APOSTLE ISLANDS NATIONAL LAKESHORE
BI-ANNUAL
RESEARCH, MONITORING AND RESTORATION REPORT

2004-2005

Research

Monitoring

Restoration

Highlights

Research Projects

Re-evaluation of the Environment of the Deposition of the Devils Island Sandstone

- Devils Island and Hinkley sandstones were originally thought to have been formed by deposition in a near-shore lake environment.
- Recent information indicates that the Hinkley sandstone may have been deposited sub-aerially by wind and stream action.
- This study will try to determine whether the Devils Island sandstone may also have been deposited by wind and stream action, rather than in a lake environment.

Characterization of Mercury Contamination of Aquatic Food Webs in Lagoons in the Apostle Islands National Lakeshore

- Methylmercury exposure can cause a health risk to both humans and wildlife.
- The primary objective of this study was to assess the potential significance of lagoon habitat as pathways of methylmercury exposure to wildlife that feed on aquatic organisms.
- Levels of methylmercury in both water and fish samples were found to be very high, as was the percentage of total mercury present as methylmercury.

Assessment and Development of Water Quality Monitoring Protocols for Park Units in the National Park Service's Great Lakes Network

- Overall objective is to provide the Great Lakes Inventory and Monitoring Network with potential water quality indicators and protocols for monitoring these indicators in the nine network parks.
- Part of this project was to assess historical water quality trends within the network parks and another part was to utilize Apostle Islands National Lakeshore as a pilot park.
- Sampling of water quality, zooplankton and bottom sediment samples were collected from three Apostle Island lagoons and seven open water sites during 2004.
- Results indicate high water quality of Lake Superior remains high. Lagoons have complicated hydrology influenced by Lake Superior and adjacent wetlands.

Apostle Islands Brook Trout Distribution with Emphasis on the 'Coaster' Life Form

- The primary objective of this project was to determine if there are existing brook trout populations within Apostle Islands National Lakeshore and to attempt to identify any migrating life history presence.
- The project is a collaborative effort between the U.S. Fish and Wildlife Service, National Park Service, Red Cliff Band Natural Resources Department, Bad River Band Natural Resources Department, Wisconsin Department of Natural Resources, and Trout Unlimited.
- Four streams on Oak Island were sampled by backpack electro fishing during mid-July to establish the presence of brook trout in these systems. Brook trout were captured in 3 streams on the island.

Inventory of Nearshore Fishes and Descriptions of Nearshore Fish Population Densities and Community Structure at Apostle Islands National Lakeshore and Isle Royale National Park

- The objective of this study was to inventory fish species within the nearshore areas of Apostle Islands National Lakeshore and Isle Royale National Park, where little previous work has been conducted.
- During the two year study, 25 species were captured in nearshore waters.
- The nearshore fish community at Apostle Islands and Isle Royale were found to be similar and distinct from that of the offshore fish community.
- Differences in habitat characteristics and protection from the open lake determine the local composition and structure of nearshore fish communities.

Biodiversity in Selected Natural Communities Related to Global Climate Change

- Environmental changes associated with global warming can have significant impacts on natural communities.
- Peatland natural communities are being used to assess the influence of climate change on a diversity of wildlife and plant species.

Odonata Communities of Open Peatlands Adjacent to Lake Superior in Wisconsin

- The objectives of this study are to survey coastal peatlands for dragonflies and damselflies (Odonata) by identifying breeding adults and collecting exuviae (shed skin) with a special emphasis on rare species.
- A population of a new state record species for Wisconsin, the zigzag darner (*Aeshna sitchensis*) was found in a Stockton island poor fen, along with a population of the state-endangered incurvate emerald (*Somatochlora incurvata*).
- This list provides numerical rankings of rare species and indicates whether a species will be watched or actively tracked by the Bureau of Endangered Resources of the Wisconsin Department of Natural Resources.

Aquatic Insect Communities of Open Peatlands Adjacent to Lake Superior in Wisconsin

- Surveys were made for Natural Heritage Inventory working list aquatic insects, including Odonata, Coleoptera, Heteroptera, and others.
- Rare species found include the dragonfly *Williamsonia fletcheri* and the predacious diving beetles *Ilybius angustior, Ilybius ignarus* and *Neoscutopterus hornii.*

Rare Plants and Invertebrates of Open Peatlands Adjacent to Lake Superior

- As part of the state's peatlands study, plant and rare invertebrate surveys were conducted at sites on Stockton Island and the mainland unit.
- A number of rare plant species were found at these sites, including new records on the mainland unit for *Thalictum venulosum, Plantanthera orbiculata,* and *Goodyera oblongifolia*.
- Observations were made of rare moths and grasshoppers.

Biogeographic Distribution and Genetic Diversity of Pitcher Plant (Sarracenia purpurea) within the Lake Superior Watershed

- The objective of this study was examining the biogeographic dispersal of wetland plants and their patterns of colonization on isolated islands and adjacent mainland systems throughout the Lake Superior Watershed.
- Preliminary data suggests moderate genetic diversity and that populations of pitcher plants across large distances are relatively similar.
- In terms of restoration, this may mean that individuals from any established population can be used to restore an extirpated population.

Mapping the Vegetation of Apostle Islands National Lakeshore

- As part of the National Park Service's Vegetation Mapping Program, a project to create a vegetation map for the park that uses a community classification began in 2005.
- In 2005, 104 vegetation plots were sampled within several habitats across the majority of the mid-sized to larger islands, as well as the mainland unit.
- Results of plots sampled in 2005 and 2006 will be analyzed to develop a classification for vegetation communities within the park that will, in turn, be used to develop a parkwide vegetation map.

Annual Forest Inventory and Analysis for Wisconsin

- This project is part of a nationwide project to conduct annual forest inventories of forested lands throughout the country.
- In 2004, two inventory plots were completed, one on Bear Island and the other one on Cat Island.

Terrestrial Vegetation Structure and Dynamics

- The objectives of this project were to: compare the effectiveness of two different vegetation methodologies (forest inventory analysis-FIA and U.W. plant ecology laboratory-PEL) and to resample PEL plots for comparison with data collected 50 years ago.
- A hybrid method was developed that is more effective at sampling the herb and shrub layers.
- Analysis of the PEL plots has not been completed.

Glacial History and Genetic Variation in Natricine Snakes of the North American Great Lakes

- This project focuses on local and regional genetic consequences of glacial history in five species of natricine snakes (garter snakes and allies).

- Data obtained will be used to test whether:
    - Lake Michigan served to divide snakes into eastern and western lineages during colonization,
    - island age, size, or mode of origin influence patterns of island and mainland differentiation, and
    - patterns of variation differ among species as predicted based on dispersal ability.

Recovery of Great Lakes Piping Plover Population: Banding and Genetic Studies

- To aid in the recovery and conservation of piping plovers, this project utilizes data collected through the capture of chicks and adults to determine natal sites or sites of previous capture, track individual plovers into the future, and DNA analysis to differentiate among three populations of piping plovers.
- In 2005, a single chick was banded that was hatched from a nest on Long Island.

Occurrence and Relative Abundance of Bats at Selected National Parks in the Great Lakes Network

- This inventory was part of a larger scale investigation to determine the occurrence and relative abundance of bats in selected national parks of the Great Lakes Network. This project began in 2003 and continued in 2004.
- The primary objectives were to:
  - document the occurrence of all bat species believed to be present within the park and establish a collection of catalogued voucher specimens;
  - determine the summer relative abundance of each species; and
  - locate and map important habitats including: feeding areas; day or seasonal roosts; maternity sites, and hibernacula.
- Four species of bats were captured, including little brown bat, northern Myotis, Eastern red bat, and silver-haired bat.

Small Mammal Inventory of Apostle Islands National Lakeshore and St. Croix National Scenic Riverway

- The purpose of this study was to determine what species of small mammals occupy selected islands of Apostle Islands National Lakeshore and St. Croix National Scenic Riverway and to estimate the relative abundance of each species.
- Seven of the 22 Apostle Islands, as well as Little Sand Bay on the mainland unit, were inventoried for small mammals during 2003 and 2004. Eight species were captured.
- No winter-inactive or winter hibernators were captured, suggesting that small mammals likely disperse to the Apostle Islands in the winter when the water is frozen.
- Distance to island coupled with island size seems to limit the poorer dispersers, such as North American deer mouse, from many of the islands in the archipelago.

Determine Appropriate Harvest Levels of Deer to Protect Unique Vegetation from Overbrowsing

- This study is designed to gather critical information to assist management and includes: vegetation plots to determine levels of deer browse; pellet counts; aerial surveys to determine deer presence, and hair snares to collect hair samples for DNA analysis.
- Many of the park's islands have little or no evidence of deer presence and currently support a very unique plant community that has become exceedingly rare on the mainland.
- Deer have recently become established on Sand and York Islands, two islands without a known history of deer. Data collected to date indicate a high density and widespread deer population on Sand Island and a very high density deer population on York Island.

Determine Population Status of Black Bears and Develop Monitoring Protocols

- The work conducted in 2004 was a continuation of the black bear DNA project that began in 2002.
- In 2004, snares were established on islands previously not sampled that have had bear sightings or sign.
- The purpose of the 2004 sampling was to obtain data that will enable the park to better understand dispersion population dynamics of bears in the archipelago.
- Hair was successfully obtained from Basswood, Manitou, Michigan, Outer and Raspberry. These samples are scheduled for analysis in 2005/2006.

Highlights

Monitoring Projects

Vegetation and Ecological Communities

Rare Plants

- Goal – monitor status of special concern, threatened, and endangered plant populations.
- Devil's Island:
  2004 - 513 butterwort plants, and 692 arctic primrose.
  2005 – 236 butterwort plants, and 2,258 arctic primrose.

Sandscapes

- The park has rare, high quality sandscapes with vegetation sensitive to trampling
- 2004
  - Sandscapes at Bear, Oak, Long Island, Little Sand Bay and Sand River monitored
  - Vegetative litter increased and vegetation cover decreased on all 5 sandscapes.
  - Percent bare soil decreased on 3 of 5 sandscapes.
- 2005
  - Percent vegetation cover decreased on Cat and Michigan Island sandspits

Campsites

- Monitoring done to detect impacts from use.
- Limits of Acceptable Change (LAC) exceeded at 6 sites monitored in 2004.
- Total number of sites exceeding LAC in the park is 10.
- Sites that exceed the LAC are in need of site restoration.
- Percentage of bare ground increased at 6 sites in 2004.

Exotic/Invasive Species

Exotic Plant Management Team

- Great Lakes Exotic Plant Management Team spent 187 hours in 2004 and 154 hours in 2005 in the park treating exotics.
- Species treated included hawkweed, Japanese knotweed, mullein, purple loosestrife, sheep sorrel, and spotted knapweed.

Hawkweed

- Exotic, invasive species that threatens sandscapes and cultural openings.
- Treatment is completed on Oak Island through hand-pulling.
- Hawkweed plants in monitoring plot decreased by >50% between 2003 and 2004.

Purple Loosestrife

- Exotic, invasive species that threatens wetlands on Long Island.
- Two pronged approach:
  - Long Island 'cut' – biological control through beetle release.
  - Long Island tip – chemical control.
- Long Island 'cut'
  - Approximately 4,400 plants treated with herbicide.
- Long Island tip - 2004
  - More intensive survey resulted in the high count – 1,149 plants treated.

Gypsy Moths

- Exotic, invasive species that threatens hardwood forests.
- Highly significant increase in number of moths trapped over past 4 years ($P < 0.0000$).
- Over 6,700 moths caught in traps in 2005.
- Cooperators include the U.S. Forest Service and Wisconsin Department of Agriculture

Wildlife Species

Birds

Breeding Bird Survey

- 2004 – 1,047 birds among 72 species.
- 2005 – 1,162 birds among 77 species.
- Ovenbird and hermit thrush are showing significant increasing trends.
- Eight species showing decreasing regional trends are stable or increasing at the park and between 1995-2005 were among the most abundant 27 bird species on park surveys
- Role of Apostle Islands in a regional context:
  - Serving as a control area where timber harvest does not occur
  - Providing habitat for ground nesting species.

Colonial Birds

- 30 years of monitoring gulls, cormorants, and great blue herons throughout the park.
- Approximately 40% fewer cormorants on Gull Island in 2004 than in 1999.
- Approximately 50% fewer gulls on Eagle Island in 2004 than in 1999.
- Trend analysis – no significant trends for gulls between 1979-2004.

Bald Eagle

- Federally threatened species.
- 2004 had the highest number of nests (13) and the highest number of chicks fledged (15) since 1980.
- 2005 – 10 nests initiated; 6 successful with 10 chicks fledged.
- Number of occupied nests in the archipelago has increased significantly ($P < 0.001$) since 1980.
- Mean productivity between 1980 and 2004 is 0.73 young/active nest which is lower than regional productivity of 0.92 young/nest.

Piping Plover

- Federal and state listed endangered species.
- 2004 - Three birds observed; no nests established.
- 2005 – Three birds observed; one nest established; one chick out of four eggs fledged and banded.
- Population increasing overall in Great Lakes states.

Ruffed Grouse

- Monitored in cooperation with the State of Wisconsin.
- Game species.
- 2004 - 11 birds.
- 2005 – 5 birds.
- No significant trend over time.

Woodcock

- Monitored in Cooperation with the State of Wisconsin.
- Game species.
- 2004 - 5 birds.
- 2005 – 11 birds.
- Decreasing population trend – significant between 1989 and 2004 ($P<0.05$), but not significant between 1989 and 2005.

Mammals

Black Bear

- Database to track bear observations developed.
- Increased efforts in public education.
- 2004 - 60 observations in the park, 10 of which were bears heard but not seen, or sign.
- 2005 – 8 observations only.

Habitat Restoration

Cabin sites

- Restoration conducted at previous cabin sites on Long, Otter, Rocky, Sand and South Twin Island and the Mainland
- 2003 and 2004 – native trees transplanted
  - Survival rate high for most species and very high for red maple, red oak, white cedar, white pine, white spruce, and jack pine.
- 2004 - approximately 4,000 propagated native plants used in restoration
  - Survival rate very high for blueberry, hairgrass, Pennsylvania sedge, and raspberry.

Oak Island Sandscape

- Restoration initiated in 2000
- Cooperative effort with NRCS, FWS and volunteers
- Bare ground decreasing, vegetative litter increasing.
- Planted and non-planted natives out-competing exotic plants.

South Twin and Raspberry Island Sandspits

- Cooperative effort with NRCS, FWS and volunteers
- South Twin – Over 3,600 native plants used in restoration
- Raspberry – Over 850 native plants used in restoration
- % survival was high for many species, especially blueberry, goldenrod, hairgrass, rush, and wild rose

Raspberry Island Slope

- Goal is to provide long-term stabilization of reconstructed slope in front of lighthouse.
- Cooperative project with the Natural Resource Conservation Service Rose Lake Plant Materials Center.
- Native shrubs and forbs planted in 2003 and 2004.
- Most planted species had a good to excellent survival rate.
- Many weedy species were brought in with topsoil.

Outer Island Slope

- Goal is to provide long-term stabilization of reconstructed slope in front of lighthouse.
- Cooperative project with the Natural Resource Conservation Service Rose Lake Plant Materials Center.
- 2004 – Rock revetment and drainage trenches installed.
- 2005 - Log cribs and slope grids installed, restoration using live stakes and approximately 3,900 plantings.

TABLE OF CONTENTS

HIGHLIGHTS

RESEARCH AND INVENTORY PROJECTS

MONITORING PROJECTS

RESTORATION PROJECTS

LIST OF TABLES

LIST OF FIGURES

Research and Inventory Projects

GEOLOGY

Re-evaluation of the Environment of Deposition of the Devils Island Sandstone

Dr Karen Havholm and Lynn Galston, University of Wisconsin, Eau Claire, WI

The Devils Island Sandstone is a quartz-rich sandstone deposited during the late stages of development of the Keweenawan Rift around 1 billion years ago. Along with other members of the Bayfield Group, this rock unit forms some of the spectacular cliffs within the Apostle Islands National Lakeshore. This rock unit has been interpreted as having been formed by deposition in a near-shore lake environment. The Hinckley Sandstone in eastern Minnesota is considered to correlate to the Devils Island Sandstone. It was also originally interpreted to have been deposited in a near-shore lake environment. However, recent study indicates that it was deposited subaerially by wind and stream action, rather than in a lake environment. The purpose of this study is to determine whether the environment of deposition of the Devils Island Sandstone should also be re-interpreted.

Work in the 2005 field season focused on mainland exposures of the Devils Island formation. Four sections were measured or examined in Iron and Bayfield Counties; two of these were inside the park. Several sedimentary facies (units with distinct characteristics) similar to those in the Hinckley Sandstone in Minnesota have been identified. There is evidence for deposition by wind-blown dunes and in dry to wet interdune flats. Some sediment was also deposited by water, but the precise environments of deposition still need to be determined. Additional fieldwork is needed to clarify the details of depositional processes. This work is planned for summer of 2006, and will focus on Devils and Sand Islands where there are much more extensive exposures available than on the mainland.

Characterization of Mercury Contamination of Aquatic Food Webs in Lagoons in the Apostle Islands National Lakeshore (Lake Superior)

Kristofer Rolfhus, James Wiener, Mark Sandheinrich, and Roger Haro, Universtiy of Wisconsin, La Crosse, WI

Methylmercury exposure can adversely affect humans and wildlife through dietary uptake from aquatic food webs. Lake Superior is generally regarded as a relatively clean body of water, yet fish consumption advisories for mercury have been issued for some of its resident fish. It is known that wetland habitats are sites of active microbial methylation of inorganic mercury to its bioaccumulating and highly toxic form, methylmercury, and the Apostle Island lagoons represent areas of significant potential exposure of methylmercury to wildlife. The objective of this study is to assess the potential significance of lagoon habitats as pathways of methylmercury exposure for wildlife atop aquatic food webs of the Apostle Islands National Lakeshore. The current work is a pilot study in which lagoons on two islands were sampled to quantify mercury contamination of the lagoons and methylmercury contamination of their aquatic food webs. Information from this study will be used (a) to assess the mercury contamination of the lagoons, (b) to estimate methylmercury bioaccumulation and exposure in sampled organisms used as bioindicators of food web contamination, and (c) to determine whether or not additional research is needed.

Sampled lagoons of the Apostle Islands National Lakeshore exhibited several characteristics associated with high rates of methylmercury production and elevated concentrations in aquatic biota, including high temperature in summer, adjoining wetlands, low pH, high concentrations of organic carbon, and dense submersed vegetation. Sampling was done in late July 2005 to coincide with the seasonal period of active microbial production of methylmercury. Water, seston (mostly algae), zooplankton, surficial sediment, benthic macroinvertebrates, and fish were sampled from the Julian Bay lagoon on Stockton Island (125 acres) and the Outer Island lagoon (48 acres). The analyses of water and fish sampled from the two lagoons have been completed. Concentrations of methylmercury in water averaged 1.3 ng/L in Outer lagoon and 2.5 ng/L in Stockton lagoon, greatly exceeding concentrations in Lake Superior (Rolfhus et al. 2003) and inland lakes of the region (including Voyageurs National Park; Wiener et al. in review). Corresponding mean concentrations of total mercury were 4.5 ng/L in the Outer lagoon and 10.0 ng/L in Stockton lagoon. The fraction of total mercury present as methylmercury in water was unusually high, averaging 31% in Outer lagoon and 25% in Stockton lagoon. Thus, the high concentrations of methylmercury in water probably result from high rates of methylation, not from elevated abundances of total mercury. Concentrations of mercury in fish were also high relative to concentrations in regional surface waters. Mercury in axial muscle of northern pike (*Esox lucius*, total length ranging 19-43 cm) averaged 0.78 parts-per-million (ppm or Âµg/g) wet weight and ranged from 0.25 to 1.15 ppm, exceeding the US Environmental Protection Agency's

criterion of 0.3 ppm for protection of human health in 15 of 17 fish analyzed. Concentrations of mercury in 25 whole northern redbelly dace (Phoxinus eos, total length ranging from 5.5 to 8.1 cm) from the Stockton Island lagoon averaged 0.105 ppm wet weight and ranged from 0.07 to 0.19 ppm. This project is producing data of high analytical reliability that will provide a solid foundation for an initial assessment of mercury contamination and associated ecological risks in lagoons of the Apostle Islands. These initial findings show that the studied lagoons are sites of active production of methylmercury, a toxic compound that can bioaccumulate to potentially harmful concentrations in organisms atop aquatic food webs. These data, along with results from ongoing analyses of sediment, seston, zooplankton, and benthic invertebrates will be used to further assess the contamination of the lagoons and the potential significance of these habitats as pathways for dietary methylmercury exposure of wildlife.

Assessment and Development of Water Quality Monitoring Protocols for Park Units in the National Park Service's Great Lakes Network

Dr. Richard Axler, Elaine Ruzycki, George Host, Joe Mayasich, Natural Resources Research Institute, University of Minnesota, Duluth, MN

The objective of this project was to provide the Great Lakes Inventory and Monitoring Network with potential indicators and protocols for monitoring water quality in the nine network parks. Part of this project was to assess historical water quality trends within the network parks. Another part was to utilize Apostle Islands National Lakeshore as a pilot park. Apostle Islands water quality monitoring program includes annual bacteriological sampling, biannual sampling of physical measurements and comprehensive sampling that is done every five years (contingent on funding) that includes sampling of physical, chemical and biological parameters. The pilot study was done, not only provide important monitoring information, but to assist in the development of water quality protocols for all network parks.

In 2004, field sampling for the pilot study was conducted in June, July and October with the assistance of park staff. In June and July, water quality, zooplankton and bottom sediment samples were collected from three lagoon and seven open water sites. Five of the open water sites are part of Apostle Island's water quality monitoring program, two are long-established sites monitored by the U.S. Geological Survey. In October, five lake sites and three lagoons were sampled.

Results indicate high water quality at Lake Superior sampling locations. Dissolved oxygen concentrations were uniformly high and at or near saturation, mean chlorophyll values (indicator of productivity) were very low, and total phosphorus concentrations were extremely low, consistent with the oligotrophic nature of the lake. Results from the Long Island (Chequamegon Bay) sampling location indicate somewhat higher productivity. Temperatures were highest in August. pH values were approximately 8 (slightly alkaline).

The lagoons had highly variable dissolved oxygen levels and specific conductivity. This is likely due to the complicated hydrology of these small and shallow systems that are strongly influenced by Lake Superior, as well as bog and other wetland vegetation adjacent to and on the bottom of the ponds. The pH of the lagoons was lower than open water sites, ranging from 4.8 to 7.7.

Results of biological monitoring indicate the zooplankton diversity and abundance tend to be highest in August.

Report:

Axler, R, E. Ruzycki, J. Henneck and G. Host. 2006. Surface water quality assessment of Apostle Islands National Lakeshore. Great Lakes Inventory and Monitoring Network, Ashland, WI.

Brook Trout Distribution with Emphasis on the 'Coaster' Life Form, Apostle Islands NL

Jonathon Pyatskowit, U.S. Fish and Wildlife Service, Ashland, WI
Bill Mattes, Great Lakes Indian Fish and Wildlife Commission, Odanah, WI
Julie Van Stappen, Apostle Islands National Lakeshore, Bayfield, WI
Matt Symbal, Red Cliff Band, Red Cliff, WI
Steve Schram, Wisconsin Department of Natural Resources, Bayfield, WI
Todd Breiby, Trout Unlimited, Madison, WI
Tom Doolittle, Bad River Tribe, Odanah, WI

The primary objective of this project was to determine if there are existing brook trout populations within Apostle Islands National Lakeshore (APIS) and to attempt to identify any migrating life history presence. A migratory form of the lake dwelling brook trout (*Salvelinus fontinalis*) was historically widespread and common in the nearshore waters of Lake Superior and in the Apostle Islands area. Local residents called these brook trout "coasters" or "rock trout" because of their preference for rocky nearshore habitat. "Coasters" were highly valued and provided a productive nearshore fishery in the lake and in tributary streams. Becker (1983) described coaster brook trout as "those spending part of their life in the Great Lakes". By the late 1800's the "coaster" brook trout became a rare feature of the Lake Superior shoreline waters. A combination of exploitation and destruction of habitat from logging activities reduced tributary populations enough to disrupt and displace the migratory form of brook trout.

The Lake Superior Committee of the Great Lakes Fishery Commission (GLFC) has recognized the "coaster" brook trout as an important component of the fish community in the fish community objectives for Lake Superior (Horns et. al. 2003) and outlined strategies for rehabilitating brook trout stocks in Lake Superior (Newman et. al. 2003). The goal stated for the Wisconsin DNR's Lake Superior Basin Brook Trout Management Plan (2002) is "to protect and improve the self-sustaining brook trout populations and their habitat in Wisconsin's Lake Superior Basin, and attempt to establish several populations that exhibit life history diversity (both stream resident and migratory "coaster" life history types)". In addition, the work plan will support NPS resource management and Red Cliff Natural Resource Department fishery management plan.

This project is a collaborative effort between the U.S. Fish and Wildlife Service, National Park Service, Red Cliff Band Natural Resources Department, Bad River Band Natural Resources Department, Wisconsin Department of Natural Resources, and Trout Unlimited. Dennis Pratt has done extensive research of newspaper articles from the 1800's that documents accounts of coaster brook trout throughout the Bayfield Peninsula which includes the proposed area of study. Fishery surveys conducted by WIDNR in years 1961-2003 and by USFWS in years 1982, 1983, 1994, and 1995 as well as studies of fish community composition by the USFWS in years 1958-1982, served as a guide in determining where to concentrate efforts for this study. Information that is obtained in this assessment can be used by management agencies to guide attempts to rehabilitate or restore self-sustaining populations of brook trout including the migratory form to the

Apostle Islands National Lakeshore. Funding for this work is coming from Trout Unlimited for completion of work in 2004.

In 2004, four streams on Oak Island were sampled by backpack electrofishing during mid-July to establish the presence of brook trout in these systems. Brook trout were captured in streams #1 and #2 on the north side, and in stream #4 which was one of two sampled on the south side of the island. Summarization of fish caught from Oak Island streams are shown below (Table 1). Streams were sampled on 7/13/2004.

Table 1. Size of fish caught in 3 streams at Oak Island during Summer and Fall seasons.

Season	Stream	Number	Size Range (mm)	Average Size
Summer	1	100	31-194	92.8
Fall	1	105	42-212	77.7
Summer	2	35	32-161	70.8
Fall	2	25	40-188	83.6
Summer	4	2	124-174	

During late October, 2004, the lakeshore along Sand and Little Sand Bays, Oak Island and Basswood Island were surveyed by boat electro fishing. No brook trout were captured along any of the transects. The four streams sampled by backpack electro fishing during the summer were re-sampled in the fall in an attempt to capture brook trout that might be indicative of a coaster life history. Brook trout were captured in streams #1 and #2 but streams #3 and #4 were both no longer flowing during the fall period. Summarization of fish captured is shown above.

Inventory of Nearshore Fishes, and Description of Nearshore Fish Population Densities and Community Structures at Apostle Islands National Lakeshore and Isle Royale National Park

Dr. Owen Gorman and Seth Moore, U.S. Geological Survey, Biological Resources Division, Ashland, WI

An assessment of the fish communities of the nearshore waters of the Apostle Islands National Lakeshore (APIS) and Isle Royale National Park (ISRO) was conducted during the summers of 2003-2004. This assessment addressed the following objectives: conduct an inventory of fish species, estimate relative abundances, describe community structures, identify distribution patterns related to habitat associations, compare nearshore and offshore fish communities in APIS, evaluate the effectiveness of various gear to sample fish communities, and provide recommendations for establishing a long-term monitoring and research program.

The nearshore fish communities of APIS and ISRO was found to be dominated by a common set of native species: lake chub, ninespine stickleback, slimy sculpin, burbot, and trout-perch. The predominant nearshore habitat of the APIS region was characterized by low slope with sandy substrates and in ISRO was characterized by moderate to steep slopes with coarse and bedrock substrates. Most of the shoreline of APIS and ISRO was exposed to the open lake, but embayments in ISRO provided protected habitat, particularly at the head of bays. Habitat in these protected areas provided little structure and was characterized by low slope and fine substrates but harbored relatively diverse assemblages with high relative abundances. Species indicative of these protected habitats included spotfin shiner, blacknose dace, and white sucker. Unprotected areas at the mouth of bays provided the greatest structure (steep rocky slope) and harbored simple assemblages strongly dominated by lake chub. In APIS, there was a less contrasting pattern; areas of high slope and coarse substrates harbored more diverse assemblages while areas of low slope and fine substrates harbored less diverse assemblages. At a regional scale, the similarity in composition of nearshore fish communities of APIS and ISRO suggests that the fish communities of the nearshore waters of Lake Superior are drawn from a common source pool and that differences in habitat characteristics and protection from the open lake determine the local composition and structure of those communities. The structure of the offshore fish community was found to be distinct from that of the nearshore community. The offshore community was dominated by coregonids and sculpins and only the slimy sculpin held a position of strong importance in both communities. The lake chub was the most distinctive feature of the nearshore fish community as it was both unique to nearshore waters and was an abundant, conspicuous member of that community. Of the four gears used for sampling nearshore fish communities (seines, bottom trawls, Windermere traps, fyke nets) Windermere traps were found to be most suitable because they effectively sampled fish over the full range of nearshore habitats in both APIS and ISRO, thus providing common measure of community attributes (species richness, community structure, density andbiomass, and habitat associations). Long-term monitoring programs should consider using Windermere traps supplemented by fyke nets and electrofishing to characterize

nearshore fish communities. Future research needs in nearshore waters include: habitat and life history associations of nearshore and offshore species; spawning and nursery areas for open water fishes; and trophic and energetic contributions of nearshore waters to the Lake Superior ecosystem.

Report:

Gorman, Owen and Seth Moore. 2006. Inventory of nearshore fish population densities and community structures at Apostle Islands National Lakeshore and Isle Royale National Park. Draft final report submitted to: NPS Great Lakes Inventory and Monitoring Network, Ashland, WI. 65 pp.

ECOLOGICAL COMMUNITIES

Biodiversity in Selected Natural Communities Related to Global Climate Change

Environmental changes associated with global warming can have significant impacts on natural communities. Animals and plants are expected to respond to climate change. At present, it is unknown how such changes might affect biotic diversity in Wisconsin. This study is focusing on peatland natural communities as a medium to assess the influence of climate change on a diversity of wildlife and plant species. Baseline data are being collected from 2004 through 2007 on birds, small mammals, amphibians, rare reptiles, rare vascular plants, and rare invertebrates in order to allow comparisons with future studies. This study is designed to provide fine-scale temporal resolution through intensive studies of 13 peatland complexes and broad-scale spatial resolution through extensive study of 50-200 additional wetlands statewide. The following three summaries report on different aspects of this project.

Odonata Communities of Open Peatlands Adjacent to Lake Superior in Wisconsin

Robert DuBois, Wisconsin DNR

The objectives of this portion of the global change study are to survey coastal peatlands for dragonflies and damselflies (Odonata) by identifying breeding adults and collecting exuviae (shed skin) with a special emphasis on rare species. The Wisconsin DNR has an active statewide Odonata atlas project to better understand distributions and critical habitats of rare dragonfly species. Coastal peatlands, especially those in the Apostle Islands NL, are an under surveyed type of habitat that have considerable potential to hold not just rare species, but possibly new records for the state.

Eleven poor fens or coastal fens were selected for sampling, three of which were in the Apostle Islands National Lakeshore (APIS). A total of 72 sampling visits were made to the fens, including ten visits to the three APIS fens, from June through September 2004. Over 4,200 specimens were identified, and evidence of breeding in the fens was found for 32 species of Odonata. A population of a new state record species for Wisconsin, the zigzag darner (*Aeshna sitchensis*) was found in a Stockton island poor fen, along with a population of the state-endangered incurvate emerald (*Somatochlora incurvata*). The most common species of Odonata breeding in the fens, in decreasing order of abundance, were *Nehalennia irene, Sympetrum obtrusum, S. vicinum, Leucorrhinia hudsonica, Ladona julia, Enallagma hageni, Lestes disjunctus, Leucorrhinia frigida*, and *Libellula quadrimaculat*a. This study contributed information that led to changes in the tracking status of seven rare species on the Natural Heritage Inventory Working List. This list provides numerical rankings of rare species and indicates whether a species will be watched or actively tracked by the Bureau of Endangered Resources of the Wisconsin Department of Natural Resources.

Aquatic Insect Communities of Open Peatlands Adjacent to Lake Superior in Wisconsin

Wayne Steffens, Duluth, MN
Dr. Kurt Schmude, University of Wisconsin, Superior, WI

For this component of the study, surveys were made for NHI Working List (rare) aquatic insects including Odonata, Coleoptera, Heteroptera, and others.

The following species were collected during our survey in June, 2004. Interesting species found during this survey include:

- The dragonfly *Williamsonia fletcheri* was considered quite rare in WI prior to 2004, however many new sites were found during 2004 and its state status may be upgraded.

- *Ilybius angustior*, a predacious diving beetle, is a rare species in Wisconsin; it has been found in only 8 counties in northern WI. It was in Sand Bay, which was the only site where it was found in 2004.

- *Ilybius ignarus*, a predacious diving beetle, was a target species for this study; it is uncommon to rare. Specimens were only found at Sand Bay and a site Fond du Lac County.

- *Neoscutopterus hornii*, a predacious diving beetle, was also a target species. It is uncommon to rare throughout the state, but it can be found regularly and in good numbers in certain bogs or peatlands. It was found at Sand Bay.

Rare Plants and Invertebrates of Open Peatlands Adjacent to Lake Superior in Wisconsin

Janeen Laatsch, Craig Anderson, Eric Epstein, Kathy Kirk, Loren Ayers, Tara Bergeson
Bill Smith, Wisconsin Department of Natural Resources, Madison, WI
Andy Clark, Madison, WI

Two study sites fall within the Apostle Islands National Lakeshore. Results of plant and rare invertebrate surveys at these two sites during the 2005 field season are presented here. One study site is located on Stockton Island, and the other is located on the mainland at Sand Bay. The following rare plant species were observed on Stockton Island: *Rhynchospora fusca, Utricularia resupinata, Carex exilis, C. michauxiana, Platanthera orbiculata*, and *Goodyera oblongifolia*. All of these species were already known from this site, but presence in 2005 was confirmed and documented with notes and/or photographs. On the mainland at Sand Bay, the following rare plants were observed: *Thalictrum venulosum, Platanthera orbiculata, Arethusa bulbosa, Rhynchospora fusca, and Goodyera oblongifolia. Arethusa bulbosa* and *Rhynchospora fusca* were already known from this site. *Thalictrum venulosum, Platanthera orbiculata*, and *Goodyera oblongifolia* are new records for the site. On Stockton Island, rare invertebrate surveys were conducted. Observation were made of the moths *Cingulia catenaria* and *Sphinx cf. poecila; Scudderia curvicauda* (a katydid); *Melanoplus islandicus* (a grasshopper); and *Oecanthus fultoni*, (the snowy tree cricket). The Sand Bay site contained Booneacris glacialis, Orgyia leucostigma (white-marked tussock moth), *Cinguilia caternaria* (a moth) and *Stethophyma gracile* (graceful sedge grasshopper).

VEGETATION

Biogeographic Distribution and Genetic Diversity of Pitcher Plant (*Sarracenia purpurea*) within the Lake Superior Watershed

Jennifer Karberg, Michigan Technological University, Houghton, MI
Joy Marburger, National Park Service, Porter, IN
Margaret R. Gale, Michigan Technological University, Houghton, MI

The objectives of this study are to examine the biogeographic dispersal of wetland plants and their patterns of colonization on isolated islands and adjacent mainland systems throughout the Lake Superior watershed. *Sarracenia purpurea* is being used as a representative species of northern wetland bog and fen communities. Genetic diversity of individuals on Isle Royale National Park, the Apostle Islands, Pictured Rocks, and three Canadian Provincial Parks will be compared for an understanding of plant dispersal capabilities across a natural fragmentation barrier such as Lake Superior. Understanding the ability of this plant to move across barriers will provide information about the potential of plant communities to move in response to habitat loss, fragmentation, and in the face of changing ecological habitat caused by such events as global warming. This study will provide valuable information on the ability of northern bog/fen ecosystems to respond to fragmentation events and help in restoration projects centered around this plant.

This two year project began in 2004. During the summer of 2004, pitcher plant populations were discovered and surveyed in the Apostle Islands National Lakeshore, Isle Royale National Park, and Pictured Rocks National Lakeshore. Up to 5 populations per park were surveyed and sampled. Measurements were taken of flower number, leaf number, flower height, and basal diameter for each plant, pH was measured, and tissue samples collected.

Preliminary data, using samples from Isle Royale National Park and Sleeping Giant Provincial Park, suggests moderate genetic diversity within sampled pitcher plant populations and that populations of pitcher plants, even across large distances are relatively similar. Pitcher plant is a clonal species and further investigation might prove that this species, even though separated by great distances, does not experience enough environmental pressure to drastically alter its genetic diversity. In terms of restoration, this may mean that individuals from any established population can be used to restore an extirpated population. The validity of this assumption will be explored using samples collected from the other parks, United States and Canadian, to get a large scale picture of genetic variability around the western Great Lakes region. Geologic material and its influence on environmental pH may play in role in differentiating populations – this will be further explored through correlation of the collected pH data and genetic diversity measures. Samples collected from Apostle Islands NL are currently being analyzed and will be related to other populations.

Mapping the Vegetation and Fuels of the Apostle Islands National Lakeshore

Dr. Shannon Menard and Jim Drake, NatureServe, Minneapolis, MN
Eric Epstein, Wisconsin Department of Natural Resources, Madison, WI
Janet Marr

Summer 2005 was the first of two field seasons to collect vegetation data across Apostle Islands National Lakeshore (APIS). These data are to be used to develop a community classification for APIS as part of the National Park Service Vegetation Mapping Program (http://biology.usgs.gov/npsveg/). In 2005, 104 plots were collected. These occurred with varying intensity within several habitats across the majority of the mid-sized to larger vegetated islands including Sand, Stockton, Outer, Devils, Long, Oak, Bear, and Michigan. The mainland of the park also was sampled. These plots will be combined with plots taken during 2006 and analyzed to develop a classification of and keys to the vegetation communities of APIS. The classification and keys, along with the plot data, will then be used to help inform the mapping of vegetation throughout APIS.

Annual Forest Inventory and Analysis for Wisconsin

William Burkman, U.S. Forest Service

This project is part of a cooperative program authorized by the U.S. Congress to conduct annual forest inventories on all forested lands within the country. Plots are selected across the entire United States for measurement by Forest Inventory and Analysis (FIA) staff and their cooperators. There is one plot for every 6,000 acres in the US. Each plot is installed and measured on a 5-year cycle. FIA is a national program of the USDA Forest Service that conducts and maintains comprehensive inventories of the condition and health forest resources in the US.

In 2004, two inventory plots were completed, one on Bear Island and the other on Cat Island. Both areas were classified as Forest land. Information, as it is published, will be available at http://www.ncrs.fs.fed.us/4801/. The information on these two plots will be combined with the other 8,000 plots done on a 5 year cycle in the State of Wisconsin.

Terrestrial Vegetation Structure and Dynamics

Dr. Donald Waller, Dave Rogers, Sarah Johnson, University of Wisconsin, Madison, WI

Long-term ecological monitoring is essential to understanding how natural systems change over time and to determine if current conditions fall within the natural range of historic variability. The Great Lakes Inventory and Monitoring Network (GLKN) of the National Parks has systematically identified terrestrial vegetation as a high priority "Vital Sign". This calls for development of a protocol to survey the status of park plant communities and trace shifts in plant species composition and community structure among the nine parks in the region. The ability to detect and interpret such ecological change is largely a function of the breadth and intensity of the monitoring program. In order to develop a sound ecological monitoring program, we must address plot size, number, spacing and frequency of sampling. We explore the inherent limits that such finite sampling issues place on our ability to document and understand temporal change at different scales within sites, across habitat type, within parks and across the region. Existing vegetation monitoring programs throughout the Mid-West are linked to established forest sampling schemes, such as fixed-area plots of FIA (Forest Inventory and Analysis) and variable-radius methods of PEL (UW-Plant Ecology Laboratory). We compared these two methods in forested sites at APIS (n = 20) and the FIA method with a modified Whittaker nested plot design (â Hybridâ) at PIRO (n = 20) in summer 2005. The Hybrid method was developed to be better balanced in the ratio of sampled vegetation strata (trees: saplings: shrubs: herbs) than FIA and PEL. Our objective was to compare the time and effort, aerial extents, intensities and amount of data gathered by all three methods, and to further evaluate the relative statistical power of each method to detect change associated with single and composite indicators. In addition to comparing sampling methods, our study was designed to monitor short-term (PIRO) and long-term (APIS) vegetation changes. The 20 sites we sampled at PIRO were permanently-marked FIA plots previously sampled by PIRO biologists 3-5 years earlier. A total of 28 PEL sites at APIS were surveyed to assess the ability of our methods to detect 50-year changes in community composition and structure.

The PEL and HYBRID methods sample a larger area than FIA for all vegetation strata, which inherently allowed the FIA method to be quicker. Preliminary results indicate that the methods returned similar data per unit area for comparable vegetation strata; however, the FIA method generally sampled fewer individuals and species. Notably, species diversity was highest in the herb and shrub layer at PIRO and APIS. Despite this distinction, the PEL and FIA methods both placed more emphasis on sampling of the overstory in terms of area ratios sampled for all vegetation strata. The HYBRID method was determined to be more powerful than FIA at detecting changes of a lower magnitude in metrics such as tree basal area, tree density, herb frequency and richness; however, both HYBRID and FIA are comparable at detecting a 20% change in these metrics. Simulated species-specific changes, such as a 20% change in *Fagus grandifolia*, were not detected by HYBRID or FIA, suggesting that composite indicators may prove to be more powerful at detecting change across the region. The relative statistical power of the PEL and FIA methods in APIS is being analyzed.

Glacial History and Genetic Variation in Natricine Snakes of the North American Great Lakes

Dr. Gary Casper, Milwaukee Public Museum, Milwaukee, WI
Dr. Gordon Burghardt, University of Tennessee, Knoxville, TN
Dr. Richard B. King, Northern Illinois University, DeKalb, IL
Jace Robinson, Northern Illinois University, DeKalb, IL

This project focuses on local and regional genetic consequences of glacial history in five species of natricine snakes (garter snakes and allies). These snakes are widely distributed in the region but differ in timing of colonization and ability to cross water. Tests of regional consequences will focus on patterns of variation at sites outside and within glaciated areas of Wisconsin, Illinois, Indiana, Michigan, and Ohio. Tests of local consequences will focus on archipelagos and adjacent mainland areas of Lake Erie, Lake Michigan, and Lake Superior. Molecular techniques will be used to characterize patterns of variation in two classes of genetic markers, maternally inherited mitochondrial DNA sequences and biparentally inherited micro satellite DNA markers. Data obtained will be used to test whether (1) Lake Michigan served to divide snakes into eastern and western lineages during colonization, (2) island age, size, or mode of origin influence patterns of island and mainland differentiation, and (3) patterns of variation differ among species as predicted based on dispersal ability. This study is significant in that it provides tests of specific biogeographic hypotheses in multiple sympatric species using both nuclear and mtDNA genetic markers at local and regional geographic scales and is the first such study to focus the North American Great Lakes.

DNA analyses were completed for one species (garter snake) and a manuscript is nearing submission. DNA analyses were begun on a second species (red-bellied snake).

Recovery of Great Lakes Piping Plover Population: Banding and Genetic Studies

Dr Francesca Cuthbert, Jennifer Stucker, and Erin Roche, University of Minnesota, St. Paul, MN

The objectives of this study are to:
(1) Capture banded adult breeding plovers to determine natal site or site of previous capture. This activity will provide information on source of birds that recolonize the Apostle Islands NL and their movements and reproductive success can be monitored in future years.
(2) Capture and band unbanded breeding plovers and/or chicks to allow tracking of individuals in the future. Information from monitoring will be added to the population database that has been developed since 1993 and provides diverse information such as life time reproductive success, habitat use, mate fidelity, and reasons birds change nesting locations.
(3) Collect genetic information (feather collection/trimming) on Great Lakes Piping Plovers that will assist in understanding differences among the 3 populations.
(4) To use the information obtained to enhance recovery and conservation efforts and activities for the endangered Great Lakes Piping Plover population.

Appropriate piping plover habitat was visited in 2005 by Apostle Islands NL, Bad River Band of Lake Superior Chippewa, U.S. Fish and Wildlife Service, and Wisconsin DNR biologists to look for nesting birds. A four egg nest and was located in May on Long Island. Both adults had been previously banded. The natal site for the male was likely Vermilion, Michigan and Point aux Chenes, Michigan for the female. An exclosure was constructed to protect the nest from predators. One chick was banded and is believed to be the only young from the nest that fledged.

Occurrence and Relative Abundance of Bats at Selected National Parks in the Great Lakes Network

Laura Kruger, Michigan Technological University, Houghton, MI
Bill Route, National Park Service, Great Lakes Inventory and Monitoring Network, Ashland, WI
Frank Maragi, Ashland, WI
Rolf Peterson, Michigan Technological University, Houghton, MI

The Apostle Islands National Lakeshore (APIS) bat inventory is part of a larger scale investigation to determine the occurrence and relative abundance of bats in selected national parks of the Great Lakes Network. This project began in 2003 and continued in 2004. The primary objectives of this project were to: (1) to document the occurrence of all bat species believed to be present within the park and establish a collection of catalogued voucher specimens; (2) to determine the summer relative abundance of each species; and (3) to the extent possible, locate and map important habitats including: feeding areas; day or seasonal roosts; maternity sites, and hibernacula. An additional objective was added to the Apostle Islands survey in 2004: investigating the activity levels of bats in and around sea caves located on the mainland and islands of APIS by comparing bat activity levels between shoreline with sea caves, shoreline without sea caves, and an open inland area.

Sea caves located throughout the mainland and islands of APIS could potentially provide summer roosting habitat for area bats. However, the extent of use by bats of these sea caves was not known. Relative use of sea caves by bats was investigated at three sites: the mainland, Sand Island and Devils Island. At each site, bat use of sea caves was examined by comparing bat activity levels between three different habitats: shoreline with sea caves; shoreline without sea caves; and an interior, open area. All three habitats were simultaneously sampled from sunset to sunrise using ANABAT II acoustic recording equipment. A total of 8 points in each habitat (24 points total) were sampled on the mainland and Sand Island, and a total of 5 sites in each habitat (15 points total) were sampled on Devils Island throughout June, July and August of 2004. Bats were also captured to verify species present in the area and to obtain identified call recordings for a reference library that will be used for later analysis.

Four species of bats and 10 individuals were captured in the park: little brown bat (*Myotis lucifugus*, 0 females & 2 males); northern Myotis (*Myotis septentrionalis*, 0 females & 2 males); the Eastern red bat (*Lasiurus borealis*, 3 females & 2 males); and the silver-haired bat (*Lasionycteris noctivagans*, 0 females & 1 male). A total of 6,747 calls were recorded on the mainland; 3,513 calls were recorded on Sand Island; and 2,171 calls were recorded on Devils Island. Insects were also collected at half of the sampling points in each habitat using black light traps. A total of 10 different insect orders were collected, including: Coleoptera, Diptera, Homoptera, Hymenoptera, Lepidoptera, Neuroptera, Orthoptera, Trichoptera, Ephemeroptera and Plecoptera.

ANABAT II call recordings are in the process of being identified and insects have been identified to the order and a dry biomass (g) by order determined. An index of bat and insect activity will be compared between habitats (shoreline with sea caves, shoreline without sea caves and inland) both within and amongst the different sampling sites (mainland, Sand Island, Devils Island).

Small Mammal Inventory of Apostle Islands and St. Croix National Scenic Riverway

Dr. Douglas Smith, Northland College, Ashland, WI
Emily Fawver, Northland College, Ashland, WI

The purpose of this study was to determine what species of small mammals occupy selected islands of Apostle Islands National Lakeshore and St. Croix National Scenic Riverway and to estimate the relative abundance of each species.

Seven of the 22 Apostle Islands, as well as Little Sand Bay on the mainland unit, were inventoried for small mammals during 2003 and 2004. On each island and the mainland unit Sherman live traps were used to capture small mammals. During 3,288 trap nights in 2003 and 1,814 trap nights in 2004, eight small mammal species were caught on the mainland and a subset of those species on seven islands. In 2003, southern red-backed vole (*Clethrionomys gapperi),* North American deer mouse (*Peromyscus maniculatus*), masked shrew (Sorax cinereous), and red squirrel (*Tamiasciurus hudsonicus*) were caught on all of the islands except Devil's. In 2004, mammals were trapped in the small, distant (from the mainland) islands nearest to Devils Island and did not capture deer mice. Also in 2004, meadow vole (*Microtus pennsylvanicus*) was captured on Basswood Island, a species that was not captured on the mainland unit in 2003. No winter-inactive or winter hibernators were captured, suggesting that small mammals likely disperse to the Apostle Islands in the winter when the water is frozen. Distance to island coupled with island size seems to limit the poorer dispersers, such as North American deer mouse, from many of the islands in the archipelago.

At Apostle Islands National Lakeshore, small mammals were live trapped on South Twin, Rocky, Cat, North Twin and Basswood Islands. Species captured and released included: southern red-backed vole (*Clethrionomys gapperi*); masked shrew (*Sorax cinereus*); red squirrel (*Tamiasciurus hudsonicus*); and meadow vole (*Microtus pennsylvanicus*). The southern red-backed vole was the most commonly captured small mammal on the islands, constituting 70% of the captures and 67% of the total small mammal biomass. It was also the most abundant small mammal captured on the islands in 2003. Meadow voles were captured in 2004 on Basswood Island. This species was not captured on any of the islands inventoried in 2003.

Report:

Smith, G. and E. Fawver. 2005. Small mammal inventory of Apostle Islands National Lakeshore and St. Croix National Scenic Riverway. National Park Service Great Lakes Inventory and Monitoring Network Report GLKN/2005/03.

Determine Appropriate Harvest Levels of Deer to Protect Unique Vegetation from Overbrowsing

Dr Douglas Smith, Northland College, Ashland, WI
Frank Maragi, University of Minnesota, Duluth, WI
Emily Fawver, Herbster, WI
Julie Van Stappen, Apostle Islands National Lakeshore, Bayfield, WI
Tom Doolittle, Bad River Band of Chippewa Indians, Odanah, WI
Jerry Belant, Pictured Rocks NL, Munising, MI

Apostle Islands National Lakeshore has a critical need for information related to deer abundance and distribution, and impacts to vegetation. This need is especially urgent due to recent changes in deer distribution and abundance. Many of the park's islands have little or no evidence of deer presence. As a result, they currently support a rare, but once widespread, plant community that includes species now mostly absent on the mainland due to chronic overbrowsing by white-tailed deer (e.g, Canada yew). Forest ecosystems that have not had a history of deer are exceedingly rare, as is their associated understory vegetation. In recent years, deer have become established on two islands, Sand and York, where deer populations were not known to occur historically.

This study has a number of components designed to assist management with this important issue. Vegetation plots, focusing on woody browse and herbaceous species, are being measured to determine impacts from deer browsing on vegetation, especially sensitive species, such as Canada yew (*Taxus canadensis*). Pellet counts are being done in association with the wood browse plots. Both islands with and without an understory dominated by Canada yew are being studied. Aerial overflights are being conducted to determine deer presence and potential expansion and hair snares are being used to obtain samples for DNA analysis.

In 2005, vegetation plots were sampled on Sand, York, Raspberry, Oak, and Basswood Islands. Results of this sampling indicate that Basswood Island had a low level of deer browse throughout the island. The species with the highest amount of browse was red and sugar maple. The mainland unit showed high browsing by deer and high density of pellet groups. Mainland plots had a lot of browse on red and mountain maple. No other browse species occurred in the plots, suggesting a long history of over-browsing by white-tailed deer. Oak Island had a moderate level of deer browse throughout the island. White pine and mountain maple were largely unavailable to deer but in one plot, deer had removed nearly all available stems. Otherwise, deer browse on shrubs and saplings was less than 1% browse except sugar maple (5% browsed). Although one deer was seen during a winter overflight in early 2005 on Raspberry Island, it appears that the deer did not stay. Only one deer rub and no scrapes, trails, or deer pellet groups were found. Raspberry Island does not have a history of deer presence and has a rich understory of Canada yew. Sand Island showed evidence of a high deer population. Canada yew was browsed in every plot where it was present. Red maple was also heavily browsed, with lighter browse on mountain maple, red-osier dogwood, and northern white cedar. York Island showed evidence of a very high white-tailed deer population. Canada yew is being

heavily browsed, as is mountain maple. A fairly low percent of northern white cedar was browsed.

In 2006, vegetation plots will be resampled, hair snares will be established in a manner that will hopefully enable the park to obtain an accurate populations estimate on both Sand and York Islands, aerial overflights will continue, and exclosures will be established on Sand and Basswood Islands to assist in determining long-term vegetation changes.

Determine Population Status of Black Bears and Develop Monitoring Protocols

Julie Van Stappen, Apostle Islands National Lakeshore, Bayfield, WI
Jerry Belant, Pictured Rocks National Lakeshore, Munising, MI
David Peatkau, Wildlife Genetics, Nelson, B.C.

The work conducted in 2004 was a continuation of the black bear DNA project that began in 2002. In 2002, hair samples were collected to determine population levels and genetic variability on Stockton and Sand Islands, two islands with known bear populations. In 2003, a much smaller number of snares were established to better understand the bear population on Oak Island and to obtain samples from mainland bears. This data provided excellent information on unique populations within the lakeshore and provided information on dispersion. In 2004, snares were established on islands previously not sampled that have had bear sightings or sign. The purpose of the 2004 sampling was to obtain data that will enable the park to better understand dispersion population dynamics of bears in the archipelago.

Effective management of American black bears (*Ursus americanus*) requires an understanding of population demographics. To obtain an estimate of the black bear population and data on population genetics on Stockton (4,069 ha) and Sand (1,193 ha) Islands, bear hair was collected using barbed-wire hair traps in 2002. Hair samples were also collected from two nuisance bears on Oak Island. Over 370 hair samples from Stockton and Sand Islands were collected on 4 occasions at about 14-day intervals. Repeated sampling of hair is similar to the marked-recapture technique used in estimating wildlife populations and enables similar analysis to be performed on the data. DNA analysis of the hair samples allowed for a very accurate population estimate to be determined for Sand (6) and Stockton Islands (26). Data results also revealed that the bear populations within the park have a relatively high degree of genetic variability along a gradient; highest on islands close to the mainland and lowest on an island further from the mainland.

In 2003, an additional 62 hair samples were collected from Oak Island and the mainland. These additional individuals increased sample size and regional coverage. Initial analysis of this data revealed two genetically distinct groups, with 41 of 44 individuals estimated to have greater than 95% ancestry in a single population. Each animal was overwhelmingly assigned to either Stockton Island or “everything else”. Further analysis separated the “everything else” into two geographic groups, Oak Island and Sand/Mainland. Although clustering wasn’t as tight, 84% of animals continued to have more than 90% of their ancestry ascribed to a single population. There are therefore three biologically meaningful clusters of individuals. The data identified 11 immigrant individuals (7 male, 4 female) with 6 Stockton animals appearing to come from the mainland and a seventh from Oak Island, while both Oak and the mainland appear to include a single immigrant from Stockton. Three of the animals on Oak appear to have mainland origins. There were no immigrants on Sand Island, indicating that the high degree of connectivity with the mainland prevents genetic differentiation.

Using this dataset, it was possible for geneticists to identify movements in both directions between three genetic groups, a huge technical accomplishment. Also, having populations that are so closely related and, at the same time, having such rapid genetic drift that the populations can be clearly clustered is very different from current thought in population genetics.

To further our understanding of the park's bear population, snares were established in 2004 on islands that had bear sign, but not a known population. Hair was successfully obtained from Basswood, Manitou, Michigan, Outer and Raspberry. These samples are scheduled for analysis inn 2005/2006 and should provide excellent information relating to population dispersion.

This project has shown that the use of DNA analysis of hair can reveal a great deal of information important for understanding populations and critical to management. Methods used are feasible and require less time and expertise than standard methods of capture and radio telemetry. The hair snares were very effective at collecting samples and are unobtrusive to the animals involved. Using this technique, we were able to: obtain very accurate population estimates; determine that the island populations have relatively high genetic variability under a gradient of more genetic variability on islands close to the mainland and less on island further from the mainland; and determine that the park has three genetically distinct bear populations. The importance of this data will become even more valuable if this technique is used for long-term monitoring. Future sampling has the potential to provide incredible insight into the park's bear population, greatly increasing our understanding of dispersion and island biogeography.

Publication:

Belant, J., J. Van Stappen and D. Paetkau. 2005. American black bear population size and genetic diversity at Apostle Islands National Lakeshore. Ursus 16(1)85-92(2005).

Monitoring Projects

VEGETATION AND ECOLOGICAL COMMUNITIES

Rare Plants

- **Goal – monitor status of special concern, threatened, and endangered plant populations**
- **Devil's Island**
- **2004 - 513 butterwort plants, and 692 arctic primrose**
- **2005 – 236 butterwort plants, and 2,258 arctic primrose**

The lakeshore contains several plants that are rare and unique in Wisconsin. This is due primarily to the fact that the park lies in the tension zone between the boreal and temperate forests. Regionally rare habitats in the lakeshore include old-growth forest, boreal forest, northern forests (five types), forest seep, clay bluff communities, sandstone cliff communities, lagoonal and bog communities, forested ridge and swale, coastal fen, Great Lakes barrens (only example in the State), and dunal communities. An intensive rare plant inventory was conducted in the park in 1991 and 1992 (Judziewicz and Koch 1993). In 1996, monitoring protocols were developed, permanent plots established, and monitoring conducted of high priority rare plants (Judziewicz 1996). Apostle Islands National Lakeshore provides important habitat for six State endangered plants: butterwort, lake-cress, small shinleaf, moonwort, mountain cranberry, and satiny willow; twelve state threatened plants: beautiful sedge, coast sedge, lenticular sedge, Michaux's sedge, drooping sedge, broad-leafed twayblade, marsh grass-of-Parnassus, spike trisetum, northern gooseberry, flat-leaved willow, and plains ragwort (see Appendix 1 for scientific names), and 26 species of concern. A rare plant monitoring program was developed and implemented in 1998.

In June of 2004, four new plots were established at clearly identifiable sites on Devil's Island to monitor butterwort and arctic primrose. Table 2 displays these results which are quite variable between years. Continued monitoring will provide further information regarding this range over time.

Table 2. Number of flowering and non-flowering butterwort and arctic primrose at Devil's Island in 2004-2005.

Year	Species	Number Flowering	Number Non-Flowering	Percent Flowering	Total Plants
2004	Butterwort	229	284	81	513
2005	Butterwort	157	79	67	236
2004	Arctic Primrose	692	0	100	692
2005	Arctic Primrose	1494	764	34	2,258

Sandscapes

- **The park has rare, high quality sandscapes with vegetation sensitive to trampling**
- **2004**
  - **Sandscapes at Bear, Oak, Long Island, Little Sand Bay and Sand River monitored**
  - **Vegetative litter increased and vegetation cover decreased on all 5 sandscapes.**
  - **Percent bare soil decreased on 3 of 5 sandscapes.**
- **2005**
  - **Percent vegetation cover decreased on Cat and Michigan Island sandspits**

The lakeshore has a rich assemblage of coastal features including barrier beaches (Long Island) and beaches, cuspate forelands, sand spits, and tombolos, collectively termed sandscapes. The sandscapes within the park are among the most pristine and highest quality left in the Great Lakes region. The Wisconsin Department of Natural Resources Natural Heritage Inventory has evaluated sandscapes in the park and they are included in a sandscape State Natural Area. Visitor-use on sandscapes is relatively high due to their accessibility, scenery and beaches. The vegetation on these sandscapes is also very sensitive to trampling.

Sandscape vegetation monitoring began in 1988 and 1989 and continues to be conducted on a regular basis. Vegetation monitoring is conducted in the dune and interdunal zones using the step-point method. It is designed to obtain baseline information, monitor change over time, and determine the impact of visitor use/trampling. In addition to vegetation monitoring, numbers and size of informal trails are tracked. Since 1995, mapping of the sandscapes has been done using a Global Positioning System (GPS). The GPS allows monitoring of sandspit geomorphological changes and will assist in separating out natural versus human caused impacts where human impact is not obvious.

Five sandscapes were monitored in 2004. The sandscape on Bear Island was monitored and mapped. Sandscapes at Little Sand Bay, Sand River, Oak Island, and Long Island had been mapped in the last five years and were monitored only. Sandscape data collected with GPS units included perimeters of the vegetated and non-vegetated beach areas as well as any trails that traverse the sandspits. Base maps were then developed with area acreage.

Overall conditions on these five sandscapes have improved specifically related to increased litter amounts and associated decreases in bare soil (see Table 3). These are conditions that would typically indicate more stability overall on the sandscapes. However, in spite of the increasing litter and decreasing bare soil, the overall long-term trend for percent basal cover of vegetation is down for all five sandscapes. The most plausible explanation for this situation is that recruitment of new plants is not high enough to offset losses. If this trend continues into the future litter will decrease and bare soil will increase, resulting in less stable sandscapes.

Table 3. The percent change (+/-) of various parameters associated with sandscapes monitored in 2004.

	All Species			Invasive	
Island and Timeframe	Vegetative Litter	Bare Soil	Basal Cover	Basal Cover	Composition
Bear (1989-2004)	21.78	-5.48	-16.3	-2.39	-4.42
Long (1995-2004)	10.3	8.95	-20.00	0.00	-2.09
Little Sand Bay (1989-2004)	37.99	-23.87	-14.12	-0.78	-1.39
Sand River (1991-2004)	65.42	-49.18	-16.23	0.00	0.00
Oak (1988-2004)	35.74	7.42	-43.15	-4.97	4.97

In 2005, Cat, Michigan, Otter, and Stockton (north beach) sandspits were monitored. Otter Island sandspit has previously been monitored using a visual inspection method due to its small size (0.4 acres). However, this method indicated visitor impacts which prompted the use of the more in depth monitoring point-step method. The total percent litter was 79%; bare soil was 19%; and basal cover was 2 percent. Of the basal cover, 83% was composed of native species. A similar but less consistent trend to that in 2004 was observed on the remaining three sandspits; litter increased between 3 and 12%, and bare ground ranged between a decrease of 7.5% (Stockton), and an increase to 7 percent. The basal cover of vegetation decreased on Cat (16%) and Michigan (21%) and increased slightly (5%) on Stockton North Beach. The percent of exotic species decreased on all three sandspits.

Campsites

- **Monitoring done to detect impacts from use**
- **Limits of Acceptable Change (LAC) exceeded at 6 sites in 2004**
- **Total number of sites currently exceeding LAC is 10**
- **Percentage of bare ground increased at 6 sites in 2004**

There are sixty-five designated campsites within the park and undesignated camping is also allowed within established zones. Campsites are designed to minimize associated environmental impacts and provide a high quality camping experience for park visitors.

In 1989 and 1990, resource management staff inventoried and monitored all designated campsites within the Lakeshore using both qualitative and quantitative methods. Since then a schedule has been established to monitor one-third of the campsites each year. The primary emphasis of monitoring is to map the campsites to determine size, rate of boundary change, and determine size of area within the campsite that has lost all vegetation. Other measurements include amount of root exposure, number of undesignated trails, tree damage, shoreline exposure, vegetation composition within and outside the campsite, and soil compaction. Results from monitoring data are used to determine which campsites are in need of restoration and to prioritize campsite restoration needs.

Each campsite is mapped to determine changes in the area of bare ground and disturbed vegetation. The size of impacted area of campsites was chosen as a "Limits of Acceptable Change" (LAC) indicator. Resource impact reduction or mitigation will generally be implemented when a campsite size approaches or exceeds 250 m^2 for individual sites or 1200 m^2 for group sites.

Disturbed Area

In 2004, the 21 individual sites on Stockton Island were monitored. There was a large range in the net change of the campsite area from a decrease of 547 m^2 at sites 10 and 11, which are monitored together, to an increase of 71 m^2 at site 20 (see Table 4).

Four sites exceeded the limits of acceptable change in 2001. Sites 10 and 11 were approximately 300 m^2 in size each, site 12 was 310 m^2 and site 19 measured 334 m^2. In addition, sites 16 and 20 were approaching these limits with areas of 221 m^2 and 226 m^2 respectively at that time. These same sites have continued to change over time and in 2004, all six of these sites exceeded the LAC. However, sites 10 and 11 have decreased in size at a rate of about 24% annually even though they still exceed the LAC at this time. An additional site, number 17, is approaching the LAC with a size of 227m^2.

The length of shoreline erosion was monitored at most sites and the percent change over time was determined for each site. The length of shoreline decreased at ten sites (between 13 and 79 percent; x = 51, sd = 24) and increased at 7 sites (between 0.03 and 82 % ;x = 43, sd = 33). Sites 8 and 12 through 14 are among those showing an increase in the percent change of shoreline disturbance. These sites are located on higher ground with associated steeper bluffs. This situation is likely contributing to the increased erosion of the shoreline as visitors move back and forth between campsites and the beach.

There is no apparent relationship between whether or not the LAC was exceeded and the percent change of shoreline disturbance.

Table 4. Campsites monitored (2004), change in total area (m^2) disturbed since monitoring was initiated (1989 unless otherwise stated), change in bare ground, if the Limits of Acceptable Change have been exceeded, and the percent change in the length (m) of shoreline disturbance.

Location	Sites Number	Net Total Area Increase or Decrease Between 1989 and 2004 (m2)	Current Size (m^2)	LAC Exceeded (Y or N)	Percent Change in Bare Ground	Percent Change in Shoreline Disturbance
Stockton Island						
Presque Isle	1	-93	103	N	-41	-21
	2	-79	104	N	-9	-43
	3	-3	123	N	+24	-67
	4	-0.3	104	N	+44	-43
	5	-547	133	N	-28	NA
	6	-21	116	N	-13	-29
	7	-43	172	N	-21	-77
	8	-60	165	N	-0.9	+79
	9	-34	134	N	-0.9	No Data
	10 & 11	-356	539 (2 sites combined)	Y	+2	-13
	12	+24	289	Y	-2	+47
	13	+10	114	N	+3	+82
	14	+7	152	N	+4	+43
	15	+3	130	N	-10	No Data
	16	+30	260	Y	+17	-57
	17	-126	227	N	-34	-79
	18	+6	194	N	-2	-76
	19	-106	292	Y	-24	+48
Quarry Bay	20	+72	256	Y	-22	+0.03
Trout Point	21	+65	104	N	-8	0

Percent Bare Ground

In six (30%) of the sites monitored there was an increase in the percent change of bare ground, ranging from 2.0% to 44.1%. Four of the seven sites which are approaching or have exceeded the limits of acceptable change have decreased in the percentage of bare ground.

Campsite 21, located at Trout Point, which is a remote location, has had an increase in the size of the site by 65.4 m^2, while the percentage of bare ground has decreased by 7.9%.

A total of four sites exceeded the LAC in 2002 and 2003 (Oak 1, Oak 4, Outer 1, Basswood A) for a total of ten, or 15% of all campsites in the park. In addition, criteria used to define limits of acceptable change need to be re-evaluated and potentially expanded to include criteria such as percent bare ground and shoreline disturbance. Also, non-designated, but repeatedly used area will be identified and added to the monitoring schedule.

Exotic Plant Management Team

- **Great Lakes Exotic Plant Management Team spent 187 hours in 2004 and 154 hours in 2005 in the park treating exotics**
- **Species treated included orange hawkweed, Japanese knotweed, mullein, purple loosestrife, sheep sorrel, and spotted knapweed**

In 2004, the Great Lakes Exotic Plant Management Team consisting of a 4-person crew spent 10 days at the Park. Table 5 identifies the species and locations that were targeted for treatment and the hours of effort expended. Herbicide (glyphosate) was applied to cut Japanese knotweed and purple loosestrife; all other species were hand-pulled. All areas visited and treated were mapped using GPS.

On the Oak Island sandscape, where restoration has been occurring since 2000, the percent of exotic species have decreased, reflecting in part the efforts of the Exotic Plant Management Team reducing hawkweed and sheep sorrel on this sandspit.

Table 5. Exotic species and locations of treatment and hours expended in 2004.

Location	**Species**	**Number of Person Hours**
Little Sand Bay	Mullein, Sheep Sorrel, and Spotted Knapweed	8
Long	Purple Loosestrife	36
Oak Sandspit	Hawkweed, Sheep Sorrel	100
Raspberry	Japanese Knotweed	3
South Twin	Hawkweed, Sheep Sorrel	40
Total		**187**

In 2005, the EPMT inventoried almost 17 acres of the park for exotics. Of these, approximately 1 acre was considered to infested at a more gross level, while 0.1 acres was considered infested. This latter acreage was treated by the team. Orange hawkweed and sheep sorrel were again hand-pulled on both Oak and South Twin Islands. At Oak Island, the EPMT team noted that both hawkweed and sheep sorrel were less dense with a patchier distribution than what was found on South Twin. In this type of situation hand-pulling should continue to be effective. The EPMT recommended surveying the campsites adjacent to the sandspit in the future. Recommendations for South Twin included hand pulling for controlling small isolated patches of orange hawkweed and selective use of herbicide for controlling the large, monotypic stands found on this island.

Table 6. Exotic species and locations of treatment and hours expended in 2005.

Species	**Location**	**Number of Person Hours**
Little Sand Bay	Spotted Knapweed, Burdock, Common Mullein, Crown Vetch	12
Long	Purple Loosestrife	65
Oak Sandspit	Orange Hawkweed, Sheep Sorrel	47
Raspberry	Japanese Knotweed	4
South Twin	Orange Hawkweed, Sheep Sorrel	26
Total		**154**

Hawkweed Monitoring

- **Exotic, invasive species that threatens sandscapes and cultural openings.**
- **Treatment is completed on Oak Island through hand-pulling.**
- **Hawkweed plants in monitoring plot decreased by >50% between 2003 and 2004.**

Orange hawkweed (*Hieracium aurantiacum)* is a highly invasive plant species that rapidly establishes itself in disturbed areas, roadsides, dry fields, logged areas, woods, marshy ground, and shores. It is believed to have been introduced from Europe as an ornamental and has since spread rapidly. In the park, this species is found on all 21 islands as well as the mainland unit in disturbed areas, both historic and present. It tends to be limited to open areas, such as developed areas, fields, and along some trails. It is however, a problem on a couple of the sandspits, including the one on Oak Island.

The monitoring and treatment of hawkweed began in 2002 on the sandspit of Oak Island where extensive restoration was underway. Monitoring at that time indicated that hand-pulling was the most effective treatment for this species. There were 19 plants in a monitoring plot in 2002, 103 plants in 2003, and there were 51 plants in 2004, none of which had flowers.

Purple Loosestrife

- **Exotic, invasive species that threatens wetlands on Long Island.**
- **Two pronged approach:**
  - **Long Island 'cut' – biological control through beetle release.**
  - **Long Island tip – chemical control.**
- **Long Island 'cut'**
  - **Approximately 4,400 plants treated with herbicide.**
- **Long Island tip - 2004**
  - **More intensive survey resulted in very high count – 1,149 plants treated.**

Purple loosestrife (*Lythrum salicaria*) is a highly aggressive Eurasian plant that rapidly takes over wetlands, displacing native vegetation. In 1988, purple loosestrife was noted in the "cut" area of Long Island (a region that periodically is washed away) and it has since spread.

The strategy for controlling loosestrife has changed over time as more information and new techniques became available. Early efforts at hand-pulling were abandoned after monitoring indicated neutral or negative results. In 1992, an Apostle Islands NL Integrated Pest Management (IPM) plan was written for purple loosestrife control and the preferred alternative (dab application of Rodeo) was implemented. Since 1992 purple loosestrife has been treated with Rodeo by cutting and treating individual plants. In 1994, the state of Wisconsin initiated a biological control program that is coordinated by the DNR and in 1996 the Lakeshore began releasing beetles (*Galerucella pusilla, G. calmariensis*). There is an overall strategy to use beetles near the "cut" on Long Island and chemically treat a band to the northwest of the beetles in an effort to slow the spread into the island tip. The herbicide RODEO is also used on any plants found in the tip and on any plants found elsewhere in the park during annual surveys. In addition, the lagoons at Michigan, Outer and Stockton-Julian Bay are surveyed annually.

Long Island Cut - Beetles have been released annually since 1997 at the Long Island "cut" (see Table 10). Monitoring indicated little damage early on but this has increased over time both in area impacted by the beetles and in the intensity of damage to individual plants. The year 2003 was the seventh year of the purple loosestrife biological control program on Long Island. Approximately 1,000 leaf-feeding beetles (*Galerucella pusilla, G. calmariensis*) and a few egg masses were collected in Bayfield County and released at six locations on Long Island. In addition, approximately 20,000 beetles were obtained from the Great Lake Indian Fish and Wildlife Commission (GLIFWC) and released at two locations on Long Island in the area with the highest density (just north of the park boundary). No beetles were released in 2004 or in 2005.

A total of 10 plots have been established on Long Island to monitor the effects of beetles on purple loosestrife (see Table 7). Five plots were established in 1997 adjacent to a wetland in the more southeastern portion of the island. Monitoring indicates that the number of purple loosestrife stems has decreased in 1 plot and increased in the other 4 plots (between 17-91% and averaged 53 percent).

Additional plots were established in 1998 and 1999 (4 and 1 respectively) throughout a broader area that extended to the northwest of the original plots. Monitoring indicates

that the number of purple loosestrife plants has decreased in 4 of these plots (ranging between 16-100%, and averaging 73 percent). The differences seen in the plots established in 1997 and those initiated later are likely tied to their location. Purple loosestrife can decrease in density during drought conditions. The plots showing decreases are in areas that have become drier over time in association with decreasing lake levels. The remaining plots are adjacent to a wetland that is still retaining deep enough water levels to support purple loosestrife.

The mean height of all plants monitored between 1999 and 2005 indicates a significant decrease ($P<0.05$) in this parameter. Overall monitoring in the meadows around the "cut" indicated that there were approximately 4,400 plants in this area in 2004.

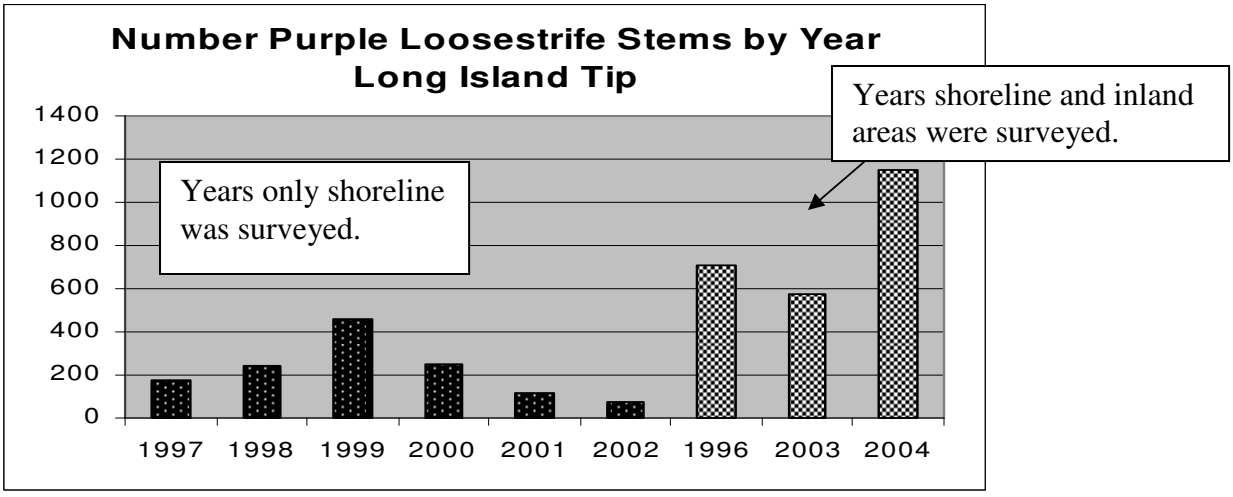
Table 7. The number of purple loosestrife stems at the time of plot establishment, in 2004, 2005, as well as the percent change of stems over time.

Plot Number	1997	1999	2004	2005	Percent Change*
97-1	39		94	118	67
97-2	83		58	100	17
97-3	52		66	96	46
97-4	10		68	106	91
97-5	93		44	**72**	**-23**
98-6		33	55	74	45
98-1		37	26	**31**	**-16**
98-2		33	16	**8**	**-76**
98-3		19	2	**0**	**-100**
98-4		32	0	**0**	**-100**

*A negative number indicates a decrease in the number of stems.

Long Island Tip - The Chequamegon Bay shore along the tip of Long Island has been surveyed annually since 1995 and any loosestrife plants found counted, mapped and treated with Rodeo. In 1996, 2003, and 2004 surveys extended inland for greater distances and resulted in higher numbers of purple loosestrife stems as can be seen from Figure 1. The years are grouped by area of similar survey size.

Figure 1. Number of purple loosestrife stems by year on the tip of Long Island. Data grouped by area of similar survey area and size.



Dark bars – years only the shoreline was surveyed
Light bars – years the shoreline and inland areas were surveyed.

Changes in the number of stems over time are at least in part related to water levels fluctuations which can affect the density and distribution of purple loosestrife. Despite the continued high water levels in 1997, stem numbers were much lower in 1997. Areas intensely treated in 1996 had reduced loosestrife, but there were increased numbers on drier soils at the alder shrub transition zone between sedge/grass wetlands and the dune sand. Loosestrife numbers increased slightly in 1998 and even more in 1999. There was a larger decrease in loosestrife plants encountered in 2000 than in 1999 and it was noted that the majority of the plants found were either very young or were older, unhealthy plants. The number of purple loosestrife plants found and sprayed in 2001 reached a record low since the implementation of the IPM plan. This decrease could be partially due to treatment and to the drier conditions that are a result of lower lake levels over the previous four years.

In 2003, shoreline and inland reconnaissance indicated approximately 571 plants, and populations were noted further north than in previous years. Of these, approximately 554 plants (97%) were flowering compared to 29 (25%) in 2001. In 2004, 1,149 plants were noted on the north tip of the island, but only 54 (4.7%) were flowering. This is the most ever noted in this region of the island. Approximately 5,549 plants were treated with herbicide on Long Island in 2004 at both the cut and the tip. This type of data was not collected in 2005.

Gypsy Moths

- **Exotic, invasive species that threatens hardwood forests**
- **Highly significant increase in number of moths trapped over past 4 years (P< 0.0000)**
- **Over 6,700 moths caught in traps in 2005**
- **Cooperators include the U.S. Forest Service and Wisconsin Department of Agriculture**

The gypsy moth is the most serious insect pest of oak and other hardwood forests in the eastern United States. The caterpillar stage consumes the leaves of over 300 different tree species during the spring and early summer. This leaf damage seriously weakens affected trees, leaving them vulnerable to other life threatening diseases and insects.

After trapping a single gypsy moth on Stockton Island in 1997, lakeshore gypsy moth monitoring was intensified (see Table 8). No moths were caught in 1998, despite increased trapping effort. In 1999, six gypsy moth traps were placed at Sand Island, two on Long Island, and one each on Oak Island, Stockton Island-Presque Isle, Stockton Island-Quarry Bay, and Basswood Island. A total of five gypsy moths were caught at four locations. In the year 2000, a total of 29 gypsy moths were caught, and in 2001 a total of 75 were caught, a large increase from 1999.

In 2002, gypsy moth traps were placed 7 islands and the mainland including 1 at Sand Island, 1 at Oak Island, 4 at Stockton Island-Presque Isle, 11 at Stockton Island-Quarry Bay, 11 at Basswood Island, 2 at Long Island, and 3 at the mainland at Menard Road, Little Sand Bay, and Meyer's beach. Gypsy moth numbers continued to increase in 2002 with 286 moths caught in 33 traps. In 2003, 35 traps were set which captured 704 moths, and moths were also trapped at Long and Oak Islands for the first time since trapping began.

By 2004, there was a dramatic increase in the numbers of gypsy moths trapped in the park, especially on Basswood Island. In 2004, 26 traps were set which resulted in the capture of 3,127 gypsy moths. In 2005, 27 traps were set on 5 islands and all traps were retrieved except one. The total number of moths captured was 6,741, more than twice the previous year. Ninety-one percent of these moths were captured from the 7 traps set on Basswood Island. The results of trapping between 1997 and 2005 are in Table 8 below. The total number of moths over time was analyzed (regression) and the results are highly significant ($P < 0.0000$). As a result of the significant increase in moths on Basswood Island egg mass surveys were completed by the state Department of Agriculture. Numerous egg masses were found during this survey.

Smart Traps were placed on Basswood and Stockton Islands in cooperation with the U.S. Forest Service North Central Experiment Station. These traps detect and record temperature and date as moths enter. Results indicated that moths entered the trap on Stockton Island between August 7th and August 26th with a peak between the 12th and 21st. On Basswood moths entered the trap over a broader period of time (between July 25th and September 6th) with a concentration between August 2nd and August 20th.

Intense trapping efforts will continue at the same locations next year to try to determine the rate of gypsy moth population expansion. In addition, traps will be dispersed on several other islands to determine the distribution of the gypsy moth infestation. The park will continue to cooperate with the U.S. Forest Service and Wildlife Service and the Agricultural Resource Management Division of the Wisconsin Department of Agriculture in the management of this species.

Table 8. Locations and numbers of Gypsy moth traps set, and the number of moths caught at each location between 1997-2005.

Islands	1997		1998		1999		2000		2001		2002		2003		2004		2005	
	# Traps Set	# Moths Caught	# Traps Set	# Moths Caught	# Traps Set	# Moths Caught	# Traps Set	# Moths Caught	# Traps Set	# Moths Caught	# Traps Set	# Moths Caught	# Traps Set	# Moths Caught	# Traps Set	# Moths Caught	# Traps Set	# Moths Caught
Basswood	0	0	1	0	1	2	5	3	5	21	11	99	13	208	6	1,676	7	6,176
Long	2	0	2	0	2	0	2	0	2	0	2	0	3	3	1	0	1	1
Mainland	0	0	3	0	0	0	1	0	3	0	3	0	0	0	0	0	0	0
Oak	0	0	1	0	1	0	1	0	1	0	1	0	1	3	1	25	2	58
Sand	1	1	6	0	3	2	7	0	6	0	1	0	1	0	1	1	1	3
Stockton Presque Isle	1	0	1	0	1	0	1	0	1	1	4 (3)	10	4 (3)	37	11	327	7	75
Stockton Quarry Bay	1	0	1	0	1	1	5	26	5	53	11	177	13 (12)	453	1	192	4	376
Stockton Trout Point	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	906	5	66
Total	5	1	15	0	9	5	22	29	23	75	33 (32)	286	35 (33)	704	26	3,127	27	6,741

( ) Indicates the number of traps retrieved at each location when different from the number set

WILDLIFE SPECIES

Birds

Breeding Bird Survey

- **2004 – 1,047 birds among 72 species**
- **2005 – 1,162 birds among 77 species**
- **Ovenbird and hermit thrush are showing significant increasing trends**
- **Eight species showing decreasing regional trends are stable or increasing at the park and between 1995-2005 were among the most abundant 27 bird species on park surveys**
- **Role of Apostle Islands in a regional context:**
  - **Lands serving as a non-managed control,**
  - **Providing habitat for ground nesting species.**

The Apostle Islands NL, with its strategic geographical location and wide diversity of habitats, provides refuge for resident breeding birds as well as neotropical migrant land birds (those which migrate to Central and South America in winter). Over 89% of the breeding birds in the park are migrants, 59% of which are neotropical migrants.

In the late 1970's the first survey of nesting birds was conducted in the Apostle Islands. The park's long-term breeding bird monitoring program began in 1990 and is conducted annually. The survey is conducted at 106 permanently marked points along 10 transects using 5 and 10 minute observation points. Devils, Long, Oak, Outer, Raspberry, Sand, Stockton Islands and the mainland unit are surveyed.

As can be seen from Table 9, the number of species by island in 2005 was low on Long and the mainland when compared to the average but the same or above average for all other islands. Total numbers of birds were high for 5 of 8 locations. Notable among the number of birds per point were Devils and Raspberry Islands, the latter of which was very high at 17 birds per point on average.

Table 9. The mean number of species, total number of birds, and mean number of birds per point by island for 1995-2004 and 2005.

Island	# Points	Number of Species		Total Number Birds		Number Birds/Point	
		Mean 1995-2004	2005	Mean 1995-2004	2005	Mean 1995-2004	2005
Devils	8	32	32	94	111	11	14
Long	12	32	26	145	157	11	13
Mainland	10	45	35	107	84	10	8
Oak	13	25	28	104	149	7	11
Outer	20	41	56	174	153	9	8
Raspberry	9	29	39	101	149	10	17
Sand	12	32	32	148	126	11	11
Stockton	22	46	67	218	233	10	11
Total (10 transects)	106		77		1,162		

Species diversity - # birds by species

Surveys are completed in 14 different habitat types which are listed below in table 10 along with the number of points in each habitat type. Compared to the 1995-2004 average, the total number of species by habitat in 2005 was high in several habitat types, especially the northern hardwoods-sugar maple, old growth conifer and the sandscape-shrub types. It was low in the conifer, and old-growth hemlock types. The total number of birds was also high in 2005 in the aspen/birch type, bog, northern hardwoods-sugar maple, oak forest, and old-growth conifer types; and low in the beaver pond, conifer, and old-growth hemlock types. The number of birds in the beaver pond type is a bit misleading in that there is only one stop in this habitat type.

Table 10. A comparison of the number of species, total number of birds, and average number of birds per point by habitat between 1995-2004 (mean) and 2005.

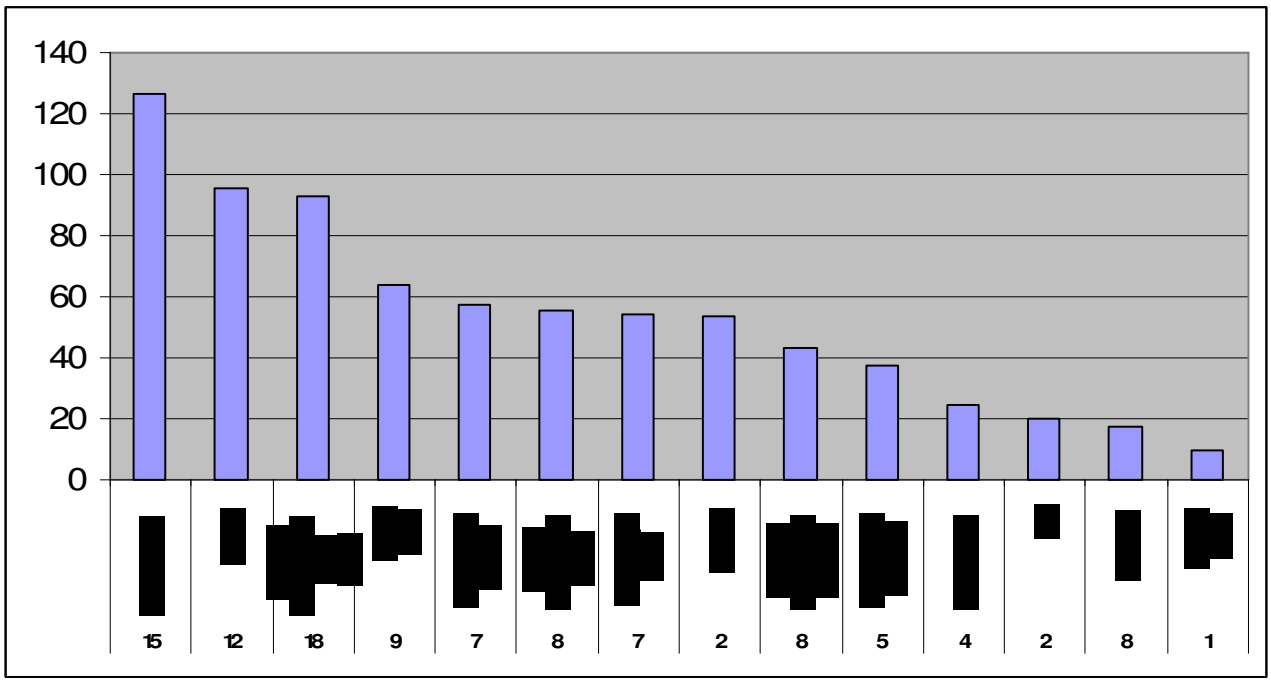
Habitat	# Points	Number of Species		Total Number Birds		Average # Birds/Point	
		Mean 1995-2004	2005	Mean 1995-2004	2005	Mean 1995-2004	2005
Aspen/Birch	9	64	67	92	99	10	11
Bog	2	20	21	27	37	13	19
Boreal forest	12	95	95	138	138	11	12
Beaver pond	1	10	7	16	9	16	9
Clearing	8	17	19	26	27	13	14
Conifer	2	54	46	75	56	9	7
Northern hardwoods-hemlock	8	43	46	63	67	8	8
Northern hardwoods-mixed forest	8	56	55	79	74	10	9
Northern hardwoods-sugar maple	18	92	103	148	183	8	10
Oak forest	4	24	24	38	49	9	12
Old-growth conifer	7	55	81	76	120	11	17
Old-growth hemlock	5	38	31	52	37	10	7
Pine forest	15	126	132	193	182	13	12
Sandscape-shrub	7	53	64	80	84	11	12

An examination of the number of birds per habitat type indicates that sites at pine forest, northern hardwoods, and boreal forest types supported the highest numbers of birds during 2005.

The mean number of birds per habitat type between 1995 and 2005 was examined (see Figure 2). Some interesting points are revealed with this data including a general trend of higher numbers of points surveyed associated with higher numbers of birds which continues down to through the lower numbers of sites. In addition there is a higher

abundance of birds for pine forest community types even though there are more northern-hardwoods sugar maple plots surveyed. Northern hardwoods mixed, northern hardwoods hemlock, and clearing community types each have 8 bird survey points yet there is a clear difference in the number of birds using these types.

Figure 2. The mean number of birds per habitat type (1995-2005). The number of points sampled by type is included along the bottom.



An analysis of 10 years of breeding bird data was completed in order to determine if birds distribute themselves on the islands according to principles of island biogeography. Under this theory larger or closer islands would be populated more readily than smaller or more distant islands. Table 11 shows the islands and their distance from the mainland and information regarding the number of birds by island. As can be seen from this data there does not seem to be any pattern of distribution. Devils, Sand, and Long Islands are variable distances from the mainland but have the highest average number of birds per point. Island size also does not appear to be a factor because Stockton, Outer, and Oak are the largest islands in the archipelago but are not among the islands with the highest number of birds per point.

Table 11. Average number of species and birds by island, and point by island.

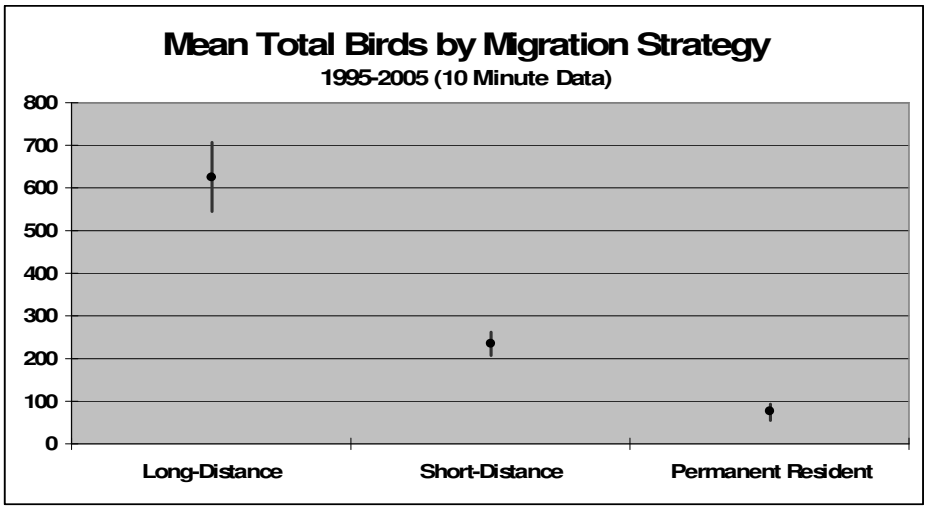
Island and Acreage	Distance from Mainland (mi)	Average Number of Species	Average Number of Birds	Average Number of Birds Per Point
Devils (318)	8.9	32	97	12
Sand (2,949)	1.2	32	141	12
Long (500)	0	32	144	12
Raspberry (295)	1.7	29	106	12
Stockton (10,054)	4.9	46	216	11
Mainland (2,565)	0	45	106	11
Outer (8,000)	14.8	41	177	9
Oak (5,078)	1.3	25	111	9

The top 15 species for each year (1995-2005) by relative abundance were combined into a single list which resulted in a total of 27 species. These species collectively comprise about 70% of the species detected during surveys each year. Seven species that have been in the top 15 in all ten years include the ovenbird, red-eyed vireo, black-throated green warbler, American redstart, Nashville warbler, song sparrow, and yellow-rumped warbler in order of abundance. Other species commonly found include the blue jay, American robin, and common yellowthroat at 8 years each, and the veery and hermit thrush at 6 years each.

Regression analysis of the number of birds over time was completed for several species including black & white warbler, mourning warbler, Nashville warbler, Swainson's thrush, and veery with data from 1990-1994. Results indicated that these species were significantly decreasing during that timeframe. Regression analysis of these same species between 1995 and 2004 did not indicate any significant trends in either direction. These two timeframes were treated separately because data were collected differently.

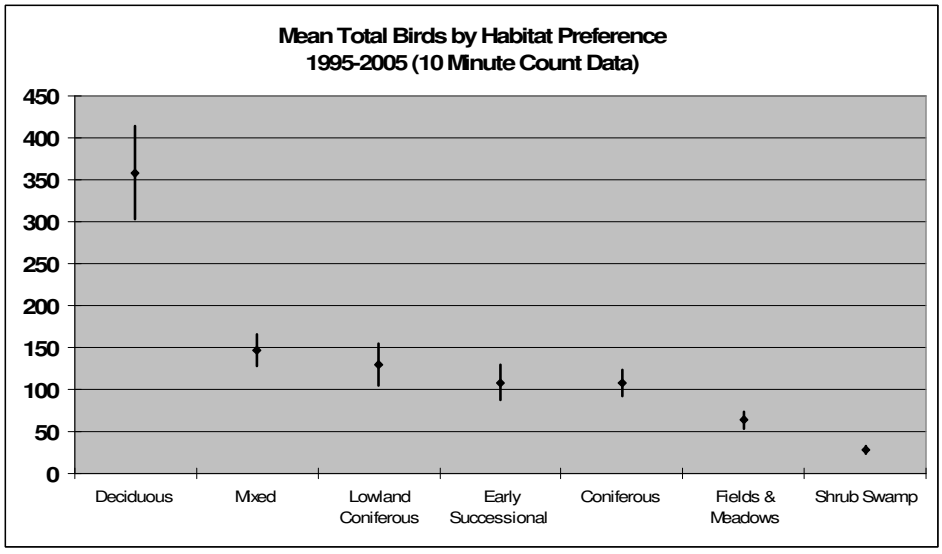
An effort was made to place birds using the Apostle Islands in a regional context by comparing data park data to information from three surrounding national forests including the Chequamegon, Chippewa, and the Superior (Lind et al. 2003). A total of about 60 species using the park were grouped into 3 guilds used by Lind et al. to facilitate comparison. This classification indicates that the majority of these 60 species are long-distance migrants, followed by short-distance migrants, and finally permanent resident species (see Figure 3) which was consistent with data from the national forests.

Figure 3. The mean number of birds by migration strategy (data from the 60 species of interest only).



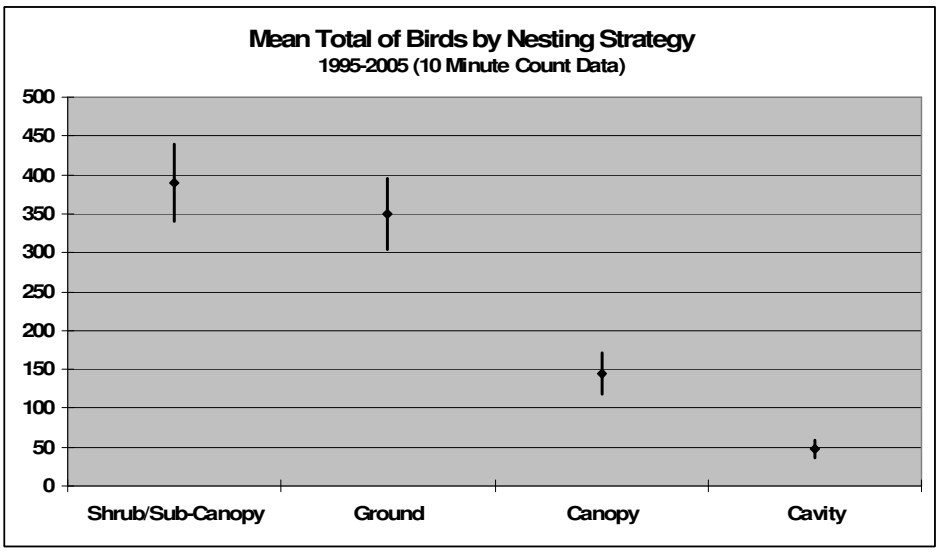
Classification by vegetation preference indicated that birds in the Apostle Islands are found more often in deciduous forest than other types, which was also consistent with the regional data (Figure 4). Differences between the two geographic areas were most obvious in the mixed forest type which was second in terms of use in the park but lowest in the national forests. The early successional type was second in terms of use in the national forests.

Figure 4. The mean number of birds by habitat preference (data from the 60 species of interest only).



Grouping the 60 species by nesting strategy indicated that birds using the park are most often shrub/sub canopy or ground nesting species, and that the number of cavity nesting species is lowest in both the park and the surrounding national forests.

Figure 5. The mean number of birds classified by nesting preference (data from the 60 species of interest only).



Lind et al. (2003) reported significantly decreasing trends for several species (see Table 12). These species have all been in the top 15 species by relative abundance for Apostle Islands between 1995 and 2005. The ovenbird, song sparrow, and Nashville warbler have been in this group in all 10 years. The ovenbird is the most abundant species overall and is showing a significantly increasing trend ($p < 0.05$). The hermit thrush is also showing a significantly increasing trend at this level. No trends were detected for other species in this group.

All of these species are also ground nesting birds. A 9th ground nesting species (black-and-white warbler) commonly in the top 15 for Apostle Islands did not show a significant regional trend but did show a significant decreasing trend on the Chequamegon National Forest.

Table 12. A comparison of regional trends (Chequamegon, Chippewa, and Superior National Forests) and Apostle Island data for migration, nesting, and vegetation preference guilds.

Species	Trends at Apostle Islands National Lakeshore	Regional Trend Reported by Lind et al.**	Apostle Islands National Lakeshore Data				
			Number Times in Top 15	Mean Relative Abundance	Migration Strategy	Vegetation Preference	Nesting Preference
Ovenbird	I*	D**	11	17.0	LD	DEFO	G
Veery	None	D**	6	3.5	LD	DEFO	G
White-throated Sparrow	None	D**	1	3.6	SD	EASU	G
Song Sparrow	None	D**	11	4.4	SD	FIME	G
Nashville Warbler	None	D**	11	7.6	LD	LOCO	G
Winter Wren	None	D**	5	4.4	SD	LOCO	G
Hermit Thrush	I*	D**	7	3.8*	SD	MIFO	G
Common Yellow-throat	None	D**	9	3.1	SD	SHSW	G

* Significant at the 0.05 level at Apostle Islands.
** Lind et al. (2003) Significant at the 0.01 level

Some other observations regarding these ground nesting species in the park include:

- Nashville warblers and ovenbirds are not frequently found on the same point in the same year.
- Ovenbirds and veery frequently overlap.
- Common yellowthroats and song sparrows have a strong preference for Long Island.

Colonial Birds

- **30 years of monitoring gulls, cormorants, and great blue herons throughout the Park**
- **Approximately 40% fewer cormorants on Gull Island in 2004 than in 1999**
- **Approximately 50% fewer gulls on Eagle Island in 2004 than in 1999.**
- **Trend analysis – no significant trends for gulls between 1979-2004**

The year 2004 marked the 30th year that colonial birds at Apostle Islands National Lakeshore have been monitored. Herring gull, double-crested cormorant, and great blue heron nesting was surveyed throughout the park from May 20th to June 2nd, 2004. Eagle and Gull Islands were surveyed on May 20th and May 25th, respectively. Tables 13 and 14 display the number of herring gull nests counted on Gull and Eagle Islands from 1979 to 2004.

Table 13. Number of herring gulls and double-crested cormorants nests between 1979-2004 on Gull Island.

GULL ISLAND	1979	1982	1989	1991	1994	1996	1997	1998	1999	2004
Herring Gulls	550	N/A	682	650	767	564	596	525	606	599
Double-crested Cormorants	41	210	396	520	602	569	416	N/A	651	374

The number of herring gulls nest on Gull Island in 2004 was 599, and the average number of eggs per nest was 1.6. As can be seen from Table 13 the herring gull population peaked in 1994, declined to below 1979 levels in 1998 and then increased in 1999, remaining stable in 2004. No significant trend over time was detected with regression analysis for this data. However, the 1999 and 2004 levels are considerably lower than population levels in the late 1980's to mid-1990's. The number of cormorants on this island was 374 in 2004 and the average number of eggs per nest was 2.9. However, the double-crested cormorant population on Gull Island has strongly declined from a peak level in 1999 with a current population level that is slightly less than that recorded in 1989.

Table 14. Number of colonial birds nests between 1979 and 2004 on Eagle Island.

EAGLE ISLAND	1979	1989	1991	1994	1997	1998	1999	2004
Herring Gulls	227	331	334	400	N/A	326	404	214
Double-crested Cormorants	N/A	89	137	133	151	N/A	77	81
Great blue herons	N/A	46	N/A	43	N/A	N/A	17	31

There were 214 herring gull nests with an average of 2.3 eggs per nest in 2004 on Eagle Island. Data from Table 14 shows that the number of gull nests peaked in 1994, dipped in 1998, and then increased in 1999. However, the numbers in 2004 are lower than those obtained in 1999 and they approximate 1979 levels. Double-crested cormorants nest in trees on Eagle Island so eggs are not counted. Overall, this population increased steadily from 1989 to 1997, decreased sharply in 1999, and stayed low in 2004. No significant trends over time were detected on Eagle Island for either species.

Great blue heron nesting recovered somewhat from a low in 1999. Since 1989, the number of nests had been fairly stable, in the mid-40's. However, in 1999, there was a sharp decline to 17 nests and in 2004, an increase to 31 nests.

Smaller colonies of herring gulls occur on various islands throughout the park (see Table 15). A colony is defined as two or more young or nests. Nesting was lower in 2004 than 1999 by 36 nests or 34% overall. On the larger of these dispersed colonies, nests declined by 60% on Bear, 26% on Otter, and 17% on Hermit Island.

Table 15. Number of herring gull nests on various locations in 1999 and 2004.

Location	**No. of Nests 1999**	**No. of Nests 2004**
Basswood	0	2
Bear Island	20	8
Cat Island	1	5
Devils Island	1	0
Hermit Island (colony A)	15	8
Hermit Island (colony B)	3	7
Little Manitou Island	2	6
Naden's Point	0	4
Otter Island	27	20
Outer Island	6	1
Raspberry Island	8	3
Red Cliff Bay	9	0
Rocky	0	1
Roman Point	5	3
Roys Point Marina bldg.	7	2
Mawikwe Bay	2	0
Total	106	70

Nesting success varied in 2004 by location as can be seen from Table 16, which shows information for 6 of 11 colonies. Five colonies did not produce any young. For colonies that successfully produced young birds, the nesting success ranged from a low of 0.48 young/nest on Eagle Island to a high of 1.0 young/nest on Little Manitou Island.

Table 16. Nest productivity data for various islands throughout the park.

Location	Number of Nests	Number of Young Produced	Number of Young/Nest
Bear Island	8	7	0.87
Eagle Island	214	103	0.48
Gull Island	50	32	0.64
Little Manitou Island	6	6	1.0
Otter Island	20	12	0.6
Roman Point	3	2	0.67

Bald Eagle

- **Federally threatened species**
- **2004 had the highest number of nests (13) and the highest number of chicks fledged (15) since 1980**
- **2005 – 10 nests initiated; 6 successful with 10 chicks fledged**
- **Number of occupied nests in the archipelago has increased significantly (P< 0.001) since 1980**
- **Mean productivity between 1980 and 2004 was 0.73 young/active nest which is lower than regional productivity of 0.92 young/nest.**

During the 1970's, eagles were absent from the Apostle Islands, most likely due primarily to adverse effects of organochlorine contamination. The bald eagle is still listed as a threatened species by the federal government, but the species is in the process of being delisted. The state of Wisconsin "down listed" the bald eagle from endangered to threatened in 1989 and the species was delisted in 1997 due to population increases.

Table 17 shows the islands that eagle nesting has occurred on, the time period nesting has occurred, the number of times nests were used, and the percent success (number of nests with at least one chick fledged) over time. The overall number of occupied nests per year in the archipelago has increased significantly ($P<0.001$) between 1980 and 2004. The mean number of occupied nests was 3.8 in the 1980's, 5.5 in the 1990's, and is already 8.8 in the current decade.

Between 1980 and 2005 there have been a total of 147 nesting attempts and 83 successful nests, a success rate of 56 percent. Productivity, or the number of nestlings per occupied nest, has ranged between zero and 1.9 during this timeframe, with a mean of 0.7 young/active nest. Compared to historical and regional data this productivity rate is low. Between 1983 and 1988 productivity was 0.8 young/active nest along the Wisconsin shoreline including Apostle Islands. In 2004 productivity was 0.92 young/active nest in north central Wisconsin.

Table 17. Bald Eagle nesting locations and success data between 1980 and 2005.

Year	Occupied Nests	Successful Nests	Number Young Hatched	Number Young Fledged	Location
1980	1	0	0	0	ML
1981	0	0	0	0	MI
1982	4	0	0	0	OU, NO, YO, MI
1983	3	1	2	1	OU*, NO, YO
1984	4	2	6	4	OU*, NO*, OA, MI
1985	3	2	4	2	OU*, MI*, NO
1986	5	3	5	5	OU*, DE*, YO*, NO, ML
1987	7(8?)	3	4	4	OU*, NO*, YO*, MI, ML, DE, BA, RO?
1988	4	3	5	5	BA*, DE*, ML*, MI
1989	7	7	13	13	NO*, DE*, YO*, BA*, OA*, LO*, ML*
1990	8(9?)	4	4	4	NO*, BA*, LO*, MI*, DE, OU, YO, ML, OA?
1991	7	5	7	7	NO*, OU*, LO*, BA*, OA*, DE*, MI, ML
1992	4	2	3	3	MI*, DE*, NO, YO
1993	5	3	3	3	DE*, MI*, YO*, LO, NO
1994	6	1	2	0	OU*, BA, LO, MI, OA, YO
1995	5	4	6	6	LO-lt*, LO-cut*, HE*, YO*, MI
1996	6	3	4	4	LO-lt*, LO-cut*, MD* YO, NO, OA
1997	5	3	6	6	MD*, EA*, MI, NT*, BA
1998	4	3	5	5	MD, OA*, BA*, LO*
1999	5	1	1	1	BA, DE, LO*, OA, YO
2000	9	6	9	9	BA, DE*, EA*, LO*, MD*, RO*, SA*, NO, YO
2001	8	6	8	7	DE, EA*, MI*, ML*, OA, RO*, SA*, YO* (note: young at Sand did not survive to banding age)
2002	6	2	3	3	LO, MI*, NO, RO*, SA, EA
2003	8	4	6	6	BE, MD(2)*, MI, ML(2)*, RO(1)*, SA(1)*, YO
2004	14	10	16	16	BA, EA, LO(4)* - 2 nests, MD(2)*, MI, ML(5)* - 3 nests, NO(1)*, OU(1), RO(1)*, SA(2)*, YO
2005	10	6	10	10	EA(1)*, LO, ML-2 nests (2-one active nest)*, NO (2)*, OU (2)*, RO, SA(2)*, ST(1)*, YO, HE

Locations: BA=Basswood; BE=Bear; DE=Devils; EA=Eagle; HE=Hermit; LO=Long (lt=light, cut=island breach); MD=Mainland; MI=Michigan; ML=Madeline; NO=North Twin; OA=Oak; OU=Outer; RO=Rocky; SA=Sand;YO=York

* Locations with successfully fledged young.

Nesting has occurred on North Twin Island 18 times during 1982-2005 with 50% of nests successful (see table 18). In contrast, nesting has occurred 14 times on Long Island with an

80% success rate over a shorter time span of 1989 to 2004. This high success rate could be due to the close proximity of Long Island to the Kakagon sloughs and the shallows of Chequamegon Bay, areas that are likely to have a higher amount of food availability. Nesting was successful 80% of the time on Outer Island from 1982-1994. No nesting occurred on Outer from 1995-2003, but there was again successful nesting in 2004 and 2005 at a different nest location. Nesting has not been detected on Cat, Ironwood, Otter, Manitou, or South Twin Islands, all of which have an interior location in the archipelago, since monitoring began. It is conceivable that these islands have not been selected because, with the exception of South Twin, they do not have any significant shoals or shallow waters which are likely used as fishing grounds. Nesting was successful on Stockton Island for the first time in 2005.

Table 18. Summary of eagle nesting by island/unit between 1980-2004.

Island/Unit	Time Period*	No. Years Nesting Occurred	Percent Success
North Twin	18	50	1982-05
Michigan	17	35	1981-04
York	17	35	1982-05
Long	16	75	1989-05
Madeline	13	54	1980-05
Devil's	11	64	1986-01
Basswood	11	45	1980-04
Outer	11	82	1982-05
Oak	9	44	1982-04
Mainland	8	71	1996-04
Rocky	6	83	1987-04
Eagle	6	67	1997-05
Sand	6	67	2000-05
Hermit	2	50	1995
Bear	1	100	2003
Stockton	1	100	2005

*Not always consecutive years.

Piping Plover

- **Federal and state listed endangered species.**
- **2004 - Three birds observed; no nests established.**
- **2005 – Three birds observed; one nest established; one chick out of four eggs fledged and banded.**
- **Population increasing overall in Great Lakes states.**

The Great Lakes population of piping plover was listed as a federally endangered species in 1985 by the U.S. Fish and Wildlife Service (Federal Register, Vol. 50, No. 238: 50727-733) and was listed as an endangered species by the State of Wisconsin in 1979. The piping plover's drastic population decline in recent decades has primarily been due to habitat loss through development, loss of breeding and wintering habitat, and other human intrusions. Wide, sandy beaches are the preferred nesting habitat. These areas are also favored by humans for recreational use.

Protection of plovers on Long Island is a cooperative effort between the park, Wisconsin DNR, Bad River Tribe, U.S. Fish and Wildlife Service, and University of Minnesota researchers. Long Island is surveyed annually by the Wisconsin DNR and park staff to identify nesting pairs. If nesting occurs, an exclosure is placed around nests to prevent predation, and the park closes a ¼-mile "buffer zone" to visitor use. The nest is also monitored. In 2001 chicks were banded as part of a region wide effort to better understand piping plover population dynamics, including migratory pathways and important wintering grounds. In April of 2001, the U.S. Fish and Wildlife Service designated Long Island and Michigan Island sandscapes as critical habitat for piping plover.

Apostle Islands National Lakeshore currently provides habitat for the only successful piping plover nesting location in the State of Wisconsin. Piping plovers nested successfully on Long Island/Chequamegon Point from 1974-1984 and, after a 15-year gap, in 1998. Piping plovers successfully nested (one nest) in the park in 1998, 1999 and 2001; however, young were predated upon in 1999. In 2002, 4 eggs were laid but all were unfortunately predated. In 2003, 3 piping plovers were observed displaying breeding behavior but no nests were ever constructed. In 2004, 3 birds were observed, and 2 scrapings of non active nests (no rock lining) were found. No active nesting was detected. In May of 2005 3 birds were observed including one pair. On June 7 a nest was discovered with 4 eggs and two days later an enclosure was established and the area was posted to restrict entry. Monitoring was completed cooperatively with protection officers from the park and the Bad River Tribe. On July 12, members from both agencies and the State DNR, Endangered Resources Division, in cooperation with the U.S. Fish and Wildlife Service captured and banded the one remaining chick south of the original nest site. The adults were still in the vicinity.

Ruffed Grouse

- **Monitored in cooperation with the State of Wisconsin.**
- **Game species.**
- **2004 - 11 birds.**
- **2005 – 5 birds.**
- **No significant trend over time.**

The ruffed grouse is a game bird in the State of Wisconsin that also resides within the park. The only significant population occurs in the mainland unit. The Wisconsin Department of Natural Resources (DNR) conducts annual drumming surveys to obtain information on the status of the ruffed grouse breeding population state-wide. In cooperation with the DNR, park staff has conducted surveys on the mainland since 1990.

Surveys between 1990 and 2005 indicate that the number of birds recorded on the mainland route has ranged between 4 and 18 birds per year (see Table 19). In 2004, 11 birds were heard during surveys, which is close to the average of 10 birds per year. There were 5 birds in 2005.

The number of birds per stop ranged between 0.4 and 1.8 along the auto survey route between 1990 and 2005, and the average was 0.8 birds/stop which is the same as that for the Department of Natural Resources (DNR) northern region for 2005. The statewide average ranges between 0.09 in the southeast region, to 0.96 for the central region during this same year. There was no significant trend in the number of birds detected during park surveys over time using regression analysis.

The park has also completed walking surveys of various lengths several times between 1989 and 1996 at locations separate from the auto route. The number of birds per stop along these transects has ranged between 0.2 to 0.9 birds per stop with an average of 0.4 birds per stop.

Table 19. Ruffed grouse auto surveys (1990-2005) on route 04-1 (part of old route B-68).

	First Survey			Second Survey	
Dates	**No. Birds**	**No. Drums**	**No. Birds/Stop**	**No. Birds**	**No. Drums**
4/25 & 5/03/90	16	18	1.1	20	21
4/23 & 4/26/91	7	7	0.6	12	16
4/28 & 5/05/92	6	7	0.6	8	12
4/22 & 5/04/93	12	17	0.9	10	15
4/24 & 5/06/94	11	16	0.9	1	1
4/20 & 4/27/95	7	14	0.5	16	31
5/09 & 5/16/96	7	9	0.5	15	21
5/5/97	4	7	0.4		
4/23/98	16	37	1.6		
4/26/99	12	21	1.2		
5/2/00	15	27	1.5		
4/25/01	18	28	1.8		
4/30/02	5	3	0.5		
4/25/03	5	6	0.5		
5/2/04	2	4	0.2		
5/6/05	5	9	0.5		

Woodcock

- **Monitored in cooperation with the State of Wisconsin.**
- **Game species.**
- **2004 - 5 birds.**
- **2005 – 11 birds.**
- **Decreasing population trend – significant between 1989 and 2004 (P<0.05), but not significant between 1989 and 2005.**

The U.S. Fish and Wildlife Service and Canadian Wildlife Service conduct an annual woodcock singing-ground survey (auto) to obtain information on the status of the woodcock breeding population. Route 1, in northern Bayfield County, runs along Highway 13 and has been surveyed since 1954 by the Fish and Wildlife Service, Wisconsin DNR, private individuals, and park staff. The route starts at the western intersection of Highway K and Highway 13, and goes westerly on Highway 13 for 4 miles. The park has participated in this survey every year since 1983.

Data from 1989 to 2005 are presented in Table 20. The range of birds picked up on surveys during this time frame is zero to 16. Between 1989 and 1994 the range was 7-16, while between 1995 and 2004, the range was 0 to 6. In 2004, 5 woodcock were detected during the survey. Linear regression of the number of birds over time indicates a significant decreasing trend (P<0.05) during this timeframe along this transect. This decreasing trend is consistent with a regional trend for this species. In 2005, a total of 11 birds were heard and when linear regression was completed with this point, no significance was detected.

It is interesting to note that sky conditions were ½ to ¾ overcast 75% of the time between 1989 and 1994, or the time period when more birds were recorded. The year 2005 is the anomaly to the weather pattern, but the general trend of more birds picked up during times with more cloud cover is consistent. In addition when surveys were done in temperatures of 60 degrees and above, numbers of birds detected were between 0-4 in 75% of the cases.

Table 20. Summary of annual woodcock surveys (1989-2005) with weather conditions at the onset of surveys. Surveys are not completed if precipitation is present.

Year*	Month	Day	Start Time	Sky Conditions	Temperatures	Winds	Number Birds
2005	May	16	8:47	3/4 overcast	40-49	Light 4-7	11
2004	May	15	8:43	3/4 overcast	40-49	Gentle 1-3	5
2003	May	14	9:04	Clear	35-39	Calm	6
2002	June	5	8:22	1/4 overcast	60+	Calm	0
2001	May	16	8:54	Clear	60+	Calm	4
2000	May	16	8:58	Clear	40-49	Calm	6
1998	May	13	8:52	1/4 overcast	60+	Gentle 1-3	2
1996	May	12	8:51	Clear	40-49	Calm	4
1995	May	12	8:57	1/4 overcast	50-59	Gentle 1-3	6
1994	May	15	8:45	> 3/4 overcast	40-49	Calm	12
1993	May	12	8:47	Clear	50-59	Calm	7
1992	May	20	8:54	Clear	60+	Light 4-7	8
1991	May	7	8:48	1/2 overcast	40-49	Calm	16
1990	May	11	8:43	> 3/4 overcast	50-59	Gentle 1-3	11
1989	May	17	8:55	> 3/4 overcast	50-59	Calm	9

*Survey not completed in 1997 and 1999.

Black Bear

- **Database to track bear observations developed.**
- **Increased efforts in public education.**
- **2004 - 60 observations in the park, 10 of which were bears heard but not seen, or sign.**
- **2005 – 8 observations only.**

A database to track bear observations was developed prior to the 2003 field season, which was the first year an attempt was made to systematically track all observations. Staff, volunteers, and visitors were highly encouraged to report all sightings. In addition, staff and volunteers spent a great deal of effort educating the public regarding camping practices that reduce the likelihood of bear impacts.

In 2004, a total of 50 bear observations were made between June 21th and September 26th, which is much lower than the 221 reported in 2003. Observations were made on 31 days of this 98 day period which averages 1 observation every 3.1 days. This information reflects reports coming from more than one island in the same day (multiple bears), and also multiple reports of the same animal over an entire day.

Observations from all sources were made on several islands as can be seen from Table 21. The largest numbers came from Stockton Island (36% of reports) followed by Sand (32% of reports), and then Oak (20%). Observations from Oak Island encompassed the broadest range of dates and were the only reports that encompassed all summer months.

Table 21. Number of black bear observations in 2004 by island with the inclusive range of dates that observations occurred.

Location	Number of Observations	Date(s)
Basswood	1	August 22nd
Cat	1	July 17st
Hermit	1	July 24th
Michigan	1	August 30
Oak	10	June 21st to September 4th
Raspberry	1	July 13th
Sand	16	June 21st to August 23rd
Stockton	18	July 7th to September 6th

A total of 50% of the observations were made by visitors, 6% by volunteers, 34% by employees, and 10% were of unknown origin. Bear observations included the age class (adult, yearling, and cub) in 74% percent of the reports received. Of these, 54% were adults, 35% were yearlings, and 11% were cubs.

There were no instances reported of bears obtaining food from visitors, and 3 occurrences of property damage. Non-lethal deterrence was used successfully 6 times over the summer season to move bears away from visitor use areas. In 2005, only 8 observations

were reported. One bear was observed on the mainland, 3 on Oak Island, and 2 each on Sand and Stockton Islands. Three bears were observed in campsites and one obtained food.

It appears as though visitor education and non-lethal deterrence was successful in minimizing the number of negative bear-human interactions. However, implementation of this strategy is new and continued evaluation will be completed. It is recommended that observations continue to be recorded in the database. As part of this, every effort should be made to collect and record information regarding the exact location of the bear at the time of observation. In addition, it is strongly recommended that visitor education efforts continue to be made a priority.

Restoration Projects

Cabin sites

- **Restoration conducted at previous cabin sites on Long, Otter, Rocky, Sand and South Twin Island and the Mainland**
- **2003 and 2004 – native trees transplanted**
  - **Survival rate high for most species and very high for red maple, red oak, white cedar, white pine, white spruce, and jack pine.**
- **2004 - approximately 4,000 propagated native plants used in restoration**
  - **Survival rate was very high for blueberry, hairgrass, Pennsylvania sedge, and raspberry.**

When the park was established, lands were purchased that included cabins. A number of landowners chose to enter into use and occupancy agreements with the park. Many of these agreements were 25 year leases and have recently expired. On a number of these sites, associated structures that were not historically significant have been removed. Leaving bare, open ground is problematic because exotic species can invade and quickly dominate an area. Once established, exotic species can be difficult and costly to remove, and they slow the forest regeneration process.

In 2003, restoration was initiated at several of these sites, and in 2004, restoration of two locations on Long Island was started (Table 22). Trees were relocated from the surrounding forest into the openings left behind by the removal of these two cabins. A total of 37 seedlings, consisting of jack pine (5%), red maple (32%), red oak (14%), and white pine (49%), were transplanted into these sites. Monitoring plots were established at the time of planting and monitored in late summer. Monitoring was again completed in 2005.

Table 22 shows tree survival at individual cabin site locations. Tree survival was highest at the Rocky Nourse and Long Island locations. At the Lindgren site on Rocky Island, the survival rate was affected by an illegal campfire in which some of the trees were destroyed. Tall, thick grass cover, as well as deer browse, may have affected the survival on the mainland sites. The rocky soil at the ranger cabin site on South Twin may have affected the survival of transplanted trees, however, overall tree survival was still very good.

Table 22. A comparison of tree survival at each of the restoration sites. At all sites, except Long Island, trees were planted in May of 2003.

		2003		2004		2005	
Location	**No. Planted**	**No. Survived**	**% Survival**	**No. Survived**	**% Survival**	**No. Survived**	**% Survival**
MD Carlson	19	17	89	16	84	12	63
MD Deneker	27	22	81	23	85	18	67
MD Deneker-McNeil	38	32	84	33	87	18	47
RO Lindgren	59	46	78	41	69	31	53
RO Nelson	25	25	100	21	84	19	76
RO Nourse	27	27	100	26	96	25	93
RO Nourse south	12	12	100	11	92	11	92
SO Ranger Cabin	36	32	89	27	75	27	75
LO-2 Trapper Cabin	20	Established in 2004		20	100	18	90
LO-4 Sivertson Cabin	17	Established in 2004		17	100	17	100

Table 23 shows percent survival for individual tree species at cabin site locations. All of the species showed good to excellent survival rates. Of particular note are the 100 percent survival rates for red maple, white cedar, and white pine, all of which are considered later successional species.

Table 23. Planted tree species, and the number and percent that survived.

		2004		2005	
Species	**Total No. Planted**	**No. Survival**	**% Survival**	**No. Survival**	**% Survival**
Balsam Fir	199	165	83	127	64
Eastern Hemlock	3	3	100	2	67
Jack Pine	2	2	100	2	100
Paper Birch	6	4	67	4	67
Red Maple	21	21	100	20	95
Red Oak	5	5	100	5	100
White Cedar	10	10	100	10	100
White Pine	20	19	95	19	95
White Spruce	5	5	100	5	100
Yellow Birch	2	1	50	1	50

The vigor of some species on the mainland and Long Island, such as balsam fir, white pine, eastern hemlock, and red maple has been affected by deer browse. In the fall of 2004, the mean vigor ranged between 2.6 and 4.1 and averaged between 3.0 and 3.1 in 2005. The highest vigor ratings occurred on Long Island at the Sivertson cabin site and

the lowest value occurred at the Lindgren site on Rocky Island. Vigor at all the sites was affected by the tall grasses later in the summer. These grasses may shade out some of the smaller trees.

In May 2004, approximately 4,000 plants were used in cabin site restoration on Long, Otter, Rocky, Sand and South Twin Islands and the mainland. The plants were propagated from materials collected within the park at the Natural Resource Conservation Service's Rose Lake Plant Materials Center. Species included blueberry, evening primrose, common hairgrass, bush honeysuckle, common juniper, Pennsylvania sedge, red raspberry, red elderberry, red osier dogwood, and thimbleberry. To monitor the effectiveness of restoration efforts, ten sets of square meter plots were set up at selected sites. These sets included three plots; one as a control, one as a half density plot, and one as a full density plot. In sites where one species was planted, 3 plugs were planted in the half density plots and 6 plugs in the full density plots. At sites where more than one species was planted, the half density plots had 2 plants of each species, and the full density plots had 3 plants.

Table 24 shows plant survival by species for each cabin site location. With the exception of the plots on Rocky Island, where grass out-competed the restoration plantings, survival was very good to excellent.

Table 24. Plant survival based on monitoring plots at cabin restoration sites (May 2004-August 2005).

	Mainland	**Long Island**	**Rocky Island**	**South Twin Island**
Blueberry		87%		
Common hairgrass		100%		100%
Pennsylvania sedge	67%		0%	100%
Raspberry				100%
Red Elderberry			0%	

Table 25 shows changes in bare ground, vegetative litter and plant cover from the time restoration began in May of 2004 until monitoring was conducted in August of 2005. Results of monitoring show decreases in bare ground and increases in native plant cover at all locations. Non-native plant cover also increased, but at a much lower rate than native plant cover. Results for Rocky Island are not shown because the survival rate for plantings was zero and, as a result, monitoring was discontinued.

Table 25. Change in aerial coverage of bare ground, vegetative litter and plant cover based on monitoring plots at cabin restoration sites (May 2004-August 2005).

	Mainland	**Long Island**	**South Twin Island**
Bare ground	-24%	-40	-8%
Vegetative litter	-4%	+17	-8%
Native plant cover	+16%	+24	+13%
Non-native plant cover	+8%	+1%	+3%

Overall, results of monitoring show that the restoration efforts at the cabin sites were, in general, very successful. Transplanting trees as soon as possible after cabins were removed enabled trees to become established before non-native grasses took over the site. The survival rates for the transplanted trees was very good. Following up tree transplanting with planting of native species worked very well on all sites except those that already had a dense grass cover. In those locations, it is recommended that only trees and shrubs are used in the restoration efforts. However, at locations like Long Island, where the percent of bare ground was very high immediately following cabin removal, planting herbaceous species worked very well in decreasing bare ground, increasing native plant cover and keeping exotic invasion to a minimum.

Oak Island Sandscape

- **Restoration initiated in 2000**
- **Cooperative effort with NRCS, FWS and volunteers**
- **Bare ground decreasing, vegetative litter increasing.**
- **Planted and non-planted natives out-competing exotic plants.**

The park's seventeen significant sandscapes have been monitored since 1988. Among those monitored is a 1.6 acre cuspate foreland on Oak Island that has a long history of human use as well as current visitor impacts. Monitoring results over a ten-year period indicated that the Oak Island sandscape was the most threatened of the park's sandscapes and in need of restoration.

Since 2000, park natural resource staff has been working with the Natural Resource Conservation Service's (NRCS) Plant Materials Center in Rose Lake, Michigan to restore the Oak Island sandscape. Funding for the project was obtained from both the National Park Service's disturbed lands restoration program and the U.S. Fish and Wildlife Service's (FWS) Great Lakes Coastal Program. In 2000, NRCS gathered native plant materials from the site and began to propagate fifteen species. The following year (2001), eighteen plots were established to determine how well propagated plants could be established under various lighting conditions and additional plant materials were gathered for the full restoration effort. Park maintenance staff assisted the restoration effort by installing additional floating boardwalk. These boardwalks have been very effective in directing visitor traffic on sandscapes.

Results of the 2001 restoration plots are shown in Table 26. In general, species that were planted in shade to partially shaded conditions had a higher survival rate. This is not surprising, considering that the "soil" is pure sand and areas needing restoration tended to have very little, if any, vegetative litter to moderate temperatures and hold in moisture. With the exception of wild rye, most of the species stabilized or increased after becoming established. This was especially true of common juniper. Although there was a large decrease in survival from 2001 to 2002, the remaining plants that became established have done very well.

Table 26. Oak Island sandscape monitoring plots showing percent survival by species and light conditions.

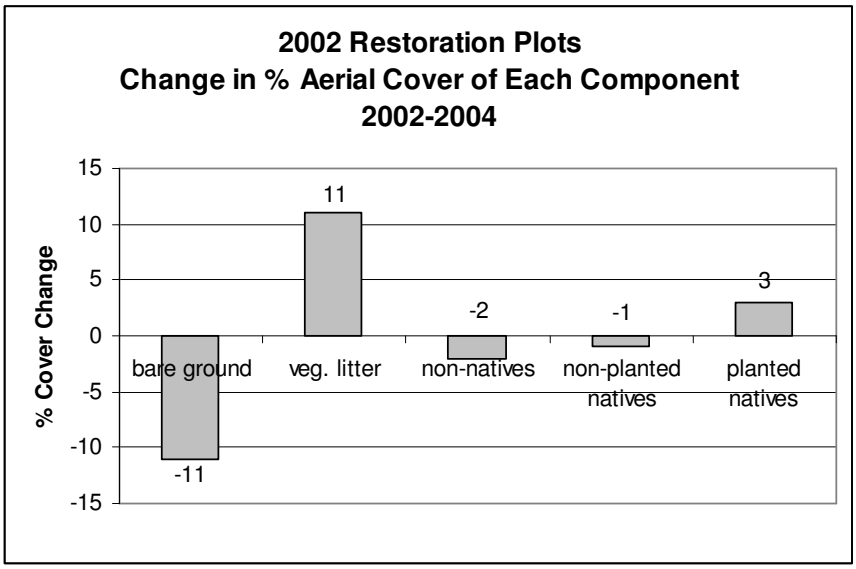
Species		Percent Survival					Light Condition
Scientific Name	**Common Name**	**Oct 2001**	**Sept 2002**	**Sept 2003**	**Sept 2004**	**Aug 2005**	
Equisetum arvense	Equisetum	87	464	246	277	239	Shade
Carex pensylvanica	Pennsylvania sedge	79	86	107	114	114	Shade
Vaccinium angustifolium	Low-sweet blueberry	89	111	100	100	155	Partial shade
Anaphalis margaritacea	Pearly everlasting	0	57	65	83	35	Full sun, Partial shade
Rosa blanda	Wild rose	82	94	88	82	65	Full sun
Juniperis communis	Common juniper	100	44	44	44	44	Full sun
Fragaria virginiana	Wild strawberry	24	13	13	11	18	Full sun
Elymus canadensis *	Canada wildrye		40	20	9	-	Partial shade
Aristida dichotoma	Churchmouse 3-awn	0	0	0	0	0	Full sun

* Tranplant quantity estimated

Note - In 2004, equisetum had poor vigor; juniper, sedge, blueberry had high vigor

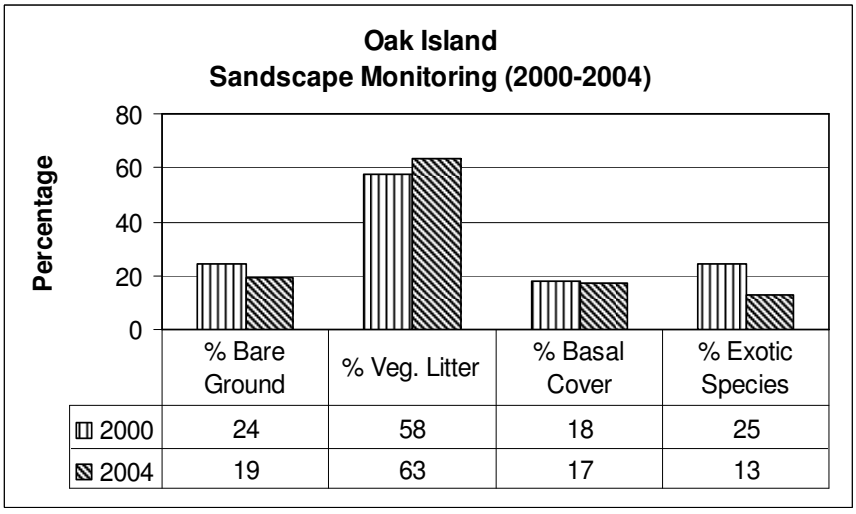
In late May of 2002, the majority of the on-site restoration occurred with 3,200 propagated plants of fifteen species planted with the assistance of a Northland College field ecology class, technical assistance from the NRCS, and park staff. Funding was provided from the U.S. Fish and Wildlife Service's Great Lakes Coastal Program. Some additional planting was done in 2003 and 2004. In 2002, 20 monitoring plots were established in 10 of the more heavily planted areas. In addition, plots were established to determine the effectiveness of pulling vs. treating orange hawkweed (*Hieracium aurantiacum*), the most abundant exotic species on the sandscape. Results of the orange hawkweed plots showed that pulling was more effective than chemical treatment, however, hand pulling might not be feasible for larger areas. Results of the restoration monitoring plots are shown in Figure 7 and are encouraging. In comparing data from 2004 with 2002, bare ground has declined by 11%, with a corresponding increase in vegetative litter. There was a small decrease in non-native species, a very small decrease in native species that were not planted and an increase in planted natives (those used in the restoration effort).

Figure 6. Oak Island sandscape restoration monitoring.



In 2004, the Oak Island sandscape was monitored as part of the park's overall sandscape monitoring program for the first time since restoration took place. This monitoring is designed to look at changes on the entire sandscape, providing a broader look than the restoration plots. In comparing monitoring data collected in 2000 (prior to restoration) with 2004 data, results are consistent with the restoration monitoring plots (Figure 7). The amount of bare ground has decreased, with a corresponding increase in vegetative litter. Basal cover is virtually unchanged. Results of this monitoring show a much more dramatic decrease in the percent of exotic species (nearly 50%) compared to the restoration plots. This is because exotic species, or non-natives, were only controlled outside of the restoration monitoring plots.

Figure 7. Oak Island sandscape monitoring.



	% Bare Ground	% Veg. Litter	% Basal Cover	% Exotic Species
2000	24	58	18	25
2004	19	63	17	13

South Twin and Raspberry Island Sandscapes

- **Cooperative effort with NRCS, FWS and volunteers**
- **South Twin – Over 3,600 native plants used in restoration**
- **Raspberry – Over 850 native plants used in resotoration**
- **% survival was high for many species, especially blueberry, goldenrod, hairgrass, rush, and wild rose**

The history of the South Twin Island sandscape includes fairly intensive human use. From the early-mid 1900's, there was a row of fishing cabins along the sandscape. Currently, the sandscape is a very popular visitor use area. The vegetation of the sandscape reflects these past and current uses. Sandscape monitoring conducted since 1989 found a high percentage of exotic species and a recent decrease in vegetation cover. The Raspberry Island sandscape did not have the same level of human use historically. However, two campsites were removed from Raspberry Island in the early 1990's and more than ten years later, the area had still not substantially recovered. The coastal features in Apostle Islands NL are among the most significant in the Great Lakes, it is therefore especially important that efforts are made to restore and protect them.

Funding to conduct restoration on these two sites was obtained through the U.S. Fish and Wildlife Service's Coastal Grant Program. A very similar approach that proved successful on Oak Island sandscape was used for this project. During the fall of 2004, plant materials (e.g., seeds, cuttings) were collected from these and other sandscapes. Over the winter, plant materials were propagated by the Natural Resource Conservation Service's Rose Lake Plant Materials Center and Becky Brown, a local native plant nursery. This approach enables the park to plant not only native species, but plants specific to the park, preserving genetic integrity and adaptation to the site.

In May of 2005, over 3,600 plants were planted on the South Twin sandscape and nearly 850 on the Raspberry sandscape by park staff, a Northland College class, and volunteers. A variety of native plants were used. On the South Twin sandscape, wild rose, beachgrass, hairgrass, blueberry, raspberry, juniper, sand cherry, redtop, pin cherry, three toothed cinquefoil, scouring rush, beach pea, common milkweed, evening primrose, fireweed, goldenrod, pearly everlasting, and wormwood were planted. On Raspberry Island sandscape, the following species were planted: wild strawberry, speckled alder, wild rose, beachgrass, hairgrass, blueberry, raspberry, and sand cherry. In addition, 20 monitoring plots were established in areas of focused planting to determine the effectiveness of the restoration effort.

Tables 27 and 28 summarize the percent survival of various plantings within the plots. In subsequent monitoring, it will be possible to determine changes in native vs. non-native plants and planted native vs. non-planted native species.

Table 27. South Twin vegetation survivorship based on monitoring plots between May and August, 2005.

Species	% Survival
Blueberry (*Vaccinium angustifolium*)	100
Common goldenrod *(Solidago canadensis*)	100
Hairgrass (*Deschampsia flexuosa*)	100
Scouring rush (*Equisetum hyemale*)	100
Wild rose (*Rosa blanda*)	100
Wormwood (*Artemisia compestris*)	93
Beach grass (*Ammophila breviligulata*)	67
Pearly everlasting (*Anaphalis margaritacea*)	67
Evening primrose (*Oenothera biennis*)	38
Common milkweed (*Asclepias syriaca*)	29
Beach pea (*Lathyrus maritimus*)	25
Common juniper (*Juniperus communis*)	25
Fireweed (*Epilobium augustifolium*)	0
Raspberry (*Rubus strigosus*)	0
Red top (*Agrostis gigantea*)	0
Sand cherry (*Prunus pumila*)	0
Strawberry (*Fragaria virginiana*)	0

Table 28 Raspberry Island vegetation survivorship based on monitoring plots between May and August, 2005.

Species	% Survival
	Percent Survivorship
Wild rose (*Rosa blanda*)	90
Sand cherry (*Prunus pumila*)	71
Hairgrass (*Deschampsia flexuosa*)	61
Speckled alder (*Alnus rugosa*)	50
Blueberry (*Vaccinium augustifolium*)	25
Raspberry (*Rubus strigosus*)	0

Percent survival was lowest for fireweed, raspberry, red top, sand cherry and strawberry on the South Twin sandscape. Raspberry also did poorly on the Raspberry Island sandspit. This is the first year that red top, fireweed, goldenrod, evening primrose and common milkweed were used in sandscape restoration. The fireweed had been over wintered and was therefore not as vigorous as some of the other plants which may have contributed to their low success. Sand cherry has tended to have low survival rates in the field, even though the Plant Materials Center has been able to successfully propagate this species. Common juniper had a fairly low initial survival rates; however, experience on Oak Island has shown that once established, juniper tends to do fairly well. Species that have tended to do well in sandscape restoration efforts and are very important components of sandscape ecosystems are hairgrass, beach grass and wormwood. Wild rose had a high survival rate on both islands; however, its vigor tends to be fairly low on sandscapes.

Sandscape restoration is challenging. Restoration takes place in nearly pure sand in areas denuded of protective vegetative litter. This litter is important in moderating temperatures and holding in moisture. Other factors that made restoration challenging are that the summer of 2005 tended to be dry, especially late summer and rabbit browsing damaged or killed a number of transplants on Raspberry Island. Despite these conditions, we have successfully increased native plants in these locations and the survival rate for most species is good to excellent. Gathering plant materials and having them propagated has worked out very well. In addition, the use of conetainers is highly recommended in draughty soils like sand as they force roots to form downward, greatly increasing the root depth upon planting.

Special thanks to all who assisted with this project, including: Dr. Gus Smith and his Northland College class, Ted Koehler, Karin Kozie, and Tana Route who helped with planting and Dave Burgdorf, John Lief and Gail Bischoff at the NRCS's Rose Lake Plant Materials Center and Becky Brown who propagated the plants.

Raspberry Island Slope

- **Goal is to provide long-term stabilization of reconstructed slope in front of lighthouse.**
- **Cooperative project with the Natural Resource Conservation Service Rose Lake Plant Materials Center.**
- **Native shrubs and forbs planted in 2003 and 2004.**
- **Most planted species had a good to excellent survival rate.**
- **Many weedy species were brought in with topsoil.**

The Raspberry Island light station is listed on the National Register of Historic Places and is among the park's premier visitor attractions. The slope in front of the Raspberry Island lighthouse has eroded over the past several years and was seriously threatening the light station. In 2001, a large-scale shoreline stabilization project was initiated that included a combination of a rip-rap revetment to stabilize the toe of the slope and bio-engineering on the remaining portion of the slope. Bioengineering included the use of brush layers and fascines and covering the slope with coconut fiber. In addition, plant materials were gathered from the site and propagated at NRCS's Rose Lake Plant Materials Center. In 2003, these plants were placed in-between the rows of brush layers and fascines to increase the stabilization and enhance the aesthetics of the slope. A total of 675 shrubs and forbs were planted including 54 speckled alder, 178 willow, 53 red-osier dogwood, 349 red elderberry, 13 wild strawberry, 19 staghorn sumac, 8 bristly rose, and 1 clump of 8 wild roses.

In 2004, the slope was monitored in June and results indicated a slight decrease in the overall percent survival to 65 percent (see Table 27). Red elderberry still had the lowest overall survival of 56% while the wild rose was still at 100%. A visual inspection of the slope showed a decrease in the amount of lamb's quarter and bindweed, but Canada wild-rye was abundant.

Table 29. Monitoring results from May 2003 planting on Raspberry Island slops

Common Name	Number of Monitored Plants (5/03)	Number of Monitored Plants (6/04)	% Survival (5/03-6/04)
Brush Willow	26	17	71
Red Elderberry	58	31	56
Red-osier Dogwood	10	9	90
Speckled Alder	9	5	71
Staghorn Sumac	5	4	80
Wild Rose	4	3	100
Wild Strawberry	15	8	57

Vigor was evaluated according to a scale that ranged between low (1) to high (5). There was a slight increase to 2.6 in the overall vigor of the species planted on the slope. The mean vigor for each individual species changed slightly except for that of staghorn sumac which decreased slightly. There was an increase in mean vigor for the red elderberry, red-osier dogwood, and the wild strawberry, and a decrease for the other four species.

In 2005, 51 individual plants were monitored; 12 of these were dead which indicates a 76% survival rate. The mean vigor was all plants combined was moderate for all plants. Mean vigor by species ranged between 3.1 and 3.7 for brush willow, red osier dogwood, and speckled alder, and was low for red elderberry (0.8).

An additional 3,200 plants were placed on the slope in 2005 and monitored at planting using a meter plot method. The species planted and the results of follow-up monitoring on the number of plants that survived are in table 28. This type of information is useful in determining which species are likely to do well in similar restoration efforts in the future.

Table 30. Species planted on Raspberry Island slope in 2005 and their survival.

Common Name	Number Planted	Number Survived	% Survival
Willow	6	3	50
Grasses	65	23	35
Red Elderberry	22	4	18
Red-osier Dogwood	12	11	92
Thimbleberry	25	20	80
Wild Raspberry	1	1	100
Wild Rose	18	1	5
Wild Strawberry	35	22	63

On the Raspberry Island slope, a large number of weedy species appeared as a result of seeds brought in with the top soil used to fill the slope. The plants used in restoration therefore had a lot of competition from weedy, often non-native, species. Despite that, plot results indicate good to excellent survival rates for most species. Red-osier dogwood and thimbleberry, in particular, had excellent survival rates. Survival greater than 50% is considered good in restoration projects (Burgdorf, pers. comm. 2007) – all of the species monitored from the 2003 plantings exceeded this and most of the species monitored from the 2005 plantings exceeded this rate.

Outer Island Slope

- **Goal is to provide long-term stabilization of reconstructed slope in front of lighthouse.**
- **Cooperative project with the Natural Resource Conservation Service Rose Lake Plant Materials Center.**
- **2004 – Rock revetment and drainage trenches installed.**
- **2005 - Log cribs and slope grids installed, restoration using live stakes and approximately 3,900 plantings.**

Erosion of the slope below the station complex was starting to threaten the Outer Island light station in recent years. Beginning in 2004, Apostle Islands National Lakeshore collected plant materials which were propagated by the Natural Resource Conservation Service (NRCS) Rose Lake Plant Materials Center. In addition, NRCS provided technical expertise in soil bioengineering and restoration.

In 2004, a rock revetment was created at the base of the slope for stabilization and drainage trenches were installed on the top of the slope to manage water flow. In 2005, crib walls and vertical slope grids created out of lumber and rocks were constructed on-site. In addition, approximately 300 willow live stakes and approximately 3,900 propagated shrubs and plants were planted (Table 29). Similar to other restoration projects, the plants were propagated from plant materials collected within the park. The herbaceous species were placed on the upper third of the slope while the shrubs were put in the lower two-thirds. Thirty one-meter square plots were established to determine survivorship of various planted species.

Table 31. The species and number planted in 2005.

Common Name	Number Planted
Blackberry	65
Blueberry	6
Bunchberry	110
Canada Bluejoint	483
Canada Goldenrod	714
Canada wildrye	80
Evening Primrose	489
Fireweed	285
Pearly Everlasting	441
Poverty oatgrass	51
`Red Elderberry	22
Red Osier Dogwood	321
Speckled alder	62
Thimbleberry	554
Wild Rose	174
Yellow Avens	34

Appendix I - Scientific Names for Rare Plants

Scientific Name	Common Name
Arethusa bulbosa	Swamp-Pink
Armoracia lacustris	Lake-cress
Botrychium lunaria	Moonwort Grape-fern
Botrychium minganense	Mingan's Moonwort
Calypso bulbosa	Fairy Slipper
Carex capillaris	Hair-like Sedge
Carex concinna	Beautiful Sedge
Carex exilis	Coast Sedge
Carex lenticularis	Shore Sedge
Carex michauxiana	Michaux's Sedge
Carex pallescens	Pale Sedge
Carex prasina	Drooping Sedge
Ceratophyllum echinatum	Prickly Hornwort
Deschampsia cespitosa	Tufted Hair Grass
Deschampsia flexuosa	Crinkled Hair Grass
Dryopteris expansa	Spreading WoodFern
Eleocharis robbinsii	Robbins' Spike-rush
Equisetum palustre	Marsh Horsetail
Equisetum variegatum	Variegated Horsetail
Goodyera oblongifolia	Giant Rattlesnake-Plantain
Lycopodium selago	Fir Clubmoss
Nuphar advena	Yellow Water Lily
Ophioglossum pusillum	Aadder's-tongue
Osmorhiza chilensis	Chilean Sweet Cicely
Pamassia palustris	Marsh Grass-of-Parnassus
Pinguicula vulgaris	Common Butterwort
Platanthera dilatata	Leafy White Orchis
Platanthera orbiculata	Large Roundleaf Orchid
Primula mistassinica	Bird's-eye Primrose
Rhynchospora fusca	Brown Breakrush
Salix pellita	Satiny Willow
Salix planifolia	Tea-leaved Willow
Scirpus torreyi	Torrey's Bulrush
Senecio indecorus	Plains Ragwort
Streptopus amplexifolius	White Mandarin
Trisetum spicatum	Narrow False Oats
Utricularia resupinata	Northeastern Bladderwort
Vaccinium vitis-idaea ssp minus	Mountain Cranberry

Appendix II – References

Becker, G.C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison, Wisconsin. 1081 pp.

Burgdorf, D. 2007. Personal communication.

Horns, W.H., C.R. Bronte, T.R. Busiahn, M.P. Ebener, R.L. Eshenroder, T. Gorenflo, N. Kmiecik, W. Mattes, J.W. Peck, M. Petzold, D.R. Schreiner. 2003. Fish-community objectives for Lake Superior. Great Lakes Fish. Comm. Spec. Pub. 03-01. 78p.

Judziewicz, E. J. and R. G. Koch. 1993. Flora and vegetation of the Apostle Islands National Lakeshore and Madeline Island, Ashland and Bayfield Counties, Wisconsin. The Michigan Botanist. Vol 32 (2) 194 pp.

Judziewicz, E. J. 1996. Monitoring of rare vascular plants, Apostle Islands National Lakeshore, Wisconsin. NPS Order No 1443PX614095117.

Lind, J., N. Danz, J.M. Hanowski, and G.J. Niemi. 2003. Annual update report: breeding bird monitoring in Great Lakes National Forests: 1991-2003. Report to Chequamegon/Nicolet, Chippewa and Superior National Forests. Natural Resources Research Institute Technical Report NRRI/TR-2003/46.

Newman, L., R. DuBois, and T. Halpern, T. [Eds.]. 2003. A brook trout rehabilitation plan for Lake Superior. Great Lakes Fisheries Commission. Miscellaneous Publication 2003-03, 40 p.

Rolfhus K.R., H.E. Sakamoto, L.B. Cleckner, R.W. Stoor, C.L. Babiarz, R.C. Back, H. Manolopoulos, and J.P. Hurley. 2003. Distribution and fluxes of total and methylmercury in Lake Superior. Environmental Science and Technology 37(5):865-872.

Wiener, J.G., B.C. Knights, M.B. Sandheinrich, J.D. Jeremiason, M.E. Brigham, D.R. Engstrom, L.G. Woodruff, W.F. Cannon, and S.J. Balogh. In review. Methylmercury in lacustrine food webs in the Voyageurs National Park: importance of atmospheric deposition and ecosystem factors. Submitted to Environmental Science and Technology.