	I			XXHq								
<i>Viola blanda</i> var. <i>palustriformis</i> Gray	large-leaved white violet									XXS			
<i>Viola lanceolata</i> L.	lance-leaved violet								XX				XX
<i>Viola macloskeyi</i> ssp. <i>pallens</i> (Banks ex DC.)M.S. Baker	northern white violet		XX						XX			XX	XXS
<i>Viola septentrionalis</i> Greene	northern blue violet		XX	q			XXS	XXS	XXS		XX	XX	q

Table 3. Vascular plant species lists (continued).

Species	Common Name	Status	Name of Island										
			Baker	BaldP	Bar194	Bar265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	WstEar
<i>Zostera marina</i> L. var. <i>stenophylla</i> Aschers. & Graebn.	eel-grass								XX	XX			

Table 4. Numbers of plant species on 11 park islands, including Greene (1988, 1992), as determined by field surveys and voucher specimens stored in herbaria at the College of the Atlantic and Acadia National Park.

Island Name	Numbers of:			
	Species	State-listed Rare Species	Locally Rare Species	Non-native Species (%)
Baker	212	3	4	47 (22%)
Bald Porcupine	143	1	1	29 (20%)
Bar (MIR# 59-194)	191	0	2	64 (34%)
Bar (MIR# 59-265)	97	1	0	14 (14%)
Heron	117	5	3	34 (29%)
The Hop	142	2	3	34 (24%)
Little Moose	174	7	3	15 (9%)
Pond	136	0	2	21 (15%)
Schoodic	139	1	2	25 (18%)
Sheep Porcupine	145	1	0	28 (19%)
Western Ear	108	2	2	19 (18%)

Forests

HISTORIC INFORMATION

Only limited research exists on forests on offshore islands in mid-coastal Maine (Greene et al. 1992). In a major study of the vegetation of Maine's coastal areas, plant associations and island forests in the Penobscot Bay region are qualitatively described (Hill 1919, 1923). Other studies in the area include that of Davis (1961, 1966), who describes the spruce-fir forest on Ironbound Island in Frenchman Bay and a few other local island forests, and Rappaport and Wesley (1985), who characterize the spruce-fir forest on Little Duck Island. Personnel of the University of Maine studied the age, distribution, and height of trees in relation to the lighthouse on Baker Island (Gilmore et al. 1993).

Some information on composition of historic forests has been gleaned by Moore and Taylor (1927), Davis (1961, 1966), and Conkling (1981), who summarize and interpret notes from early travelers to the region. Although interpretation of these accounts is often difficult, it seems that selected genera, e.g., pines (*Pinus* sp.) and oaks (*Quercus* sp.) that were once common on the islands in the 1700s have become less common and probably is related to the lumber and boat-building trades that flourished along the Maine coast in the 1700s-1800s (Conkling 1981).

Since settlement by Europeans in the mid-1700s many island forests have been cut for wood products or cleared for pasture. During the 1800s The Hop was principally used for haying, grazing, and logging (McLane 1989). By the mid-1800s the summit of Bald Porcupine Island was cleared and hay was harvested annually. Many islands along the Maine coast have been used for raising sheep (Moore and Taylor 1927); sheep were pastured on both Sheep Porcupine Island and The Hop in the 1880s. Heron Island, the only treeless island in the park, had sheep on it during the 1900s (McLane 1982), but sheep were eventually removed in 1968 when the NPS acquired the island (Sullivan and Favour 1968). Details of logging operations on park islands are few; however, most island forests have had at least small-scale logging operations in the past and McLane (1989) reports that 4,000 cords of pulpwood were harvested from The Hop and adjacent Long Porcupine Island during 1938.

The forest on Bald Porcupine Island is a Research Natural Area designated by the Society of American Foresters (Maine Natural Areas Program 1994a) because of its unique forest type of white spruce, balsam fir, and paper birch.

METHODS

We identified primary forest communities on each island by interpreting vegetation cover-type maps (Waggoner 1981), analyzing recent aerial photographs, and on site visits. Using computer-generated maps and grids, we randomly chose plot locations in each forest community. Plots were established in the field using tape and compass to measure from landmarks. If a plot was not representative of the community being sampled (e.g., contained open field), another random plot was chosen.

In response to comments by technical advisors and field assistants, we modified our methods after the first field season so that original methods used on Pond and Schoodic Islands differ from methods used on the remaining six islands (Bald Porcupine Island, Bar Island (MIR# 59-265), The Hop, Little Moose Island, Sheep Porcupine Island, Western Ear). Differences in methods used between years are outlined below.

Plots were 10 m x 10 m (0.01 ha) and were oriented along north-south and east-west transects corrected for local declination. Two, 10-m-long line transects, oriented north-south and east-west, bisected each plot. These were used to measure ground and canopy cover and to conduct foliage height profiles (Figure 2). In 1992, we sampled shrubs in two, 2-m x 10-m belt transects surrounding the line transects. In 1993, we sampled shrubs in four, 2-m x 4-m belt transects to avoid collecting data from the central portion of the plot, which often became trampled.

Plots sampled in 1993 were permanently marked on two opposite corners with rebar stakes capped with yellow plastic and labeled "ACADIA NP". Plots on Pond Island and Schoodic Island were not permanently marked, although Universal Transverse Mercator (UTM) coordinates (Appendix A) will facilitate approximate relocation of plots. Data from all plots are stored in the Natural Resource Library at ANP (Mittelhauser et al. 1996).

Tree and Shrub Counts

In each 10-m x 10-m plot, we tallied number of trees by species and by diameter at breast height (DBH; 1.37 m above ground level). During data collection in 1992 on Pond and Schoodic Islands, we defined a tree as any upright woody stem, dead or alive, with a DBH > 7.5 cm. In 1993, we modified this definition to include species with DBH > 2.5 cm. We counted multi-stemmed individuals as separate stems if they branched below breast height. Not all spruce (*Picea sp.*) were identified to species, as some did not have branches low enough to positively identify. From these data we calculated basal area, density of trees per ha, and importance values for each species in each forest community. We calculated importance values by summing the relative density, relative frequency, and relative dominance for species (Russell and Marion 1990).

Density of shrubs was tallied by species in belt transects within the 10-m x 10-m plots (Figure 2). On Pond and Schoodic Islands, we defined shrubs as any upright woody plant taller than 0.5 m with a DBH < 7.5 cm. We modified this definition in 1993 to include any upright woody plant with a DBH < 2.5 cm, regardless of height. In 1993, shrubs were tallied by species as well as by 0.5-m height classes.

Tree Cores

We obtained cores of tree boles at breast height with an increment borer at breast height from the largest individual of each tree species within each plot sampled in 1993. Rings were counted under microscope and are presented as age at breast height. Cores were not obtained from trees on Pond or Schoodic Islands.

Ground and Canopy Cover

Percent ground cover by cover-class categories was estimated in each plot using techniques we modified from Bonham (1989). On Pond and Schoodic Islands ground cover was estimated by averaging measurements taken with an ocular tube (James and Shugart 1970) at 1-m intervals along the two perpendicular line transects within each 10-m x 10-m plot. At each point, one of the following categories was identified: herbaceous plant, woody plant or stems (including deadwood), moss, lichen, and soil/leaf litter. In 1993, the method was revised to sample the remaining six islands. A rebar stake, 1.3 cm diameter x 0.5-m long, was lowered from 1-m heights at 1-m intervals along the two line transects, and a tally of all ground cover categories that made contact with the rebar stake were recorded. We revised ground cover categories in 1993, dividing soil and leaf litter into separate categories and adding rock as a new category.

In 1992, we defined canopy cover as the percent vegetative cover 2 m or more above the ground. Canopy cover was measured by recording presence or absence of such vegetation or stems at 1-m intervals along the two line transects bisecting the plots. Presence or absence was determined using an ocular tube (James and Shugart 1970). We calculated percent cover by dividing the number of points with vegetation by the 21 points sampled, then multiplying by 100. The ocular tube was difficult to use; we used a convex spherical densiometer to estimate canopy cover in 1993. Twenty readings, four at each corner and at the center, were taken in each 10-m x 10-m plot.

Foliage Height Profiles

Foliage height profiles depict the structural complexity of forests (Karr and Roth 1971, Brokaw and Grear 1991). We measured vertical structure of vegetation by recording the presence or absence of all vegetation and woody stems within the following height intervals: 0-0.5 m, 0.5-1 m, 1-1.5 m, 1.5-2 m, 2-2.5 m, 2.5-3 m, 3-4 m, 4-6 m, 6-8 m, 8-10 m,

10-12 m, 12-15 m, 15-20 m, and > 20 m. Vegetation intercepts for each of these height intervals were measured at 21 points along two line transects in each plot. In 1992, we used a 2.2 cm diameter x 3-m-long, round, pole marked at 0.5-m intervals positioned vertically to measure vegetation intercepts. For heights above 3 m, presence or absence of vegetation in the height intervals was estimated by sighting along the pole and measuring the height of vegetation in line-of-sight above the pole with a rangefinder. This method proved cumbersome, and in 1993, we used an 8-m-long, telescoping, measuring pole to determine heights. Heights above 8 m were estimated. We calculated percent vegetation cover for each height interval as the number of intercepts recorded for that height interval divided by the total number of sample points, then multiplied by 100.

Statistical Analyses

Because sample sizes were small on each island, data from all islands were grouped before analysis. We used detrended correspondence analysis (Gauch 1982) of tree basal area to group similar plots and determine relationships of the species and plots sampled. To adjust data for comparability between years, we included only live trees > 7.5 cm DBH in this calculation. Forest communities interpreted from the results of this analysis correspond to those of the Maine Natural Heritage Program (1991). For each forest community, we calculated average basal area, average tree and shrub density, and importance value for each species (Table 6), percent ground cover by cover class categories (Table 7), and vegetation height profiles (Table 8).

RESULTS

We established 33 plots on 8 islands. Plot locations are presented in Appendix A (Figures A1-A10); Universal Transverse Mercator (UTM) coordinates are listed in Appendix A, Table A-4.

Forest Communities

From our detrended correspondence analysis we separated four groups of similar plots (Gleason 1926) (Figure 3). Three clusters correspond to Maine Natural Heritage Program (1991) descriptions of the maritime spruce/fir, mixed hardwood/conifer, and early successional forest communities. One cluster was intermediate between maritime spruce/fir and northern white cedar seepage forest communities. Forest community determinations for each plot are summarized in Table 5. Because of time restraints, we did not sample all forest communities on all islands.

Maritime Spruce-Fir Forest

Twenty-three plots located on The Hop, Little Moose Island, Pond Island, Schoodic Island, Sheep Porcupine Island, and Western Ear were classified as maritime spruce-fir forest (Table 5). This was the most common forest community on park islands. These plots had major components of spruce, deadwood, balsam fir, and paper birch with minor components of red maple (*Acer rubrum*), staghorn sumac (*Rhus hirta*), American beech (*Fagus grandifolia*), and yellow birch (*Betula alleghaniensis*). White spruce occurred in higher percentages than red spruce. Dominant shrubs and seedlings included American mountain-ash (*Sorbus americana*), paper birch, red maple, spruce, balsam fir, cherry (*Prunus* sp.), honeysuckle (*Lonicera* sp.), and sheep laurel (*Kalmia angustifolia*) (Table 6). Canopy cover averaged 75%, whereas ground cover below 1 m was 25% herbaceous plants, 61% woody plants, 21% moss, 23% lichen, and 78% leaf litter (Table 7). Minimal rock or soil cover classes were found in this forest community. This forest community had the highest percent ground cover for both moss and lichen. Percent cover of vegetation from 2-8 m was the lowest of all forest communities sampled (Table 8).

Maritime Spruce-fir Forest X Northern White Cedar Seepage

All plots on Bald Porcupine Island were classified as intermediate between maritime spruce-fir and northern white cedar seepage forests (Table 5). A typical northern white cedar seepage forest community is dominated by cedar with mixtures of spruce or balsam fir and sparse shrubs (Maine Natural Heritage Program 1991). However, plots on Bald Porcupine Island were equally dominated by spruce and northern white cedar with minor amounts of striped maple (*Acer pensylvanicum*), deadwood, and balsam fir (Table 6). Dominant shrubs and seedlings included striped maple, balsam fir, northern white cedar, spruce, honeysuckle, American mountain-ash, and birch (*Betula* sp.) (Table 6). Maple seedlings were abundant in all plots. Canopy cover averaged 74% and ground cover below 1 m was 18% herbaceous plants, 62% woody plants, 5% moss, 1% lichen, and 82% leaf litter (Table 7). Minimal rock or soil cover classes were found in this forest community. Percent cover of vegetation from 6-10 m (Table 8) was the highest of all forest communities sampled, with 54% cover at 6-8 m and 38% cover at 8-10 m.

Mixed Hardwood-Conifer

Mixed hardwood-conifer forest communities were found on Bar Island (MIR# 59-265), Little Moose Island, and Sheep Porcupine Island (Table 5). This forest community is transitional between spruce-fir forests and northern hardwoods forests (Maine Natural Heritage Program 1991). Dominant tree species included spruce, deadwood, and red maple, with minor amounts of balsam fir, paper birch, northern red oak (*Quercus rubra*), and yellow birch (Table 6). Dominant shrubs and seedlings included balsam fir, spruce, red maple, American mountain-ash, currants (*Ribes* sp.), and blueberry (*Vaccinium* sp.) (Table 6). Canopy cover averaged 80% and ground cover below 1 m was 7% herbaceous plants, 48% woody plants, 10% moss, 9% lichen, and 92% leaf litter (Table 7). No rock or soil cover classes were found in this forest community. This forest community had the lowest percent of herbaceous plant ground cover of all forest communities sampled; however, the percent ground cover of leaf litter was the highest recorded. Percent cover of vegetation was nearly 50% from 0-8 m

(Table 8). Percent cover at the 10-12 m interval was the greatest of all forest communities sampled, with 56% cover.

Early Successional

Two plots on The Hop were classified as early successional forest community (Table 5). This forest community is associated with recent disturbance such as blowdowns, fire, or agricultural activities, and is dominated by mixed or hardwood forests (Maine Natural Heritage Program 1991). This forest community was composed of American mountain-ash and deadwood, with minor amounts of quaking aspen (*Populus tremuloides*), cherry, and spruce (Table 6). Dominant shrubs and seedlings included cherry, American mountain-ash, quaking aspen, striped maple, honeysuckle, and American highbush cranberry (*Viburnum opulus* var. *americanum*) (Table 6). Canopy cover averaged 63% and ground cover below 1 m was 62% herbaceous plants, 60% woody plants, 2% moss, 10% rock, and 71% leaf litter (Table 7). No lichen and little soil cover classes were found in this forest community. This forest community had the highest percent ground cover for herbaceous plants of all forest communities sampled and the lowest percent ground cover of moss and leaf litter. Percent cover of vegetation from 0-6 m (Table 8) was the highest of all forest communities sampled, ranging from 93% cover at 0-2 m to 62% cover at 4-6 m.

Tree Cores

The minimum age of trees in plots sampled varied from 30 years on The Hop to ≥ 100 years on Bald Porcupine Island and Western Ear. On Western Ear, all of the trees over 100 years old were red spruce with the oldest being at least 116 years old. Northern white cedar was the only species over 100 years old in the plots on Bald Porcupine Island. The center of every northern white cedar cored on this island was rotten; trees were much older than cores indicated. We cored a 29.7-cm DBH northern white cedar and counted 110 rings before reaching the rotten central portion of the core. Most of the oldest trees were found on the northeast corner of this island.

No trees were over 100 years old within the study plots on Bar Island (MIR# 59-265); however, we cored several large trees outside the plots. These included a 180 year-old red pine (*Pinus resinosa*), a 138 year-old northern red oak, and a 117 year-old eastern white pine. These, and other large trees were scattered over the island, interspersed with much younger trees.

DISCUSSION

Most forest plots on islands were categorized as maritime spruce-fir forest communities. This is a common forest community in coastal Maine (Maine Natural Heritage Program 1991). These forests are dominated by red spruce, balsam fir, and white spruce, with red spruce typically more common than white (Hill 1923, Davis 1966) except in a narrow coastal

band where white spruce dominates (Davis 1966). We found predominantly white spruce in the maritime spruce-fir forest communities.

The forest on Bald Porcupine Island was unusual because of its high percentage of northern white cedar. Northern white cedar is often found on sites with high soil moisture. However, the forest floor on Bald Porcupine Island was very dry. Hill (1923) notes that northern white cedar forests are rarely found on islands and speculates that these forests use fog for needed moisture. A number of cedar that we cored were 125 to 200 years old. This forest warrants further study to assess whether it qualifies for designation as a Maine Critical Area.

Bar Island (MIR# 59-265) and Western Ear also supported unique forest communities. The aggregation of large northern red oaks, eastern white pines, and red pines on Bar Island was found only on this island of those we studied. An increment core indicated that one red pine was 180 years old. Cut stumps indicated previous logging activities but it appears to have been selective, resulting in an uneven-aged stand. The forest on Western Ear contained large, old red spruce. Ten red spruce cored on this island were ≥ 100 years old, the oldest being 116 years. The park has recommended a survey to identify, map, and characterize old-growth forests (Acadia National Park 1994b); these islands should be included in these surveys.

Our efforts were intended to provide an initial attempt to identify and characterize forest habitats on small islands within Acadia National Park. Not all island forest communities were sampled. For example, we did not inventory any forests on Bar Island (MIR# 59-194) or Baker Island. Not all forest communities were sampled on Bald Porcupine Island, Bar Island (MIR# 59-265), and Little Moose Island. We recommend additional sampling on Bar Island (MIR# 59-194), Bar Island (MIR# 59-265), Baker Island, Bald Porcupine Island, and Little Moose Island. Recommendations for habitat protection could be derived from additional data collection, analysis, and interpretation.

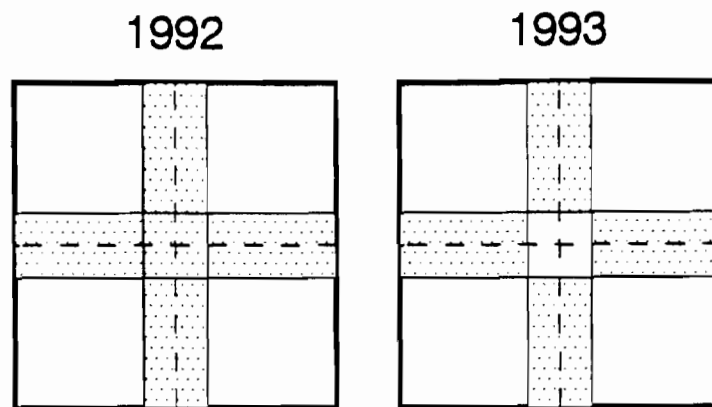


Figure 2. Layout of line (---) and belt transects (stippled areas) within 10-m x 10-m forest plots, with the center of plots not sampled in 1993.

Table 5. Number of plots used during 1992-93 to classify forest communities based on Maine Natural Heritage Program (1991) on eight islands of Acadia National Park.

Abbreviations: MS-F = Maritime Spruce/Fir; MS-F x NWCS = Maritime Spruce-fir X Northern White Cedar Seepage; MH/C = Mixed Hardwood-Conifer, ES = Early Successional.

Island Name	Forest Community Classification			
	MS-F	MS-F x NWCS	MH-C	ES
Bald Porcupine		4		
Bar (MIR# 59-265)			2	
The Hop	2			2
Little Moose	2		1	
Pond	11			
Schoodic	3			
Sheep Porcupine	1		1	
Western Ear	4			

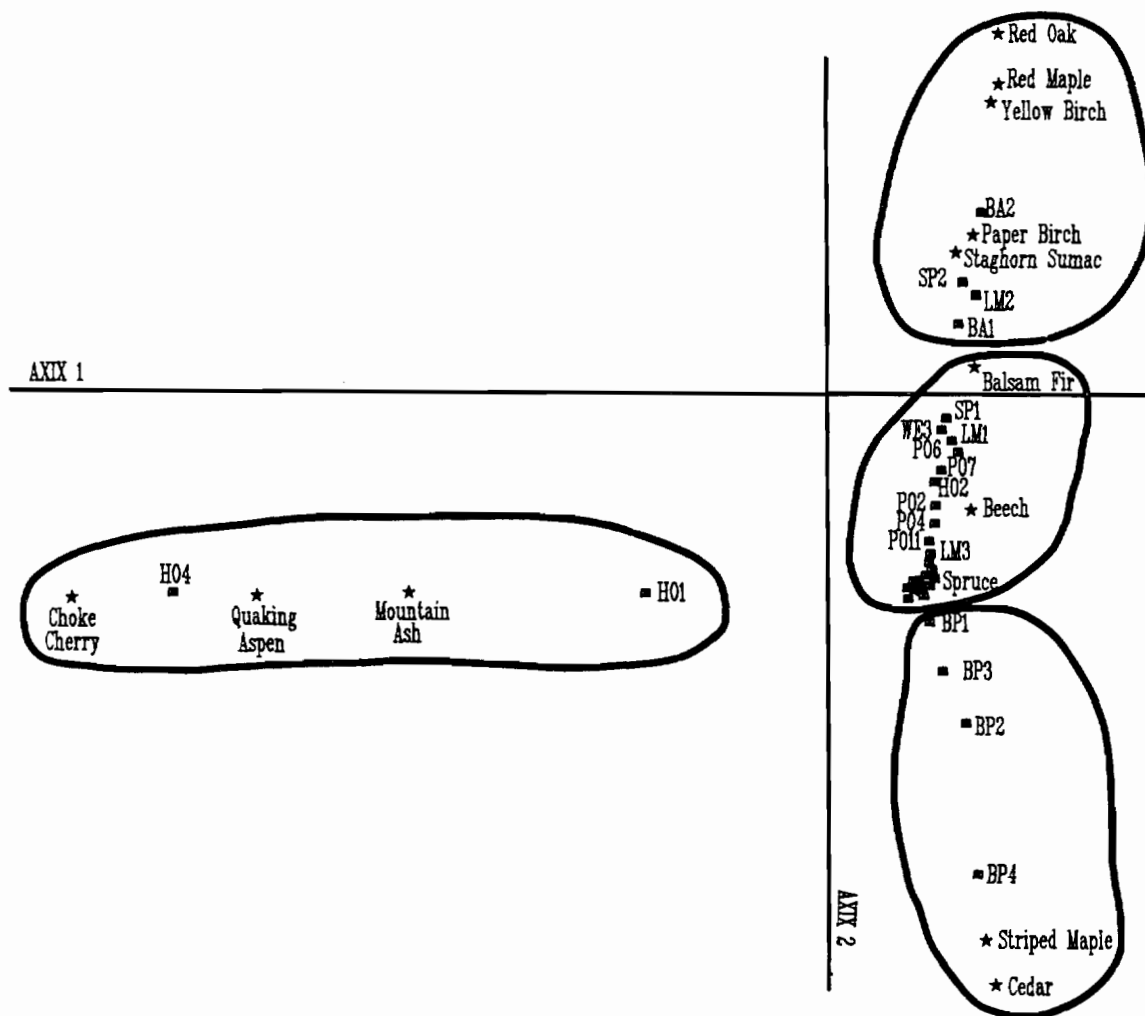


Figure 3. Plot of detrended correspondence analysis of forest community samples from eight islands of Acadia National Park, 1992-93.

Table 6. Stand structure of forest communities on eight islands of Acadia National Park, 1992-93.

Forest Community	Species	Basal Area ¹ (SE)	Density (Stems/ha) (SE)		Importance Value
			Trees ² (SE)	Shrubs ³ (SE)	
MARITIME SPRUCE/FIR	spruce sp.	26.0 (2.4)	760 (80)	4700 (2000)	139
	deadwood	10.5 (2.1)	645 (125)	865 (265)	92
	balsam fir	3.7 (1.2)	170 (50)	4600 (3200)	43
	paper birch	1.8 (0.7)	52 (19)	5750 (4200)	15
	red maple	.3 (.3)	13 (13)	5000 (3300)	4
	staghorn sumac	.04 (.04)	4 (4)	60 (35)	3
	American beech	.1 (.1)	4 (4)	0	2
	yellow birch	.1 (.1)	4 (4)	0	2
NORTHERN WHITE CEDAR SEEPAGE AND MARITIME SPRUCE/FIR	spruce sp.	14.6 (3.3)	400 (60)	830 (250)	83
	white cedar	14.1 (5.2)	400 (80)	2200 (1150)	81
	striped maple	5.4 (2.0)	325 (120)	80700 (30900)	55
	deadwood	5.5 (2.8)	150 (100)	460 (105)	43
	balsam fir	2.3 (1.2)	175 (75)	3950 (2150)	38
MIXED HARDWOOD/CONIFER	spruce sp.	10.1 (3.1)	750 (300)	1600 (1075)	70
	deadwood	20.0 (13.8)	275 (80)	840 (290)	66
	red maple	10.1 (3.2)	600 (200)	1100 (750)	59
	balsam fir	5.1 (3.0)	250 (75)	2400 (1600)	39
	paper birch	3.5 (2.3)	150 (75)	415 (190)	27
	red oak	4.3 (2.3)	175 (90)	125 (80)	25
	yellow birch	.8 (.7)	25 (20)	0	7
EARLY SUCCESSIONAL	American mountain-ash	5.1 (3.6)	300 (210)	1850 (900)	91
	deadwood	3.6 (2.5)	250 (175)	900 (140)	74
	quaking aspen	2.0 (0)	200 (0)	1650 (800)	58
	cherry sp.	1.5 (1.1)	150 (105)	69250 (14950)	49
	spruce sp.	1.6 (0)	50 (35)	50 (35)	28

1. Basal Area = m²/ha,

2. In this table, trees are defined as any upright woody stem with a DBH > 7.5 cm.

3. In this table, shrubs are defined as any upright woody tree species with a DBH < 2.5 cm regardless of height.

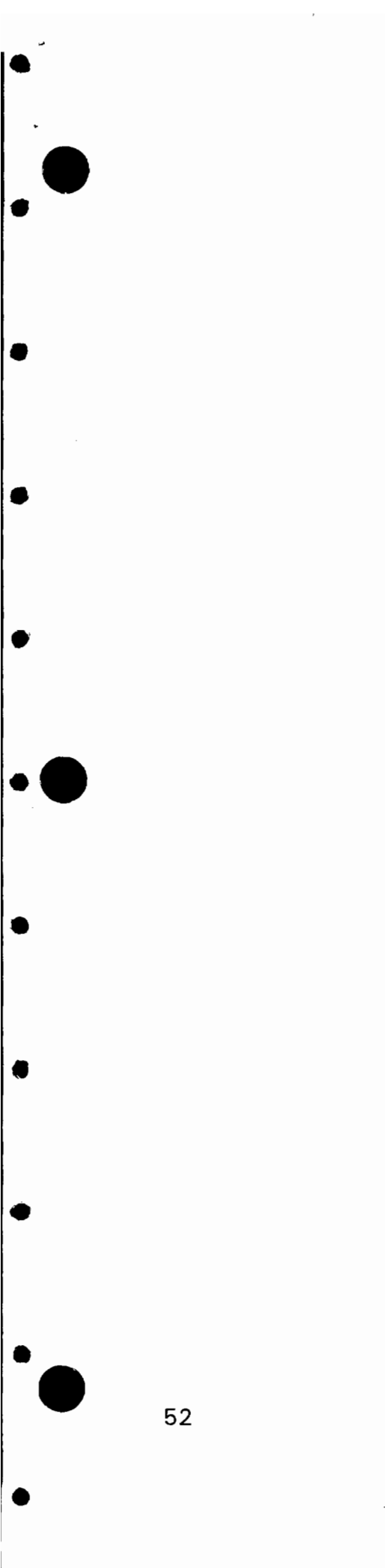
Table 7. Average percent ground cover by forest community on eight islands of Acadia National Park, 1992-93.

Forest Community	Number of Plots	Mean (SE)						
		Herbs	Woody Plants	Moss	Lichen	Soil	Rock	Leaf Litter
Maritime Spruce/Fir ¹	22	25 (8)	61 (4)	21 (5)	23 (8)	1 (1)	2 (1)	78 (5)
Northern White Cedar Seepage x Maritime Spruce/Fir	4	18 (11)	62 (7)	5 (4)	1 (1)	0	4 (1)	82 (6)
Mixed Hardwood Conifer	4	7 (4)	48 (14)	10 (4)	9 (3)	0	0	92 (4)
Early Successional	2	62 (0)	60 (2)	2 (2)	0	2 (2)	10 (7)	71 (10)

1. Excludes data collected in 1992 because of differing methodologies.

Table 8. Average percent cover of vegetation at different heights by forest community on eight islands of Acadia National Park, 1992-93. The percent vegetation cover for each height interval was calculated as an average of the number of intercepts recorded for that height interval divided by the total number of sample points taken at that height interval, then multiplied by 100.

Forest Community	Number of Plots	Mean (SE) by height intervals in m							
		0-2	2-4	4-6	6-8	8-10	10-12	12-15	> 15
Maritime spruce/fir	22	84 (4)	46 (5)	40 (5)	39 (5)	28 (4)	20 (3)	12 (3)	5 (2)
Northern white cedar seepage x maritime spruce/fir	4	70 (5)	57 (4)	57 (7)	54 (11)	38 (9)	32 (8)	5 (2)	0
Mixed hardwood conifer	4	52 (13)	52 (6)	51 (10)	48 (10)	32 (11)	56 (19)	26 (9)	2 (2)
Early successional	2	93 (2)	62 (10)	62 (13)	40 (15)	12 (2)	0	0	0



Mammals

HISTORIC INFORMATION

Records of mammals on small park islands are sparse (Greene et al. 1992). The most work on Maine islands was conducted by Crowell (1973, 1975, 1983, 1986), who has been studying mammals on islands in this region during the last 30 years. He has documented that meadow voles (*Microtus pennsylvanicus*), masked shrews (*Sorex cinereus*), and mink (*Mustela vison*) are the only resident terrestrial mammals on small islands in Penobscot and Jericho Bays. His research also investigates the effects of isolation and island size on species richness.

Manville (1942) noted that sea mink (*Mustela macrodon*) were common around the islands in the ANP area before being extirpated about 1900. Davis (1961) attempted to trap small mammals on Ironbound Island in Frenchman Bay, but did not catch any. Packie and Nadeau (1975) recorded meadow voles on Bar Island (MIR# 59-194) and Folger (1986) reports that muskrats (*Ondatra zibethica*) have been on Heron Island since the 1960s. Cole (1993) surveyed the mammalian fauna of Isle au Haut and recorded masked shrews, coyotes (*Canis latrans*), mink, raccoon (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus*), boreal red-backed voles (*Clethrionomys gapperi*), meadow voles, deer mice (*Peromyscus maniculatus*), red squirrels (*Tamiasciurus hudsonicus*), and snowshoe hare (*Lepus americanus*). Kilpatrick et al. (1994) reports on the distribution and identification of *Peromyscus* species on small islands along the coast of Maine.

The NPS has no jurisdiction over marine waters, therefore, marine mammals are not included in this study; however, Richardson (1977) identified Schoodic and Heron Islands as important sites for harbor seals (*Phocoena phocoena*) to haulout.

METHODS

We placed four to six transects to trap small mammals on each island to cover all habitat types. We identified habitat types by interpreting vegetation cover-type maps (Waggoner 1981), analyzing recent aerial photographs, and visiting study sites.

Small mammals were trapped along 100-m transects using Sherman live traps and pitfall traps on Baker Island, Bald Porcupine Island, Bar Island (MIR# 59-265), Heron Island, The Hop, Little Moose Island, Pond Island, Schoodic Island, Sheep Porcupine Island, and Western Ear. Start and end points of transects were permanently marked with rust-proofed rebar; locations are depicted in Appendix A.

Eleven trapping stations were established at 10-m intervals along each transect. Two Sherman live traps of different sizes (24 cm x 9 cm x 8 cm and 17 cm x 6 cm x 5 cm) were placed within 1 m of each station. Traps in open areas were shaded from direct sunlight with grasses, downed wood, or other materials. Traps were open continuously in good weather and closed during periods of heavy rain to prevent mortalities. Two to four pitfall traps (#10 metal can - 15.5-cm diameter by 17.5-cm deep) were installed along most transects. Pitfall traps were buried with the top of the can flush with the ground surface (Call 1986) and placed within 1 m of selected stations. Additional pitfalls were added to a transect if shrews were thought to occur in the area.

Sherman and pitfall traps were baited with a mixture of one part each of peanut butter, rolled oats, suet, raisins, and one-half part paraffin (Calhoun 1959) on all islands except Pond Island and Baker Island, which were baited with a mixture of peanut butter, rolled oats, and sunflower seeds (Johnson et al. 1984). To minimize death of animals in traps, dry polyfiber or cotton was placed in each trap for bedding and moistened cotton for fresh water. Traps were checked, at least, twice daily.

A large Havahart live trap (105 cm x 33 cm x 27 cm) was baited with sardines and set for one or two nights on Baker Island, Bald Porcupine Island, Heron Island, The Hop, Little Moose Island, Pond Island, Schoodic Island, and Western Ear to capture larger mammals.

We installed 10-m or 20-m-long plastic drift fences, with six to eight pitfall traps, to capture shrews on Bald Porcupine Island, Little Moose Island, and Western Ear. Methods for establishing drift fences are described in chapters on amphibians and reptiles.

We defined a trap night as a trap that was set and in working condition during an entire night. For drift fences, a trap night was tallied for each pitfall along the fence.

Mammals were identified using keys by Burt and Grossenheider (1976). Dead shrews were identified in the lab by dental pattern (Glass 1981, Franq 1981, Baker 1983). We identified tracks and scat using field guides by Murie (1974) and Stokes and Stokes (1986). We identified *Peromyscus* species using pelage color and length, and ratio of tail length to head and body length (Choate 1973). Identifications were confirmed using electrophoretic assay of salivary amylase (Aquadro and Patton 1980). Samples of saliva were collected by rinsing each mouse's mouth with distilled water. Samples were sent to W. Kilpatrick, at the University of Vermont, where they were fractionated and stained, and species were determined following methods described in Aquadro and Patton (1980) and Kilpatrick et al. (1994).

We noted observations of large mammals i.e., raccoon, white-tailed deer, which were easily identified at a distance. Also we searched for scat and tracks of mammals. Scats that were easily identified, e.g., white-tailed deer and showshoe hare, were noted; others were collected to identify in the laboratory.

We marked small mammals by clipping a patch of dorsal hair to note recent recaptures. We weighed all small mammals and measured tail and body lengths, except for shrews. Most animals were released at capture sites, but voucher specimens were collected when individuals died in traps. Voucher specimens are stored in freezers at Acadia National Park Headquarters. Voucher photographs were taken of other mammals captured whenever possible using a 35 mm camera and Kodak 64 ASA slide film. Trapping data and slides of small mammals are stored in the Natural Resource Library at ANP (Mittelhauser et al. 1996).

To compare number of species as related to island isolation, we grouped park islands into the following categories: islands attached to the mainland or MDI by a tidal bar [Bar Island (MIR# 59-265), Little Moose Island, and Pond Island]; islands attached to larger isolated islands by tidal bars (Baker Island, The Hop, and Western Ear); and islands continually surrounded by saltwater (Bald Porcupine Island, Heron Island, Schoodic Island, and Sheep Porcupine Island).

RESULTS

We conducted trapping June-July 1992 and June-September 1993 (Table 9). We trapped small mammals for 3,090 trap nights using Sherman live traps and 547 trap nights using pitfall traps on 10 islands.

We captured 117 small mammals representing nine species (Table 10). No federal or state-listed mammal species were captured or observed. Mice and voles were predominantly captured in Sherman live traps, and shrews were almost exclusively captured in pitfall traps. No captures were made using the large Havahart live trap. Recaptures and mortality varied widely among species. The highest recapture rate was 17% for the boreal redback vole. Overall mortality of mammals trapped was 24%, ranging from 14% for mice and voles to 77% for shrews.

Live muskrats were observed and some skeletons were collected on Heron Island.

Six species were verified by sight: mink, muskrat, porcupine, raccoon, red squirrel, and white-tailed deer (Table 10). Porcupine, snowshoe hare, mink, and white-tailed deer also were identified by sign (tracks or scat) on some islands.

Scats of a carnivore were collected on Little Moose Island, but we were unable to identify them to species because scats were too badly decomposed. Bobcat (*Lynx rufus*), red fox (*Vulpes vulpes*), and coyote are on the neighboring mainland (Mittelhauser et al. 1995). These species might visit Little Moose Island or Pond Island because these islands are connected to the mainland by a tidal bar.

We identified eight mammal species on both Bar Island (MIR# 59-264) and Little Moose Island; seven were found on Western Ear, and six on Pond Island. Only three species were found on Baker Island, two on Sheep Porcupine Island, and one on Heron Island. We verified two species from specimens collected by island residents on Bar Island (MIR# 59-194). We did not find any mammals on three islands: Bald Porcupine Island, The Hop, and Schoodic Island.

Marine mammals were not a focus of this research, however, many adult harbor seals were observed in the waters of Frenchman and Jericho Bays, and adjacent to Schoodic and Heron Islands on which they hauled out. A harbor seal pup was also observed on the bar at Western Ear in 1993.

DISCUSSION

We captured or collected skeletons of 10 mammal species and observed five additional species. Also, the occurrence of mink, porcupine, snowshoe hare, and white-tailed deer were documented by scat or tracks.

Although we did not conduct any field work on Bar Island (MIR# 59-194), residents of the island provided two small mammal specimens that we identified as a white-footed mouse and a shorttail shrew. They also reported observing coyotes, eastern chipmunk, raccoon, red fox, and white-tailed deer on the island within the last five years. Furthermore, their domestic cat recently killed a star-nosed mole. Table 10 includes these observations, as well as historic records for Bar Island (MIR# 59-194) (Packie and Nadeau 1975).

No mammals were found on Bald Porcupine, The Hop, or Schoodic Island. Steep cliffs, strong currents, and large expanses of water may effectively isolate these islands from other islands and the mainland, preventing immigration.

The degree of island isolation, i.e., distance from the mainland and other land masses, dictates the number of mammal species present on the islands (Crowell 1986). The number of mammal species on islands connected to the mainland or MDI by a tidal bar was higher than those on isolated islands (Table 11). Fourteen species were on islands connected to the mainland or MDI, seven species on islands connected to other islands, and three species on isolated islands. Tidal bars may provide routes for immigration or emigration, explaining the higher number of species on islands connected to other land masses.

On the small, isolated islands that Crowell (1973, 1975, 1983, 1986) studied, meadow voles, masked shrews, and mink were the only resident terrestrial mammals. We observed meadow voles, mink, and muskrats on islands not attached by tidal bars to other islands or the mainland, but found masked shrews only on islands connected by tidal bars to other islands or the mainland. Other comparisons between our results and that of Crowell's are difficult

because unlike Crowell, we studied many islands connected by tidal bars to the mainland or other islands.

The population of muskrats on Heron Island is an unusual occurrence, as this island is >5 km from the mainland. Clough (1987) reports muskrats on Damariscove Island in southern Maine, adapted to upland habitats similar to habitat conditions on Heron Island. The vulnerability to extinction of muskrat populations on islands (Crowell 1986), and use of the island by muskrats despite a lack of freshwater habitats, justifies further study of the ecology of muskrats on Heron Island.

Muskrats on Heron Island do not seem to have an adverse affect on seabird nesting activities, but their coexistence this may warrant additional study. The absence of mammalian predators on Bald Porcupine Island and Schoodic Island allow for successful nesting of colonial seabirds.

This survey was preliminary, and detailed research regarding the ecology of mammals on park islands was beyond our scope. We recommend additional trapping of shrews by establishing drift fences on islands with wetlands (Baker Island, Little Moose Island, Pond Island, and Schoodic Island). Further research is needed on natural fluctuations and extinctions of mammal populations and genetic diversity on park islands, rate of mammal immigration and emigration on islands, occurrence of bats, and on the ecology of the Heron Island muskrat population. Periodic monitoring of all mammal populations is also recommended.

Table 9. Effort expended to capture small mammals on 10 islands of Acadia National Park, 1992-93.

Island Name	Year	Dates of Trapping Effort	Transects	Trapnights		
				Sherman	Pitfalls	Drift Fence Pitfalls
Baker	1992	7/7 - 7/9	5	220	20	0
Baker	1993	8/3 - 8/6	6	380	34	0
Bald Porcupine	1993	7/5 - 7/9, 9/2 - 9/27	5	389	32	168
Bar (MIR# 59-265)	1993	9/15 - 9/20	4	172	28	0
Heron	1993	7/12 - 7/14	5	201	20	0
The Hop	1993	6/7 - 6/10	4	259	8	0
Little Moose	1993	6/2 - 6/4, 9/13 - 9/15	5	202	4	88
Pond	1992	6/30 - 7/3	4	212	8	0
Schoodic	1992	7/21 - 7/30	6	572	40	0
Sheep Porcupine	1993	9/7 - 9/14	4	264	62	0
Western Ear	1993	6/29 - 7/2	4	219	23	12
TOTALS			52	3090	279	268

Table 10. Mammal species lists, including species we observed, historic observations we verified, and historic observations not relocated during 1992 and 1993 on 10 islands of Acadia National Park. All collections and observations on Bar Island (MIR# 59-194) were made by island residents J. & M. Perkins. Key to abbreviations:

Mammal presence: XXS = voucher specimen; XXP = voucher photograph; XXX = captured, no voucher; XX = positive sightings; X = identification by tracks or scat.

Islands:
 Baker = Baker Island, BaldP = Bald Porcupine Island, Bar 194 = Bar Island (MIR# 59-194), Bar 265 = Bar Island (MIR# 59-265), Heron = Heron Island, Hop = The Hop, LtlMo = Little Moose Island, Pond = Pond Island, Schdc = Schoodic Island, WstEar = Western Ear.

Mammal Species	Common Name	Island										
		Baker	BaldP	Bar 194	Bar 265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	Wst Ear
<i>Blarina brevicauda</i>	shorttail shrew			XXS ¹	XXS							
<i>Canis latrans</i>	coyote			XX ²								
<i>Clethrionomys gapperi</i>	boreal redback vole				XXS				XXS			
<i>Condylura cristata</i>	starnose mole			XX ²								
<i>Erethizon dorsatum</i>	porcupine							XX	X			
<i>Lepus americanus</i>	snowshoe hare								X			X
<i>Microsorex hoyi</i>	pygmy shrew							XXS				
<i>Microtus pennsylvanicus</i>	meadow vole	XXP		Packie & Nadeau (1975)				XXS		XXS		XXP
<i>Mustela vison</i>	mink	XX						X			X	X
<i>Odocoileus virginianus</i>	white-tailed deer	XX		XX ²	X			X	X			
<i>Ondatra zibethica</i>	muskrat					XXS						
<i>Peromyscus leucopus</i>	white-footed mouse			XXS ¹	XXS							
<i>Peromyscus maniculatus</i>	deer mouse											XXS
<i>Procyon lotor</i>	raccoon			XX ²	XX							
<i>Sorex cinereus</i>	masked shrew				XXS			XXS	XXS			XXS
<i>Tamias striatus</i>	eastern chipmunk			XX ²	XXX							
<i>Tamiasciurus hudsonicus</i>	red squirrel				XX			XX	XX			XX
<i>Vulpes vulpes</i>	red fox			XX ²								
<i>Zapus hudsonius</i>	meadow jumping mouse							XXP				

¹ Collected by J. & M. Perkins 1992-1993, voucher specimen provided for verification

² Noted by J. & M. Perkins (pers. comm.) during the previous five years

Table 11. Degree of island isolation and number of mammal species on 10 islands of Acadia National Park, 1992-93.

Mammal Species	Common Name	Connected to Mainland by Tidal Bar (3 islands)	Connected to Other Islands by Tidal Bar (3 islands)	Isolated by Salt Water (4 islands)
<i>Blarina brevicauda</i>	shorttail shrew	X		
<i>Clethrionomys gapperi</i>	boreal redback vole	X		
<i>Erethizon dorsatum</i>	porcupine	X		
<i>Lepus americanus</i>	snowshoe hare	X	X	
<i>Microsorex hoyi</i>	pygmy shrew	X		
<i>Microtus pennsylvanicus</i>	meadow vole	X	X	X
<i>Mustela vison</i>	mink	X	X	X
<i>Odocoileus virginianus</i>	white-tailed deer	X	X	
<i>Ondatra zibethica</i>	muskrat			X
<i>Peromyscus leucopus</i>	white-footed mouse	X		
<i>Peromyscus maniculatus</i>	deer mouse		X	
<i>Procyon lotor</i>	raccoon	X		
<i>Sorex cinereus</i>	masked shrew	X	X	
<i>Tamias striatus</i>	eastern chipmunk	X		
<i>Tamiasciurus hudsonicus</i>	red squirrel	X	X	
<i>Zapus hudsonius</i>	meadow jumping mouse	X		
TOTALS		14	7	3

Amphibians and Reptiles

HISTORIC INFORMATION

No information exists on amphibian or reptile species on small park islands (Greene et al. 1992).

Of the 34 species of amphibians and reptiles found in Maine (Hunter et al. 1992), only a few species have been found on islands. Four species of salamanders and snakes are noted from Isle au Haut, a large offshore island within ANP: spotted salamanders (*Ambystoma maculatum*), red-bellied snakes (*Storeria occipitomaculata*), common garter snakes (*Thamnophis sirtalis*), and smooth green snakes (*Opheodrys vernalis*) (Bishop and Clarke 1923, Manville 1964).

Common garter snakes and redback salamanders (*Plethodon cinereus*) are the most common species on the mainland and occur on many coastal Maine islands (Lesser 1977, Folger and Wayne 1986, Hunter et al. 1992). Tynning (1990) reports that some coastal islands in the eastern U.S. have populations of milk snakes (*Lampropeltis triangulum*), although no milk snakes were recorded from islands in Maine (Hunter et al. 1992).

METHODS

We used direct searches, artificial shelters, and trapping to inventory reptiles and amphibians. A combination of these methods was used on each island as time allowed.

We searched for amphibians and reptiles during the day on all islands and after nightfall on Baker Island, The Hop, Pond Island and Schoodic Island. Searches focused on examining micro-habitats appropriate to particular species to verify presence (Heyer et al. 1994). Searches were conducted by turning over logs and rocks, looking through leaf litter, walking slowly through tall grasses, examining rock piles, old foundations and other suitable habitat where snakes were expected to bask in the sun, and by investigating areas with standing fresh water. These searches involved modest habitat modification such as breaking apart rotten logs or turning over debris.

We used wooden boards (29.5 cm x 29.5 cm x 4.0 cm) cut from untreated construction-grade fir as artificial shelters to attract amphibians (Fellers et al. 1988). Boards were placed, unbaited, approximately every 10 m along the same 100-m transects used for trapping small mammals (see mammal chapter). Vegetation beneath boards was either trampled down or removed. We checked boards daily. In an effort to improve capture success, wooden

shelters were left in place on Schoodic Island following our field work in 1992 and revisited in 1993.

Fitch (1987, 1992) suggests use of corrugated roofing material and wood as reptile shelters. We used sheets of black polyethylene plastic (3 mil) as artificial shelters, primarily to attract snakes, because it was more easily transported to the islands. Unbaited, 2-m x 3-m plastic sheets were placed in appropriate snake habitats, e.g., rock piles and grassy areas (Hunter et al. 1992). Plastic sheets were checked daily.

Stockwell and Hunter (1985) suggest using 35-cm deep pitfall traps for capturing snakes and amphibians. The shallowness of soils on the islands prevented us from using such traps. Pitfalls were created using No. 10 metal cans (15.5-cm diameter by 17.5-cm deep) buried so the lip of the can was flush with the ground (Call 1986). Two pitfall traps were placed along transects also used for small mammal trapping (see mammal chapter) on each island. Pitfall traps were baited for small mammals using a mixture of rolled oats, raisins, peanut butter, and suet. Invertebrates were often caught in pitfalls and may have served as bait for amphibians.

Drift fences set with pitfall traps were used on three islands: Bald Porcupine Island and Western Ear each had one 10-m-long fence, and Little Moose Island had two 20-m-long fences. Fences were made of polyethylene plastic supported by wooden stakes. Each fence was 50 cm high, the lower edge buried approximately 10 cm into the ground to prevent animals from passing underneath. Pitfall traps were sunk into the soil adjacent to the fence until they were flush with the ground surface (Vogt and Hine 1982). Traps were placed approximately every 5 m along the 10-m-long fences and approximately every 7 m along the longer fences. These traps were not baited, although invertebrates that fell into traps may have served as bait.

Snake traps were designed after a model described by Hall (1967). Each trap consisted of a one pound coffee can (14 cm tall x 10 cm diameter) attached to a funnel constructed of 0.3 cm mesh hardware cloth. Traps were placed in grassy habitats and along old foundations and rock piles, situated so that these features would lead snakes into traps (Fitch 1992). These funnel traps for snakes were not baited.

Species, location, body length, and weight were recorded for each salamander captured. Although salamanders are sometimes measured from tip of snout to vent (Heyer et al. 1994), we measured total body length from tip of snout to tip of tail. Salamanders were weighed by placing them in a small nylon bag and attaching it to a 10-g capacity Pesola scale. All weights were recorded to the nearest 0.1 g. Generally, snakes were not handled unless it was necessary to identify them.

We defined a trap night as a trap or shelter set during the night. For drift fences, we tallied a trap night for each pitfall trap along the fence each night. Direct searches were conducted day and night intermittently throughout our field work; total effort was not quantified.

Field guides and literature of Hunter (1984), Tynning (1990), Conant and Collins (1991), and Hunter et al. (1992) were used to determine appropriate habitats for selected species, and to identify species.

We photographed specimens whenever possible using a 35 mm camera and Kodak 64 ASA slide film. Data and slides are stored at the Natural Resource Library at ANP (Mittelhauser et al. 1996)

RESULTS

We trapped and searched on 11 islands during June-July 1992 and June-September 1993. We trapped reptiles and amphibians for 1,417 trap and shelter nights using various methods. Methods used, timing, and level of sampling effort are summarized in Table 12. Only three hours of direct searches were conducted on Bar Island (MIR# 59-194) in June and July of 1992 and 1993, much less than the other islands studied.

Amphibians

We found redback salamanders on seven of the eleven islands (Table 13). Both redback and leadback phases were on most islands. Although the level of effort varied among islands, we observed many salamanders on Baker Island, The Hop, Schoodic Island, and Sheep Porcupine Island; only one was found on Bald Porcupine Island, four on Bar Island (MIR# 59-265), and two on Little Moose Island. Salamanders were absent from Bar Island (MIR# 59-194), Heron Island, Pond Island, and Western Ear.

Effectiveness of each capture method is summarized in Table 14. Redback salamanders were captured most frequently during direct searches and in pitfall traps along transects. Direct searches were generally most productive on damp or wet evenings. Only one salamander was captured using drift fences.

Wooden board shelters were used on Pond Island and Schoodic Island but were not effective in attracting salamanders. Even after two weeks, conditions under the boards remained dry. To improve trap effectiveness, we left the shelters in place on Schoodic Island following our field work in 1992. The capture rate of the boards on Schoodic Island increased from 0.06 salamanders/board in July, 1992, to 0.16 salamanders/board in August, 1992, and to 0.39 salamanders/board in June, 1993.

Reptiles

Reptiles were observed on six islands. We found the eastern subspecies of the common garter snake (*T. s. sirtalis*) on Baker Island, The Hop, Little Moose Island, Schoodic Island, and Sheep Porcupine Island. Individuals approaching the maritime subspecies (*T. s. pallidulus*; Bleakney 1959) were found only on Baker Island, The Hop, and Schoodic Island, however, overall color and pattern of individuals examined was highly variable. Smooth green snakes were found only on Bar Island (MIR# 59-194). No reptiles were found on Heron Island, Pond Island, or Western Ear.

Snakes were observed most frequently during direct searches (Table 14). Black plastic shelters were also effective. Snake funnel traps were ineffective for capturing snakes.

DISCUSSION

We captured or observed redback salamanders on seven islands, eastern garter snakes on five islands, and smooth green snakes on one island. No amphibians or reptiles were found on Heron Island, Pond Island, or Western Ear (Table 13). We conducted only limited field work on Bar Island (MIR# 59-194). Residents of the island provided a detailed description of an eastern garter snake they observed in 1993 (Perkins, pers. comm.).

Island size or isolation did not seem to affect a species occurrence. We found reptiles and amphibians on islands of various sizes and ranging in isolation from being connected to the mainland by a tidal bar to being unconnected.

The low number of reptile and amphibian species observed may be, in part, a result of the lack of fresh water on many of the islands. Some species of amphibians, i.e., toads, frogs, and some salamanders, require open water to breed. Fresh water was scarce on many islands. The only islands with even meager amounts of standing fresh water were Baker Island, Little Moose Island, Pond Island, and Schoodic Island.

Amphibians emergence is often related to specific short-term weather events (Heyer et al. 1994) and may last only a briefly. Our searches and trapping were not timed to match optimal emergence times; instead, they were often conducted during the driest part of the year. We recommend additional surveys for amphibians in spring, targeting islands with suitable amphibian habitat.

We used a variety of methods to detect amphibians and reptiles. Vogt and Hine (1982) and Jones (1986) report that only a small percentage of species that occupy an area are observed during direct searches. We found direct searches worked well for detecting both reptiles and amphibians. Pitfall traps along transects were also successful for detecting amphibians, whereas pitfalls along drift fences resulted in only a single capture of a salamander.

Drift fences have been used extensively to inventory and monitor amphibian populations and are a technique that has proven successful in many areas (Campbell and Christman 1982, Stockwell and Hunter 1989, Vogt and Hine 1982). Our lack of success with this method may be the result of poor timing of field work and the limited number of drift fences erected. The diversity and number of habitats sampled by drift fences also was far less than those sampled by pitfall traps along transects; this may have contributed to the disparity in trapping success of these two methods.

Few redback salamanders were captured under wooden shelters that had been set out for less than two weeks. This may have resulted from low moisture under the boards. We had more success with this method when boards had been in place for a month or longer. By then, boards had begun to settle into the ground and retain moisture. Because of our limited field time on each island, this method proved ineffective. However, if boards remain in place over longer periods, wooden board shelters can be highly effective in attracting amphibians (Fellers et al. 1988).

Black plastic shelters were the most effective method for attracting snakes. Although funnel traps are a common method for trapping snakes (Fitch 1951, 1987, Clarke 1966, and Campbell & Christman 1982), we had no success using funnel traps placed next to natural objects that served as drift fences.

Table 12. Trap and shelter nights by capture method used to survey amphibian and reptiles on small islands of Acadia National Park, 1992-93.

Island Name	Year	Dates of Field Work	# of Trap or Shelter Nights by Capture Method				
			Shelters		Pitfalls	Drift Fence Pitfalls	Snake Funnel Traps
			Wooden Boards	Black Plastic			
Baker	1992	7/7 - 7/9	100	--	20	--	--
Baker	1993	8/3 - 8/6	--	17	34	--	14
Bald Porcupine	1993	7/5 - 7/9, 9/2 - 9/27	--	15	32	168	24
Bar (59-265)	1993	9/15 - 9/20	--	--	28	--	--
Heron	1993	7/12 - 7/14	--	16	20	--	14
The Hop	1993	6/8 - 6/10, 8/9 - 8/10	--	16	8	--	--
Little Moose	1993	5/20 - 6/4, 9/13 - 9/15	--	8	4	88	--
Pond	1992	6/30 - 7/6	264	--	8	--	--
Schoodic	1992	7/21 - 7/30	350	--	40	--	--
Sheep Porcupine	1993	9/7 - 9/14	--	--	62	--	--
Western Ear	1993	6/29 - 7/2	--	16	23	12	16
Total number of trap nights			714	88	279	268	68

Table 13. Reptiles and amphibians observed on 10 islands of Acadia National Park, 1992-93.

Key to abbreviations:

Amphibian and reptile presence: XXS = voucher specimen; XXP = voucher photograph; XXX = captured, no voucher;
XX = positive sighting

Islands:

Baker = Baker Island, BaldP = Bald Porcupine Island, Bar 194 = Bar Island
(MIR# 59-194), Bar 265 = Bar Island (MIR# 59-265), Heron = Heron Island,
Hop = The Hop, LtlMo = Little Moose Island, Pond = Pond Island,
Schdc = Schoodic Island, WstEar = Western Ear.

Species	Common Name	Island Name										
		Baker	BaldP	Bar 194	Bar 265	Heron	Hop	LtlMo	Pond	Schdc	ShpPr	Wst Ear
<i>Plethodon cinereus</i>	redback salamander	XXP	XXS		XX		XX	XX		XXP	XX	
<i>Thamnophis sirtalis</i>	common garter snake	XXP		XX ¹			XX	XX		XXP	XX	
<i>Opheodrys vernalis</i>	smooth green snake			XX								

¹ Observed by M. Perkins (pers. comm.).

Table 14. Numbers and percent of total captures of redback salamanders and common garter snakes by methods used on 10 islands of Acadia National Park, 1992-93.

Species	Numbers and Percent of Total Captures					
	Methods					
	Direct Search	Wooden Boards	Black Plastic	Pitfalls	Drift Fences	Funnel Traps
<i>Plethodon cinereus</i> redback salamander (n=175)	88	4	<1	7	<1	N/A
<i>Thamnophis sirtalis</i> common garter snake (n=24)	88	N/A	12	N/A	N/A	0

Human Use and Effects

HISTORIC INFORMATION

The park has little information on historic or contemporary patterns of human use on islands or the effects of visitors on natural resources, yet this information is vital to the management and protection of island resources.

Information on human use of the study islands before park acquisition is limited to McLane (1982, 1989) who summarizes historic use of Baker Island, Bald Porcupine Island, Bar Island (MIR# 59-194), Heron Island, The Hop, Schoodic Island, Sheep Porcupine Island, and Western Ear.

McLane (1989) reports the presence of structures on seven islands within the last 200 years: Baker Island, Bald Porcupine, Bar Island (MIR# 59-194), The Hop, Schoodic Island, Sheep Porcupine and Western Ear. The Baker Island lighthouse and four other structures on Baker Island were built in the early 1800s by the Gilley family (Eliot 1967). The Baker Island Light Station is listed on the National Register of Historic Places (National Park Service 1993b).

Haying, farming, and pasturing of livestock has been a common use of islands along the Maine coast since the 1800's (Conkling 1981, McLane 1982, 1989). Baker Island, Bald Porcupine Island, Bar Island (MIR# 59-194), Heron Island, The Hop, and Sheep Porcupine Islands are all known to have supported livestock (McLane 1989). Thirty-two sheep, as well as nesting common eider and gulls, were noted on Heron Island on 11 July 1968, shortly after the NPS acquired the property (Sullivan and Favour 1968). Sheep were removed from the island soon thereafter (McLane 1982).

The Hop was logged for cordwood in 1938 (McLane 1989), and we suspect timber on many other park island forests was cut during the 1700-1800s when lumber and boat building were lucrative industries along the Maine coast (Conkling 1981).

The park has almost no figures on visitor use of islands under its jurisdiction. Ranger-guided boat cruises, which land visitors on Baker Island have been offered for many years, and these tours since 1991 have averaged 3,066 persons each year during July and August. Manning (1987) found that 5.4% of park visitors responding to his survey visited Baker Island, and 13.5% visited Bar Island (MIR# 59-194). Eighteen percent of MDI residents surveyed had visited Baker Island and 20% had visited Bar Island (MIR# 59-194). He did not address other visitor use issues on park islands other than MDI and Isle au Haut.

The park's General Management Plan (National Park Service 1992b) advocates prohibiting human visitors to offshore islands that serve as important bird nesting and breeding sites during critical nesting periods. It calls for retaining current levels of use and opportunities for low-density recreation on islands to protect the environment and the opportunity for solitude for visitors.

METHODS

During our visits to the islands we recorded evidence of previous human use (i.e., structures, foundations, walls and fences), the numbers of human visitors we saw, and effects on resources of each island as we conducted our inventories. We made no systematic, quantified assessments of visitor use or their effects.

We noted visitors to the islands while we conducted field work (see Table 1 in Introduction chapter for dates of field work). Whenever possible, we noted how visitors reached each island and their pattern of use on the island to assess potential threats to natural resources resulting from their visitation.

While conducting other natural resource inventories we searched for effects of humans, including social trails, campsites, fire rings, damage to vegetation, soil compaction, disturbance of wildlife, trash, and marine debris.

We spent only limited field time on Bar Island (MIR# 59-194). Information provided below is based on general knowledge of the area and incidental findings.

We did not address pre-European use or archaeological resources of the islands in this study.

RESULTS

We saw building structures or other evidence of human occupation on Baker Island, Bald Porcupine Island, Bar Island (MIR# 59-194), Bar Island (MIR# 59-265), Sheep Porcupine Island, and Western Ear. We saw evidence of visitor use on all islands except Heron Island. Effects of humans on natural resources were evident on many islands, but were especially prominent on Little Moose Island and Schoodic Island. Observations of evidence of historic human uses, general observations of current visitor use and use patterns on the islands, and evidence of visitor effects are discussed below.

Baker Island: Six structures still stand: one private home, a school house, an old homestead, a barn with hay loft, the lighthouse and the keeper's quarters. Several old foundations also were noted. Stone walls were observed throughout the island and an old metal fence supported by stone posts still exists in places around the lighthouse.

A regularly scheduled NPS tour transports and leads approximately 350 visitors per week to this island in July and August, and fewer numbers in June and September. Most visitors followed an ANP naturalist across the island on a trail. Some visitors explored the shore, or visited the lighthouse and cemetery on their own. Baker Island also

received day use by boaters. Only minor amounts of trash were noted along the trail despite the large number of people that use it.

Bald Porcupine: A stone foundation was found on the northwest corner of the island. We found the remains of stove pipe, coal, and a stone-lined hole approximately 2 m in diameter. A large metal pulley attached to granite ledge was located inland in line with the breakwater, approximately 40 m from the edge of the rocks. A rope was found at the entrance to the sea cave and allowed access up and down a steep, slippery bank. No visitors and little trash were observed. Arduous landing sites and steep cliffs make access to this island difficult.

Bar Island (MIR# 59-194): One winterized private residence is located on the southeastern shore. Scattered bricks on the southwestern corner of the island combined with the presence of daylily (*Hemerocallis fulva*) and common lilac suggests previous human occupation. An abandoned field is located where the road enters the island from the tidal bar.

Because of its proximity to the town of Bar Harbor, and its accessibility at low tide by tidal bar, visitation is high throughout the summer season. The island also receives regular use throughout the remainder of the year.

Despite regular use, few effects of visitors were noted other than occasional trash. A trail leads from the bar to the highest point on the island, and other less conspicuous trails exist near the perimeter of the island.

Bar Island (MIR# 59-265): We observed a concrete cistern at the highest point of this island with many metal pipes extending above ground. A small stone-lined hole and the remains of a well were noted on the northwestern side of the island. An engraved granite stone memorializing the island's donor also was found on the northern end of the island along the shore.

No visitors were seen during our field work; however, a path on the island originates at the tidal bar, suggesting regular use. No other effects of visitors were noted.

Heron Island: No structures, visitors, or effects of human visitors were observed.

The Hop: We found no evidence of structures on The Hop.

One commercial kayak tour and an additional two kayakers were the only visitors observed on the island.

A fire ring, the presence of tent stakes, ax marks, a burn scar on a tree, and trash indicate that The Hop has received day and overnight use.

Little Moose Island: Swings and seats constructed of logs and debris were found in the woods near a fire ring on the north side of the island. This was the only evidence of structures on the island.

Visitors were seen daily on Little Moose Island.

A myriad of trails traverse the southern end of the island. One trail leads through the park's only population of marsh felwort, a state-listed plant of special concern. Trampling also appears to be impacting boreal knotty pearlwort, another state-listed rare plant. Trash was observed in many areas along the trails and on the shore.

Pond Island: We found no trace of structures on the island.

Visitation was infrequent and numbers of visitors low during our time on this island. Minimal amounts of trash were noted.

Schoodic Island: We found no evidence of structures or human habitation on the island.

We saw visitors regularly on Schoodic Island. We observed canoers and kayakers using the island. Most seemed to have paddled from the Schoodic mainland.

We recorded many incidents of visitors inadvertently disturbing nesting common eiders and gulls. Human presence causes adult birds and chicks to flush from the nest, making chicks and eggs vulnerable to predation or hatch failure (Kuss et al. 1990). On June 19, 1992, for example, we visited the island and, despite our staying along the shore to minimize disturbance, we flushed many birds and witnessed gulls killing eider chicks when the chicks were separated from their parents. On our next visit July 16, 1992, we observed at least 15 people traversing nesting habitat on the island, flushing birds. We witnessed gulls killing gull chicks flushed onto the water and eating unprotected eggs as a result of this disturbance.

On one morning visit we observed a kayaker leaving the island and later found a trampled area in the grass which appeared to be a campsite. We saw no other evidence of camping or overnight use. Little trash was noted in the interior of the island; however, the shoreline was heavily littered with marine debris.

Sheep Porcupine Island: We found the deteriorated remains of a structure at the summit of this island. Evidence of this structure will probably be lost soon. Apple trees and barberry bushes are cultivated plants that suggest previous human occupation.

Two visitors were observed on the island.

Effects of visitors on island resources included two recently used fire rings, a trampled campsite, trash, and a trail along the western side of the island.

Western Ear: An old, dilapidated fishing shack is in the forest on the north side of the island.

One to three visitors were observed daily during both summer and fall.

Evidence of human use was minimal with only a few pieces of trash noted on the entire island. Shotgun shells were observed in a few areas along the perimeter of the island.

DISCUSSION

We noted evidence of structures on six islands, and observed visitors on all islands except Heron Island. Two islands accessible by tidal bars seemed to receive the most visitor use - Bar Island (MIR# 59-194), and Little Moose Island. Natural resources on The Hop, Little Moose Island, and Schoodic Island appear to be effected by human visitors.

State-listed rare plants were found on all islands except Bar Island (MIR# 59-194) and Pond Island. Kuss et al. (1990) found that low levels of human use can be damaging to soils and vegetation. Effects from visitors on rare plants on ANP islands include trampling, collecting, and unauthorized plantings (L. Gregory, ANP, pers. comm.). On islands where effects of human visitors are already apparent, immediate action may be necessary to protect vegetation and soils from further degradation.

We observed soil compaction, erosion, and trampling of plants on Little Moose Island. This island is readily accessible from Schoodic Peninsula by a tidal bar and was one of the most heavily visited and impacted islands studied. Of particular concern are populations of two rare plants, marsh felwort and boreal knotty pearlwort, being trampled as a result of dispersed use across the island. There are currently no restrictions or other management actions employed to reduce these effects on Little Moose Island, although a sign is being constructed to place near the most commonly used access point to the island from the tidal bar to educate island visitors of the potential for effects on resources.

Although we did not observe any unauthorized collecting of plants, some species commonly found on islands are collected illegally throughout the park (N. Dodge, ANP, pers. comm.). These include showy flowers and plants of commercial value such as sea lavender (*Limonium carolinianum*). Islands may be especially attractive to collectors because they are seldom patrolled by park rangers. We also have received reports (L. Gregory, ANP, pers. comm.) of well-meaning local residents who propagate native species and plant them on park

islands, and other park visitors who scatter seed of unknown origin. These practices disturb soils and may alter the genetic composition of plant populations on islands.

Wildlife resources also may be at risk from human effects such as disturbance, habitat loss, and trash.

Sheep Porcupine Island, Schoodic Island, and Bar Island (MIR# 59-265) have supported eagle nests for many years (Jacobi 1994). We observed people on these islands during the summers of 1992 and 1993. Despite much study, there is conflicting information regarding the effects of human disturbance on reproductive success of eagles (Kuss et al. 1990). Nevertheless, the State of Maine closes to visitors selected bald eagle nesting islands under the jurisdiction of the Department of Inland Fisheries and Wildlife (MDIF&W; A. Hutchinson, MDIF&W, pers. comm.). In Maine, The Nature Conservancy strongly encourages visitors to avoid bald eagle nesting areas through signs, literature, and staff contacts with recreational users (J. Henderson, The Nature Conservancy, pers. comm.). The U.S. Fish and Wildlife Service administers Cross Island, 681 ha, which supports nesting bald eagles. On Cross Island, visitors are banned from within one-quarter mile of the nest to prevent disturbance from humans (B. Benedict, U.S. Fish and Wildlife Service, pers. comm.). Park staff are meeting with local tour operators and kayak rental concessioners to educate these groups about the potential for disturbance to eagles, and asking them to avoid disturbing eagles during critical nesting times. The NPS has not placed a seasonal closure to visitors on bald eagle nesting islands in ANP.

Although eagle pairs seem to vary locally in their tolerance to human activity (A. Matz, University of Maine, pers. comm.), we suspect eagles have been disturbed by visitors on some park islands. Further study is needed to determine the type, extent, and effects of human disturbance on bald eagles. This research may be beyond the scope of the NPS, and may necessitate a cooperative effort with the U.S. Fish and Wildlife Service, state agencies, and private conservation organizations. Until that work is conducted, the park should manage visitors to protect these federally listed birds from undue stress during their nesting periods (Jacobi 1994). Such management actions could include posting signs on islands to encourage visitors to avoid nesting areas during critical periods, continued cooperative education efforts with local tour operators and boat concessioners, or island closure during the nesting season.

Less is known about disturbance of other wildlife species by humans (Kuss et al. 1990). Little quantitative information is available about what level of visitation is too great, but it is clear that disturbance affects specific species. It is generally accepted that protection of critical habitat such as feeding and nesting areas is important to protect wildlife.

Bald Porcupine Island, Heron Island, and Schoodic Island support colonies of nesting seabirds. Bald Porcupine Island supports black guillemots nesting on steep, rocky cliffs, inaccessible to most visitors except climbers. Heron Island and Schoodic Island support ground-nesting species including common eiders, herring gulls, great black-backed gulls, double-crested cormorants, and Leach's storm petrels.

Colonially nesting seabirds may be especially vulnerable to disturbance because they nest on the ground in high densities (Rodgers and Smith 1991). Human visitors can unknowingly step on the nests of common eiders and gulls that are hidden in the vegetation and on the rocks. Common eiders flush easily in response to human presence and temporarily abandon their nests, leaving eggs and chicks exposed to predation by gulls (Keller 1991). Double-crested cormorants are seldom flushed by motorized boats unless boaters land and walk near the colony (Lock and Ross 1973). Hunt (1972) found that hatching success of herring gulls is inversely related to human disturbance by picnickers. We observed human disturbance to nesting seabirds during the nesting season.

The State of Maine, U.S. Fish and Wildlife Service, The Nature Conservancy, and Maine Audubon Society restrict public access to seabird nesting islands under their jurisdiction during nesting seasons, from April 15 to at least July 31 (B. Allen, MDIF&W, pers. comm.). State-owned islands supporting at least five pairs of any species of colonial nesting seabirds (terns, petrels, and guillemots), and colonial wading seabirds (herons) are closed to the public from April 15 to August 15. The U.S. Fish and Wildlife Service, The Audubon Society, and The Nature Conservancy close seabird nesting islands under their jurisdictions until August 31 to allow for annual weather variables, and to protect species that attempt a late or second clutch. At this time, only the NPS allows visitors on its seabird nesting islands during the nesting season.

Dogs set loose on nesting seabird islands also could adversely affect nesting success. In 1993, in response to our preliminary observations and the potential for resource effects, the NPS enacted regulations prohibiting pets from April 1 to September 30 on Heron Island and Schoodic Island.

Camping is of special concern on seabird and eagle nesting islands such as Heron Island and Schoodic Island, where seabirds are sensitive to even small amounts of disturbance during the nesting season, because camping extends the time birds are exposed to human disturbance. Camping is not allowed on park islands, except in designated campgrounds on Isle au Haut and MDI. The park is developing signs to be placed on seabird nesting islands to educate visitors about potential disturbance to seabirds and encouraging voluntary avoidance of the islands during the nesting season.

We observed evidence of overnight camping on several other park islands. Waste disposal, threat of fire, and wildlife disturbance are of concern where illegal camping occurs. In July 1994, ANP rangers were informed that a group of 16 persons was camping illegally on The Hop. A local tour group leader was cited for camping in a non-designated area, fire outside a designated area, and improper disposal of human waste. In August, rangers placed a boundary marker on The Hop to indicate that it is under the jurisdiction of the NPS. Although camping, fires, and collecting are restricted on all islands, ANP does not regularly post or patrol offshore islands to enforce visitor use regulations.

Trash and marine debris were observed on all islands. Trash can inadvertently trap or kill small animals when they enter bottles and other containers with restricted openings. Wildlife can be attracted to food scraps or other trash. Plastics decompose slowly, if ever, and present a visual intrusion to the natural scene of island shores.

Based on our observations, we recommend the following management actions be implemented as soon as possible to protect island resources.

We recommend actively managing visitor use on park islands on an island-by-island basis, beginning with the development of individual island management plans. Prioritization of islands for management should consider the sensitivity of ecological and cultural resources to human disturbance, the threat to resources from human use, and ease of access to the island. Whereas all park resources are technically protected by federal regulations, some islands have resources that justify immediate and proactive management. These include:

- 1) islands supporting federal or state-listed species;
- 2) islands used by colonially nesting seabirds;
- 3) islands with archeological or other cultural resource values.

Islands supporting these resources should be high priority for the development of management plans.

Although protection of State critical areas is strictly voluntary and is not mandated by law, islands with special habitat designations such as State critical areas should also be a high priority for management because these areas have been recognized as being regionally significant natural areas.

Development of management plans for islands should include discussions with other federal, state, and local agencies as well as private conservation and user groups with an interest in island resources.

We suggest that Schoodic Island, Little Moose Island, and Bald Porcupine Island receive the highest priority for management (Table 15), and that the park begin immediately to document current use levels as management plans are being developed.

Schoodic Island is a high priority for management because of the sensitivity of its nesting seabirds to disturbance, and because it is relatively accessible from the mainland by small boat. Although Heron Island has similar resources, it is much less accessible and appears to receive little use, although use levels should be evaluated in a more formal manner to confirm our observations.

Little Moose Island is a Maine critical area as a rare plant station (Maine Natural Areas Program 1994a) and supports seven state-listed rare species. Previous recommendations for addressing effects of human use on Little Moose Island include constructing a boardwalk, clearly establishing and signing authorized trails and closing all others, and rerouting existing trails around rare plant populations (Greene 1992). In addition, signing, personal contacts, and messages in interpretive programs may be effective ways to educate visitors of their effects on natural resources. These actions should be considered in developing a visitor use management plan for Little Moose Island to prevent further degradation to rare plant populations.

Bald Porcupine Island also is a Maine critical area and research natural area harboring sensitive plants and nesting guillemots. Although visitor use of the main portion of the island appears to be low, use levels of the sea cave are unknown, and access to the cave is

made easier by the presence of a rope at the entrance. Above the cave, the bold cliffs on Bald Porcupine Island support nesting populations of black guillemots and may provide suitable nesting habitat for expanding populations of peregrine falcons. These sea cliffs are among the few in the park supporting black guillemots that are not popular rock climbing areas. As a precaution to increasing use, and because this habitat and nesting black guillemots are unusual in the park, we recommend the cliffs on Bald Porcupine Island be closed to rock climbing from April 15 to August 31 to protect this population of black guillemots. The cliffs are not widely used and few if any climbers would be displaced. Installing bolts on climbing routes should be forbidden because the presence of bolts could make these cliffs more attractive to climbers.

Sheep Porcupine Island and Western Ear support federally listed species, but these resources do not seem to be threatened by visitor use at this time. The eagle pair on Sheep Porcupine Island is among the most productive in the area (Jacobi 1994). Winter visitors to Western Ear, when harlequin ducks are present, are rare. The area near Isle au Haut and Western Ear is one of the most important wintering areas for harlequin ducks in the western Atlantic (Mittelhauser 1991). Therefore, low visitor use levels should be maintained, and future development along the shore restricted to protect these secretive ducks. Further study to confirm our observations of use and potential threats to federally listed species is needed.

Although the effects of human visitors are not apparent on Baker Island at this time, the resources of the island should be monitored to ensure resource preservation. Should effects of visitor use become apparent in the future, the NPS can reduce visitation to the island by eliminating the boat tour that lands there. Protecting the cultural landscape of Baker Island while preserving natural resources in the surrounding natural zone is a high priority in the development of an island management plan.

After plans are developed and implemented, visitor use and its effects should be closely monitored to ensure that management actions are resulting in effective protection of island resources.

Until island management plans are developed, we recommend a number of specific actions to immediately address effects of visitor use on natural resources.

We recommend the park close islands harboring active eagle nests to visitors from March 15 to August 15 to ensure compliance with the Endangered Species Act and to be consistent with other agencies managing islands with active bald eagle nests. Eagle nesting islands currently include Sheep Porcupine Island, Schoodic Island, and Bar Island (MIR# 59-265), although nesting islands may change from year to year. MDIF&W identifies active nests through aerial surveys each spring. Upon MDIF&W confirmation that NPS islands support active eagle nests, those islands should be closed to the public during the nesting season. If eagles nest on NPS islands which also have privately owned land [Bar Island (MIR# 59-194) and Baker Island], the NPS should work with MDIF&W and private property owners to develop appropriate management strategies to protect nesting eagles.

We recommend that Heron Island be closed from April 15 to August 31 to protect colonial nesting seabirds such as petrels, guillemots, and gulls. By closing this island, the NPS will

be consistent with other land management agencies managing seabird nesting islands in the Gulf of Maine. Other park islands should be inventoried at least every five years for the presence of nesting seabirds, and, like State islands, closed to visitors if five or more pairs of seabirds of any species are found to be nesting.

As long as Schoodic Island supports both colonial nesting seabirds and nesting bald eagles, we recommend the island be closed to visitors from March 15 to August 31.

Park seabird and eagle nesting islands should be signed to educate visitors of the potential impacts of disturbance and patrolled regularly to enforce island closures during critical nesting periods, using care that patrols do not disturb birds.

Patrols of all park islands should be conducted throughout the visitor use season to prevent overnight camping, free roaming dogs, illegal collecting, and fires. All patrols should note numbers of visitors, types of visitor uses, and resource condition. The presence of spent shotgun shells near the shore on Western Ear may indicate that ducks are being hunted there. The NPS should cooperate with local law enforcement officials to ensure that duck hunting regulations are strictly enforced to protect harlequin ducks.

Island users should be educated about proper disposal of trash and human waste. We recommend the park sponsor volunteer efforts to pick up trash and marine debris on islands. Because the problem of marine debris transcends park boundaries, the NPS should participate in local and regional efforts to educate the public and enforce regulations restricting overboard discharge and land sources of marine debris.

We recommend that park staff engage in outreach activities to local garden clubs and plant conservation groups regarding the effects of human visitors on native plant populations from collecting and unauthorized reintroductions and augmentations of plant populations. The collection of additional voucher or other specimens of rare plants on islands should be discouraged.

Current human use and types of visitor uses of islands must be documented if the recommendations of the General Management Plan (National Park Service 1992b) are to be implemented.

Evidence of historic human occupation was observed on seven islands, although McLane (1982, 1989) suggests that most of the islands were once occupied. Although beyond the scope of this study, we recommend a survey to document the presence and assess the condition of archaeological and cultural resources on these islands. Law enforcement rangers should be apprised of the location of archaeological resources so that these resources can be protected from illegal collecting.

Table 15. Sensitive natural resources, ease of access, and resulting suggested priority for development of management plans for selected islands within Acadia National Park, 1992-93.

Island Name	Wintering Harlequin Ducks	Nesting Bald Eagles	Nesting Seabirds	State- Listed Plants/ Habitats	State Critical Areas	Method of Access	Manage- ment Priority
Baker				X		Power Boat	9
Bald Porcupine			X	X	X	Small boat	3
Bar (MIR# 59-194)						Walk	10
Bar (MIR# 59-265)		X		X		Walk	5
Heron	X		X	X	X	Power boat	4
The Hop				X		Small boat	8
Little Moose	X			X	X	Walk	2
Pond						Walk	11
Schoodic	X	X	X	X	X	Small boat	1
Sheep Porcupine		X		X		Small boat	6
Western Ear	X			X		Walk	7

Summary and Management Recommendations

SUMMARY

Before this study, Acadia National Park managers lacked even basic information on the resources of small islands under their stewardship. The goal of this project was to provide park managers with preliminary resource information to facilitate more informed management of park islands. Specifically, we attempted to provide resource information on existing species, rare or unusual species, habitats of concern to managers, and to identify potential threats to sensitive resources on 11 small islands within ANP: Baker Island, Bald Porcupine Island, Bar Island in Frenchman Bay (MIR# 59-194), Bar Island in Somes Sound (MIR# 59-265), Heron Island, The Hop, Little Moose Island, Pond Island, Schoodic Island, Sheep Porcupine Island, and Western Ear.

A secondary goal of this study was to test the feasibility and effectiveness of "Expedition into America" - a partnership formed between the NPS and the Center for Field Research (Earthwatch). This partnership was established to provide the NPS with a labor force of Earthwatch teacher/volunteers to facilitate inventory and monitoring research projects and to provide field research experience to elementary and secondary school teachers to help broaden and enliven their science teaching. Thirty-four Earthwatch volunteers assisted with this study during portions of the summers of 1992 and 1993. An analysis of the NPS/Earthwatch partnership is addressed in a separate report (Connery et al. 1992) and in a questionnaire distributed by the NPS Office of Natural Resources (Connery and Mittelhauser 1993).

We summarized previous reports of vascular plants on park islands, then conducted field surveys on islands to verify and expand species lists. Through this effort we compiled a list of 433 species and 16 additional varieties and subspecies of vascular plants. No federally listed endangered or threatened plants have been reported for this coastal region. Ten state-listed species were identified: three state endangered species (*Carex adusta*, *C. recta*, and sandy sedge, one state threatened species (*C. echinata*), three state special concern species (blue birch, marsh felwort, and blinks) and three state watch list species (beachhead iris, boreal knotty pearlwort, and knotty pearlwort). We found seven state-listed species on Little Moose Island and five species on Heron Island. Twenty-five percent (111 species) of the species observed were non-native, ranging from 9% on Little Moose Island to 34% on Bar Island (MIR# 59-194) in Frenchman Bay.

Thirty-three plots 0.01 ha in size were randomly established on eight forested islands to quantitatively describe current forest conditions. From our detrended correspondence analysis of tree basal area we separated four groups of similar plots. Three clusters correspond to distinct forest communities as described by the Maine Natural Heritage Program (1991): maritime spruce/fir, mixed hardwood-conifer, and early successional. Maritime spruce/fir was the most common forest community, and was found on The Hop, Little Moose Island, Pond Island, Schoodic Island, Sheep Porcupine Island, and Western Ear. In these forests, white spruce tended to be more abundant than red spruce. Mixed

hardwood-conifer forest communities were found on Bar Island (MIR# 59-265), Little Moose Island, and Sheep Porcupine Island. Plots on The Hop were classified as early successional forest community. Plots on Bald Porcupine Island clustered intermediate between maritime spruce/fir and northern white cedar seepage forest communities. Tree basal area and age, shrub density, ground and canopy cover, and vegetation height profiles were collected and summarized for each forest type. Forests on portions of Bald Porcupine Island, Bar Island (MIR# 59-265), and Western Ear and were >100 years old and unique in terms of their diversity and structure. In addition, the northern white cedar seepage forest community, found only on Bald Porcupine Island, is notably rare on small islands in the region. Not all forest communities were sampled on all islands.

Sixteen species of terrestrial mammals were recorded using various trapping methods and searches for sign on 11 islands. We trapped small mammals for 3090 trap nights using Sherman live traps and 547 trap nights using pitfall traps. We captured 117 small mammals representing nine species: three species of shrews (shorttail shrew, pygmy shrew, and masked shrew) and six species of rodents (boreal redback vole, meadow vole, white-footed mouse, deer mouse, eastern chipmunk, and meadow jumping mouse). Muskrats were observed and muskrat skeletons were collected on Heron Island. Six other species were identified by sight or sign: mink, porcupine, raccoon, red squirrel, snowshoe hare, and white-tailed deer. Islands connected to other land masses by tidal bars supported the most mammal species: eight species were found on Bar Island (MIR# 59-264) and Little Moose Island, seven on Western Ear, and six on Pond Island. We confirmed the presence of muskrats on Heron Island - unusual because of the island's isolation and lack of wetland habitat. No mammals were captured or observed on Bald Porcupine Island, The Hop, or Schoodic Island.

We used direct searches, artificial shelters, and trapping to inventory reptiles and amphibians on 11 islands. We trapped reptiles and amphibians in pitfall traps along drift fences for 268 trap nights, in pitfall traps not associated with a drift fence for 279 trap nights, in snake funnel traps for 68 trap nights, and using artificial shelter for 802 shelter nights. Day and night searches were also conducted, although this effort was not quantified. We documented three species: redback salamanders were found on seven islands, common garter snakes on five islands, and smooth green snakes only on Bar Island (MIR# 59-194). No reptiles or amphibians were captured or observed on Heron Island, Pond Island, or Western Ear. The low number of reptile and amphibian species observed may be, in part, a result of the lack of fresh water on many of the islands. The only islands with even meager amounts of standing fresh water were Baker Island, Little Moose Island, Pond Island, and Schoodic Island. Our searches and trapping were not timed to match optimal emergence times; instead, they were often conducted during the driest part of the year, which may have influenced our findings.

We observed effects of humans on federally and state-listed species, Maine critical areas, and colonially nesting seabirds. Assessments of human effects on resources were qualitative. Identifying archaeological sites and potential effects of human visitors on these sites was beyond the scope of this study. Throughout our visits to the islands, we looked for signs of historic as well as current use. All islands except Bar Island (MIR# 59-194) and Pond Island supported at least one resource sensitive to human disturbance. Evidence of recent human use was observed on all islands except Heron Island. Bar Island (MIR# 59-194) and Little Moose Island seemed to receive the most visitor use. We noted evidence of historic human use, including remains of foundations, stone walls, wells, and buildings on six islands: Baker Island, Bald Porcupine Island, Bar Island in Frenchman Bay (MIR# 59-194), Bar Island in Somes Sound (MIR# 59-265), Sheep Porcupine Island, and Western Ear. Signs of effects of humans on flora and fauna were also observed. Visitors were observed on eagle and seabird nesting islands during the nesting season. We observed visitors disturbing colonially nesting seabirds. In addition, trails have developed through populations of rare plants on Little Moose Island. Other effects of human visitors observed on islands included the presence of fire rings, human waste, trash and marine debris, as well as damage to trees from axes.

To facilitate additional inventory or monitoring efforts, we permanently marked and surveyed the locations using tape and compass, and global positioning technology for 19 forest plots, 52 transects, and 23 control points. Base maps showing vegetation features and all study sites were created for each island. In addition, we took three types of photographs to document current conditions: the perimeter of each island, directional photographs (taken from 115 control points), and panoramic photopoints (taken from 15 control points).

MANAGEMENT RECOMMENDATIONS

The following list provides a general overview of recommendations. Specific details for each recommendation are provided in the preceding chapters of this report.

Vascular Flora

- * Conduct additional field searches throughout the growing season on Bar Island (MIR# 59-265) and Sheep Porcupine Island to obtain more comprehensive species lists.
- * Nominate Heron Island as a Maine critical area to provide additional protection for its rare plants.
- * Participate in partnerships with federal and state agencies and private organizations to enhance protection of rare plants in the region.
- * Assess threats to native island communities by non-native species, and, if necessary, develop and implement non-native plant management plans.

- * Study the role that sheep grazing had in the distribution and presence of the flora of the islands and the implications of their use to maintain cultural landscapes, particularly on Baker Island.
- * Support research on the taxonomic status of leafy-bracted aster and dwarf rattlesnake root.
- * Develop and implement monitoring strategies to detect the existence and changes in populations of rare plants at five-year intervals to help ensure their protection.

Island Forests

- * Conduct additional forest sampling on islands not adequately sampled: Bar Island (MIR# 59-194), Bar Island (MIR# 59-265), Baker Island, Bald Porcupine Island, and Little Moose Island. Conduct further analysis of our data to better protect forest habitats on the park's small islands.
- * Conduct additional studies of island forests identified as unique in this study: Bald Porcupine Island, Bar Island in Somes Sound (MIR# 59-265), and Western Ear.

Mammals

- * Conduct additional trapping of shrews by establishing drift fences on islands with wetlands (Baker Island, Little Moose Island, Pond Island, and Schoodic Island).
- * On selected islands, monitor mammal population cycles, including immigration, and emigration, and local extinctions.
- * Study the ecology of muskrats on Heron Island.
- * Conduct inventories of bats, because many species are state-listed and almost no information exists regarding their status in the park.
- * Participate in studies of the genetics of island mammals.

Amphibians and Reptiles

- * Conduct additional surveys timed to correspond with emergence of amphibians on islands with suitable habitat (Baker Island, Little Moose Island, Pond Island, and Schoodic Island).
- * Conduct periodic monitoring of amphibian and reptile populations on selected islands to detect immigrations and local extinctions.

Human Use and Impacts

- * Collect quantitative information on visitor use on all islands as soon as possible to comply with the goals of the ANP General Management Plan (National Park Service 1992b).
- * Manage, on an island-by-island basis, use by humans, based on threats and the sensitivity of natural and cultural resources. Schoodic Island, Little Moose Island, and Bald Porcupine Island should be the highest priorities for island management plan development.
- * Close islands that support nesting bald eagles and nesting seabirds to use by humans during the nesting season to protect birds and be consistent with other agencies. Islands with nesting bald eagles should be closed from March 15 until August 15; islands with nesting seabirds should be closed from April 15 until August 31; islands with both nesting eagles and seabirds should be closed from March 15 until August 31. Restrict human use on islands which are designated as Maine critical areas or support state-listed species, or other especially sensitive resources, and preserve solitude in compliance with the goals of the ANP General Management Plan (National Park Service 1992b).
- * Maintain current low levels of human use in winter, and prevent development near harlequin duck habitat.
- * Work cooperatively with local law enforcement officials to strictly enforce duck hunting regulations to protect harlequin ducks.
- * Protect rare plants from trampling, collecting, and other adverse effects of humans, especially on Little Moose Island.
- * Discourage scientific collecting of specimens of plants that are state-listed or locally rare.
- * Monitor resources to ensure effectiveness of management actions.
- * Participate in educational efforts to discourage plant collecting, transplanting to and from park populations, and direct seeding within the park.
- * Patrol islands throughout the visitor use season to enforce island closures, prevent camping, free-roaming dogs, illegal collecting, and fires.
- * Educate park users of proper human waste and trash disposal methods.
- * Quantify marine debris through a regular monitoring program to assist regional and state education and enforcement actions.
- * Periodically clean up trash and marine debris.

- * Survey and assess archeological and cultural resources on islands, and strictly enforce the Archaeologic Resource Protection Act.

Additional Recommendations

- * Collaborate with U.S. Fish and Wildlife Service, Maine Department of Inland Fisheries and Wildlife, The Nature Conservancy, and other private and government agencies, as well as interested user groups, to manage island resources.
- * Develop and implement a systematic monitoring plan for selected island resources.
- * Initiate and implement inventory and monitoring plans for breeding bird populations.
- * Inventory bryophytes and invertebrates, with special emphasis on federal and state-listed species.
- * Monitor the scenic condition of islands using photography on a regular basis.
- * Protect the scenic integrity of the islands by preventing development and placement of signs within view from the water.
- * Designate priority order of islands for protection from oil spills and participate in the development of oil spill response plans. Over 18 million barrels of petroleum-base liquids are transported each year through Penobscot Bay (Kelly Bishop, U.S. Coast Guard, Southwest Harbor, Maine, pers. comm.). Thirty-eight oil spills have occurred in the vicinity of the park since 1987 (National Park Service 1994). Large, ocean going luxury cruise liners visit Frenchman's Bay in increasing numbers each year and pose a risk to island resources from fuel spills or groundings. Results from this and subsequent studies should be incorporated into oil spill management plans currently being formulated.
- * Incorporate regular trips to the islands by park natural resource, interpretation, and protection staff in an effort to note changes in visitor use levels, associated effects on island resources, major ecological changes, and to increase knowledge and protection of these very special places.

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Appendix A: Sampling Locations

For the purpose of creating accurate base maps, and relocating line transects, forest plots, and photopoints, we established permanent points and surveyed their locations using tape and compass or global positioning system (GPS) technology. To facilitate on-site relocation of points, we made written descriptions of each location. All surveying began from one or a series of known control points on each island (Table A-1). Control points were U.S. Coast and Geodetic Survey (USCGS) permanent markers or points that we established using a Trimble Basic-Plus Global Positioning System. This system has an estimated 2 m - 5 m accuracy. Differential corrections were performed using files obtained from the University of Maine, Orono, community base station. GPS data files were converted using PFinder software, version 2.53 (Trimble Navigation, Ltd. 1992).

We were unable to locate USCGS markers on Pond and Schoodic Islands and did not have access to GPS technology in 1992 when those islands were surveyed. As a result, locations of control points on these islands were estimated from USGS maps and aerial photographs.

A Lutz surveyor's staff compass mounted on a Jacob's staff was used for all directional measurements. Readings were recorded to the nearest half of a degree. All readings were recorded in true direction, adjusted for 18.5° W declination. Distance measurements were made with a 100-m fiberglass tape read to the nearest centimeter.

All permanent points were marked with a length of rust-proofed metal rebar (1.3 cm in diameter). The top of each rebar was capped with a yellow plastic protective cap stamped "ACADIA NP". Metal tags engraved with island name, point identifier, date, and other locational data were attached to each rebar stake.

Base maps of the islands were generated using Arc/Info software, version 3.4D+ (Environmental Systems Research Institute, Inc. 1991). High-water-mark of all islands was digitized in Universal Transverse Mercator (UTM) projection units (North American Datum 1927) off the USGS 7.5 minute quadrangle maps (scale 1:24000). High-tide line, the edge of vegetation along the shore, and other spatial information was digitized off aerial photographs with scales of 1:660 to 1:9000 (Table A-2). All GIS computer generated covers are stored at the ANP Resource Management Office. We permanently marked and surveyed the locations of 52 transects (Table A-3), 19 forest plots (Table A-4), and 23 control points on 10 islands (Figures A1-12). An additional 14 forest plots were surveyed but not permanently marked. Written descriptions of the locations of all rebar stakes are located at the Natural Resource Office at ANP.

Table A-1. UTM coordinates of control points on 10 islands of Acadia National Park, 1992-93.

Island Name	Control Point Label	Source	UTM N	UTM E
Baker	CP1	GPS	4899182	563676
Baker	CP2	GPS	4898757	563913
Bald Porcupine	CP4	GPS	4915152	565138
Bald Porcupine	USCGSM	USCGS	4914927	565216
Bar (MIR# 59-265)	Transect T4-1	GPS	4911419	553994
Bar (MIR# 59-265)	Transect T3-11	GPS	4911400	553972
Bar (MIR# 59-265)	Transect T1-1	GPS	4911439	553857
Heron	USCGSM	Estimated	4883196	542105
The Hop	USCGSM	USCGS	4917727	567186
The Hop	Transect T3-1	GPS	4917892	567237
The Hop	CP4	GPS	4917826	567183
Little Moose	Transect T3-1	GPS	4909377	576045
Little Moose	Transect T4-1	GPS	4909194	575859
Little Moose	CP3	GPS	4909065	575702
Pond	CP1 (100 m/150 m)	Estimated	4910172	574064
Pond	CP2 (150 m/210 m)	Estimated	4910122	574004
Pond	CP3 (150 m/100 m)	Estimated	4910122	574114
Pond	CP4 (230 m/150 m)	Estimated	4910042	574064
Schoodic	USCGSM	USCGS	4908277	577086
Schoodic	CP1 (0 m)	Estimated	4909436	577088
Schoodic	CP2 (250 m)	Estimated	4909186	577088
Schoodic	CP3 (500 m)	Estimated	4908936	577088
Schoodic	CP4 (750 m)	Estimated	4908686	577088
Schoodic	CP5 (1000 m)	Estimated	4908436	577088
Schoodic	CP6 (1042.25)	Estimated	4908394	577088
Sheep Porcupine	USCGSM	USCGS	4916554	564192
Sheep Porcupine	CP2	GPS	4916455	563964
Western Ear	USCGSM	USCGS	4872250	527479
Western Ear	Transect T1-1	GPS	4872367	527581
Western Ear	CP3	GPS	4872093	527601

Table A-2. Dates, types, and scales of aerial photographs used for generating maps of 10 islands of Acadia National Park, 1992-93.

Island Name	Date	Type of Photo	Scale
Baker	1991	Panchromatic	1:6000
	1985	Black and White	1:9000
Bald Porcupine	1979	Color Infrared	1:9000
	1953	Black and White	1:10000
Bar (MIR#59-265)	1985	Black and White	1:9000
	1979	Color Infrared	1:9000
Heron	1981	Black and White	1:660
The Hop	1981	Black and White	1:660
Little Moose	1987	Color	1:6000
	1985	Black and White	1:9000
	1981	Black and White	1:660
Pond	1987	Color	1:6000
	1979	Color Infrared	1:9000
Schoodic	1985	Black and White	1:9000
	1979	Color Infrared	1:9000
Sheep Porcupine	1979	Color Infrared	1:9000
	1953	Black and White	1:10000
Western Ear	1979	Color Infrared	1:9000

Table A-3. Transect locations and headings on 10 islands of Acadia National Park, 1992-93.

Island Name	Rebar Locations (transect and station numbers)	Transects Heading (degrees from true north)	Transect Length (meters)	UTM N	UTM E
Baker	T1-1	339	100.4	4898804	563927
	T1-11	159		4898898	563891
Baker	T2-1	114	99.2	4898709	563951
	T2-11	294		4898668	564041
Baker	T3-1	161	101.1	4898459	563991
	T3-11	341		4898364	564025
Baker	T4-1	200	100.0	4899110	563576
	T4-11	20		4899016	563541
Baker	T5-1	272	99.1	4898709	563879
	T5-11	92		4898713	563780
Baker	T6-1	195	99.8	4898964	563547
	T6-11	15		4898867	563521
Baker	T7-1	20	100.0	4898494	563653
	T7-11	200		4898588	563687
Baker	T8-1	0	100.0	4898376	563852
	T8-11	180		4898476	563852
Baker	T9-1	110	99.4	4899271	563915
	T9-11	290		4899237	564008
Baker	T10-1	220	99.6	4899017	564280
	T10-11	40		4898941	564216
Baker	T11-1	275	99.5	4898617	564365
	T11-11	95		4898626	564266
Bald Porcupine	T1-1	87	96.2	4914965	564921
	T1-11	267		4914959	565017
Bald Porcupine	T2-1	63	99.7	4914887	565086
	T2-11	243		4914932	565175
Bald Porcupine	T3-1	358	98.8	4914886	565248
	T3-11	178		4914985	565244
Bald Porcupine	T4-1	70	100.0	4915046	564989
	T4-11	250		4915080	565083
Bald Porcupine	T5-1	123	99.7	4914890	565009
	T5-11	303		4914836	565092

Table A-3. Transect locations and headings (continued).

Island Name	Rebar Locations (transect and station numbers)	Transects Heading (degrees from true north)	Transect Length (meters)	UTM N	UTM E
Bar (MIR# 59-265)	T1-1	65	99.1	4911439	553857
	T1-11	245		4911481	553947
Bar (MIR# 59-265)	T2-1	27	99.6	4911333	553896
	T2-11	207		4911422	553942
Bar (MIR# 59-265)	T3-1	178	100.0	4911500	553968
	T3-11	358		4911400	553972
Bar (MIR# 59-265)	T4-1	210	100.3	4911419	553994
	T4-11	30		4911332	553943
Heron	T1-1	82	100.0	4883088	541852
	T1-11	262		4883103	541951
Heron	T2-1	186	100.0	4883196	542105
	T2-11	6		4883097	542094
Heron	T3-1	246	100.0	4882972	542321
	T3-11	66		4882931	542230
Heron	T4-1	305	100.0	4882771	542024
	T4-11	125		4882828	541942
Heron	T5-1	288	100.0	4882981	542037
	T5-11	108		4883011	541941
The Hop	T1-1	33	100.2	4917661	567160
	T1-11	213		4917745	567214
The Hop	T2-1	337	100.6	4917727	567186
	T2-11	157		4917819	567147
The Hop	T3-1	257	98.6	4917892	567237
	T3-11	77		4917870	567141
The Hop	T4-1	8	99.6	4917727	567186
	T4-11	188		4917825	567201
Little Moose	T1-1	310	100.4	4909292	575675
	T1-11	130		4909356	575597
Little Moose	T2-1	183	98.2	4909534	575636
	T2-11	3		4909436	575630
Little Moose	T3-1	248	100.0	4909377	576045
	T3-11	68		4909340	575952
Little Moose	T4-1	4	100.2	4909199	575860
	T4-11	184		4909299	575866

Table A-3. Transect locations and headings (continued).

Island Name	Rebar Locations (transect and station numbers)	Transects Heading (degrees from true north)	Transect Length (meters)	UTM N	UTM E
Little Moose	T5-1 T5-11	30 210	100.0	4908956 4909043	575718 575768
Pond	T1-1 T1-11	244 64	98.7	4910165 4910121	574174 574085
Pond	T2-1 T2-11	171 351	100.9	4910189 4910089	574005 574021
Pond	T3-1 T3-11	324 144	101.9	4910015 4910097	574133 574074
Pond	T4-1 T4-11	322 142	100.0	4910105 4910184	574067 574005
Schoodic	T1-1 T1-11	121 301	100.0	4909298 4909246	577031 577117
Schoodic	T2-1 T2-11	74 254	100.0	4908953 4908980	576998 577094
Schoodic	T3-1 T3-11	65 245	100.0	4908579 4908621	577027 577118
Schoodic	T4-1 T4-11	25 205	100.0	4908457 4908548	577054 577097
Schoodic	T5-1 T5-11	119 299	100.0	4908712 4908664	577087 577174
Schoodic	T6-1 T6-11	23 203	100.0	4908404 4908496	577129 577168
Sheep Porcupine	T1-1 T1-11	85 265	99.4	4916497 4916507	563967 564066
Sheep Porcupine	T2-1 T2-11	178 358	96.9	4916554 4916457	564192 564195
Sheep Porcupine	T3-1 T3-11	278 98	99.5	4916347 4916362	564263 564165
Sheep Porcupine	T4-1 T4-11	60 240	96.6	4916349 4916398	564014 564098
Western Ear	T1-1 T1-11	132 312	99.6	4872367 4872300	527581 527655
Western Ear	T2-1 T2-11	155 335	99.0	4872365 4872275	527524 527566

Table A-3. Transect locations and headings (continued).

Island Name	Rebar Locations (transect and station numbers)	Transects Heading (degrees from true north)	Transect Length (meters)	UTM N	UTM E
Western Ear	T3-1	300	97.9	4872219	527685
	T3-11	120		4872268	527600
Western Ear	T4-1	11	95.0	4872100	527557
	T4-11	191		4872193	527576

Table A-4. UTM coordinates of forest plot locations on eight islands of Acadia National Park, 1992-93.

Island Name	Forest Plot #	UTM N	UTM E
Bald Porcupine	WP1	4914935 4914925	565186 565196
Bald Porcupine	WP2	4915086 4915076	565101 565091
Bald Porcupine	WP3	4914907 4914917	565066 565056
Bald Porcupine	WP4	4915073 4915062	565198 565208
Bar (MIR# 59-265)	WP1	4911436 4911446	553948 553938
Bar (MIR# 59-265)	WP2	4911362 4911372	553940 553930
The Hop	WP1	4917783 4917773	567178 567188
The Hop	WP2	4917792 4917802	567174 567164
The Hop	WP3	4917857 4917867	567165 567155
The Hop	WP4	4917777 4917767	567195 567205
Little Moose	WP1	4909271 4909281	575764 575754
Little Moose	WP2	4909262 4909252	575715 575705
Little Moose	WP3	4909262 4909252	575775 575765
Pond	WP1	4910152 4910142	574064 574074
Pond	WP2	4910162 4910152	574074 574084
Pond	WP3	4910152 4910142	574024 574034
Pond	WP4	4910122 4910112	574034 574044

Table A-4. UTM coordinates of forest plot locations (continued).

Island Name	Forest Plot #	UTM N	UTM E
Pond	WP5	4910082 4910072	574104 574114
Pond	WP6	4910072 4910062	574044 574054
Pond	WP7	4910052 4910042	574094 574104
Pond	WP8	4910032 4910022	574124 574134
Pond	WP9	4910082 4910072	574034 574044
Pond	WP10	4910182 4910172	574124 574134
Pond	WP11	4910182 4910172	574074 574084
Schoodic	WP1	4908687 4908677	577070 577080
Schoodic	WP2	4908587 4908577	577097 577107
Schoodic	WP3	4908628 4908618	577073 577083
Sheep Porcupine	WP1	4916412 4916422	564123 564113
Sheep Porcupine	WP2	4916443 4916453	564241 564231
Western Ear	WP1	4872186 4872176	527604 527614
Western Ear	WP2	4872180 4872170	527598 527588
Western Ear	WP3	4872279 4872289	527638 527628
Western Ear	WP4	4872214 4872224	527638 527648

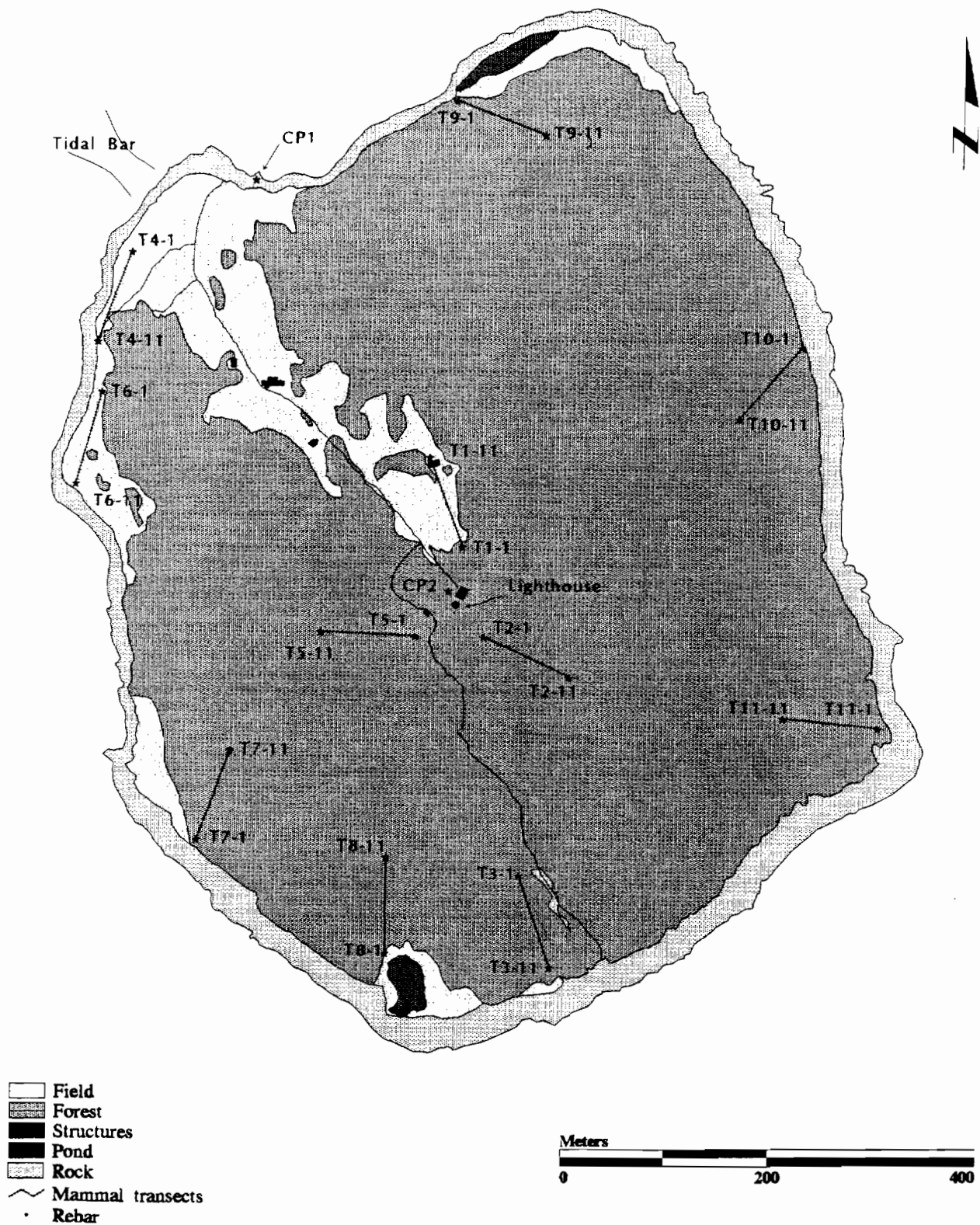


Figure A-1. Control points, transects, and forest plots on Baker Island.

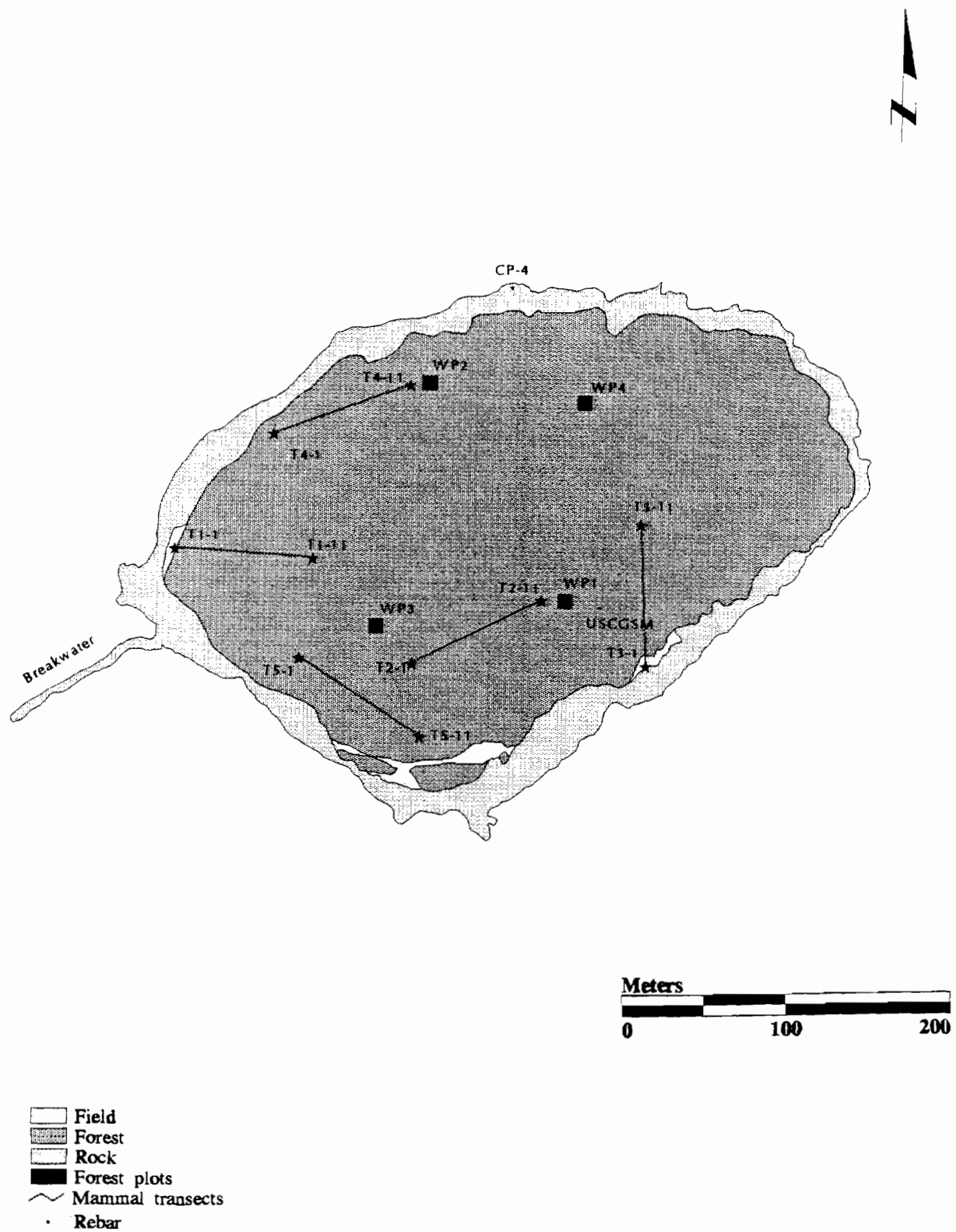


Figure A-2. Control points, transects, and forest plots on Bald Porcupine Island.

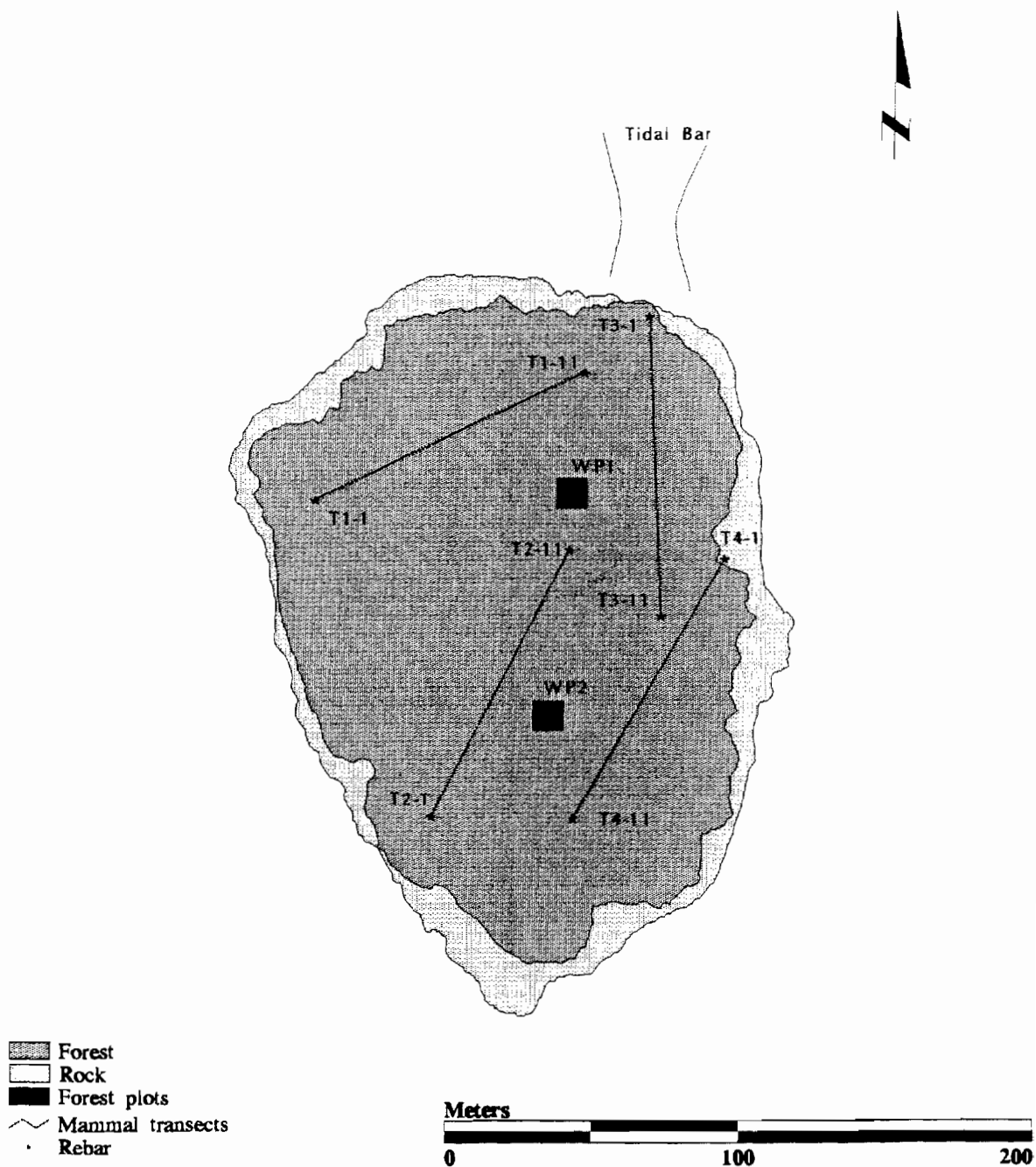


Figure A-3. Control points, transects, and forest plots on Bar Island (MIR# 59-265).

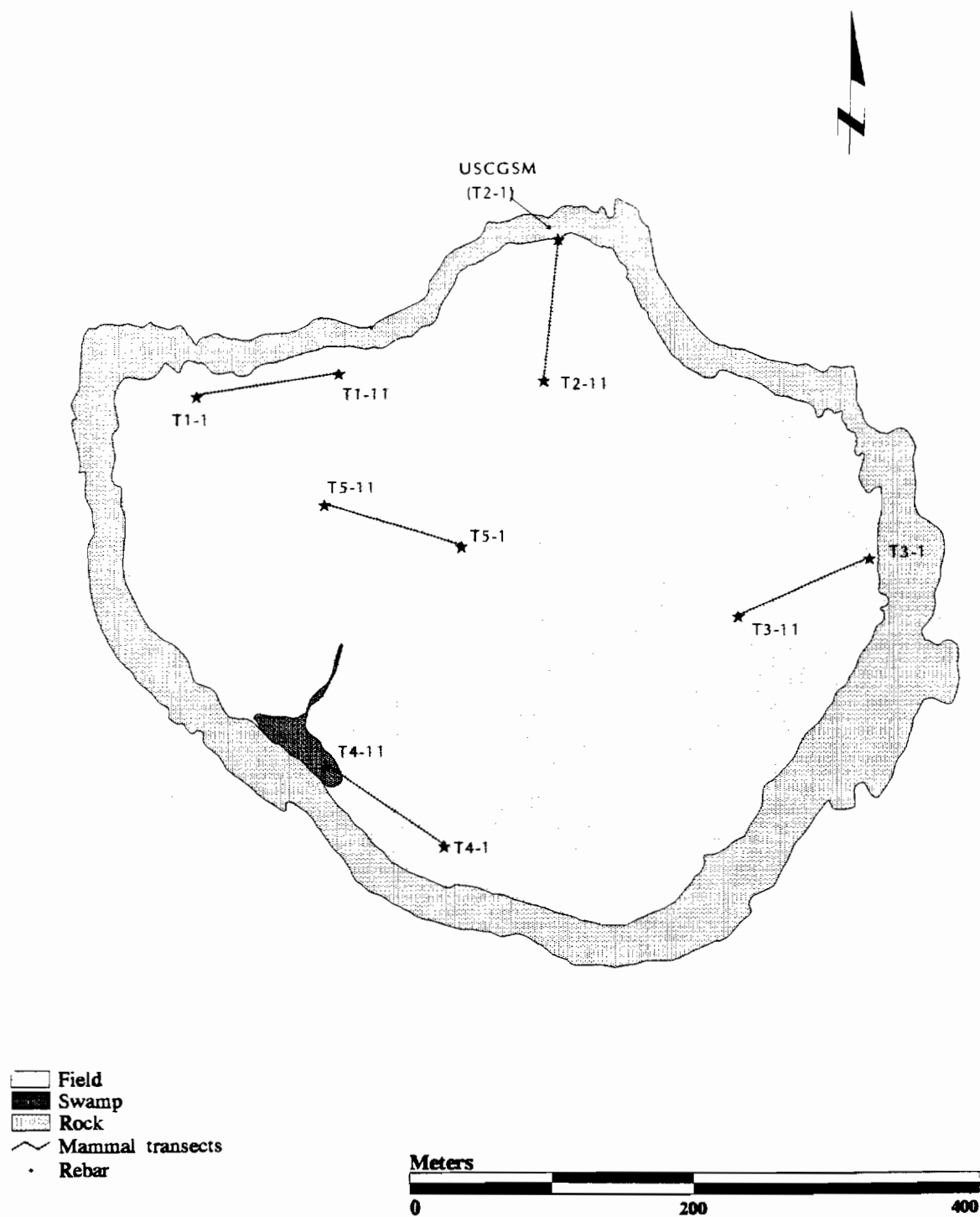


Figure A-4. Control points, transects, and forest plots on Heron Island.

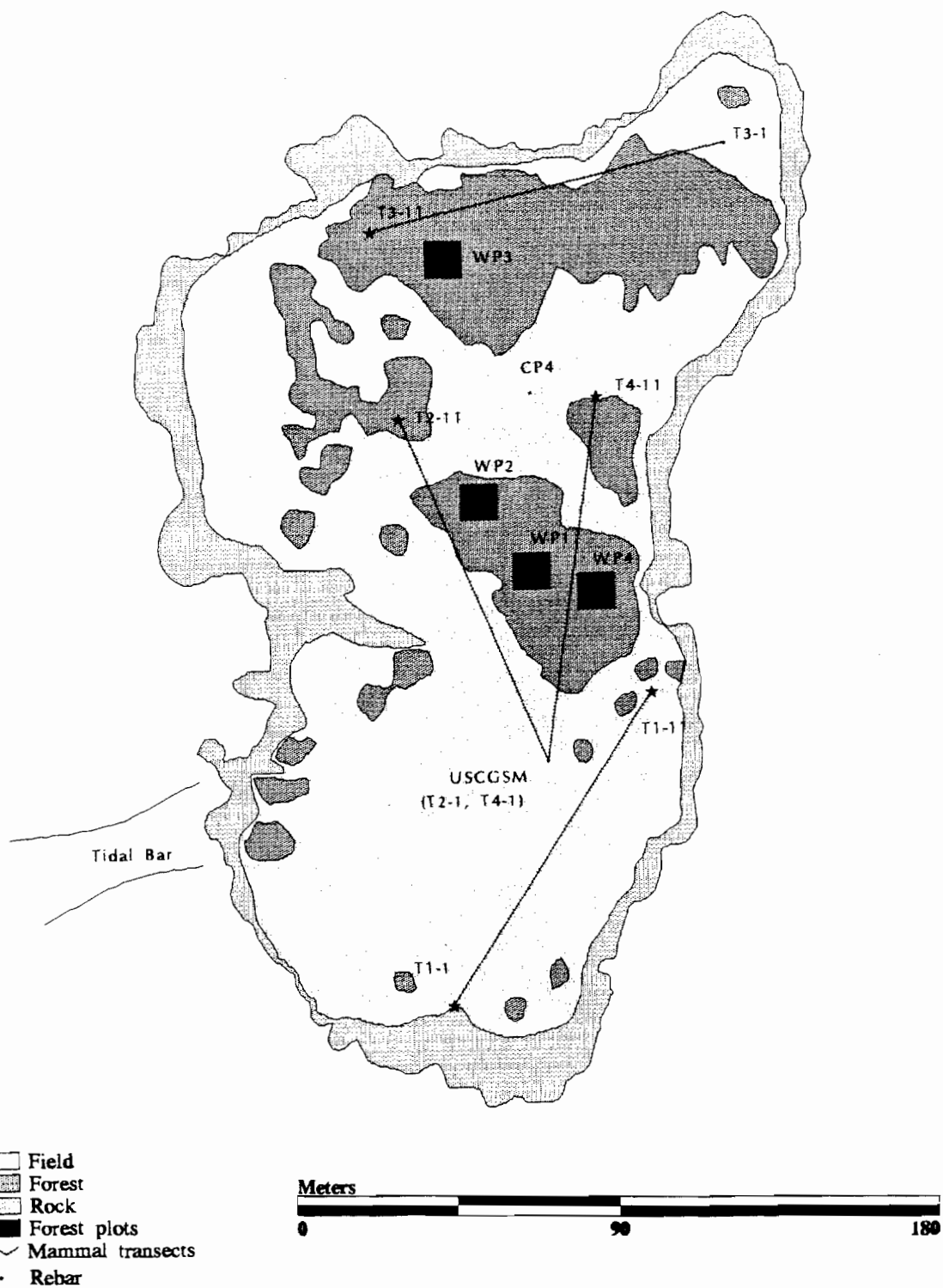


Figure A-5. Control points, transects, and forest plots on The Hop.



Figure A-6. Control points, transects, and forest plots on Little Moose Island.

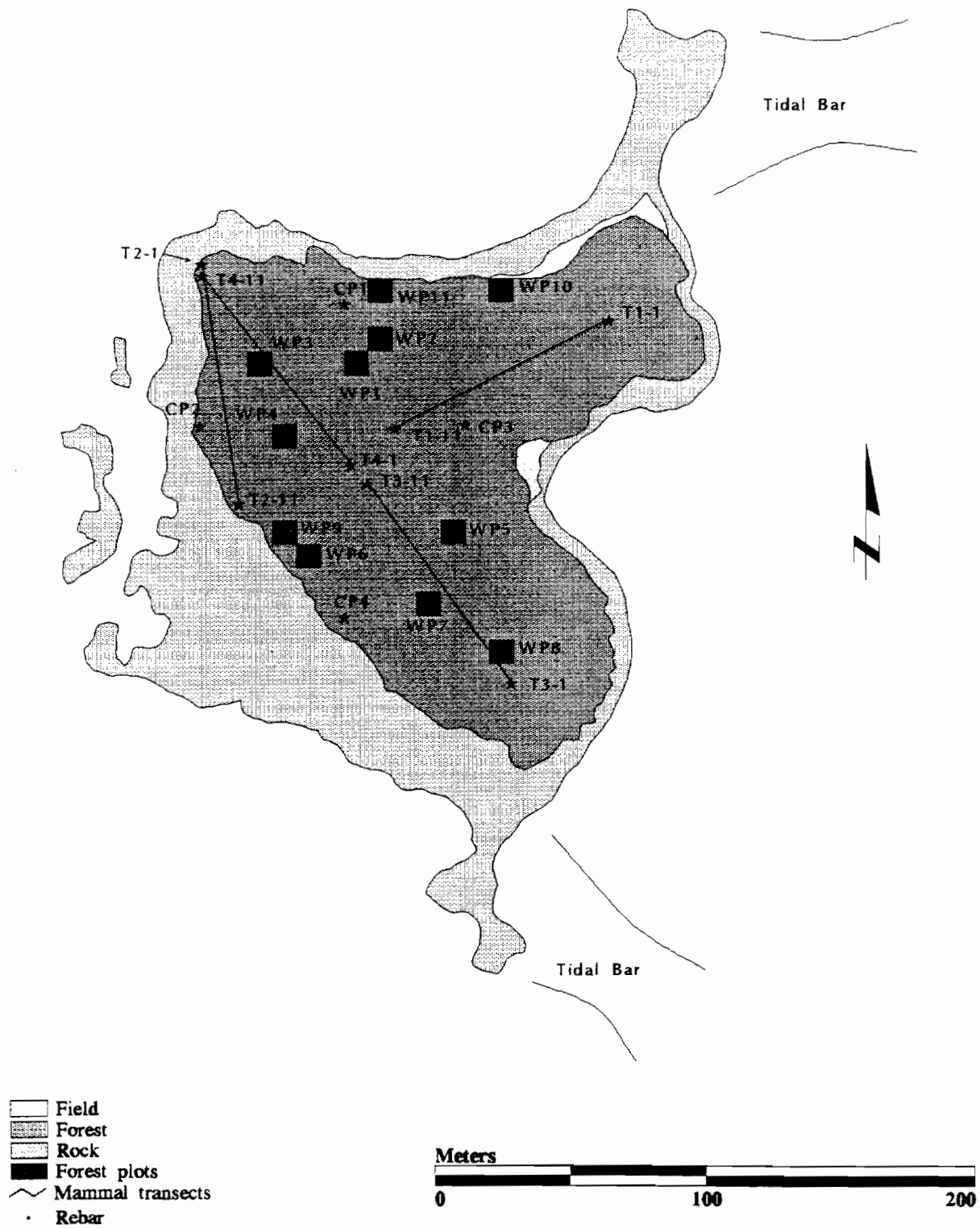


Figure A-7. Control points, transects, and forest plots on Pond Island.

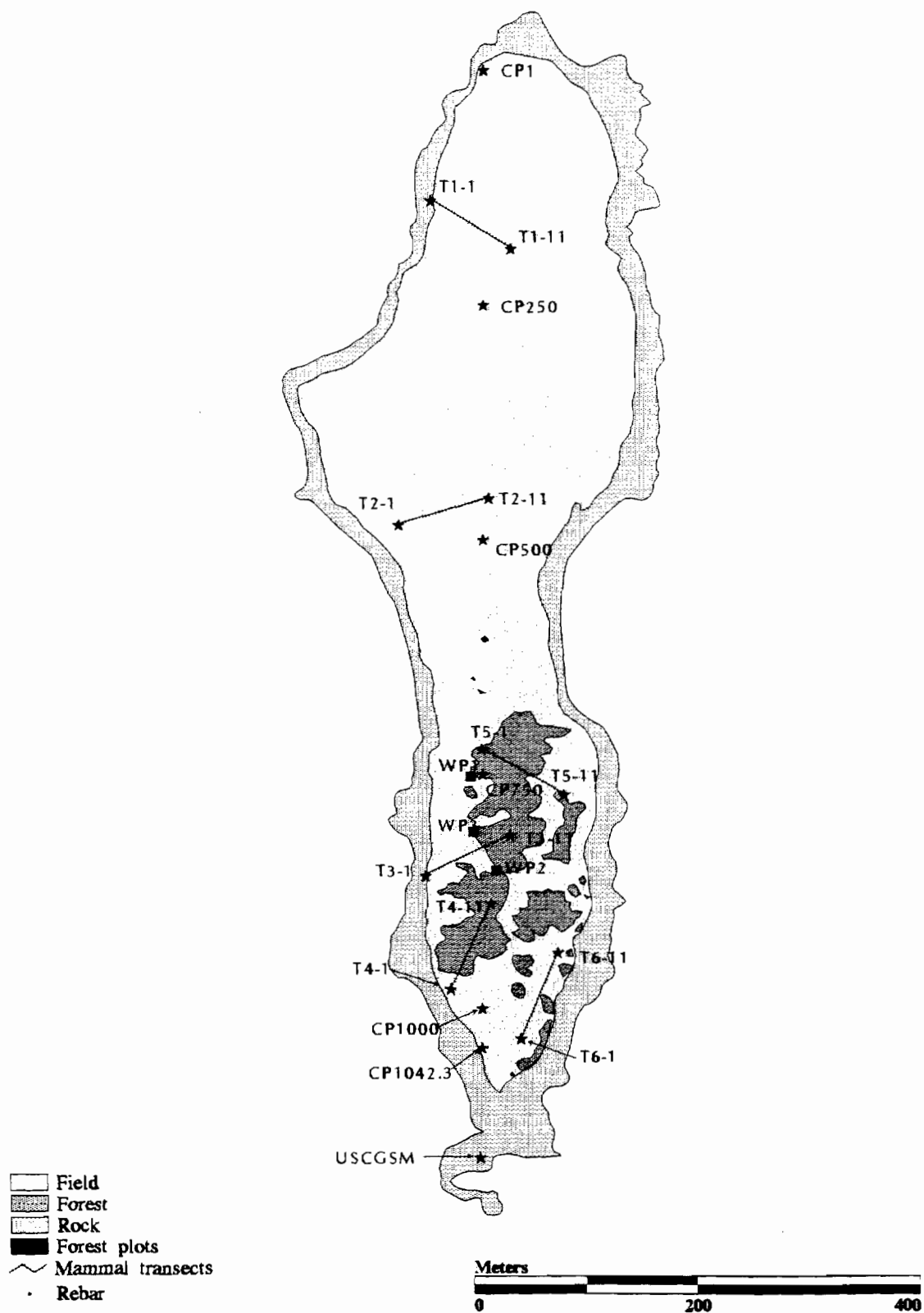


Figure A-8. Control points, transects, and forest plots on Schoodic Island.

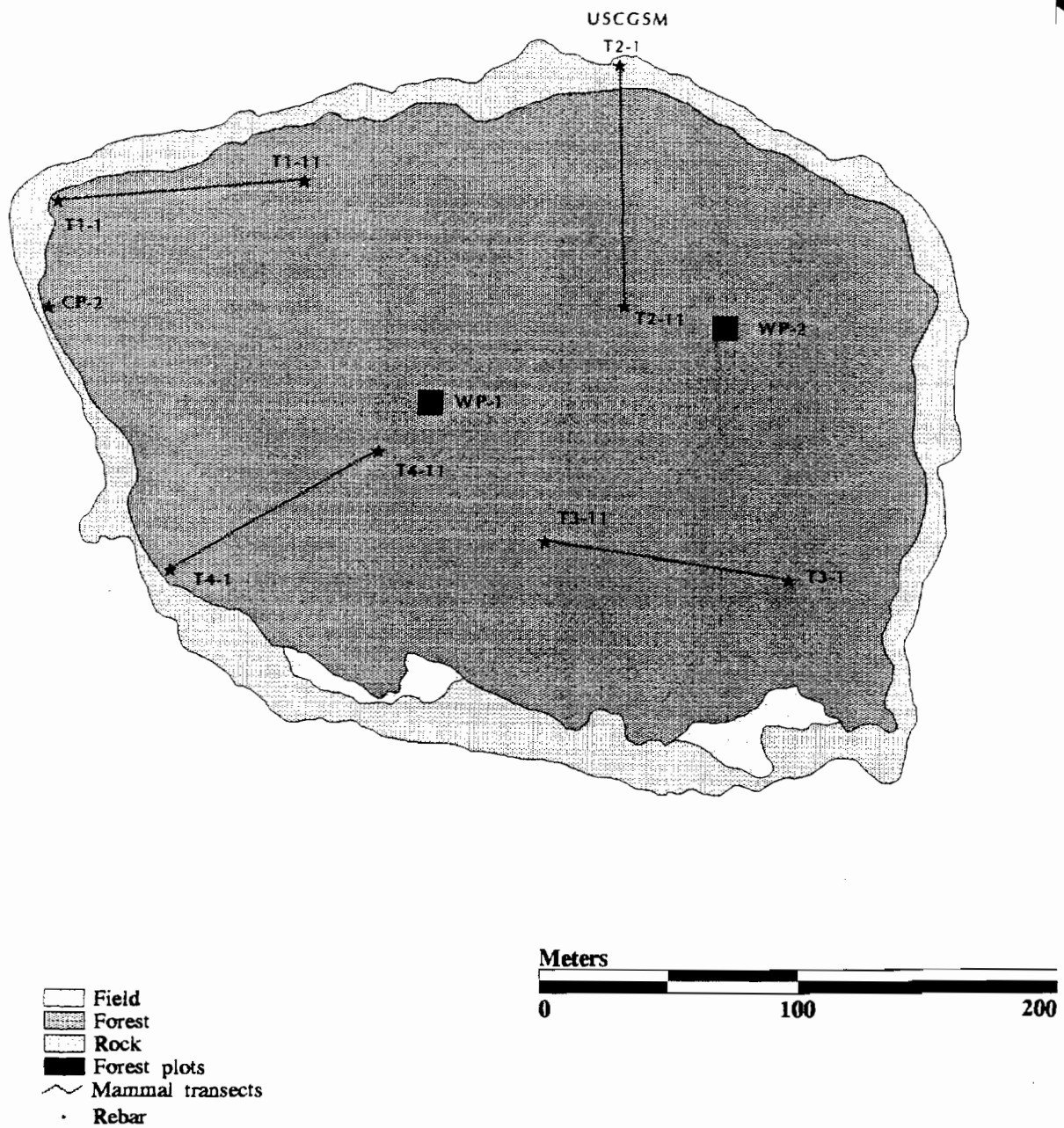


Figure A-9. Control points, transects, and forest plots on Sheep Porcupine Island.

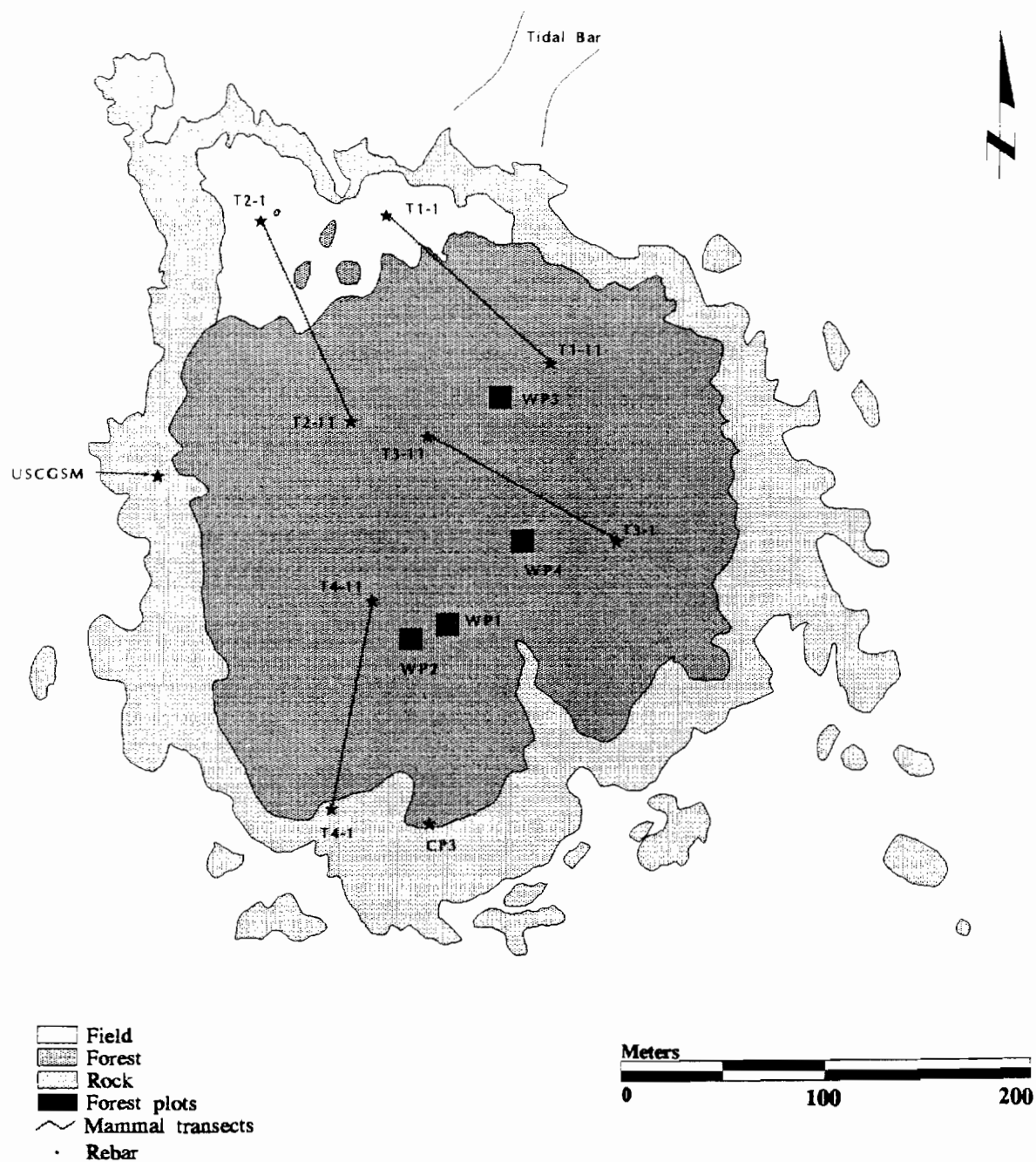


Figure A-10. Control points, transects, and forest plots on Western Ear.

Appendix B: Photographic Monitoring

We took three types of photographs while on the islands: perimeter photographs taken from the water, directional photographs taken from control points and along permanent transects, and panoramic photographs taken from transect ends and control points. Photographs were taken with an Olympus OM1N camera, Kodachrome film (ASA 64), and a 50 mm lens. We recorded compass direction for all photographs using a hand-held compass adjusted for 18.5° W declination. Photographs from permanent points were obtained at a height of 1.37 m (lens height) on a tripod carefully positioned over each rebar stake using a fiberglass measuring tape, plumb-bob, and level. Camera settings were recorded for each slide taken.

Perimeter Photographs

To photograph island perimeters, we circled the island in a motor boat or small dory and took a series of overlapping photographs of the islands' circumference. Shots were taken as close to the island as was feasible and include the high-tide line to the top of the vegetation whenever possible.

Directional Photographs Along Transects

Permanently marked control points and transect ends were used as photopoints (see Appendix A for maps illustrating location of control points and transect ends on each island). Two photographs were taken from the ends of each transect: one photograph was taken along the transect (with transect heading centered in the frame), the other was taken 180° from the transect heading. Directional photographs also were taken from control points.

Panoramic Photographs

We shot a series of overlapping panoramic photographs on selected islands from either transect ends or control points, or both. These series were taken using a panoramic head attached to a tripod.

Photographs were taken from 115 permanently marked photopoints on park islands (Table B-1). Panoramic photographs were taken from 15 points on five islands: Bar Island (MIR# 59-265), Heron Island, The Hop, Little Moose Island, and Sheep Porcupine Island. Island perimeter photographs were taken for 11 islands.

Photographic data, including point locations, directional angles, camera settings, date of each slide, and slides are stored in the Natural Resource Library at ANP (Mittelhauser et al. 1996).

Table B-1. Dates of perimeter photographs and number of permanent photopoints on park islands.

Island Name	# OF Permanent Photopoints	Date of Perimeter Photographs
Baker	21	October 6, 1993
Bald Porcupine	10	July 8, 1993
Bar (MIR# 59-265)	8	September 20, 1993
Bear	0	October 6, 1993
Heron	10	July 14, 1993
The Hop	9	October 6, 1993
Little Moose	11	September 21, 1993
Pond	12	July 2, 1992
Schoodic	18	July 29, 1992
Sheep Porcupine	8	October 6, 1993
Western Ear	8	October 14, 1993
TOTAL	115	11 islands



As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility of the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.