APOSTLE ISLANDS NATIONAL LAKESHORE
BI-ANNUAL
RESEARCH and MONITORING REPORT

2002 AND 2003

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Highlights

Research Projects

Inventory of Near shore fishes, and Description of Near shore Fish Population Densities and Community Structures at Apostle Islands National Lakeshore and Isle Royale National Park

- Inventory of fish community within near shore areas (0-15m) of Lake Superior
- 6 dominant habitat types found
- 19 species collected

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

- Part of Great Lakes wide project
- Biogeography and distribution of snakes
- 2003 fieldwork on Sand, Outer and Rocky Islands

Levels of Polybrominated Diphenyl Ethers (PBDEs) in Eggs of Wisconsin Cormorants

- Great Lakes wide project
- Cormorant eggs collected to test for exposure to PBDEs
- PBDEs – man made chemical added to plastics as a flame retardant

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

- 2003 was year one of two year bat inventory
- Sites on Stockton, Devils and Outer Islands and the mainland at Little Sand Bay
- 4 species of bats captured; recordings being analyzed

Small Mammal Inventory of the Apostle Islands National Lakeshore

- Sampling sites on Outer, Stockton and Devils Islands and the mainland at Little Sand Bay
- 7 species of small mammals captured
- 2 species on Devils, 4 on Outer and Stockton, 7 on mainland

Determine Population Status of Black Bears and Develop Monitoring Protocols

- DNA analysis from hair used to obtain population information
- 26 bears on Stockton Island; 6 on Sand Island
- Black bear population has been relatively stable for 12 years
- Genetic variation shows immigration from mainland

Determine Distribution and Abundance of Otter, Apostle Islands NL

- Otter sign found on Michigan, Outer, Sand and Stockton
- Amount of open water (primarily beaver ponds) has decreased 39% since 1992 on Outer Island
- Occurrence and abundance of otter on Michigan, Outer and Sand related to beaver ponds

Monitoring Projects

Water

Water Quality

- Dissolved Oxygen above minimums needed
- pH within optimal ranges
- Secchi disc readings at or above lake average

Vegetation and Ecological Communities

Campsites

- Monitoring done to detect impacts from use
- Limits of Acceptable Change exceeded at 4 sites
- Percent bare ground increased at several sites

Rare Plants

- Goal – monitor status of Special Concern, Threatened, and Endangered plant populations
- 2002 – beautiful sedge and butterwort populations at Devil's Island monitored
- 2003 - satiny willow located on Otter, and butterwort populations monitored on Devil's Island.

Sandscapes

- Rare, high quality sandscapes with vegetation sensitive to trampling
- High visitor use
- Decreasing percent vegetation litter over time – 3 sites
- Increasing percent bare soil over time – all 8 sites

Exotic/Invasive Species

Hawkweed

- Exotic, invasive species that threatens sandscapes and cultural openings
- Hand-pulling treatment found most effective

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'
  2002 – 800-1,000 larvae and 200 beetles released
  2003 – approximately 20,000 beetles released
- Long Island tip 2003 — more intensive survey revealed greater area of infestation - 571 plants treated

Spotted Knapweed

- Exotic, invasive species that threatens sandscapes and cultural openings
- New sites located at Little Sand Bay and Long Island
- Chemical treatment found to be effective at control

Gypsy Moths

- Exotic, invasive species that threatens hardwood forests
- Significant increase in number of moths trapped over past 3 years

Wildlife Species

Birds

Breeding Bird Survey

- 2002 – 1,176 birds among 81 species
- 2003 – 1,227 birds among 84 species
- Six species showing decreasing regional trends are in the top 26 birds on park surveys between 1995-2003.

Migratory Birds

- Outer Island sandspit – significant migratory stopover point
- Monitoring completed with 13 volunteers
- Approximately 84,240 birds counted during 114 hours of effort in 2003

Bald Eagle

- Federally Threatened species
- 2002 – 3 fledged; all banded
- 2003 – 6 fledged; nest initiated on Bear Island

Piping Plover

- Federal and State Endangered species
- 2002 - 4 eggs laid; all predated
- 2003 – 3 birds displaying breeding behavior – no nest
- Population increasing overall in Great Lakes states

Ruffed Grouse

- Game species
- 5 birds in 2002 and in 2003

Woodcock

- Game species
- 2002 – 0 birds; 2003 – 6 birds
- Regional population trend – decreasing

Mammals

Black Bear

- Database to track bear observations developed
- 123 observations on Oak Island and 83 on Stockton Island
- More yearlings observed on Oak Island than on Stockton

White-tailed Deer

- Various surveys indicate densities of 10 deer/mi2 on some islands
- Deer recently observed on Sand Island in increasing numbers
- Deer browse surveys on Sand indicate very high browsing pressure on Canada yew

Habitat Restoration

Cabin Sites

- Transplanting done to promote forest regeneration
- 214 tree seedlings among 8 species transplanted in 7 sites
- Native plant materials collected for propagation

Oak Island Sandspit

- Restoration initiated in 2000
- Cooperative effort with U.S. FWS, NRCS, and volunteers
- Planted and non-planted natives out-competing exotic plants

Raspberry Island Slope

- Goal is to provide long-term stabilization of reconstructed slope in front of lighthouse
- 675 shrubs planted among 8 species
- Monitoring indicated 86% survival

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RESEARCH PROJECTS

WILDLIFE SPECIES

Inventory of near-shore fishes, and Description of Near-shore Fish Population Densities and Community Structures at Apostle Islands National Lakeshore and Isle Royale National Park

Dr. Owen Gorman, USGS Biological Resources Division, Ashland, WI
Seth Moore, USGS Biological Resources Division, Ashland, WI

Summary points:

- Inventory of fish community within near-shore areas (0-15m) of Lake Superior
- 6 dominant habitat types found
- 19 species collected

Although extensive fishery inventory and monitoring has been done within the Apostle Islands area, no known research has been conducted to inventory fish species and to describe fish population densities and community structures in the near-shore zone (depth of less than 15 m) of Lake Superior. Park boundaries only extend into Lake Superior 0.25 miles around Apostle Islands National Lakeshore (APIS); hence the majority of this area is within the near-shore zone.

The objectives of this study are to inventory fish species and describe fish population densities and community structure in the near-shore area (0-15 m) of the APIS and Isle Royale National Park. Fish assemblages found in the National Park near-shore regions will be described and related to the habitat from which they were captured. Also, the near-shore fish assemblage will be related to offshore assemblages; in this region USGS Biological Resources Division (BRD) have collected offshore community data with trawls since 1963.

In 2003, bottom trawl and Windermere traps were used to collect near-shore fish community data in a systematic-random sampling design to estimate fish community structure, biomass, and abundance. Fish habitat has been characterized at 27 locations, including proposed estuaries and inshore locations established to compliment BRD's offshore sampling for annual spring forage fish.

Six dominant habitat types were found in the Apostle Islands region: high and low gradient bedrock, low gradient boulder/cobble, low and high-gradient sand, and large gravel. Further habitat analysis will reveal the relationships that exist among near-shore fish and various aspects of their habitat.

Data from bottom trawls and Windermere traps provided general patterns of distribution and abundance of near-shore fishes in several types of fish habitat. Among all samples, 19 species were collected, and nine-spine stickleback, slimy sculpin, burbot, and johnny darter dominated the pooled catch. In trawls, fish were generally more abundant and species diversity higher in low-slope near-shore areas with vegetation (eastern shore Sand Island), and were most abundant

in sand substrate areas (Presque Isle Bay). Eleven species were captured only in trawls, which included nine-spine stickleback, johnny darter, rainbow smelt, log perch, trout-perch, round whitefish, lake whitefish, lake herring, long nose dace, three-spine stickleback, and ruffe.

Windermere traps yielded the highest abundances of burbot, lake chubs, and slimy sculpins. Four species were captured exclusively in traps, which included rock bass, longnose sucker, brook stickleback, and lake chub. In areas where the traps were used, fish generally were more abundant at depths >4m. Results from trap sampling indicated that fish were most abundant in steep bedrock (East side Basswood Island) and in intermediate gradient-boulder (south tip Outer Island) near-shore habitats. Processing of fish community and habitat data is ongoing and will yield more conclusive patterns over the coming months.

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

Summary Points

- Part of Great Lakes wide project
- Biogeography and distribution of snakes
- 2003 fieldwork on Sand, Outer and Rocky Islands

Apostle Islands NL is part of a larger project that focuses on local and regional genetic consequences of glacial history in Great Lakes amphibians and reptiles. These species are widely distributed in the region but differ in timing of colonization and ability to cross water. The initial focus is on five species of natracine snakes. 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 microsatellite 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.

In 2003 some sampling was performed and garter snake tissues collected from Sand, Rocky and Outer islands, Apostle Islands National Lakeshore. Funding for continuing work is being sought.

Levels of Polybrominated Diphenyl Ethers (PBDEs) in Eggs of Wisconsin Cormorants

Dr. Kenneth Stromborg, U.S. Fish and Wildlife Service, New Franken, WI
Sean Strom and Tara Edblom, Wisconsin Department of Natural Resources, Madison, WI

Summary points:

- Great Lakes wide project
- Cormorant eggs collected to test for exposure to PBDEs
- PBDEs – manmade chemical added to plastics as a flame retardant

The purpose of this project is to obtain basic information on concentrations of PBDEs in eggs of Wisconsin cormorants from several Great Lakes sites as well as one inland comparison. Apostle Islands National Lakeshore is one of the Great Lakes sites.

PBDE's are manmade chemicals that are added to plastics to decrease the likelihood and intensity of fire in a wide variety of consumer products, including vehicles, furniture, textiles, carpets, building materials, electronic circuits' components, etc. Although there is no definite information on the human health effects of PBDEs, studies on rats and mice showed effects on the thyroid and liver and preliminary evidence suggests neurobehavioral alterations and affects to the immune system in animals. PBDE has also been classified by EPA as a possible human carcinogen. PBDEs are widespread in the environment, in human blood and in mother's milk.

Because halogenated organic compounds, like PBDEs, are known to pass from mother to offspring, eggs can be used to detect their presence and may provide some indication of relative environmental levels. In addition, spatial or temporal patterns that might exist in egg PBDE concentrations will be determined. To obtain information on temporal trends, eggs collected during the 2003 breeding season as well as archived eggs will be analyzed. For spatial patterns, we will compare eggs from the Great Lakes sites with eggs from the inland site. This may provide some indication of spatial differences in PBDE exposure of birds living in these two geographically different types of sites. Finally, we will obtain information about how PBDE concentration patterns compare with PCB concentration patterns. Historically, PCB concentrations in wildlife samples tended to decrease with increasing distance from the Great Lakes. PBDE concentrations may follow this same pattern, or alternatively, could be higher at the inland site due to closer proximity to human activity, which is a source of PBDEs in the environment. Recent research has shown that PBDE concentrations are increasing rapidly and dramatically over time in a variety of environmental matrices, much like PCB concentrations until recently, when they have been showing declines in some areas.

Within this context, the goals of this study are as follows:
1. Determine concentrations of PBDEs in newly collected (2003) and archived cormorant eggs from sites within the Great Lakes as well as one inland site.

2. Identify temporal trends by comparing PBDE concentrations in archived eggs with concentrations in newly collected eggs, and identify spatial trends by comparing PBDE concentrations in eggs from the Great Lakes sites and the inland site. (Spatial comparisons will be made for new eggs alone, archived eggs alone, and both combined, as appropriate, AND for

only Great Lakes sites using these same combinations of eggs). We hope to collect sufficient data in order to identify temporal trends in PBDE concentrations over the past 10 years at minimum.

3. Compare PBDE concentrations in eggs at the inland site with those at the Great Lakes sites and relate any patterns to historic PCB concentration patterns.

Eggs were successfully collected at one inland Wisconsin site, one site in the Apostle Islands NL, and at four Wisconsin sites in Lake Michigan during May, 2003. All eggs were measured and contents transferred to chemically clean containers. Samples were submitted for chemical analysis by the Wisconsin State Lab of Hygiene (SLOH). Analytical methods were developed and verified by the SLOH and some results have been reported to the investigators. Data analysis is anticipated to occur during the second quarter of 2004.

References:
U.S. Dept. of Health and Human Services. 2002. Agency for toxic substances and disease registry, polybrominated biphenyls and polybrominated diphenyl ethers. Division of Toxicology ToxFAQs; September 2002.

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

Bill Route, NPS Great Lakes I&M Network, Ashland, WI.
Frank Maragi and Gus Smith, PhD, Northland College, Ashland, WI
Laura Kruger and Rolf Peterson, PhD, Michigan Technological University, Houghton, MI

Summary Points:

- 2003 was year one of two year bat inventory
- Sites on Stockton, Devils and Outer Islands and the mainland at Little Sand Bay
- 4 species of bats captured; recordings being analyzed

The Apostle Islands National Lakeshore (APIS) bat inventory is part of a larger scale investigation to determine the occurrence and relative abundance of bats that occur within selected National Parks in the Great Lakes network. The objectives of the APIS bat inventory coincide to those of a two-year, larger-scale investigation for the Great Lakes network that began in 2003.

The objectives of the study are to:

1. Document the occurrence of all bat species believed to be present within the park and establish a collection of catalogued voucher specimens.
2. Determine the summer relative abundance of each species.
3. To the extent possible, locate and map important habitats including: feeding areas; day or seasonal roosts; maternity sites; and hibernacula.

The first year of sampling for the APIS bat survey (conducted during June, July and August of 2003) focused primarily on documenting the occurrences of bat species within the park. Four sites were sampled, including Little Sand Bay, Stockton Island, Devils Island and Outer Island. At each site, bats were mist netted and bat calls were recorded using an ANABAT II detector with storage ZCAIM. Once bats were captured, they were subsequently identified, sexed, weighed, and measured (forearm, hind foot, ear and tragus height). A hair sample was obtained from the interscapular region of each bat for isotopic analysis, and a guano sample was obtained from each bat for genetic fingerprinting.

Bats were netted for a total of 20 net nights with a total capture of 22 bats. Four different species of bats were captured in mist nets, including the little brown bat (Myotis lucifugus), the northern myotis (Myotis septentrionalis), the Eastern red bat (Lasiurus borealis) and the silver-haired bat (Lasionycteris noctivagans). Northern myotis had not been previously documented within the park.

A visual inspection was done of the attic at the Devils Island lighthouse keepers' quarters. A few bats appeared to be roosting under the cedar shingles. A visual inspection was also done at both the Devils Island and Outer Island lighthouses. At either lighthouse, there was no evidence of bat inhabitants. In addition, there was a report that a little brown bat was seen in the basement of the keepers' quarters on Outer Island. No bats were seen, however, there were small amounts of guano in some places.

Bat call recordings are in the process of being analyzed and will hopefully add to the documentation of more species occurrences within the park. Genetic and isotope samples are also in the process of being analyzed. Work for the 2004 sampling season will focus more on means to determine the activity of bats located within the park.

Small Mammal Inventory of the Apostle Islands National Lakeshore

Gus Smith, PhD, Northland College, Ashland, WI
Frank Maragi, Northland College, Ashland, WI

Summary Points:

- Sampling sites on Outer, Stockton and Devils Islands and the mainland at Little Sand Bay
- 7 species of small mammals captured
- 2 species on Devils, 4 on Outer and Stockton, 7 on mainland

In this study, small mammals of the Apostle Islands National Lakeshore were inventoried on three island sites (Outer, Stockton and Devils) and one mainland site. Small mammal trapping was done in conjunction with an inventory of bats at APIS (Kruger, in progress). Trapping locations were in close proximity to bat monitoring stations and base campsites. We targeted a diversity of habitats for trapping in order to pick up as many species as possible. Trapping arrays were located during the first trapping session. Sampling effort was stratified by habitat type and by island whenever possible. Within habitat, traps were placed to maximize the probability of capturing each of the species we thought could be present on the Apostle Islands.

During the twelve-week trapping schedule there were a total of 3288 trap-nights (nights where the trap was open or had a capture). Total trap-nights by site were: Stockton 798, Devil's 796, Little Sand Bay 647, South Outer Island 530, and North Outer Island 517.

A total of seven species of small mammals were captured (Table 1). All seven were captured on the mainland site at Little Sand Bay, and each of the islands had a smaller subset of this community. Devils Island was the most depauperate with only two species while the other three island sites each had four species. North and south Outer Island sites had the same number of species but the south end had greater total abundance due primarily to the number of mice and voles.

Table 1. Number of each small mammal species captured by site, Apostle Islands National Lakeshore, 2003.

Species	Common Name	Stockton Island	Little Sand Bay	Outer Island	Devil's Island
Clethrionomys gaperi	southern red-backed vole	20	14	135	181
Tamiasciurus hudsonicus	red squirrel	14	12	13	0
Peromyscus maniculatus gracilis	woodland deer mouse	10	66	98	0
Sorax cinereus	masked shrew	8	11	32	7
Tamias striatus	eastern chipmunk	0	8	0	0
Zapus hudsonius	meadow jumping mouse	0	6	0	0
Glaucomys sabrinus	northern flying squirrel	0	4	0	0

The largest number of small mammals/trap-night were caught on the south end of Outer Island (0.55/trap-night), followed by Devil's Island (0.40/trap-night), Little Sand Bay (0.30/trap-night),

north end of Outer Island (0.21/trap-night), and Stockton (0.10/trap-night). Southern red-backed vole was the most abundant small mammal on all the islands but not on the mainland. Northern flying squirrel, eastern chipmunk, and meadow jumping mouse were present on the mainland but not found on any of the islands. Among islands, red squirrel and woodland deer mouse were found on Outer and Stockton but not on Devil's Island.

There were several interesting results highlighted in this inventory. First, and perhaps most interesting, is the absence of several species. House mouse, an exotic species from Europe that have colonized just about all sites of human habitation, was not captured at any site. Given the history of European Americans in the Apostle Islands, particularly their transportation of goods to communities and lighthouse keepers, one would think that house mice could have gained access to the cargo and colonized the human inhabited islands.

Also absent, but expected based on reports from homeowners on Madeline Island, was the southern flying squirrel. In fact, southern flying squirrels were absent on the mainland despite capture success on other parts of the Bayfield peninsula (Smith, unpublished data). This species was absent from all trapping sites and perhaps has not advanced to the northern part of the Bayfield Peninsula yet.

White-footed mice also were missing from the mainland and island sites. Jackson (1961) does not report white-footed mice in either Ashland or Bayfield Counties but the lead author considered it a possibility.

The results from Devil's Island are very interesting. Just two small mammal species were present on the island. It appears that southern red-backed voles have taken advantage of this space and filled it (e.g., competitive release). Evidence of this is demonstrated in the small mammal biomass comparisons among islands. Devil's Island has the greatest small mammal biomass; however it also has more trap-nights than either Outer Island or Little Sand Bay and has the second highest trapping success (captures/trap-night).

Stockton Island was sampled intensively (798 trap-nights), but because of the potential for black bear problems with baited traps, we did not use peanut butter for bait. Oatmeal and sunflower seeds were used instead and may have resulted in fewer captures. Stockton Island was the largest and nearest island to the mainland, so island biogeography does not explain the paucity of captures. Perhaps the absence of peanut butter as an attractant and habitats that were less productive could explain this outlier.

The results of this inventory beg for further study of the small mammal communities on the Apostle Islands. It would be interesting to know if there are more shrew species on these islands than the number of species we captured. Although we captured masked shrews, it is possible that we would have caught other species if we used pitfall traps. Also, it would be interesting to know if there are other islands, like Devil's Island, with low richness but high abundance of those species present. Do neighboring islands have the same subset of small mammals as those we captured on Devil's Island? Have woodland deer mice and red squirrels not yet colonized Devil's Island because of its size and distance from the mainland? Are those islands surrounding Devil's Island also lacking these species?

The small mammal communities on the three islands we inventoried are indeed a subset of those on the mainland. Those missing in the islands tend to be those that are inactive in winter (northern flying squirrel) and those that hibernate (eastern chipmunk and meadow jumping mouse). However, meadow jumping mice also live at low densities on the mainland, which might help explain its absence on the islands.

At larger spatial scales, Island Biogeography Theory (MacArthur and Wilson 1967) has been a helpful tool in predicting island mammalian diversity and probability of occurrence through processes of colonization and extinction, however there is current debate about which factors influence the probability of colonization. Whether island occupation depends on island size, distance from the mainland, winter activity, or mainland density, the islands we sampled appear to show some of the variability as predicted. Island by island inventories would be beneficial to track over time. Species currently absent may colonize islands in the future and alter the small mammal communities. Perhaps the small mammal community on Devil's Island is an "early" community and will increase in richness over time, while islands closer to the mainland, like Basswood and Sand, have richer small mammal communities. Tracking these communities over time will not only help the National Park Service manage the resource, but will help science understand the evolution of community dynamics.

References:

Jackson, H. H. T. 1961. Mammals of Wisconsin. Univ. Wisconsin Press, Madison, WI.

MacArthur R.H. and E. O.Wilson. 1967. The theory of island biogeography. Princeton Univ. Press, Princeton, NJ.

Reports Produced:

Smith, Gus. 2003. Small mammal inventory of the Apostle Islands National Lakeshore. Bayfield, WI.

Determine Population Status of Black Bears and Develop Monitoring Protocols

Julie Van Stappen, Apostle Islands NL, Bayfield, WI
Jerry Belant, PhD, Pictured Rocks NL, Munising, MI

Summary Points:

- DNA analysis from hair used to obtain population information
- 26 bears on Stockton Island; 6 on Sand Island
- Black bear population has been relatively stable for 12 years
- Genetic variation shows immigration from mainland

Apostle Islands National Lakeshore is directed through its enabling legislation to allow hunting while, at the same time, maintaining viable populations of native wildlife. There are known reproducing populations of black bears on Stockton and Sand Islands. The Stockton Island population was studied from the early 1980's until 1994; however, similar data for other islands within the lakeshore did not exist. In addition to needing data to determine appropriate harvest levels, population information is necessary to minimize bear-human interactions and to ensure long-term viability of this important resource.

Prior bear studies relied on traditional methods of trapping and radio-collaring bears. Although this can provide excellent information, it is very invasive, requires trapping and anesthetizing the animals, and is very time consuming and expensive. During this study, we wanted to use non-invasive methods to collect hair samples (DNA) to determine the current population status of black bears on Stockton and Sand Islands and the feasibility of using this technique for long-term monitoring.

In 2002, barbed-wire traps were used to obtain hair samples on Stockton (4,069 ha) and Sand (1,193 ha) Islands. These traps collect hair on barbs when a bear walks under the wire. Fish oil on punky logs and anise oil were used to bait the bears into the traps. We used a systematic grid (1.6 x 1.6 km) overlaid on each island to distribute trapping effort. The hair-traps were constructed using 4-barbed, 2 strand wire to create an enclosure around >3 trees with wire about 50 cm above ground (Woods et al. 1999). We placed hair traps in areas believed to maximize black bear captures. We established 15 hair traps on Stockton (1 trap/2.7 km^2) and 5 hair traps on Sand Island (1 trap/2.4 km^2) and checked them for four sessions between 26 June and 13 August 2002. We attempted to remove hair from traps at 2-week intervals. Hair samples also were collected from two nuisance bears on Oak Island. We analyzed 372 hair samples from Stockton and Sand Islands collected on 4 occasions at about 14-day intervals.

Genetic analysis was able to estimate the bear population with a high degree of statistical accuracy, especially on Stockton Island. The bear population estimate was 26 on Stockton and 6 on Sand. The estimated density on Stockton Island was 0.64 bears/km^2 and on Sand Island was 0.50 bears/km^2. The density of bears on Stockton Island was estimated previously at 0.07/km^2 in 1984 and increased to 0.76/km^2 in 1994 before declining to 0.61 bears/km^2 in 1996 (Fleming 1997). Methods between studies are not directly comparable; however, previous and current estimates suggest the population has remained approximately stable for about 12 years.

Genetic variation within both island populations was higher than could be maintained by populations of this size in isolation, suggesting substantial immigration from the mainland population. Genetic assignment testing found enough variation between bear populations on Stockton and Sand Islands to permit identification of natal origins. The two bears from Oak Island were genetically intermediate between Stockton and Sand Islands. Islands within APIS contain small black bear populations of high density that are genetically distinct and apparently influenced by immigration from the mainland population.

This study enabled the park to obtain an accurate population density for both Stockton and Sand Islands, in addition to providing important information about the population (sex ratios, individuals, etc.). The barbed wire traps were very effective at obtaining hair samples. This method did prove feasible for long-term monitoring. Although the analysis is fairly expensive, it is less expensive than trapping and radio-collaring, is non-invasive, and will enable the park to track individual bears over time.

In 2003, an additional 62 hair samples were collected from Oak Island and Mainland. They are currently being analyzed.

Fleming, K. C. 1997. A demographic comparison of a hunted and an unhunted population of black bears in northern Wisconsin. Thesis, University of Wisconsin, Stevens Point, Wisconsin, USA.

Woods, J. G., D. Paetkau, D. Lewis, B. N. McLellan, M. Proctor, and C. Strobeck. 1999. Genetic tagging of free-ranging black and brown bears. Wildlife Society Bulletin 27:616-627.

Reports Produced:

Belant, J., J. Van Stappen, and D. Paetkau. 2004. American black bear population size and genetic diversity at Apostle Islands National Lakeshore. Bayfield, WI.

Determine Distribution and Abundance of Otter, Apostle Islands NL

Thomas C. J. Doolittle, Wildlife Biologist, Bad River Band

Summary Points:

- Otter sign found on Michigan, Outer, Sand and Stockton
- Amount of open water (primarily beaver ponds) has decreased 39% since 1992 on Outer Island
- Occurrence and abundance of otter on Michigan, Outer and Sand related to beaver ponds

In 1999, the park began to work with the Bad River Band on a cooperative project to obtain much needed baseline inventory information on otter. The purpose of the study was to determine the relative abundance of otter and provide methods for population monitoring. Trapping of otter is permitted under the Apostle Islands National Lakeshore enabling legislation, yet very little was known about its distribution or abundance within the park. This study was an expansion of an on-going study within the Bad River Reservation that began in 1997.

River otter (Lutra canadensis) are relatively visible, use a variety of river, wetland and coastal habitats, and usually occur at low densities (Mason and Macdonald, 1986). Otter are common throughout most wetland, lake and river systems throughout northern Wisconsin and the adjacent upper peninsula of Michigan (Wisconsin Department of Natural Resources, 1979-1999, Michigan Department of Natural Resources, 2000). Otter are sensitive to various forms of pollution, and can be used as a bio-sentinel of environmental health. They have been listed as a State of the Great Lakes Ecosystem Conference (SOLEC) indicator.

Otter were first noted on the Apostle Islands on Oak, Stockton and Outer Islands (Jackson, 1961). Unconfirmed records occur from 13 of 22 Apostle Islands (Apostle Islands National Lakeshore, Resource Management Files). Prior to 1850, otter were common in the region and were exploited for their fur prior to the exploitation of beaver (Schorger, 1970).

In the winters of 2000 through 2003, aerial slide and track surveys were done throughout the Apostle Islands National Lakeshore to detect the presence of otter. In 2000-2003, otter sign was observed on Outer, Stockton and Sand Islands. Otter sign was also observed on Michigan Island at a new beaver colony in 2002 and 2003. Aerial surveys were also helpful in showing the relative distribution of otter from its potential mainland source. During the December 25, 2003 aerial survey, otter slide sign was observed throughout the entire Bad River Reservation open water habitats, through the tip of Long Island, to Madeline Island's most northern extent, and into every other Apostle Island that had large lagoons and interior open water bodies (Sand, Outer, Stockton, Michigan).

In addition to aerial surveys, a 22 km transect was walked on Outer Island during the fall of 2001 where otter sign were geo-referenced. Track sign of one adult with two juveniles and a single adult animal were noted. Trapping was conducted during the fall of 2000 and 2001 to obtain hair samples for mercury analysis and to determine home ranges of otter on Outer Island. Unfortunately, no otter were trapped.

The occurrence of otter sign and abundance was related to beaver ponds on Sand, Outer, and Michigan Islands. In all years, islands without interior open water bodies did not have any observed otter slide sign from the air. On Stockton Island, otter sign was observed on old beaver flowages and the tombolo lagoon. Similarly, the Outer and Michigan Island lagoons had otter sign. On Outer Island, open water has declined 39% since 1992. In 1992 and 2003, there were 209 (114.9 acres) and 139 (69.8 acres) open water bodies respectively on Outer Island. The decline of open water was determined from delineations made from 1992 digital ortho-photographs, compared to a set of aerial photographs flown on April 4, 2003. The noted decrease in open water through the 2003 aerial photographs parallels the decrease in active beaver colonies on Outer Island.

Beaver were likely never abundant on the islands prior to 1850, since they were dominated by climax forests of hemlock, white pine and hardwoods. It was not until intensive logging subsided after the 1920 and 1930's, that appropriate beaver habitat became available on the islands. The first sign of beaver inhabiting the Apostle Islands was through 1938 aerial photographic records. However, it wasn't until the 1940's and 1950's that beaver intensively colonized the Apostle Islands. Beaver numbers peaked in the 1970's and 1980's (Anderson et al., 1979; Anderson et al., 1980; Smith and Peterson, 1991) and then declined in the 1990's. Beaver have declined from a high of 30 colonies on Outer Island in 1992 (Smith, 1992) to three colonies in 2003. Beaver have been extirpated on Stockton Island since 1994. In 2003, there were three colonies on Michigan Island and one colony on Sand Island. Beaver flowages are likely richer foraging habitat, especially in winter, than the Lake Superior shoreline. Changes in the abundance of beaver colonies may affect habitat opportunities for otter. Therefore, the monitoring of beaver through aerial and ground surveys, including aerial photographic monitoring of open water bodies is important to conduct in concert with otter surveys.

Heavy metal analysis was conducted from hair samples collected from trapped otter. Since no otter were trapped within the park, all of the data was from the Bad River Reservation. Results of heavy metal analyses conducted on hair of all eight of the otter trapped from the Bad and White River systems indicate elevated total mercury concentrations in comparison to other Wisconsin mercury samples. Reservation-wide sediment and surface water mercury analysis showed non-detectable levels for all surface water and sediment samples (Bad River Natural Resource Files, 1998). One potential known source of mercury in the Bad River Reservation and throughout the Great Lakes may be from sea lamprey (Pteromyzon marinus). It is not known whether or not otter within the lakeshore would have similar mercury levels.

Based on mean otter home ranges in the Bad River Reservation (6 km^2), Outer Island (8,000 acres, 32.4 km^2) may only have enough space for two adult females and young and one male. The estimated spatial carrying capacity on Outer Island is six to eight animals (adults and young). A factor that may increase carrying capacity is that island situations may create tighter home ranges than mainland populations. However, a factor that may decrease carrying capacity is habitat availability; otter populations were apparently concentrated during winter in the lagoon and available beaver pond habitat. Aerial surveys found consistent otter sign near the lagoon, in the island's center, and southwest of the lighthouse. The walking transect found sign of one adult with two juveniles and a single adult animal.

Stockton Island (10,000 acres, 40.5 km^2), though larger than Outer, may be more habitat-limited due to the scarcity of interior beaver ponds and other open water habitats. Similar to Outer Island, Stockton Island's surface area may support seven to ten otter in the winter. In 2001, one family group of three otter were seen near Quarry Bay and slide sign was found in the tombolo lagoon drainage. In all years during winter, otter were located in the few available interior open water habitats.

Sand Island (2,949 acres, 11.9 km^2) and Michigan Island (1,578 acres, 6.4 km^2) had sign of one otter related to new active beaver colonies. Sand and Michigan Islands may be spatially limited. Sand Island is likely to recruit new animals into available habitat due to its close proximity to the mainland. Sand and Michigan Islands could likely support four to six otter.

Monitoring recommendations include:

- Continuation of aerial surveys to record presence and absence of otter sign and beaver colonies every three years. Conduct walking transects to ground-truth aerial surveys. Expand the surveys to include the mainland unit.

- Obtain aerial photography of interior open water bodies to map and measure general habitat changes every 5-10 years.

Additional research questions include determining the levels of mercury in park otter and available prey base, and studying movements and homes ranges on and between islands.

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MONITORING PROJECTS

Water Quality

- **Dissolved Oxygen above the minimums required**
- **pH within optimal ranges**
- **Secchi disc readings at or above lake average**

Water quality in Lake Superior has been found to be high and the National Park Service is mandated, at a minimum, to maintain water quality within Federal and Wisconsin standards. The park has initiated a tiered water quality monitoring program which includes data collection every 1,2, and 5 years. Annual monitoring is completed for bacteria in areas of high public use. Bi-annual monitoring is completed for water quality parameters at 5 lake sites and 3 lagoon sites. This same monitoring is completed every five years at these same sites with the additional water quality parameters of nitrogen, phosphorus, and chlorophyll a, as well as benthos and plankton. Monitoring is completed to detect early indications of degradation from bacteria, water quality problems, nutrient enrichment, or pollution related to boating.

2002 – Water quality monitoring in 2002 consisted of secchi disk readings at 5 Lake Superior monitoring sites and bacteriological testing at high visitor use areas. A total of six secchi disk readings were completed in June, July, and August. Results are in the table below with year 2000 readings at comparable times of year. Secchi disk depths were generally less than they were in 2001 possibly due to windier and cloudier conditions. The Long Island site was an exception showing a depth of 14 feet, which was twice that of the reading recorded in the previous year. This site is much shallower than other sites and often more variable.

Table 2. Water quality sampling sites and Secchi depth readings for 2000 and 2001.

Sampling Site	Secchi Depth (feet)	
	2001	2000 for Comparison
Long Island	14	7
Rocky Island	28	34
Rocky Island	23	37
Stockton Island	31	40
Sand Island	25	30
Outer Island	39	48

Bacteriological sampling was conducted at Stockton Island Presque Isle and at Little Sand Bay in July, August and September. None of the samples exceeded State of Wisconsin standards.

2003 - Water quality monitoring was completed during mid-summer (between June 30 and July 8) and mid-fall (September 9 to 17). Data was collected at 5 Lake Superior sites including 3 sites that were repeated. A Hydrolab was used, which allows for data collection at 1-meter intervals throughout a water column. Information was obtained on water temperature, pH, Dissolved Oxygen (mg/l), specific conductivity (uS/cm), Oxidation Reduction Potential (mV), and turbidity. A secchi disk was also used to obtain an indication of water clarity.

Results for the 3 sites where data collection was repeated are presented in Table 3. Dissolved Oxygen is the volume of oxygen that is found in water. This parameter ranged between 10.25 and 12 early in the year, and between 9.72 and 12.01 late in the year. These values are well above the minimums needed for recreational use (3.0mg/l) and sustaining cold water aquatic life (6.0 mg/l). The pH values obtained ranged between 7.5 and 8.1 early in the season and between 7.55 and 8.7 later in the year. This parameter also showed a decreasing trend at each site over the season which is indicative of increasing biological activity throughout the year. All pH readings were well within the optimal pH ranges for freshwater aquatic life (between 6.5 and 9.0). Secchi disk readings were near or above the average of 27 feet found by the Lakewatch program at all sites with the exception of Long Island where water depth averaged around 16 feet. In 2004, the 5-year water quality data is planned for collection.

Table 3. Water quality parameters for 3 sites at mid-summer and mid-fall. Ranges indicate data collected from 1-meter intervals.

	Long		**Sand**		**Outer**	
	7/1/2003	**10/14/2003**	**6/30/2003**	**10/17/2003**	**7/8/2003**	**10/9/2003**
Conductivity (uS/cm)	94-100	92.6-96.7	94-96	91-100	94-95	91.9-93
Dissolved Oxygen (mg/L)	10.33-11.23	9.72-10.05	11.62-12.62	9.9-10.77	10.25-12	11.39-12.01
Oxygen Reduction Potential (mV)	463-488	482-486	437-449	469-502	456-467	404-409
pH	7.5-8.1	8.63-8.65	7.72-7.93	7.55-8.7	7.95-8.04	8.53-8.6
Secchi (feet)	11	10	26	28	33	30

VEGETATION AND ECOLOGICAL COMMUNITIES

Campsites

- **Monitoring done to detect impacts from use**
- **Limits of Acceptable Change exceeded at 4 sites**
- **Percent bare ground increased at several sites**

There are sixty-five designated campsites within the Lakeshore and wilderness 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 which allows for the determination of area, such as extent of bare or vegetated ground. 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.

In 2002, monitoring was completed at 16 individual campsites and 5 group sites among 8 islands. The average annual increase in area disturbed ranged from lows of 0.8m^2/year on South Twin Island (Sites 2 and 4), to highs of 18.5 m^2/year on Outer Island and 19.6 m^2/year on Oak Island (Site 4) (See Table 1). Three sites exceeded the Limits of Acceptable change including Sites 1 and 4 on Oak, and the site on Outer Island. Site 1 on Oak Island was 273 m^2 in 2002, which is an increase from 210 m^2 in 1999. The amount of bare ground also increased by 30 m^2 during this same timeframe. The information in Table 1 for this site indicates that small Average Annual (+1.4 m^2/year) and Net Increases (+18 m^2) do not always mean that a site has not exceeded the LAC. Site 4 on Oak increased from 175 to 301 m^2, and the data also indicate an increase of 28 m^2 of bare ground. The Outer Island site increased in size from 192 to 388 m^2 between 1999 and 2002 with a coincidental increase in bare ground of 122 m^2. In addition, the length of disturbed shoreline was 95 meters during this monitoring season, up 100% from 1999. These changes on Outer are the result of a storm that occurred in 2002 that reduced a small berm between the beach and the campsite, and washed a large amount of sand into the site.

Table 4. Campsites monitored (2002), average annual increase or decrease (m^2/yr) of area disturbed, change in total area (m^2) disturbed since monitoring was initiated (1990 unless otherwise stated), and if the Limits of Acceptable Change have been exceeded.

Island and Year Monitoring Began	Sites Monitored	Average Annual Increase/Decrease of Area Disturbed (m2/yr)	Net Total Area Increase/Decrease Over Time (m^2)	LAC Exceeded (Y or N)
Devils	1	+6.5	+78	N
Michigan	1	+2.3	+27	N
Oak (1989)	1	**+1.4**	+18	**Y**
	2	-31.3	-407	N
	3	+8.4	+109	N
	4	**+19.6**	+255	**Y**
	6	+8.4	+109	N
	A	+11.2	+146	N
	B	-65.1	-846	N
Otter	1	+2.8	+34	N
Outer	1	**+18.5**	+222	**Y**
South Twin	1	+0.9	+11	N
	2	+0.8	+9	N
	3	+2.8	+33	N
	4	+0.8	+9	N
Stockton (1989)	A	-2.6	-34	N
	B[1]	-32.8	-427	N
	C	-36.7	-477	N
York (1991)	1	+4.9	+54	N
	2	+2.2	+25	N
	3	+1.4	+15	N

1 Stockton Group Site B was relocated in 1993 and changed from a standard group sited to a small group site.

Even though the majority of the sites do not exceed the Limits of Acceptable Change, some campsites are showing other indications of impact. Bare ground has increased between 47 and 83 percent since monitoring began at sites on Devils, Oak, South Twin, and Stockton Islands (see Table 2). Changes in percent bare ground at the remaining 10 sites monitored in 2002 range between a decrease of 7% (Stockton – Group Site C) to an increase of 28% (South Twin – Site 3). The amount of bare ground is important to review because it may be more difficult and time consuming to restore bare ground than partially vegetated ground.

Table 5. Percent increase in bare ground at selected sites since monitoring was initiated.

Site Name	Year Monitoring Began	Percent Bare Ground Increase
Devils	1990	47
Oak – 2	1989	64
South Twin – Site 1	1990	55
South Twin – Site 4	1990	83
Stockton – Group A	1989	81

In 2003, 20 campsites were monitored including 17 individual and 3 Group Sites among 6 islands (see Table 3). The average annual change ranged between a decrease of 11.3 m^2/year (Ironwood) to an increase of 15.6 m^2/year (Cat). The majority of sites showed annual increases below 5.0 m^2/year. The net change in area ranges between a decrease of 102 m^2 (Ironwood) to

an increase of 72 m^2 (Basswood – Site 2). The Limits of Acceptable Change were exceeded only at Basswood – Group Site A which has increased by 61 m^2 since 1990.

Table 6. Campsites monitored (2003), average annual increase or decrease (m^2/yr) of area disturbed, change in total area (m^2) disturbed since monitoring was initiated (1990 unless otherwise stated), and if the Limits of Acceptable Change have been exceeded.

Island and Year Monitoring Began	Sites Monitored	Average Annual Increase/Decrease (m^2/yr)	Net Total Area Increase/Decrease Over Time (m^2)	LAC Exceeded (Y or N)
Basswood	1	+3.5	+46	N
	2	+5.5	+72	N
	3	+3.2	+41	N
	4	+3.8	+49	N
	5	+1.0	+13	N
	6	+1.8	+23	N
	A	+4.7	**+61**	**Y**
Cat	1	+15.6	+72	N
Ironwood	1	-11.3	-102	N
Manitou	1	+4.5	+58	N
Rocky	1	-0.8	-10	N
	2	+0.2	+3	N
	3	+3.5	+45	N
	4	-5.8	-75	N
	5	-0.8	-10	N
	6,7	-6.5	-85	N
Sand	1,2	4.2	-55	N
1997 - 3	3	+9.8	+59	N
	A	+7.6	+99	N
1994 - B	B	-5.0	-65	N

Bare ground increases have ranged between 41-69% at 4 sites on Basswood and one on Rocky since monitoring began in 1990 (See Table 4). Changes in bare ground at the remaining 15 sites that were monitored have ranged between a decrease of 49% (Rocky – Site 4) to an increase of 35% (Rocky – Site 6,7).

Table 7. Percent increase in bare ground at selected sites since monitoring was initiated in 1990.

Site Name	Percent Bare Ground Increase
Basswood – Site 2	67
Basswood – Site 3	51
Basswood – Site 4	43
Basswood – Site 6	69
Rocky – Site 3	41

Recommendations include considering the incorporation of percent bare ground as part of the LAC, and placing those sites that exceeded LAC on a schedule for restoration work. In addition, it is recommended that non-designated sites be identified and added to the monitoring schedule.

Rare Plants

- **Goal – monitor status of Special Concern, Threatened, and Endangered plant populations**
- **2002 – beautiful sedge and butterwort populations at Devil's Island monitored**
- **2003 - satiny willow located on Otter, and butterwort populations monitored on Devil's Island.**

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 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: calypso orchid, 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 2002 monitoring was completed on Devil's Island near the "Spirit Caves" in late June. The beautiful sedge population was monitored along the cliff tops resulting in a total of 441 fruiting stems counted among seven colonies. In addition butterwort was monitored in the "Spirit Caves" region by foot. A total of 382 plants were counted among six locations.

In 2003, monitoring was completed for butterwort on Devil's Island and satiny willow on Otter Island. Four new plots were established and monitored for butterwort resulting in a range of 19 to 170 plants, an average of 85 plants, and a total of 338 plants. One satiny willow clump was present on Otter Island this year that appeared to have some insect damage. In 2000, satiny willow could not be located, and in 2001 sprouting was noted.

Sandscapes

- **Rare, high quality sandscapes with vegetation sensitive to trampling**
- **High visitor use**
- **Decreasing percent vegetation litter over time – 3 sites**
- **Increasing percent bare soil over time – all 8 sites**

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 Lakeshore 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 Lakeshore 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. Monitoring is conducted in the dune and interdunal zones using the vegetative sampling step-point method. It is designed to obtain baseline information, monitor change over time and determine the impact of visitor use/trampling. Since 1995, sandscape mapping has been conducted 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.

In 2002, sandscapes on Cat, Michigan, and Outer Islands, as well as North Beach on Stockton Island were mapped and monitored. Sandscape data collected with GPS units included perimeters of the vegetated and non-vegetated beach areas as well as any trails that traversed the sandspits. Base maps were then developed with area acreage.

Table 8. Sandscape monitoring data including percent change of litter, bare soil, and native and invasive species between 1990 and 2002.

Island and Timeframe	Monitoring Frequency (years)	Vegetative Litter % change + or -	Bare Soil % change + or -	Native Species Basal Cover % Change + or –	Invasive Species Basal Cover % Change + or –	Invasive Species Composition % Change + or –
Cat (1992 – 2002)	5	-14	+26	-12	-2	-9
Michigan (1993 – 2002)	3	+12	+6	-20	+ <1	+ <1
Outer (1990-2002)	3	+5	+16	-22	- <1	- <1
Stockton – North Beach (1993-2002)	3	-7	+6	+1	- <1	+ <1

The data indicates percent change in vegetative litter that ranges between decreases of 14% on Cat to an increase of 12 percent. The percent bare soil however, showed increases for all sandscapes that ranged between 6 to 26 percent. It is interesting to note that the decreases in litter for Cat and Stockton Islands correspond to the largest increases in bare soil. On all of these islands the percent bare ground increased and litter decreased from 1999 to 2002. This could be

due to a northeastern storm that occurred during that timeframe that could have impacted these sandscapes. This storm washed sand over the sandscape and campground on Outer Island.

Basal cover for native plant species showed fairly large decreases over time with the exception of Stockton Island that indicated a slight increase. Cat islands basal cover decreased by 10% within the last 5 years which could be due to a campground being installed adjacent to the sandspit in 1990. Changes in basal cover of exotic species have been small for all sites.

In 2003, four sandscapes including those on Ironwood, Raspberry, Rocky, and South Twin Islands were monitored with standard methods, and Stockton- Julian By and York Islands were monitored with modified methods due to the very large and very small sizes of the latter two sandscapes, respectively. Stockton Island – Julian Bay was monitored but not yet entered into database to date. Sandscapes were mapped using GPS and base maps for all islands with the exception of Stockton-Julian Bay.

Table 9. Sandscape monitoring data including percent change of litter, bare soil, and native and invasive species between 1993 and 2003.

Island and Timeframe	Monitoring Frequency (years)	Vegetative Litter % change + or -	Bare Soil % change + or -	Native Species Basal Cover % Change + or –	Invasive Species Basal Cover % Change + or –	Invasive Species Composition % Change + or –
Ironwood (1993 – 2003)	5	-13	+34	-21	-12	-46
Raspberry (1989-2003)	2	+21	+2	-23	0	-<1
Rocky	3	+23	+8	-31	-2	+ < 1
South Twin	3	+6	+4	-10	-5	-13

The percent change in vegetative litter ranges between a decrease of 13% on Ironwood to an increase of 23% on Rocky Island. Bare soil increases have been small on all islands but Ironwood which shows a 34% increase. The percent basal cover of non-invasive species has decreased on all 4 islands with the largest decline on Rocky Island. Basal cover of invasive species has also shown decreases over time but they are smaller in nature than those for the native species. The percent composition of invasive species showed a strong decline on Ironwood Island and a lesser decline on South Twin.

The area of the sandscape on York was determined with GPS and the condition monitored by visual inspection. This year the total area surveyed was .91 acres, mostly in the dune area. In 1992 & 1997 the total area surveyed was 1.5 acres which included around .5 acres of internal area. No trails were noticeable in 2003 and vegetation composition was strongly dominated by beach pea. Canada yew was noted growing directly in sand.

EXOTIC/INVASIVE SPECIES

Hawkweed

- **Exotic, invasive species that threatens sandscapes and cultural openings**
- **Hand-pulling treatment found most effective**

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 lakeshore, 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 initiated. Two monitoring plots were established to compare the effectiveness of chemical treatment versus manual hand-pulling. The plots were treated in July and then monitored in September. A total of 19 plants were found in the hand-pulled plot and 123 plants in the treated plot. In 2003, the plots were monitored on July 8 which resulted in 103 plants in the manual plot and 1,735 plants in the chemically treated plot. On July 9th plants were hand pulled in the manual control plot only. The number of plants showed a 5-fold increase in the hand-pulled plots between the two years compared to a 14-fold increase in the treated plots in the same timeframe. Chemical treatment does not appear to be as effective and will not be continued on Oak Island for this species. Monitoring will continue in the future on the hand-pulled plot but the chemical plot will not be maintained.

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'**
  2002 – 800-1,000 larvae and 200 beetles released
  2003 – approximately 20,000 beetles released
- **Long Island tip 2003 — more intensive survey revealed greater area of infestation - 571 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. This herbicide is also used on any plants found elsewhere in the Lakeshore during annual surveys.

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).

Table 10. The number of beetles released on Long Island and results of monitoring.

Year	Number Beetles Released	Results of Monitoring
1997	4,000	
1998	4,000	Little insect feeding damage; 1 beetle observed
1999	3,000	Insect feeding damage low but spread out over a 100-foot radius from release site.
2000	5,000	Increased feeding damage & area impacted – 200-foot radius.
2001	5,000	Increased feeding damage
2002	800-1,000 Larvae 200 Beetles	Increased feeding damage
2003	Appx. 20,000	Increased feeding damage

A total of 10 plots have been established on Long Island to monitor the effects of beetles on purple loosestrife; 5 plots in 1997, 4 in 1998, and 1 in 1999. Monitoring in the 5 1997 plots indicates that the number of purple loosestrife stems has decreased in 2 plots since 1997 with changes ranging between 28-62%, and averaging 45 percent. The three plots showing increases ranged between 34-74% and averaged 57 percent. Monitoring since 1999 in the 5 remaining plots indicates that 4 of these plots have shown decreases ranging between 27-79%, and averaging 64 percent. One plot showed a 44 percent increase in the number of stems between 1999 and 2003.

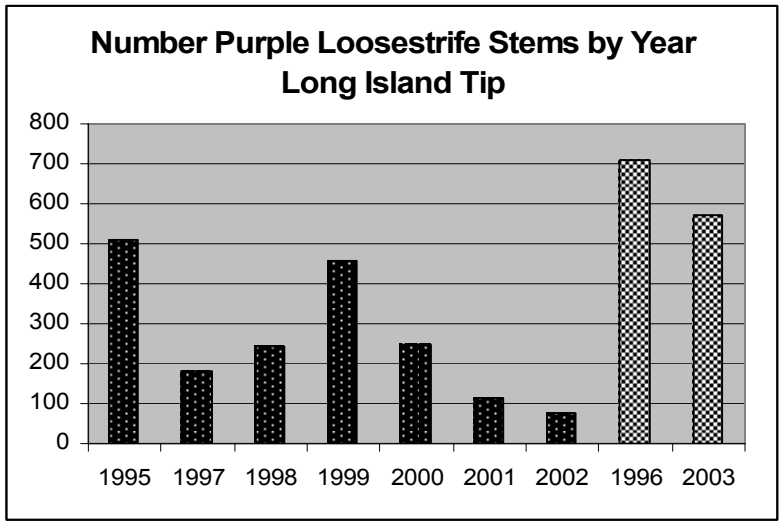
Table 11. The number of purple loosestrife stems at the time of plot establishment and in 2003, as well as the percent change of stems over time.

Plot Number	1997	1999	2003	Percent Change*
97-1	39		104	63
97-2	83		60	**-28**
97-3	52		79	34
97-4	10		38	74
97-5	93		35	**-62**
97-6		33	59	44
98-1		37	8	**-78**
98-2		33	24	**-27**
98-3		19	4	**-79**
98-4		32	9	**-72**

*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 and 2003 surveys extended inland for greater distances and resulted in higher numbers of purple loosestrife stems as can be seen from Chart 1. The years are grouped by area of similar survey size. Both groups of data indicate a general overall decreasing trend in the number of stems.

Chart 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.

Other Islands

A small patch of purple loosestrife was found and sprayed near the Michigan Island lagoon in 2000 and 2001. This lagoon, as well as ones on Stockton Island (Julian Bay) and Outer Island were checked in 2003 but no plants were found.

Spotted Knapweed

- **Exotic, invasive species that threatens sandscapes and cultural openings**
- **New sites located at Little Sand Bay and Long Island**
- **Chemical treatment found to be effective at control**

Spotted Knapweed is native to Europe, but it has thoroughly established itself in North America. It grows in sandy and stony areas, dry meadows, and along roadsides; it will tolerate both dry and wet conditions. It is an aggressive weed that easily colonizes disturbed areas and replaces native vegetation. The biggest threat in the Lakeshore is to beaches, sand spits, and other sandy or stony areas. These beach and near-beach areas contain some of the most sensitive plant communities present in the Lakeshore.

In 2002, an annual survey for spotted knapweed found plants in three locations within the Apostle Islands. As in previous years, spotted knapweed was found at Quarry Bay on Stockton Island in the field located at the end of the dock (2 large clumps and 2 small clumps) and near the drinking fountain by the group campsite (2 medium clumps and a few individual stems). The plants were cut and treated with the herbicide Round-up. Two plants were located at Little Sand Bay in the same location as previous years, near the town of Russell boat launch ramp. There were several new locations of plants found in the LSB and Town of Russell campground and roadside area. Specific locations were: the southern edge of Shaft Road from the south entrance to the Town of Russell campground east to the stop sign (5 garbage bags full); the intersection of Little Sand Bay Road and Shaft Road at north end of the culvert; across the road (north-north west side), just past the town of Russell sign; and the t-intersection between the parking lot and the visitor center. The majority of plants at this location were both cut and treated with Round-up or carefully pulled. Spotted knapweed was located for the first time on the southern side of Long Island approximately half way between the boardwalk and the sand cut where the plants were cut and treated with Rodeo.

In 2003 an annual survey for Spotted Knapweed (*Centaurea maculosa*) was conducted at the end of June and beginning of July. Eight plants were found at Stockton Island Quarry Bay near the dock, drinking fountain, and along the trail towards the campsites. These numbers are down from an approximate total of 14 plants in 2002 and 19 in 2001. At Little Sand Bay, two plants were found near the Town of Russell boat launch and the area along the southern edge of Shaft Road did not seem to be as dense and required less time for treatment. Other areas at Little Sand Bay were surveyed and no plants were found. There were no plants found on Long Island. Any plants that were located during surveys were clipped and then sprayed with Roundup. GPS locations of plant locations were taken at the end of August using both the Garmin and the Trimble units.

Overall, it appears that chemical treatment of spotted knapweed is effective at controlling the spread of this species. It is recommended that monitoring continue in identified areas as well as in new locations due to the long seed viability (7-8 years) of this species. In addition, maps of locations should be created and updated as necessary.

Gypsy Moths

- **Exotic, invasive species that threatens hardwood forests**
- **Significant increase in number of moths trapped over past 3 years**
- **Cooperators include the U.S. Fish & Wildlife 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. 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 year 2000, a total of 29 gypsy moths were caught, and in 2001 a total of 75 were caught, a dramatic 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 trapping continued to increase in 2002 with 286 moths caught in three traps. The results of trapping between 1997-2003 are in Table 12 below.

In 2003, 33 traps were set on 6 islands including 13 at Basswood, 2 at Long, 1 at Oak, 1 at Sand, 4 at Stockton-Presque Island, and 12 at Stockton-Quarry Bay. A total of 208 moths were trapped at Basswood, 37 at Stockton – Presque Isle, and 453 at Stockton – Quarry Bay. These islands have shown significant increases in infestation over the past 3 years. Moths were also trapped at Long and Oak Islands for the first time since trapping began.

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 Stockton Island to determine whether the gypsy moth infestation is located or widespread. The park will continue to cooperate with the U.S. Fish & Wildlife Service and Wildlife Service and the Agricultural Resource Management Division of the Wisconsin Department of Agriculture in the management of this species.

Table 12. Locations and numbers of Gypsy moth traps set, and the number of moths caught at each location.

Islands	1997		1998		1999		2000		2001		2002		2003	
	# 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
Long	2	0	2	0	2	0	2	0	2	0	2	0	3	3
Mainland	0	0	3	0	0	0	1	0	3	0	3	0	0	0
Oak	0	0	1	0	1	0	1	0	1	0	1	0	1	3
Sand	1	1	6	0	3	2	7	0	6	0	1	0	1	0
Stockton Presque Isle	1	0	1	0	1	0	1	0	1	1	4 (3)	10	4 (3)	37
Stockton Quarry Bay	1	0	1	0	1	1	5	26	5	53	11	177	13 (12)	453
Total	5	1	15	0	9	5	22	29	23	75	33 (32)	286	35 (33)	704

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

WILDLIFE SPECIES

Birds

Breeding Bird Survey

- **2002 – 1,176 birds among 81 species**
- **2003 – 1,227 birds among 84 species**
- **Six species showing decreasing regional trends are in the top 26 birds on park surveys between 1995-2003.**

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 Lakeshore 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 (Van Stappen 1990, 1991, 1992, 1995). 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 and the mainland unit are surveyed.

Surveys were done between June 7 and June 27 in 2002, and between June 9 and the first of July in 2003. A total of 1,227 birds were recorded in 2003 (see Table 13) which reflects the highest number between 1995 and 2003. The total number of species was 81 in 2002 and only slightly higher in 2003. The average number of birds per point was very similar for most islands between the two years with the exception of Sand Island.

Table 13. The number of species, total number of birds, and average number of birds per point by island for 2002 and 2003.

Island	# Points	Number of Species		Total Number Birds		Average # Birds/Point	
		2002	2003	2002	2003	2002	2003
Devils	8	29	30	95	95	12	12
Long	12	29	31	130	129	11	11
Mainland	10	36	38	97	107	10	11
Oak	13	32	23	144	118	11	9
Outer	20	40	43	173	204	9	10
Raspberry	9	29	29	110	126	12	14
Sand	12	40	22	215	129	18	11
Stockton	22	39	44	212	249	10	11
Total (10 transects)	106	81	84	1,176	1,227	12	12

As previously mentioned, surveys are completed in 14 different habitat types which are listed below in table 14 along with the number of points in each habitat type. The total number of species per habitat type ranged between 9 and 37 in 2002, and between 17 and 39 in 2003 for all community types. The largest differences between the two years were in boreal forest, beaver pond, clearing, and northern hardwoods mixed forest habitat types. The total numbers of birds per habitat ranged between 11 and 179 in 2002, and between 23 and 172 in 2003. The largest differences between the two years for this parameter were in the aspen/birch, boreal, northern

hardwoods – mixed hardwoods, oak forest, and pine forest community types. The average number of birds per point ranged between 7 and 16 for 2002, and 9 and 23 in 2003 with the largest differences between the two years at the beaver pond and oak forest community types.

Table 14. The number of species, total number of birds, and average number of birds per point by habitat for 2002 and 2003.

Habitat	# Points	Number of Species		Total Number Birds		Average # Birds/Point	
		2002	2003	2002	2003	2002	2003
Aspen/Birch	9	35	32	116	96	13	11
Bog	2	18	21	27	33	14	17
Boreal forest	12	27	34	150	132	13	11
Beaver pond	1	9	17	11	23	11	23
Conifer	2	21	17	32	29	16	15
Clearing	8	31	22	87	79	11	10
Northern hardwoods-hemlock	8	17	18	53	69	7	9
Northern hardwoods-mixed forest	8	36	29	124	92	16	12
Northern hardwoods-sugar maple	18	34	29	179	172	10	10
Oak forest	4	17	21	29	49	6	12
Old-growth conifer	7	24	25	86	100	12	14
Old-growth hemlock	5	20	22	48	49	10	10
Pine forest	15	37	39	159	172	11	11
Sandscape-shrub	7	30	31	75	62	11	9

The ten most common species are in table 15, and are presented by year for 2002 and 2003, and also for the timeframe between 1995 and 2003 for comparison purposes. The ovenbird, red-eyed vireo, and black-throated green warbler are consistently found in the top three positions with the highest percent abundance amounts. Other species consistently found in the 10 most abundant include the Nashville warbler, American redstart, and yellow-rumped warbler.

Table 15. The ten most common species and percent abundance in 2002 and 2003 compared to the average between 1995 and 2003.

2002		2003		Most Common Species between 1995-2003	Mean Percent Abundance
Species	Percent Abundance	Species	Percent Abundance		
Ovenbird	17.7	Ovenbird	14.9	Ovenbird	20.1
Red-eyed vireo	14.9	Red-eyed vireo	14.4	Red-eyed vireo	19.7
Black-throated Green Warbler	13.6	Black-throated green warbler	6.7	Black-throated Green Warbler	14.3
Nashville warbler	9.7	Nashville warbler	5.2	American redstart	10.2
American redstart	6.5	American redstart	4.2	Nashville warbler	9.2
Yellow-rumped warbler	5.6	Hermit thrush	4.2	Song sparrow	6.2
Blue jay	5.0	Yellow-rumped warbler	3.5	Winter wren	6.1
Magnolia warbler	4.1	Veery	3.1	Cedar waxwing	5.9
Song Sparrow	4.0	Black-capped chickadee	2.3	Yellow-rumped warbler	5.7
Northern parula	3.9	American Robin	2.2	American crow	5.0

The park has tracked 5 key species including the Canada warbler, chestnut-sided warbler, eastern wood pewee, Nashville warbler, and the veery. The number of Canada warblers heard along transects in 2002 is within the range for park surveys. However, no Canada warblers were heard in 2003 and this species has showed decreasing trends on Chippewa, Chequamegon, and Superior National Forests between 1991 and 2001. The number of chestnut-sided warblers in 2002 and 2003 fall within the mean for the park between 1995 and 2001, and also indicate an increasing trend consistent with the regional trend. There were more eastern wood pewee's heard in 2003 surveys than in any year between 1995 and 2003. However, this species showed a decreasing trend on the 3 national forests. More Nashville warblers were heard on park surveys than any other key species in all time frames. Twice as many veerys were heard in 2003 compared to the average.

Table 16. Trends for 5 key species between 1995-2001, 2002, and 2003

Species	Mean Number 1995-2001	2002	2003	Regional Trend*
Canada warbler	6	8	0	Decreasing on 3 national forests
Chestnut-sided warbler	16	18	22	Increasing on Chequamegon and Chippewa national forests
Eastern wood pewee	5	5	10	Decreasing on 3 national forests
Nashville warbler	78	78	60	Decreasing on Chequamegon NF; no significant regional trends
Veery	18	18	36	No significant regional trends

From Lind et. al 2001.

Six species including the ovenbird, song sparrow, winter wren, hermit thrush, common yellowthroat, and black-and-white warbler have shown decreasing regional trends on the Chequamegon, Chippewa, and Superior National Forests (Lind et. al 2001). The 15 most

abundant species for each year between 1995 and 2003 were combined into a single list. Because several species repeatedly show up in this category the compilation results in a total of 26 most common species. The six species mentioned above as declining regionally are among the top most common 26 species for the Apostle Islands. Indeed, the ovenbird is the most abundant, the song sparrow, winter wren, and hermit thrush are in 10th, 11th, and 12th positions respectively, the common yellowthroat in 21st, and the black-and-white warbler in 25th position. This information indicates the significance of the park as a location for breeding birds in the Great Lakes States.

The 2004 survey will be the 15th year of monitoring. Breeding bird data from the last 15 years is scheduled to be analyzed and compiled into a 15-year report next year.

Migratory Birds

- **Outer Island sandspit – significant migratory stopover point**
- **Monitoring completed with 13 volunteers**
- **Approximately 84,240 birds counted during 114 hours of effort in 2003**

The Apostle Islands National Lakeshore is designated as one of 500 Important Bird Areas in the United States by the American Bird Conservancy, a group of several private and governmental agencies working towards bird conservation. To be eligible for such a designation a location must meet at least one of 4 criteria: sites with special concern, threatened, or endangered species; sites that provide habitat for species with restricted ranges; sites with high populations of species on the Partners in Flight "Watch List"; or sites with large concentrations of migratory birds.

Migratory bird surveys were initiated primarily to get an estimate of the numbers of birds using the Apostles as a migration route and to secondarily understand the major bird group composition. Outer Island was identified as a concentration point for birds migrating south (Harris 1980). Surveys have been completed on Outer Island in 1990, 1991, 1993, 1998, and in 2003. Early surveys indicated that significant numbers of passerines (perching birds) and falcons used Outer Island during fall migration. Total numbers of birds recorded has ranged from 39,435 to a high of 141,442 in 1990 (see Table 17). In 2003, surveys were completed by volunteers on 26 mornings between September 3rd and the second of October. Results indicated the second highest number recorded over time at 84,240 birds, and 96% of birds recorded were passerines (see Table 17). A comparison of the amount of effort (hours) across the years shows that 1990 was a unique year as the number of birds/effort was more than twice the highest amount of any other year. This information also indicates that number of birds/effort in 2003 is within the range of all other years.

Table17. Total Numbers of birds by Bird Group in surveys completed at Outer Island between 1990 and 2003.

Bird Group	**Total Numbers of Birds by Bird Group**									
	1990		**1991**		**1993**		**1998**		**2003**	
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
Non-passerine land birds	**--**	--	**--**	--	**--**	--	**371**	1.1	**1,367**	1.6
Passerines	**138,584**	98.0	**37,804**	95.9	**49,534**	94.6	**31,250**	93.3	**80,592**	95.7
Raptors	**352**	0.3	**272**	0.7	**365**	0.7	**283**	0.8	**416**	0.5
Seabirds	**1,027**	0.7	**876**	2.2	**1,234**	2.4	**795**	2.3	**1,187**	1.4
Shorebirds	**164**	0.1	**65**	0.1	**100**	0.2	**16**	0.05	**54**	0.06
Waterfowl	**1,305**	0.9	**418**	1.0	**1,084**	2.0	**783**	2.3	**622**	0.7
Misc.	**10**	0.0	**0**	0.0	**9**	0.02	**1**	<0.01	**2**	<0.01
Total	**141,442**		**39,435**		**52,326**		**33,499**		**84,240**	
Hours of Effort	**55.4**		**45**		**93**		**52.2**		**114**	
# Birds/ Effort	**2,553**		**876**		**564**		**642**		**739**	

The total number of birds are grouped by the number of species found for each major bird group in Table 18. Each bird group includes a category for "unknown" species. The number of

passerine species has consistently been high when compared to other bird groups but has ranged widely from 20 to 92 species. The total number of species has also ranged widely over time from 48 to a high of 133 species in 1991. The variability in these two numbers is due, at least in part, to observer experience level. The 2003 surveys were at the lower end of the range for both numbers of passerines and total species.

Table18. Number of species by Bird Group in surveys completed at Outer Island between 1990 and 2003.

Bird Group	**Number of Species by Bird Group**				
	1990	**1991**	**1993**	**1998**	**2003**
Non-passerine land birds	--	--	--	3	10
Passerines	68	92	49	20	29
Raptors	12	13	12	10	13
Seabirds	3	4	5	5	3
Shorebirds	7	9	6	4	5
Waterfowl	14	15	8	5	8
Miscellaneous	3	0	1	1	1
Total	**107**	**133**	**81**	**48**	**69**

The ten most common species in 2003 in order of decreasing abundance were the cedar waxwing, northern flicker, blue jay, Canada goose, common nighthawk, Merlin, American robin, American crow, common merganser, with the bald eagle and double-crested cormorant tied in the last position.

Bald Eagle

- **Threatened species**
- **2002 – 3 fledged; all banded**
- **2003 – 6 fledged; nest initiated on Bear Island**

During the 1970's, eagles were absent from the Apostle Islands 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.

Although eagle populations have rebounded in most of Wisconsin, productivity is relatively poor on the Apostle Islands. A research project conducted from 1992-1994 found that the most likely cause of lower bald eagle productivity along the Lake Superior shoreline is low food availability. Other factors include: lowered nest attentiveness; higher predation rates of young; harsh spring weather or extensive ice cover; and somewhat elevated levels of PCB and DDT. The bald eagle is currently being considered as a sentinel species for Great Lakes Water Quality.

In 2002, 6 nests were active early in the season on Eagle, Long, Michigan, North Twin, Rocky, and Sand Islands. However, only three eagles fledged from 2 nests on Michigan and Rocky Islands which is below the long term average of 4 birds fledged per year. Young from the nests were banded and blood drawn for toxic analysis by the Wisconsin DNR in 2002. In 2003, 8 nests were active on Bear, Madeline, Michigan, Rocky, Sand, and York Islands as well as the Mainland Unit. Nesting has not been recorded on Bear Island since monitoring began in 1980. Unfortunately this nest was not successful. There were 2 nests with 2 young each (Madeline Island, Mainland) that were successful, along with 2 nests with one young each (Rocky, Sand) for a total of 6 young fledged this year. This is within the range of 0-13 fledglings per year that has occurred since monitoring began in 1980. This Wisconsin DNR has discontinued banding at the present time.

Table 19. Bald Eagle nesting locations and success data between 1980-2003.

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

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.

Table 20 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 (nests with at least one chick fledged) over time. Nesting has occurred on Michigan Island 16 times during 1981-2003 but only 38% of nests have been successful. North Twin and York show similar relationships of higher levels of nesting over time corresponding to lower percent success rates. In contrast,

nesting has occurred 13 times on Long Island with a 77% success rate over a shorter time span of 1989 to 2002. Nesting was successful 78% of the time on Outer Island but unfortunately nesting has not reoccurred there since 1994. Nesting has not been detected on Cat, Ironwood, Otter, Manitou, South Twin, or Stockton Islands, all of which have an interior location in the archipelago, since monitoring began.

Table 20. Summary of eagle nesting by island/unit between 1980-2003.

Island/Unit	Time Period*	No. Times Nesting Occurred	Percent Success
Michigan	1981-03	16	38
York	1982-03	15	47
North Twin	1982-02	15	40
Long	1989-02	13	77
Devil's	1986-01	11	64
Basswood	1980-03	10	50
Madeline	1987-00	10	60
Oak	1984-01	9	44
Outer	1982-94	9	78
Mainland	1996-03	6	83
Rocky	1987-03	5	80
Eagle	1997-02	4	75
Sand	2000-03	4	50
Bear	1995	1	100
Hermit	2003	1	100

*Not always consecutive years.

Piping Plover

- **Endangered species**
- **2002 - 4 eggs laid; all predated**
- **2003 – 3 birds displaying breeding behavior – no nest**
- **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 an exclosure 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 Lakeshore 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 Michigan, 19 chicks fledged in the Upper Peninsula and 69 fledged in the Lower Peninsula.

Ruffed Grouse

- **Game species**
- **5 birds in 2002 and in 2003**

The ruffed grouse is a game bird in the State of Wisconsin that also resides within the lakeshore. 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 2003 indicate that the number of birds recorded on the Mainland route has ranged between 4 and 18 birds per year (see Table 21). In 2002 and 2003, 5 birds were heard during surveys which are well below the average of 10 birds per year.

The number of birds per stop ranged between 0.4 and 1.8 along the auto survey route between 1990 and 2003, and the average was 0.9 birds/stop. The Park has also completed walking surveys of various lengths several times between 1989 and 2003 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 21. Ruffed grouse auto surveys (1990-2003) 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		

Woodcock

- **Game species**
- **2002 – 0 birds; 2003 – 6 birds**
- **Regional population trend – decreasing**

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 Lakeshore 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 2003 are presented in Table 22. 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 in the more recent time between 1995 and 2003 the range has been zero to 6. This slight decreasing trend is consistent with a similar regional trend for this species. In 2002, no woodcock were detected during the survey, while 6 were heard in 2003. It is possible that the late date of the survey in 2002 accounts for the lack of birds in that year.

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 picked up on surveys. In comparison, sky conditions were either clear or ¼ overcast during 1995 – 2003 surveys. It is also interesting to note that 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 22. Summary of annual woodcock surveys (1989-2003) 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
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**
- **123 observations on Oak Island and 83 on Stockton Island**
- **More yearlings observed on Oak Island than on Stockton**

2003

As a follow-up to research in 2002, 55 hair samples were obtained in 2003 from snares at 3 locations on Oak Island (46 samples), 3 locations on the Mainland Unit (8 samples), and 1 location on Red Cliff tribal lands (1 sample). Hair samples were also obtained from 3 trapped bears on Oak Island and one trapped bear at Stockton Island – Quarry Bay. Results of sampling have not yet been received at this point in time.

Bear-Human Interactions

A database to track bear observations was developed prior to the 2003 field season. This was the first year an attempt was made to systematically track all observations. Staff, volunteers, and visitors were highly encouraged to report all sightings. A total of 221 observations were made between June 7th and September 6th. Observations were made on 69 days of this 85 day period which averages 3.2 records per day of observation. 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.

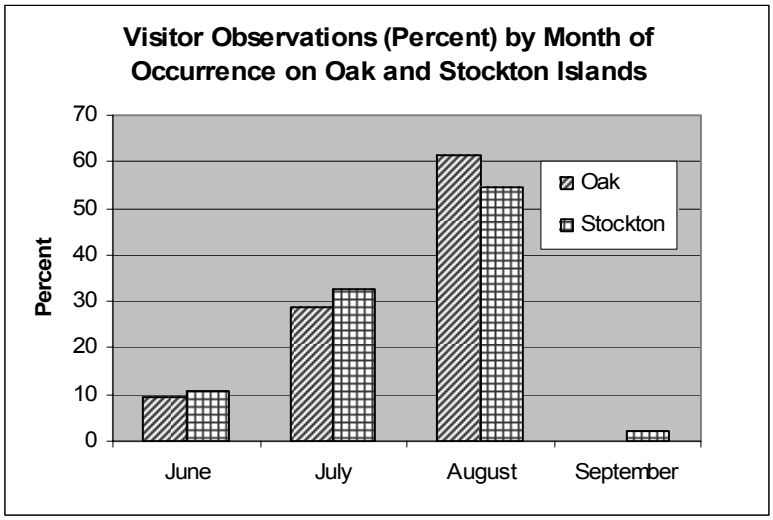
Observations from all sources were made on several islands as can be seen from Table 23. The largest number came from Oak Island (56% of reports) followed by Stockton (37% of reports). Observations from Stockton Island encompassed the broadest range of dates and were the only reports that extended into September.

Table 23. Number of black bear observations by island with the inclusive range of dates that observations occurred.

Location	Number of Observations	Range of Dates
Basswood	1	7/22
Mainland	2	8/14 and 8/30
Manitou	4	6/8 to 8/24
Michigan	1	8/23
Oak	123	6/17 to 8/30
Raspberry	3	6/8 to 6/13
Sand	4	6/18 to 8/25
Stockton	83	6/7 to 9/6

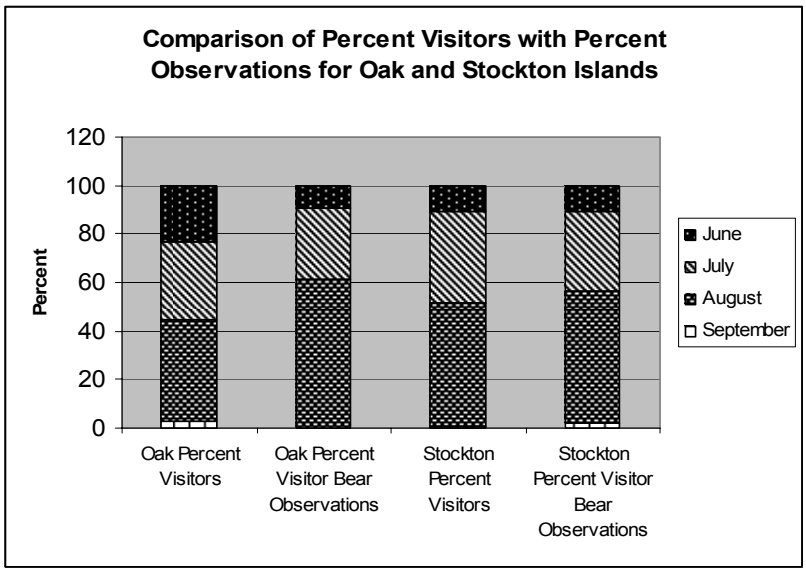
A total of 47% of the observations were made by visitors, 30% by volunteers, 19% by employees, and 5% were of unknown origin. Observations reported by visitors for Oak and Stockton Islands are presented by month in Chart 2. There is a similar pattern between the two islands with the highest percent of observations in August, followed by July, June, and dropping significantly in September.

Chart 2. Visitor observations (percent) by month of occurrence for Oak and Stockton Islands.



The number of bear observations was compared to the number of visitors on each island and Stockton Island reflected the monthly distribution pattern closely. On Oak Island the overall pattern was similar but the actual numbers were more variable (see Chart 3). A total of 23% of visitation occurred in June but only 10% of the bear observations recorded for this island over the summer took place in this same month. The reverse situation was true in August on Oak Island which had 42% of the visitation but 62% of the observations for the summer.

Chart 3. Comparison of number of visitors (percent) with number of observations (percent) by month for Oak and Stockton Islands.



Bear observations from all sources reported the age class (adult, yearling, and cub) in 68% percent of the reports received for Oak and Stockton Islands. This information was further separated by month for these two islands (see Table 24).

Table 24. Age class distribution (percent) of bears from Oak and Stockton Islands based on all observations.

Oak Island	**Adults**	**Yearlings**	**Cubs**
June	25	75	0
July	23	56	21
August	29	67	4
September	0	0	0
Stockton Island			
June	80	20	0
July	73	13	13
August	77	21	3
September	100	0	3

The data indicates that the number of yearlings observed on Oak Island was much higher throughout the summer than on Stockton and that the opposite pattern is seen for Stockton Island observations. One possible explanation for this data is dispersal of yearlings from Stockton Island, a location that has an established population of 26 bears, to Oak Island. However, previous research (Fleming 1997) indicate that animals moving from Stockton to Oak ranged between 2-4 years old. Trauba (1996) found that bears on the islands were smaller in size when compared to the mainland. It may be that observers are reporting yearlings that are in actuality small sized 2-4 year olds. Further information is needed before this pattern can be adequately explained. A second point from this data is that the number of cubs observed peaked in July on both islands.

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 location of the bear at the time of observation.

White-tailed Deer

- **Various surveys indicate densities of 10 deer/mi2 on some islands**
- **Deer recently observed on Sand Island in increasing numbers**
- **Deer browse surveys on Sand indicate very high browsing pressure on Canada yew**

The number of deer in the National Lakeshore has changed significantly over time. Prior to European settlement, the density of white-tailed deer was low at less than 1.6/mi^2. This was due to the prevalence of mature, closed canopy forests in the archipelago, which is not a habitat favored by deer. Logging on the mainland created extensive openings which allowed deer to move into lands adjacent to the islands that had rarely been utilized. Logging on the islands, followed by slash fires resulted in more open and edge habitat types on several islands. Early successional shrub and tree species colonized and deer began to move onto several islands (Basswood, Bear, Cat, Hermit, Ironwood, Manitou, Michigan, Oak, Otter, Rocky, South Twin, and Stockton) either by swimming or over the ice resulting in a severe eruption after World War II.

Hunting records indicate that between 1953 and 1965 an average of 142 deer were removed annually from the islands. The fewest deer were removed in 1959 (54 deer) while 411 were harvested in 1954. Sand Island was not impacted by deer even at this time when harvesting was peaking. Deer populations on the islands began to decline in the 1960's due to over browsed and deteriorating habitat, liberal hunting, several severe winters, and the onset of forest maturation. Between 1966 and 1971 the number of deer hunted off the islands ranged between 9 and 55 with an annual average of 28 deer. Harvest records were not collected after 1971.

Between 1984 and 1987 two aerial surveys were completed on Basswood, Oak, and Stockton Islands and indicated a very low population of deer. In 1989 snowshoeing and snowmobiling surveys were completed at the Mainland Unit. Results indicated 145 deer trails along 9.9 miles of transects or 14.6 trails/mile. Deer trails frequently ran south to north and led to deeryards at Sand Point, Little Sand Bay, and Squaw Bay. In 1992, 6-7 fawns, 2 yearling bucks, 5 does, and 1 buck were observed on Oak Island.

This changing deer population has had impacts to various floral communities on the islands. During presettlement times Canada yew was a dominant component in the understory of the mature northern hardwoods hemlock forests present at the time. Logging created edge habitat and allowed deer access to Canada yew which is a favored food source. Densities of yew decreased significantly and by 1954, a State of Wisconsin biologist reported that Rocky Island had "the fastest buildup of a deer population and the fastest degeneration of a habitat I've seen."

Several islands have never been impacted by deer including Devils, Eagle, North Twin, Outer, Raspberry, and York Islands and Canada yew is abundant. These islands remain invaluable examples of what northern Wisconsin forests might have been like had wide scale logging and subsequent deer increases not occurred. Sand Island also has Canada yew but deer have been observed in increasing numbers in recent years. Canada yew is nearly extirpated on the mainland due to over browsing by deer.

Pellet and Browse Surveys - The Lakeshore General Management Plan (1989) states that, "in general, the long-term natural resource objective of the National Park Service is to restore and maintain the biologic diversity of the dynamic ecosystem that would exist today had not human activities such as logging intervened." Regeneration of vegetative communities negatively impacted by deer has not occurred to date in some locations. Subsequently, the Lakeshore is interested in determining the impact that the current deer population is having on Canada yew.

Because of concerns over an apparently increasing population on Sand Island, a browse-pellet survey was conducted in 2003. A project entitled "Study of Deer Abundance by Browse and Pellet Surveys on Sand Island, Apostle Islands National Lakeshore" was completed by Dr. Douglas Smith and a Field Ecology class of 14 students. The group spent 224 hours completing browse and pellet surveys along 4 east to west transects across the island and near 4 clearings adjacent to East Bay.

Thirty-seven plots 0.02 acres in size were sampled for pellets along the east to west transects. There were 152 white-tailed deer pellet groups in this area leading to a calculation of 54 deer/mi^2 in the undisturbed forest. Transects in the northern half of the island indicated higher densities of deer than the southern portion which is consistent with the information generated from the walking survey described below.

Data regarding tree species and shrub density, as well as the amount of deer browse available and the amount used was collected around the pellet count plots, and the 4 disturbed areas for comparison purposes.

Table 26. The vegetation types present and the percent of each type that had been browsed in both undisturbed and disturbed plots.

	Percent of Plots with Vegetation Present		**Percent of Vegetation Browsed**	
Species	**Forested**	**Adjacent to Clearings**	**Forested**	**Adjacent to Clearings**
Canada Yew	92	75	33	70
Eastern Hemlock	10.5	0	16.5	0
Northern White Cedar	7.9	0	2.4	0
Red Osier Dogwood	10.5	25	14.1	71.4
Sugar Maple	7.9	8.3	22.6	0
White Pine	0	0	0	0

Eastern hemlock and white cedar were present in the forested areas but not in the plots near the disturbed lands on the island. While the percent of plots with Canada yew was high in both undisturbed and disturbed landscapes, there are 17% more plots with yew in the undisturbed forest community. Red osier dogwood was the only species that was more abundant in the disturbed landscape.

In the undisturbed lands, the percent browse ranged between 2.4 to 33%, with sugar maple and Canada yew receiving the most browsing pressure. In the disturbed lands however, where there

are fewer species available for browse, the pressure on Canada yew and dogwood is high at 70% and 71.4%, respectively.

Aerial Surveys - In 2001, aerial surveys were completed for several islands including Basswood, Oak, Raspberry, Sand, Stockton, and York resulting in 10 deer on Oak Island. Numerous trails were noted suggesting a possible density of 40-50 deer. Little deer sign was observed on Basswood, some on Sand Island, and none on any other island. In 2003, an aerial survey was completed for all islands on February 17th (see Table 25) by Tom Doolittle, Bad River Tribe. Three deer were observed on both Basswood and Oak Islands, and 17 were observed on Sand Island. On February 20th, an aerial survey of Oak Island was completed with 14 observers from Bad River, Great Lakes Indian Fish and Wildlife Commission, Red Cliff, and the Park Service on the ground at the same time resulting in the observation of 18 deer, a 6-fold increase over aerial surveys alone.

Walking Surveys - Surveys for deer sign were completed on Oak Island on February 20th and on Sand Island on March 5th. Snow conditions were suboptimal for Oak Island (no snow for more than a week prior to the survey) and optimal for Sand Island (snow within 24 hours of the survey). Although a total of 14 observers were involved in the Oak Island survey, only data from the two people that recorded GPS points is presented for comparison purposes with Sand Island. Methods used on Oak Island were modified for Sand Island by establishing east to west transects prior to completing surveys in the field. On Sand Island there were 18 scat piles and 32 beds observed in an area that had recently received snow. This information suggests a higher number of deer than indicated in the aerial surveys. In addition, the majority of the sign observed was located along the transect located at the north end of the island.

Table 25. Number of deer, tracks, trails, beds, pellet piles, and rubs on transects completed on Oak and Sand Islands in 2003.

	Transect Length (miles)	Deer Observed	Trails[1]	Tracks[2]	Deer Beds	Scat Piles	Rubs
Oak Island[3]							
Totals	6.4	1	10	148	11	12	0
Average Per Mile			1.6	23	1.7	1.9	0
Sand Island							
Totals	12.0	0	121	93 - 116	32	18	31
Average Per Mile		0	10.0	7.8 – 9.7	2.7	1.5	2.6

[1] Trails are defined as travel corridors used by multiple individuals.
[2] Tracks are defined as the tracks left by a single individual.
[3] Oak Island surveys were completed in the absence of recent snowfall. Only data from two NPS staff with GPS units are included.

Discussion

The various surveys suggest that deer densities are increasing on Sand Island and stable to decreasing on Basswood and Oak. The Mainland Unit of the Lakeshore falls within the Wisconsin DNR Deer Management Unit #3 and state data indicates that deer densities averaged 25 deer per square mile in 2002.

Sand Point and Little Sand Bay are well within 3 miles of Sand Island and are likely serving as a source of deer to Sand Island. The potential for increasing negative impacts to Canada yew in the future is high. Funding has been obtained for more intensive aerial and browse surveys beginning in 2005.

HABITAT RESTORATION

Cabin Sites

- **Transplanting done to promote forest regeneration**
- **214 native seedlings among 8 species transplanted in 7 sites.**
- **Cooperating with NRCS for growth of native plant materials**

When the park was established lands were purchased that included cabins. Use and occupancy agreements were made with private landowners whose property was within the boundaries of the park. Many of these agreements have recently expired and on a number of the 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. This would prevent achievement of the goal for most of these areas, which is to restore them to a natural condition using local, native plants and trees.

In 2003, trees were transplanted and local, native plant materials were gathered for propagation by the Natural Resource Conservation Service (NRCS). Seedling trees were transplanted either from surrounding forests into openings, or in the case of the Mainland Unit, from Little Sand Bay to cabin sites along Mawikwe Road. In this case, trees were removed from an area that was to be disturbed in association with construction of a septic system. Overall, seedlings were "rescued" where feasible from situations where they would possibly fail due to overcrowding and transplanted to the more open restoration sites. A total of 214 seedlings were transplanted into 7 sites including 5 on the east and south sides of Rocky Island, 1 site on South Twin Island, and 1 site on the Mainland Unit. Species included balsam fir (82%), cedar (5%), red maple (5%), paper birch (2%), and hemlock, white pine, white spruce, and yellow birch each at one percent of the total. The number of species transplanted ranged between 1 and 5 per site and was dependent upon what was available in the immediate area. Balsam fir was transplanted at all sites.

Monitoring was completed on all sites at the time of planting and two more times during mid and late summer. Data collected included species, height, and a standard vigor rating (0 = dead, 1 = nearly dead, 3 = fair, 5 = vigorous). Results of vigor data indicate that this value typically started at five and decreased to around 3 for most species and sites over the summer. The final mean vigor ratings for all balsam fir transplanted ranged between 2.3 and 3.4 at all 7 sites with the lowest at the former Nourse cabin site and the highest on the former Nelson site, both of which are on Rocky Island. The site on South Twin was planted with a total of 36 seedlings among 4 species including balsam fir, cedar, paper birch, and red maple. Vigor ratings for this site were higher overall than all other sites planted with more than one species, and ranged between 3 and 4. Vigor for the former Nelson site was similar but this site was only planted with balsam fir. Restoration work will continue in 2004 and will focus more on forbs at these site and trees, shrubs, and forbs on Long Island.

Oak Island Sandspit

- **Restoration initiated in 2000**
- **Cooperative effort with NRCS and volunteers**
- **Planted and non-planted natives out-competing exotic plants**

The parks 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 sandscape and in need of restoration.

Since 2000, park natural resource staff have been working with the Natural Resource Conservation Service's (NRCS) Plant Materials Center in Rose Lake, Michigan to restore 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.

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. Follow-up monitoring included establishing 20 plots 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.

Challenges of this effort included: planting in sand with little, if any, organic matter; very little shade; accessibility – the only access is by boat and planting needs to be done in spring when strong winds are frequent; watering after planting is not feasible; high visitor use; and impacts from deer browsing.

Results of the 2001 experimental plots showed that plants did equally well in sunny and partially shady conditions. Plants under shady conditions did the best overall. Plants, such as equisetum (*Equiseum arvense*) did extremely well the first year, tapering off during the second year. Plant counts of blueberry (*Vaccinium angustifolium*), rose (*Rosa blanda*), and Pennsylvania sedge (*Carex pensylvanica*) steadily increased with time and common juniper had a fairly low survival rate (44%) after the first year, but once established, did very well.

The 2002 plots showed very encouraging results with non-native species decreasing from a plant count of 66% in July of 2002 to 41% in September of 2003, clearly showing native species outcompeting non-natives. Changes in aerial coverage showed similar results with decreases in bare ground and non-native species and increases in vegetative litter and native species. 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.

Many lessons were learned from this effort. We found that plants propagated from local plant material could be established successfully and were effective in increasing native plant populations. We also found that having a fairly large number of people to do the initial plantings was extremely helpful and helped minimize the length of time between receiving plants and getting them into the ground. Peat pots caused us some problems, popping up with changing moisture conditions and perlite seemed to attract deer. Future sandscape restoration efforts are planned on South Twin and Raspberry Islands beginning in 2004.

Raspberry Island Slope

- **Goal is to provide long-term stabilization of reconstructed slope in front of lighthouse**
- **675 shrubs planted among 8 species**
- **Monitoring indicated 86% survival**

The Raspberry Island light station is listed on the National Register of Historic Places and 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. In 2001, a large-scale shoreline stabilization project was initiated that included a combination of toe-stabilization and bio-engineering. 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 were planted including 54 speckled alder, 178 brush willow, 53 red-osier dogwood, 349 red elderberry, 13 wild strawberry, 19 staghorn sumac, 8 bristly rose, and 1 clump of 8 wild roses. Follow-up monitoring on success of the shrubs was completed on 20% of the population in late June and early July. Data collected included species, height, and a standard vigor rating (0 = dead, 1 = nearly dead, 3 = fair, 5 = vigorous).

Results indicate that 86% of all plants monitored survived. Individual species varied in their rate of survival and ranged between 60 to 90% (see Table 27). The average vigor rating was determined for each species per monitoring session and the difference between the two means was determined. A small difference between means indicates the least amount of change, or the best mean vigor rating. Table 27 shows the species ordered by the best vigor rating which indicates that overall mean vigor was fair to vigorous for all species. High percent survival and good vigor correlated well for both brush willow and red-osier dogwood while lower percent survival and vigor correlated well for strawberry. It is likely that the reduced success of strawberry is related to the fact that the coconut fiber mat shifted and negatively impacted these short shrubs by physical impact and shading. The majority of elderberry that died were found on the first half of the slope closest to the stairs. It is unknown why this occurred. Monitoring will continue in 2004.

Table 27. The percent survival and difference between vigor between June and July for all species. The data is ordered with the most successful species at the top in both cases.

Percent Survived	Species		Difference Between Vigor Means	Species
90	Speckled alder		0.3	Brush willow
81	Brush willow		0.7	Red elderberry
80	Red osier dogwood		0.8	Red-osier dogwood
80	Staghorn sumac		1.1	Rose
70	Rose		1.2	Speckled alder
63	Red elderberry		1.8	Staghorn sumac
60	Wild strawberry		2.3	Wild strawberry

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Appendix 1

State Endangered and Threatened Plant Species

Scientific Name	Common Name	Global Rank	State Rank	WI Status
Armoracia lacustris	Lake-cress	G4?	S1	END
Botrychium lunaria	Moonwort grape-fern	G5	S1S2	END
Pinguicula vulgaris	Common butterwort	G5	S1	END
Pyrola minor	Small shinleaf	G%	S!	END
Salix pellita	Satiny willow	G5	S1	END
Vaccinium vitis-idaea ssp minus	Mountain cranberry	G5T5	S1	END
Calypso bulbosa	Fairy slipper	G5	S3	THR
Carex concinna	Beautiful sedge	G4G5	S1	THR
Carex exilis	Coast sedge	G5	S1	THR
Carex lenticularis	Shore sedge	G5	S2	THR
Carex michauxiana	Michaux's sedge	G5	S2	THR
Carex prasina	Drooping sedge	G4	S3	THR
Listera convallarioides	Broad-leaved twayblade	G%	S2	THR
Pamassia palustris	Marsh srass-of-parnassus	G5	S1	THR
Ribes oxyacanthoides	Northern gooseberry	G5	S2	THR
Salix planifolia	Tea-leaved willow	G5	S2	THR
Senecio indecorus	Plains ragwort	G5	S1	THR
Trisetum spicatum	Narrow false oats	G5	S2	THR

State Special Concern Plant Species

Scientific Name	Common Name	Globa Rank	State Rank	WI Status
Arethusa bulbosa	Swamp-pink	G4	S3	SC
Botrychium minganense	Mingan's moonwort	G4	S2	SC
Carex capillaris	Hair-like sedge	G5	S2	SC
Ceratophyllum echinatum	Prickly hornwort	G4?	S2	SC
Carex pallescens	Pale sedge	G5	S3	SC
Deschampsia cespitosa	Tufted hair grass	G5	S2	SC
Deschampsia flexuosa	Crinkled hair grass	G5	S3	SC
Dryopteris expansa	Spreading wood fern	G5	S2	SC
Eleocharis robbinsii	Robbins' spike-rush	G4G5	S3	SC
Equisetum palustre	Marsh horsetail	G5	S2	SC
Equisetum variegatum	Variegated horsetail	G5	S3	SC
Goodyera oblongifolia	Giant rattlesnake-plantain	G5?	S2	SC
Lycopodium selago	Fir clubmoss	G5	S2	SC
Nuphar advena	Yellow water lily	G5T5	S1	SC
Ophioglossum pusillum	Adder's-tongue	G5	S2	SC
Osmorhiza chilensis	Chilean sweet cicely	G5	S3	SC
Platanthera dilatata	Leafy white orchis	G5	S3	SC
Platanthera orbiculata	Large roundleaf orchid	G5?	S3	SC
Primula mistassinica	Bird's-eye primrose	G5	S3	SC
Rhynchospora fusca	Brown breakrush	G4G5	S2	SC
Scirpus torreyi	Torrey's bulrush	G5?	S2	SC
Streptopus amplexifolius	White mandarin	G5	S3	SC
Utricularia resupinata	Northeastern bladderwort	G4	S3	SC

Oak Island Restoration Plant Species

Common horsetail	Equiseum arvense
Common juniper	Juniperus communis
Lowbush blueberry	Vaccinium angustifolium
Orange hawkweed	Hieracium aurantiacum
Pennsylvania sedge	Carex pensylvanica
Smooth rose	Rosa blanda