



Fifth Annual

WESTERN GREAT LAKES RESEARCH CONFERENCE

March 22-23, 2006

ABSTRACTS



Northern Great Lakes Visitor Center
Ashland, Wisconsin

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5th Annual Western Great Lakes Research Conference

March 22-23, 2006



The Western Great Lakes Research Conference provides a forum for information and idea sharing between researchers and managers of national parks and other public lands throughout the Western Great Lakes area.

This conference provides an opportunity for participants to share current research, monitoring, and management issues affecting parks and protected areas.

This conference was collaboratively sponsored and funded by National Park Service and the University of Minnesota. Steering committee members include: **Julie Van Stappen**, Branch Chief, Natural Resources, Apostle Islands National Lakeshore, **Joy Marburger**, NPS Great Lakes Research and Education Center, **Bill Route**, NPS Great Lakes Inventory & Monitoring Network, **Wendy Smith**, NPS Great Lakes Research and Education Center, **Jerrilyn Thompson**, NPS Great Lakes-Northern Forest CESU, and **RaeLynn Jones Loss**, University of Minnesota.

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PROGRAM AGENDA

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ORAL PRESENTATION ABSTRACTS



Changes in Moth and Beetle Communities in Relation to Beech Bark Disease in Forests of the Upper Peninsula of Michigan

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Forests in the Great Lakes region are impacted by a variety of non-native organisms. Indirect impacts of these organisms on forest biodiversity are rarely quantified. To gain a better understanding of indirect impacts of non-native species, we measured insect biodiversity in relation to beech bark disease (BBD). BBD is an invasive disease complex consisting of a non-native scale insect and several species of native and non-native Ascomycete fungi. The disease causes high mortality of American beech (*Fagus grandifolia*) in infected stands. In 2003, we established 15 study sites; five sites with BBD, five sites with American beech without BBD, and five sites without American beech. From 2003-2005, we examined indirect impacts of BBD on several insect groups during the summer months: wood-infesting insects (2003-2005), ground-dwelling insects, and moths (2004-2005). We used flight intercept panel traps baited with ethanol to capture wood-infesting insects, pitfall traps to capture ground-dwelling insects, and blacklight traps to capture moths. Bark beetles were significantly more abundant at sites without BBD than at sites with BBD. In addition, several moth species that utilize beech and/or maple as a larval host plant were significantly less abundant in forests with BBD. Lower bark beetle abundance at diseased sites may indicate that dead and dying beech trees do not provide suitable habitat for these insects. The lower abundance of moths at diseased sites is likely related to a loss of larval host material. These results indicate that BBD is having negative indirect impacts on forest insect biodiversity.



Oral Abstract

Using Bald Eagles to Track Temporal Trends in Environmental Toxicants and Effects at Multiple Scales

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The bald eagle (*Haliaeetus leucocephalus*) has been adopted by the Michigan Department of Environmental Quality as a biomonitoring species of the effects and concentrations of environmental toxicants in Michigan, for both the Great Lakes and inland regions of the state. This program was formally adopted in 1999 and is funded by the Clean Michigan Initiative. The state is divided into watersheds and approximately 20% of these watersheds are sampled each year. Therefore, the entire state is sampled every five years. In addition, we utilize Voyageurs National Park, Minnesota as a control site. We report here on results of the first five years of this program.

We evaluated the statewide biomonitoring program for both spatial and temporal trends in contaminants using plasma of nestling eagles. The monitoring program allowed for contaminant assessment at five geographic scales: the entire state of Michigan; interior, Great Lakes, and anadromous breeding areas; within 6 subpopulations; by Great Lakes watershed; and by individual watershed. We found that the monitoring program achieved its objective and detected significant decreases in PCBs and p,p'-DDE concentrations in plasma of nestlings between 1987-1992 and 1999-2003. It also achieved the sample size objectives needed for precision, mean power, and mean trend analyses at all five geographic scales.



Oral Abstract

Recent Decline in Mercury Concentrations in Fish in Inland Lakes of Isle Royale National Park, Michigan, USA

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Mercury often accumulates to high concentrations in fish of boreal lakes. Research conducted at Isle Royale National Park (ISRO) by Kallemeyn and others during the 1990s documented concentrations of mercury in fish from several lakes high enough to elicit fish consumption advisories for humans and to raise serious concerns about toxicological effects to fish and fish-eating wildlife. The initial focus of the study at ISRO was to examine the reproductive toxicity of mercury in fish. We collected four species of fish from nine lakes in 2004-2005 to evaluate them for mercury contamination. Rather than observing toxicological effects, results indicated an abrupt decline during the past decade in mercury concentrations in fish. Current efforts are focused on determining the factors contributing to this decline. Mercury deposition has not declined during the past decade, as evidenced by data from sediment cores in Lakes Richie and Sargent and a nearby mercury deposition monitoring station. Therefore, mercury deposition is not the driving factor for the decline in mercury concentrations in fish. We are thus investigating other factors that affect the bioaccumulation of mercury in fish, such as mercury methylation and food web structure and function. From this research, current concentrations of mercury in fish and, hence, mercury exposure to fish-eating wildlife and humans at ISRO will be much better understood. Further, understanding the contributing factors in the recent decline in mercury concentrations in fish at ISRO will be important for predicting the decline in mercury concentrations in fish of other boreal lakes.



Oral Abstract

Living with Emerald Ash Borer: Modeling Ash Phloem Removal

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The exotic insect, emerald ash borer (*Agrilus planipennis*), is established in Michigan and in some surrounding states. At high population densities, all green, black, and white ash trees are apparently susceptible to attack and increased mortality. Removal of ash from high priority areas such as those stands in close proximity to outlier populations will reduce the population density of this insect. Emerald ash borer larvae develop in the phloem of ash stems and branches that are above 2.5 cm in diameter. We are currently estimating the amount of phloem available to the insect in a forest stand containing ash and developing models of the amount of ash tree removal necessary to reduce the breeding substrate by a target percentage. Forest resource managers will be able to view percent ash phloem volume calculated from both standing and down tree data, and determine the diameter limit for ash removal to achieve the phloem reduction target. By reducing emerald ash borer populations through phloem reduction, and decreasing the removal of the smaller trees in a stand, this model will optimize ash genetic diversity while implementing ash reduction efforts.



Biomonitoring using diatoms and paleolimnology in the Western Great Lakes National Parks

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With environmental monitoring programs it is important to have an understanding of natural fluctuations with which to compare modern measurements and trends. However, reliable long-term data sets are generally unavailable. To overcome this challenge, the Great Lakes Inventory and Monitoring Network is using a novel approach coupling paleolimnological analysis of sediment cores with modern sediment and water quality sampling.

Index lakes have been identified from GLKN parks for water quality and biomonitoring. First, index lakes in 2-3 parks per year are sampled for water quality in a 3-5 yr rotation. Second, a single surface sediment sample is collected from index lakes during fall sampling; this sample integrates spatial/temporal variability of diatom production. Third, long cores (~200 years) will be taken from 1-3 lakes in each park. Biogeochemistry, radioisotopes, and diatoms in the cores are analyzed to recreate a historical record of change in park lakes. Diatoms provide a biological measure of change and, using calibration models, quantitative reconstructions of water quality. Finally, all modern and future sampling of sedimented diatoms will be placed in a spatial and historical context to evaluate environmental trajectories and determine rates of change and recovery.

Field year 2005 focused on PIRO and SLBE. Sampling targeted PIRO (six lakes) and SLBE (seven lakes). Long cores were recovered from Grand Sable (PIRO), Manitou, Bass and Shell Lakes (SLBE). Initial results suggest that Grand Sable has been slowly increasing in productivity since the 1860s, whereas Manitou underwent a dramatic change between 1900 and 1920 and has not recovered.



Oral Abstract

Estimating Species Richness of Chironomidae in Spring-Fed, Lower Order Streams in the Middle Saint Croix River Basin

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Effective resource conservation efforts require substantial knowledge of species-level patterns of richness for targeted organisms. Results from an earlier study of macroinvertebrates inhabiting spring-fed, lower order streams of the middle Saint Croix River basin were used as a data base to develop estimates of Chironomidae species richness in these types of streams, but over broader geographic scales within the watershed. Although the earlier study documented that 75 species occurred in the 20 investigated streams, distributional and probability based models for estimating species richness predicted that 85-103 species actually existed, depending upon model assumptions used to develop the richness estimate. In addition, empirical analyses of the data set allowed predictions of species richness within a given stream as a function of sampling effort. Both approaches for modeling species richness confirmed that within-site richness (i.e., α -diversities) varied as high as 50-70 species. Across-site variability (i.e., β -diversities) appeared low, while temporal variability within a site was intermediate. These three sources of variability should be considered when estimating species richness for conserving biotic diversity within small tributaries to the Saint Croix River.



Use of a Non-Invasive Genetic Survey to Determine Marten Distribution in Wisconsin

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American marten (*Martes americana*) are rare in Wisconsin. Before decisions can be made about future recovery efforts a solid understanding of their distribution is required. Recent advances in non-invasive survey techniques and in the field of molecular ecology have enabled the use of molecular markers as “genetic tags” to identify species and/or individual animals. The objective of this project was to determine the distribution of American marten on the Chequamegon-Nicolet National Forest (CNNF), Wisconsin. Potential marten habitat was identified and 220 snares were placed on eleven transects through this habitat. Snares were checked every two weeks for three snaring periods. Hairs snared in the glue pads were sent to the Molecular Ecology Laboratory at Michigan State University for identification using genetic techniques. Of the 213 submitted samples, 21 samples were identified as marten from 15 individuals. Martens were detected on four of the 11 survey routes. Two of these routes passed through marten research areas in which positive marten detections were expected. The other two marten detections were from transects distant from release sites and may represent successful dispersal. Transect one traversed a marten research area in which six resident animals were present with established home ranges. Of these six animals, two (or 33%) were detected. Thus a lack of marten detections did not mean no martens were present. This hair snare survey was the first large-scale project attempting to describe marten distribution in Wisconsin. It confirmed that most martens remain within a few miles of the original release sites and that only limited dispersal has occurred. Survey effort and costs will be discussed.



Oral Abstract

Assessment of the Forests of Isle Royale National Park

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Consistent methods for monitoring change in the forests of Isle Royale National Park have been lacking until recently. Regular forest inventories through the United States Forest Service Forest Inventory and Analysis (FIA) program aim to fill this gap. The first FIA study on Isle Royale was completed in 2004. We summarized data from sixty-three inventory plots to characterize the current forest vegetation and provide a baseline for future inventories. We also compared forest composition and structure in Isle Royale to that in the Laurentian Mixed Forest Province of Minnesota, Wisconsin, and Michigan (Ecological Province 212) to investigate the importance of Isle Royale's forest on a regional level. Because Isle Royale is located near the northern extent of its ecological province, the island supports a higher proportion of boreal and near-boreal forest types. Trembling aspen and paper birch cover approximately 45% of the island, largely due to human disturbances in the late 1800s and early 1900s. Coniferous forest types, including northern white cedar, balsam fir, and white spruce are more frequent on Isle Royale than at the regional scale. The sugar maple-beech-yellow birch forest type is found at a level comparable to that found throughout the northern Lake States.



Monitoring Vegetation Change in the Great Lakes Region

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Long-term ecological monitoring is essential to understanding how natural systems change over time and to determine if current patterns fall within the natural range of historic variability. The Great Lakes Inventory and Monitoring Network (GLKN) of National Parks has identified terrestrial vegetation as a high priority "Vital Sign" and is developing protocols to monitor plant species dynamics, community composition and structure. Sustained monitoring of vegetation within the Great Lakes Network Region demands a sampling method that efficiently and reliably characterizes vegetation and is sensitive to various kinds of ecological change within and among parks. To assist with this effort, we are evaluating established methods of forest sampling: FIA (Forests Inventory and Analysis) and PEL (UW Plant Ecology Laboratory) and comparing these to a new "hybrid" method in consideration for use by GLKN. We can compare these methods using various descriptive metrics, including the power of each method to detect changes of a given type or magnitude within and among sites. Applying any vegetation monitoring protocol effectively in the field further involves concerns for proper site selection, adequate sample size, repeatability, efficiency and taxonomic expertise. A final challenge will be distinguishing long-term change from inter-annual variability.



Oral Abstract

Relationship between Mercury Accumulation in Young-of-the-year Yellow Perch and Water-level Fluctuations

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A three-year (2001-2003) monitoring effort of 14 northeastern Minnesota lakes was conducted to document relationships between water-level fluctuations and mercury bioaccumulation in young-of-the-year (YOY) yellow perch (*Perca flavescens*) collected in the fall of each at fixed locations. Six of those lakes are located within or adjacent to Voyageurs National Park and are influenced by dams on the outlets of Rainy and Namakan lakes. One site on Sand Point Lake coincides with a location that has nine years of previous monitoring suitable for addressing the same issue over a longer time frame. Mean mercury concentrations in YOY yellow perch at each sampling location varied significantly from year to year. For the 12-year monitoring site on Sand Point Lake, values ranged from 38 ng gww⁻¹ in 1998 to 200 ng gww⁻¹ in 2001. For the 14 lake-study, annual mean concentrations ranged by nearly a factor of 2, on average, for each lake over the three years of record. One likely factor responsible for these wide variations is that annual water-level fluctuations are strongly correlated with mercury levels in YOY yellow perch for both data sets.



Statistically-Based Sampling Design for a Large Rivers Water Quality Monitoring Protocol

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The National Park Service (NPS) Great Lakes Network (GLKN) is developing a monitoring protocol for the water quality of large, non-wadeable rivers, including the St. Croix National Wild and Scenic Riverway and the Mississippi National River and Recreational Area. Both park units are under the pressures of urban and agricultural development. This is one of the first NPS protocols of its kind in the nation, so the monitoring protocols of the U.S. Geological Survey National Water Quality Assessment (NAWQA) program and the U.S. Environmental Protection Agency Environmental Monitoring and Assessment Program (EMAP) were used as guidelines. In particular, NAWQA's nonrandom site selection method and EMAP's random site selection method were both deemed equally important. A sizable database of historical water quality data, provided by 30 years of weekly to quarterly monitoring at six locations in each park unit, was analyzed to determine the background variability of various water quality parameters. Statistical power and sample size analysis were used to determine whether water quality in the park units would be adequately characterized by a set of randomly selected monitoring stations, and if so, how many randomly selected sites would be required. In addition, nonrandomly-selected stations were targeted to monitor water quality at specific locations. Based on a projected monitoring budget, newly-selected random and nonrandom monitoring sites have been apportioned between the two park units, with monthly sampling of nutrients to begin this spring. The next step is to begin developing a water quality monitoring protocol for wadeable streams in the other GLKN park units.



Oral Abstract

Assessment of Wetland Plant Habitat on Isle Royale National Park, 2003-2005

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Isle Royale National Park (ISRO) contains numerous named and unnamed lakes, protected Lake Superior coves, open peatlands, and miles of streams – all with a variety of wetland habitat. Over the 2003-2005 field seasons, we assessed these diverse wetlands guided by 4 main objectives.

We sought to: 1) expand the known flora of the island by locating plant taxa likely but not yet documented, 2) give the island a 'bill of health' relative to aggressive wetland invaders, 3) describe the aquatic and shoreline communities of all named lakes, and 4) characterize the floristic composition in open peatlands.

Thirteen new taxa were added to the flora of ISRO, including the aquatic lake cress (*Armoracia aquatica*) and Farwell's watermilfoil (*Myriophyllum farwellii*), both ranked as threatened in Michigan. Assessing 283 km of interior lake and Lake Superior bay shoreline, we determined that less than 2% was occupied by aggressive taxa. We described three aquatic plant assemblages; the aquatic assemblages of Lake Superior bays differed from that of lakes less than 20 ha in size, and these, in turn, were different from lakes larger than 20 ha. Finally, the peatland communities appeared to differ along nutrient and water depth gradients, separating sedge meadow habitat from that of fens and bogs.

This snapshot in time will better enable the parks to begin monitoring programs for wetland plants. We offer recommendations for stratifying habitat prior to sampling and, in some cases, offer a baseline assessment.



Recent History of Canada Lynx in Minnesota and Implications for the Future

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Canada lynx (*Lynx canadensis*) presence has been documented in protected areas such as the Boundary Waters Canoe Area Wilderness and Voyageurs National Park since being listed as a threatened species under the Endangered Species Act in 2000. Minnesota is at the southern edge of Canada lynx range, and population cycles of lynx and snowshoe hare (*Lepus americanus*) further complicate the basis for management decisions at the state and federal level. Lynx became a furbearer species in Minnesota in 1976, but high pelt prices and declining lynx numbers led to season closure in 1984. Lynx were scarce in Minnesota for the next 15 years. Snow-tracking surveys were initiated in the Superior National Forest to confirm lynx presence through hair collection for DNA analysis in 2002. Thirty-one lynx and three lynx-bobcat hybrids were identified through various methods (including six carcasses) by 2003. In an ongoing radio-telemetry study, 32 lynx have been radio-collared and 21 kittens in six litters have been ear-tagged. Over 90 individual Canada lynx have been identified through DNA analysis. At least four of 42 lynx identified from snow-tracking, and at least 12 of 32 radio-collared lynx, have died, mostly through human causes. There is at least one surviving ear-tagged kitten from three litters in 2004, and at least three surviving ear-tagged kittens from four litters in 2005. Establishing protected areas for lynx in Minnesota could play a role in population persistence in the state if human-caused mortality is significant. Mortality and movements to and from Ontario will also play an important role in the future of the lynx population in Minnesota.



Oral Abstract

Understanding the Past to Plan for the Future: Paleoecology of Floodplain Wetlands and a Natural Impoundment in the St. Croix National Scenic Riverway

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The St. Croix River, which forms much of the border between WI and MN, has undergone significant land-use changes since European settlers arrived in the 1840s. The river continues to face major ecological threats as recreational use and development in the watershed increases. For guiding management decisions on the river and the St. Croix National Scenic Riverway, an understanding of the timing and magnitude of change in river conditions before and since European settlement is crucial. Paleolimnology allows us to reconstruct past changes; however, paleolimnology of rivers provides unique challenges. Sediment transport is too episodic and complex to allow accumulation of continuous sedimentary sequences, such as those found in natural lakes. Therefore, previous paleolimnological studies on the river have targeted Lake St. Croix, which is a natural impoundment on the lowermost 37 km of the St. Croix River. However, environmental impacts are not limited to Lake St. Croix; for that reason, we have analyzed sediment cores from floodplain wetlands as a way of reconstructing ecological conditions on the upper reaches of the St. Croix. Preliminary results from our work on floodplain wetlands, as well as work from Lake St. Croix, demonstrate that dating of sediment cores from riverine systems is extremely challenging. For most cores, careful site selection coupled with a combination of lead-210, cesium-137, and pollen analyses are necessary to provide reliable dating models before analyzing the paleorecord in sediment cores.



The Vanishing Present: Fifty Years of Change in Wisconsin Forests

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Using a 55 year-old baseline data set of over 240 forest sites, we examined rates of change in forest plant communities in different forest types across Wisconsin. We tested the hypothesis that Wisconsin forests are losing native diversity, gaining exotic taxa and increasing in similarity. Furthermore, we tested whether the magnitude of these trends were a function of forest type, habitat fragmentation, disturbance and human population density. Overall, we observed significant reduction in species diversity coupled with dramatic increases in the abundance of exotic species and an increase in average similarity, although the magnitude of these trends varied between forest types. Losses in diversity and increases in community homogenization were negatively correlated with patch size and isolation while the degree of exotic invasion was correlated with road and human population density. These trends coincided with strong regional differences in Wisconsin forests, with the more highly fragmented southern forests experiencing higher rates of native species loss, more intensive invasion by non-native plants, and higher rate of community homogenization. Different Wisconsin forest types also showed differences in the kinds of species that changed in abundance suggesting that different mechanisms are responsible for changes within each region. These results underscored the importance of long-term monitoring of native communities to confirm and quantify region-wide changes in native plant diversity and composition, as well as to provide insight into potential ways to manage these changes.



Oral Abstract

Preliminary Results of Exploratory Data Analysis of the National Park Service Great Lakes Network Water Quality Data

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Managing Great Lakes Network Park lakes effectively requires long-term water quality monitoring and trend analysis. Exploratory data analysis was used to determine if existing historical data showed significant trends in Vital Signs core and advanced suite variables. Electronic data from 1997-2004 from NPS were supplemented with earlier data from other sources, then restructured into “flat files” and screened for data quantity, quality, and metadata. Vertical profile data were grouped by appropriate depth strata and filtered by sample dates into three categories of censored data. Summer data for ten parameters from 37 lakes and 80 depth strata were assessed for trends using linear regression and the nonparametric Man-Kendall (M-K) test. Two lakes showed significant ($p < 10\%$) M-K trends in temperature, nine for dissolved oxygen (DO % saturation), seven for DO (mg/L), six for pH, two for specific conductivity (EC25), and one for Secchi depth. Several also showed M-K trends for water chemistry parameters; three for nitrite/nitrate-N, one for total phosphorus, and three for total alkalinity. Twenty-eight of the 37 lakes assessed showed significant ($p < 10\%$) linear trends in one or more core parameters. Examples of trends for each parameter will be discussed in the context of assessing whether they are real or due to measurement error, seasonal, daily, or natural variability.



Oral Abstract

Predictive Modeling of Invasive Plants within the National Parks of the Great Lakes Network

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Invasive exotic plants threaten natural ecosystems throughout North America. The prevention and control of invasive plants is dependent upon successful monitoring and practical use of resources. The development of a spatial model that predicts the locations at risk for introduction, establishment, and spread of invasive plants would improve monitoring and control efforts. Invasive plants are one of the Vital Signs within the Great Lakes Network of the National Park Service (NPS), which will be monitored annually as indicators of change. To determine where monitoring efforts should be focused, we are developing predictive models using a geographic information system (GIS) for ten invasive plants represented in four common habitats (coastal dunes, marsh/bog, woodlands, and grasslands) in the Great Lakes Network. These multi-criteria risk models determine the level of risk based on biological, environmental, and human-induced factors, and weigh the factors based on assigned importance and confidence values. Maps highlighting the areas at risk within individual National Parks are being produced for three phases of invasion: introduction, establishment, and spread. The models will be tested and refined using existing invasive plant GIS layers and by ground-truthing within select National Parks. The risk maps, finished models, and a user manual will be provided to the NPS which will allow personnel to focus monitoring efforts on areas at high-risk for introduction and establishment, and to further prioritize areas for control treatments.



Oral Abstract

White-tailed Deer Population Increase and its Impact on Sensitive Understory Shrubs on Sand Island, Apostle Islands National Lakeshore

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We investigated white-tailed deer population dynamics and deer browse for the past three years (2003-2005) on Sand Island in the Apostle Islands National Lakeshore. Each year we sampled about 40 plots for deer pellets and deer browse in the interior of the island and an additional 12-30 plots on the East Bay side of the island. The sampling effort was stratified in two areas because the east side of the island had more human-created canopy gaps and possibly greater deer density due to the great amount of edge. In 2005, 95 pellet groups were found in 80% of the pellet plots in the interior and 11 pellet groups were counted in 30% of the pellet plots on the east side. In both strata (east side and interior), 100% of the plots that contained Canada yew showed evidence of deer browse. Canada yew (*Taxus canadensis*) was the most preferred shrub species, followed by mountain maple, red maple and red-osier dogwood. Although the deer population should have declined over the period studied due to the limited deer harvest, browse pressure remained high and shifted from the east side of the island to the interior.



Decreasing Organochlorine Pollutant Concentrations in Lake Michigan Red-breasted Merganser Eggs from 1969-2002 Demonstrate Environmental Improvements

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Fish-eating birds have been used to monitor pollution by organochlorine contaminants including DDT and PCBs for many decades. We measured concentrations of a variety of organochlorine pollutants in eggs of Red-breasted Mergansers (*Mergus serrator*) from the approximate time when discharge of these chemicals to the environment was prohibited (1969) until the present. Our study sites were small islands near the northern tip of Door County, WI in Lake Michigan and Green Bay. We tested the consistency of analytical results over time by repeating 1990 sample analyses of samples originally collected and analyzed in 1977/78. PCBs and DDE declined steadily to contemporary concentrations of 5.5 and 3.2%, respectively, of their starting points (84 and 44 ppm). Dieldrin initially increased slightly (from 0.77 to 1.00 ppm), declined slowly until 1990 and then very dramatically by 2002. This resulted in a total proportional decline (3.9% overall) intermediate between the other two major pollutants. Our results were remarkably similar to published results for our study site from the Canadian Wildlife Service Herring Gull Monitoring Program. The three organochlorine contaminants have decreased in gulls and mergansers by approximately 8-10.5% per year over the past 30-40 years. Sponsorship by, and participation of, government agencies is essential to the continuation of long-term monitoring programs such as this.



Oral Abstract

The Prevalence of Hybridization in Cattail (*Typha* spp.) Invasions of Freshwater Wetlands in Great Lakes National Parks

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The invasive spread of cattails in the Great Lakes Region may be partially due to hybridization between native broad-leaved cattail (*Typha latifolia*) and European narrow-leaved cattail (*T. angustifolia*), ultimately causing reductions in biodiversity and ecosystem function. This study examined the prevalence of hybrids in three Great Lakes national parks representing multiple habitat types, and the relationship between clone size and hybrid status in newly invaded areas. Samples were also collected from 9 East Coast sites from Virginia to Connecticut. Intensive sampling of 150 individuals from each of 5 sites was conducted during 2004, with a less intensive, broader survey of 20-40 individuals from each of 20 sites (including Isle Royale National Park) conducted during 2005. Species-diagnostic RAPD (randomly amplified polymorphic DNA) markers were used to identify pure *T. latifolia* and *T. angustifolia* so that these individuals could, in turn, be used to identify diagnostic microsatellite makers for a subsequent analysis of genetic admixture within individuals exhibiting hybrid ancestry. Results from the 2004 samples showed a history of hybridization among all but a few pure *T. angustifolia* at St. Croix and Voyageurs. Individuals sampled at Indiana Dunes and St. Croix showed evidence of backcrossing to *T. angustifolia*, whereas those at Voyageurs were more similar to *T. latifolia*. A higher incidence of first-generation hybrids was also apparent at Voyageurs, suggesting that *T. angustifolia* has reached this park most recently. The lack of pure *T. latifolia* in these samples suggests it may be at risk of extirpation from portions of its former range.



Water Quality and Biological Conditions of Great Lakes Coastal Wetlands, with an Emphasis on Lake Superior

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EPA's Mid-Continent Ecology Division has been conducting research on Lake Superior coastal wetlands for a number of years, most recently as part of a Great Lakes-wide study seeking to test indicators and establish stressor – response relationships to support development of nutrient and habitat criteria. Over the summers of 2002 - 2004, we sampled 58 wetlands, including 17 in Lake Superior. Wetlands were selected to span a gradient in nutrient loading, as inferred from GIS/statistical analysis of watershed landuse/landcover. Field sampling included wetland hydrology, water quality, fish assemblages, food-webs, and aquatic habitat. Across the Great Lakes, there was a strong relationship between land use practices and coastal wetland nutrient status. Nutrient loading was an important stressor, directly impacting water clarity and quality, which in turn affected food-web structure and aquatic habitat (e.g., plant composition and cover), and ultimately wetland fish assemblages. Wetland hydrology and geography also helped explain patterns in wetland biological assemblages. Compared to conditions elsewhere in the Great Lakes, wetlands of Lake Superior are subject to relatively little direct impacts, although there has been historical wetland loss and hydrological alteration. The intensity of development and agriculture in surrounding watersheds is also low, so nutrient and sediment loadings are relatively small. As a result, Lake Superior wetlands have generally good water quality and habitat conditions, and support a wide variety of fishes. *This abstract does not necessarily reflect EPA policy.*



Oral Abstract

Northern Native Plants Project: Propagating Plants, Partnerships and People

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Recapturing the complexity of the northern forests that existed prior to the nineteenth century, requires the recovery of late-successional tree species, as well as the restoration of associated native understory plants. Although native plant restoration has become more commonplace in other parts of the country, citizens of the northern forest region have little experience in the field. The Sigurd Olson Environmental Institute embraced these issues by creating a project called the Northern Native Plants Project for developing plant material sources, collaborating with state and federal and tribal agencies, partnering with commercial nurseries and non-governmental organizations, and creating educational materials and events.

We completed four years of collecting and propagating native seed, as well as developed a database replete with propagation methods, locations of seed collections, physical characteristics and habitat types for each species collected. We grew plants for the National Park Service, tribal and local agencies, commercial nurseries, local schools and regional garden clubs. We surveyed 41 regional commercial nurseries about their interest in carrying native plant species, worked with two regional nurseries to carry locally grown native plant species, hosted four annual northern native plant sales, developed native seed beds, and established a native plant demonstration site. Through our education efforts we created a northern native plant coloring book, a traveling native plant display, general native plant flyers for nurseries, conducted a *Growing Northern Native Plant Gardens* workshop, and hosted a *In Your Own Backyard*, lecture series.



Methylmercury in Lagoon Habitats of the Apostle Islands National Lakeshore, Lake Superior

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Lagoons of the Apostle Islands exhibit several characteristics associated with high rates of methylmercury production and elevated concentrations in aquatic biota, including high temperature in summer, adjoining wetlands, low pH, high concentrations of organic carbon, and dense submersed vegetation. We assessed mercury contamination in a 125-acre lagoon on Stockton Island and a 48-acre lagoon on Outer Island in July 2005. Here we report results from analyses of water from both lagoons and of northern pike (*Esox lucius*) from Outer lagoon. Concentrations of methylmercury in water averaged 1.3 ng/L in Outer lagoon and 2.5 ng/L in Stockton lagoon, greatly exceeding concentrations in Lake Superior and inland lakes of the region. Corresponding mean concentrations of total mercury were 4.5 ng/L in Outer lagoon and 10.0 ng/L in Stockton lagoon. The fraction of total mercury present as methylmercury in water was unusually high, averaging 31% in Outer lagoon and 25% in Stockton lagoon. Mercury in axial muscle of 17 northern pike (total length, 19-43 cm) averaged 0.78 $\mu\text{g/g}$ (ppm) wet weight (range, 0.25-1.15 $\mu\text{g/g}$), exceeding the USEPA criterion of 0.3 $\mu\text{g/g}$ in 15 fish. These lagoon ecosystems are sites of active production of methylmercury, a toxic compound that can bioaccumulate to potentially harmful concentrations in organisms atop aquatic food webs. Information from ongoing analyses of sediment, seston (mostly algae), zooplankton, benthic invertebrates, and prey fish will be used to assess contamination of the lagoons and the potential significance of these habitats as pathways for dietary exposure of resident and migratory wildlife to methylmercury



Oral Abstract

Multi-scale Monitoring of Conservation Objectives in the Manitou Forest Landscape, Northeastern Minnesota

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The Nature Conservancy's conservation plan for the 42,000-ha Manitou landscape in northeastern Minnesota identifies forest conservation targets: mesic-birch-aspen-spruce-fir (MBSAF) and northern hardwood-conifer (NHC) and attributes (stand structure, composition, patch size, disturbance rate) that require periodic monitoring at different spatial scales. We used medium (30-m pixel) and high resolution (2.4-m pixel) satellite imagery to monitor change (1994-2000) and establish baseline conditions for these indicators: disturbance rate, patch size, and vegetation growth stage (VGS). For stand level indicators (coarse woody debris, snags, stand structure and composition) we sampled a chronosequence of stands in the MBSAF system ranging from stand initiation (< 10 years) to later successional stands (> 81 years). The satellite data analysis indicated that the MBSAF forest ecosystem showed the greatest decrease in mature forest types. A considerably shorter rotation period (80 years) was detected in the MBSAF landscape ecosystem than in the NHC system (207 years). Mean patch size and variability decreased in both the MBSAF (-11.6%, -15%) and NHC (-7.9%, -7.2). The stand level data were analyzed by VGS to both establish baseline conditions and develop more accurate ecological indicator values. Snags and coarse woody debris varied by VGS. Canopy composition in later successional stages was similar to historical data, but seedling/sapling data in early-mid successional stages indicated that long-lived conifers (*Picea glauca*, *Thuja occidentalis*) may decline in abundance over time. The multi-scale monitoring allowed us to improve our understanding of current conditions, develop better ecological indicators, and quantify short term changes in landscape structure.



Spatial Patterns of Water Quality and Plankton along 537-km of Nearshore in Western Lake Superior, 2004

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We conducted an extensive survey of the nearshore waters in western Lake Superior along a continuous segment (537 km) from Grand Marais, Minnesota to near Eagle Harbor, Michigan on the Keweenaw Peninsula. A depth contour of 20 m was targeted using a towed CTD, fluorometer, transmissometer, and laser optical plankton counter (LOPC) to gather data on temperature, conductivity, fluorescence, light transmittance, and zooplankton size and abundance. The continuous electronic data stream provided a high resolution image of spatial variability both vertically and horizontally for each parameter. We investigated the character of local, regional, and the complete segment to reveal spatial patterns not easily detected by other technologies. Distinguishable ecological zones were observed for the North Shore, South Shore, Apostle Islands, and Keweenaw Peninsula. Regional patterns within the nearshore were related to gradients in landscape character along the coastline. The land-use gradient was obtained from an extensive GIS coverage of stressors (over 200 variables) developed by the EPA funded STAR grant GLEI project (Natural Resource Research Institute –NRRI, UM-Duluth). Correlations to land-use practices and conditions now provide for hypothesis testing and making inferences of causality for nearshore conditions. Preliminary relationships were observed for water quality and plankton measures. We demonstrated that the adaptation of electronic instrumentation and towed survey strategies are effective in providing rapid, spatially extensive, and cost effective data for assessment of the Great Lakes nearshore regions. *This abstract does not necessarily reflect EPA policy.*



5th Annual
Western Great Lakes Research Conference
March 22-23, 2006



POSTER PRESENTATION ABSTRACTS



Analysis of Fin Clips as a Non-lethal Method for Monitoring Mercury in Fish

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Most existing approaches for monitoring methylmercury in sport fishes involve dissection of sampled fish and subsequent analysis of axial muscle tissue or edible filets, a process requiring removal of fish from the population. We evaluated a non-destructive approach utilizing fin clips for assessing mercury concentrations in axial muscle tissue of fish. Concentrations of mercury were determined in the axial muscle and pelvic fins of northern pike (*Esox lucius*) and walleye (*Sander vitreus*) from 21 lakes in northern Wisconsin and northern Minnesota, USA. Muscle tissue was analyzed for total mercury, whereas pelvic fins were analyzed for both methylmercury and total mercury. About 90% of the mercury in the pelvic fins was methylmercury. Both methylmercury and total mercury in fins were positively correlated with total mercury in axial muscle. Concentrations of total mercury in pelvic fins averaged about 4% of those in axial muscle. Our analysis indicates that total mercury concentrations of about 32 ng/g dry weight in pelvic fins of walleye and 43 ng/g dry weight in pelvic fins of northern pike were indicative of the upper bound of the 95% confidence interval of the USEPA's methylmercury criterion of 0.3 mg/kg wet weight in edible muscle from these species. Analysis of fin clips could be used as a non-lethal approach for monitoring and evaluating methylmercury concentrations in game fish, particularly for assessing the relative position of a lake's population within a regional continuum of mercury concentrations.



Poster Abstract

Development of a Long-Term, Multi-scale Monitoring Program that Integrates Numerous Ecosystem Components.

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As the human population and per-capita consumption rates continue to rise, protected areas will continue to assume greater importance in the conservation of composition, structure, and function of ecosystem components. In the nine NPS units of the Great Lakes region, we are developing a long-term monitoring strategy to assess whether changes are occurring in several target indicators, whether changes appear linked to one or more stressors (or covariates), and to suggest possible modifications in management. The region exhibits strong seasonality and 4-6 months of snow cover annually. Following our characterization of park ecosystems using conceptual models, we are developing monitoring strategies for our highest-ranked indicators. Ranking involved priorities of conservation managers, agency biologists, and university researchers. Ultimately, we chose 6 initial 'Vital Signs' to monitor long-term ecosystem integrity that: a) involve measurable dynamics across a range of spatial and temporal scales; b) index aquatic, terrestrial, and airborne habitats, providing a comprehensive framework into which future indicators could be incorporated; and c) are tightly linked ecologically. Indicators include terrestrial vegetation, water quality of lakes and rivers, amphibians, trophic bioaccumulation of toxins, and metrics of land use, cover, and change. Sampling strategies, which were developed with extensive collaboration and followed *a priori* power analyses to determine sample sizes needed to detect $\geq 20\%$ change with 80% power, reflect logistical, safety, financial, statistical, and life-history considerations. We minimize observer bias and method-based variability through technician training and detailed sampling procedures. Planned analytical structures involve diverse approaches, including mixed linear models, time-series analyses, estimation of detectability, repeated measures, multi-model inference, Bayesian analyses, and simulation modeling. Biggest remaining challenges include balancing Type I vs. Type II errors, appropriately limiting our sampling domain (both spatially and temporally), and limiting specific metrics to measurements of greatest importance.



Integrating and Understanding the Diverse Natural and Cultural Histories of the Apostle Islands National Lakeshore Using Modeling and GIS

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Historical ecological communities present in Apostle Islands National Lakeshore prior to any significant settlement were impacted by wind, insects, and to a lesser degree fire. Primary land use practices included farming, quarrying, logging with subsequent fires, over browsing by deer after forest regeneration, and the introduction of exotic species. Current forests are a cumulative result of these collective ecological events and cultural impacts.

Long-term, natural resource objectives are to restore and maintain the historic diversity and to support natural disturbance processes (General Management Plan 1989). In order to accomplish these goals, efforts are currently under way to identify natural disturbance regimes and successional pathways and to restore natural vegetation.

Ecological spatial data sets will be reviewed and synthesized and used to develop Integrated Terrain Units (ITU's) representing presettlement community types. Dominant disturbance types and decision rules for succession will be developed and applied to the ITU's to identify the potential natural vegetation in the absence of post-settlement human impacts. Various cultural land-use practices will be reviewed from historical documents and representative polygons mapped using GIS.

Land-use layers will be evaluated in context with the potential natural vegetation and the likely successional pathways identified after an ecological or cultural impact. This will identify departures from the natural range of variability and subsequently areas that could benefit from restoration of species or natural disturbance processes.



Poster Abstract

Long-Term Monitoring at Apostle Islands National Lakeshore

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Building on a history of inventories and research, a long-term monitoring program was initiated at Apostle Islands National Lakeshore in 1989 and continues to be refined. Because it is not feasible to track the status of all resources within the lakeshore, criteria were used to determine which resources to monitor. Criteria included species with special legal status; species subject to harvesting; park resources that are heavily used by visitors or sensitive to human use; sensitive environmental indicators; natural resources of special significance; threats to park resources; trend information needed for management decisions; and data needed to determine the effectiveness of management actions.

There are currently 17 on-going monitoring projects being applied to resource management. Monitoring results have identified sandscape restoration needs, assisted in decision-making for gypsy moth treatment initiatives, allowed rearrangement of campsites to control erosion, streamlined purple loosestrife management actions, and initiated protection of rare plants from deer browse. Fifteen years of breeding bird survey data indicate that the Apostle Islands serve a regional role in providing habitat for ground nesting birds.

Programs will continue to be responsive to issues, embrace our recent wilderness designation, increase our use of technologies such as modeling, expand efforts to share information, and be prioritized for different levels of funding.



Determining the Historical Impact of Water-level Management on Lakes in Voyageurs National Park: Namakan Lake

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A before-after, control-impact analysis of sediment cores from lakes in the Rainy Lake drainage is determining the timing of ecological change resulting from water-level manipulations in Voyageurs National Park. Critical to implementation of the most recent rule curve changes in Rainy Lake is the need to understand both the natural variability of lakes in the Rainy-Kabetogoma-Namakan system and their response to nearly 100 years of hydromanagement. Toward this end, a series of five sediment cores has been recovered: Kabetogoma; Namakan; Rainy (two); and Lac La Croix, which is unimpacted by water-level manipulation. All cores are being inventoried for ²¹⁰Pb activity to determine age and sediment accumulation rates. Sediment biogeochemistry is measured using loss-on-ignition. Subfossil diatom communities and chironomids will be analyzed over the last 300-400 years to determine natural (pre-damming) variability of biological communities and their response to landuse, damming and historical water-level management scenarios.

Initial analyses targeted Namakan Lake sediments. Lead-210 showed pre-European (c. 1865) sediment is present below 25 cm core depth. Damming in the early 20th century increased sediment accumulation rates two-fold. Analysis of diatom communities is underway and indicates that a diverse community (>40 genera) is preserved throughout the core. Variations in subfossil diatom communities will be used to determine biological response to natural and manipulated lake conditions and under different landuse patterns. Furthermore, a diatom calibration set based on modern assemblages and environmental conditions from 145 Minnesota lakes will be used to quantitatively reconstruct historical water quality parameters (e.g., TP, pH, ANC) from downcore assemblages.



Poster Abstract

Paleolimnological Investigation of Kabetogama Lake, Voyageurs National Park

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The large lakes of Voyageurs National Park have been subject to water level control for nearly 100 years. Investigations showed adverse effects of the artificial hydrologic regime on biological communities, which led the International Joint Commission to issue a new rule curve in 2000 that followed a more natural hydrologic regime. The effects of this new curve on the biota of the Park must be documented, but assessment is hampered by limited data from which to assess natural variability and a lack of pre-dam data.

Paleolimnological data facilitate assessment of natural variation over time and allow interpretation of the effects of historical management strategies. We analyzed abundance and composition of non-siliceous and siliceous microfossils in a lake sediment core from Kabetogama Lake and documented the pre- and post-impoundment quantitative variation over a period of approximately 150 years.

Results indicate that Kabetogama Lake has undergone a shift in trophic status beginning around the time of the dam installation in 1914 and increasing since the 1960s. Initial increases in zooplankton occurred following damming of the reservoir, indicating an increase in their food supply. Changes in the algae community since the 1960s are consistent with higher trophic conditions that may be occurring due to anthropogenic enrichment and long-term impoundment. Cyanobacteria were historically present, though recent increases in abundance and diversity may be due to increased water column stability and nitrogen limitation. The greatest changes in trophic status, however, are probably related to extreme water level fluctuations, climate change, and increased nutrient levels.



Road and Housing Density Growth in and around Indiana Dunes National Lakeshore 1938-2005

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National Parks serve as areas of ecological conservation protecting habitat and preventing land cover change. Increasingly, protected areas such as National Parks are becoming islands surrounded by human dominated landscapes. Housing and road development near National Parks can isolate parks and limit their ecological functionality by fragmenting wildlife habitat, altering hydrology, spreading exotic species, and polluting natural areas. Our objective was to quantify the change in housing and road density in and around Indiana Dunes National Lakeshore from 1940 to 2000 using airphotos and IKONOS satellite imagery. Houses and roads were mapped for the area within the park and 2 miles beyond the park boundary. In order to simulate the variable ecological effects from roads and houses, buffers were established at 50 meters around each house and 25 meters around each road. Our results show a strong increase in both roads and houses around Indiana Dunes National Lakeshore over the last 60 years. Increased housing and road density lead to greater isolation of the park, fragmentation of surrounding habitats, and raises concerns regarding its conservation function. Landscape fragmentation due to housing and road development are creating fragmentation patterns on the landscape that are not easily reversed. Such intense development pressure may eventually lead to deterioration in the value of National Parks as both desirable amenities and wildlife habitat.



5th Annual
Western Great Lakes Research Conference

March 22-23, 2006



Poster Abstract

Web-based Data Access – Using Internet Map Server

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The Great Lakes Network has been exploring options for solutions to providing easy access to ecological data relevant to the Network parks. This includes park and partner agency data as well as the Network's monitoring data. The Network, in cooperation with Michigan State University, and more recently, Colorado State University, has been developing an application using ArcIMS (Internet Map Server), to provide a web mapping service that allows park staff and researchers to readily view, query, upload and download data using both a spatial and tabular interface. This tool will allow for a direct workflow from collecting field data, to uploading that data to the server via secure, login access. That data, after going through QA/QC, can immediately be made available for access over the internet. This application will allow one to query data directly, using a tabular interface to directly view data, or download into a variety of formats, including Access or Excel. The other alternative will be the ability to explore the data spatially, locate and define an area of interest, and view or download selected datasets in geodatabase, shapefile format. Other options include the ability to access metadata, download any of the datasets available in a variety of formats, or simply print out a map or graph of selected data for display or report writing needs.



Control of Non-native Smallmouth Bass in Beast Lake in Voyageurs National Park, MN

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Fish stocking that pre-dated the establishment of Voyageurs National Park in 1975 has had a significant effect on the fish communities of some of the lakes in the Park. Smallmouth bass (*Micropterus dolomieu*), which were introduced in some of the Minnesota-Ontario border waters in the early 1900s, have been well established in Voyageurs large lakes for many years. Their presence in Beast Lake, which is believed to be the result of an unauthorized introduction in the early 1990s, may be hampering the Park's attempt to restore native northern pike (*Esox lucius*). The pike were eradicated in 1961 when the lake was treated with the biocide toxaphene. In 2002 an attempt was made to control smallmouth bass in Beast Lake through physical removal and disruption of nests and eggs. Removal of bass was done primarily by angling, since trap nets and minnow traps were not effective. Length, weight, and sex were determined. Stomachs were collected to determine food habits. Scales and fin rays were collected to conduct age and growth analyses. Forty spawning nests were visually located but a major rain event reduced visibility and made it impossible to locate any new nests that might have been created. Observations of young-of-the-year bass in late summer indicated that some reproduction occurred during this period. Despite this, it appeared that removal of fish and disruption of spawning activities were feasible and effective methods for limiting the abundance of smallmouth bass.



Poster Abstract

Prescribed Fire and Mechanical Treatments in Red Pine: Impacts on Insect Pests and Pathogens at Muskrat Lakes, Luce County, Michigan

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This project is an ongoing study of the effects of fire and harvesting on insects, pathogens, and biodiversity in naturally regenerated red pine. The study design is modeled after that used in the national Fire and Fire-Surrogate study. In 2004 and 2005, pre-treatment data were collected from twenty 0.04-hectare plots in each of twelve treatment areas that are more than 10 hectares in size. All trees in these plots were measured for diameter at breast height, tree height, height to live crown and tree health, and permanently tagged. Spore traps were used to measure the presence of the shoot blight fungi in the genera *Sirococcus* and *Sphaeropsis*. Pitfall traps were used to assess diversity of ground dwelling arthropods. In addition, understory vegetation data were collected. Mechanical treatment areas were marked for harvest in the summer of 2005, and harvested fall 2005. A fuel assessment will be conducted in the spring of 2006 followed by the prescribed burn. The treatment prescriptions may be utilized on a large scale in red pine forests that share similar goals of achieving structurally diverse stands. These goals include a residual basal area of 18-23 m²/ha that contains multi-aged trees, including canopies of large red pine, red oak, and white pine.



Open Burning of Trash in the Lake Superior Watershed

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Open burning of trash is a concern to air and water quality, human health, and is a significant cause of wildfires in the Lake Superior watershed. The Minnesota Department of Natural Resources estimates that about 40% of wildfires are started by careless debris burning. Surveys have shown that burning trash is prevalent in the Lake Superior watershed. Studies have found that open burning of trash produces toxic chemicals such as dioxin and distributes other toxic chemicals such as heavy metals into the environment. It is estimated that burning a pound of trash in a backyard burn barrel creates as much dioxin as burning a ton of trash in a modern waste incinerator.

Trash burning occurs in a variety of settings, including residential properties, vacation homes, campsites, and small businesses. As part of the Lake Superior Binational Program, Minnesota has produced a card describing the problems with burning trash at campsites and making recommendations on proper trash disposal practices. As part of the Lake Superior Binational Program in Ontario, a trash bag imprinted with the message, "burning garbage makes poison" was distributed to area parks to encourage a reduction in garbage burning.

The poster will introduce the Lake Superior Zero Discharge and Zero Emission Demonstration Project, describe trash burning and its associated concerns, and describe some activities undertaken to reduce trash burning. A sample of the Ontario trash bag and a limited number of the campfire cards will also be available.



Poster Abstract

The Great Lakes Research and Education Center - Linking Research and Outreach in the Great Lakes National Parks

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Since its inception in 2002, the Great Lakes Research and Education Center (GLREC) has coordinated two multi-park research projects in the Great Lakes region and five research projects at Indiana Dunes National Lakeshore (INDU). In addition, 44 research and collection permits for INDU were managed by the center in 2005. Projects include research partnerships with the USGS, Michigan Technological University, Purdue University, Valparaiso University, Sea Grant, and Chicago Wilderness. The center also coordinates programs with the Great Lakes-Northern Forest Cooperative Ecosystem Study Unit, the Great Lakes Network Inventory and Monitoring Program, and the Exotic Plant Management Team. The GLREC has developed several research-related outreach products, including workshops and publications. In 2006 the GLREC developed a summer research internship program to assist resource managers in conducting research at eight Great Lakes Network parks (GLKN). The center is meeting its Natural Resource Challenge goals of facilitating research and research-related science education in the GLNK parks.



Developing a Landscape-scale Invasive Free Zone

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The goal of this long-term project, initiated in 2005, is to eliminate non-native invasive terrestrial and emergent aquatic plants on the Whittlesey Creek NWR (540 acre acquisition area), private in-holdings, adjoining private lands and adjacent U.S. Forest Service property at the Northern Great Lakes Visitor Center. Additionally, native plant communities will be restored. Monitoring via chronological GPS mapping and GIS analysis, photo-point imagery and plant species density ratings will document treatment and restoration success.

A mapping GPS unit with post-processing was used and data dictionary entries were collected according to North American Invasive Plant Mapping Standards. Twenty one species have been identified and mapped with corresponding data collected. Out of the possible 720 acre survey area, only 115 acres weren't mapped due to lack of private landowner permission. A summer intern mapped and catalogued over 500 infestation polygons and point features. In-field mapping was aided by interpreting 2005 color air photos. Control has been initiated on 9 species covering roughly 10 acres.

During 2006, mapping will be completed and treatment and restoration plans will be developed. Invasive species control and habitat restoration will continue and be expanded as funding allows.

Project partners include; Numerous private landowners, National Park Service Great Lakes Network Office-Exotic Plants Management Team, U.S. Forest Service, Great Lakes Indian Fish and Wildlife Commission, Northland College and Sigurd Olson Environmental Institute, WI-DNR, U. of WI-Extension. Grant money was provided by U.S. Forest Service, U.S.-FWS, U.S. EPA-GLNPO.



Poster Abstract

Contaminant Concentrations and Reproductive Rate of Lake Superior Bald Eagles, 1989 - 2005

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We investigated the trend in contaminant concentrations in Lake Superior bald eagles (*Haliaeetus leucocephalus*) from 1989-2001, and examined the relationship of contaminant concentrations to eagle reproductive rate during that time. Concentrations of dichloro-diphenyl-dichloroethylene (DDE) and total polychlorinated biphenyls (PCBs) in nestling blood plasma samples decreased significantly from 1989 - 2001 ($p = 0.007$ for DDE, $p = 0.004$ for total PCBs). Mean contaminant concentrations in eaglet plasma, 21.7 $\mu\text{g}/\text{kg}$ DDE ($n=51$) and 86.7 $\mu\text{g}/\text{kg}$ total PCBs ($n= 54$), were near or below the estimated threshold levels for impairment of reproduction as determined in other studies. A preliminary assessment of polybrominated diphenyl ether (PBDE) concentrations indicated a mean of 7.9 $\mu\text{g}/\text{kg}$ total PBDEs in Lake Superior eaglet plasma ($n = 5$). The number of occupied bald eagle nests along the Wisconsin shore of Lake Superior increased from 15 to 24 per year, between 1989 and 2001 ($p < 0.001$, $r^2 = 0.70$, $n = 13$ years). Eagle reproductive rate did not increase or decrease significantly between 1989 and 2001 ($p = 0.530$, $r^2 = 0.037$, $n = 13$ years, mean productivity = 0.96 young per occupied nest). The lack of correlation between reproductive rate and contaminant concentrations, as well as the comparison of contaminant concentrations to the estimated thresholds for impairment of reproduction, suggest that DDE and PCBs no longer limit the reproductive rate of the Lake Superior eagle population in Wisconsin.



Evaluating the Impact of Methylmercury Exposure on the Common Loon Populations of Wisconsin and the Canadian Maritimes

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Assessing the population-level risk of methylmercury (MeHg) exposure for fish-eating wildlife is a research priority for government environmental protection, natural resource agencies, and industry. Numerous studies have measured elevated mercury (Hg) exposure in Common Loons (*Gavia immer*) breeding in the north central United States & New England, as well as eastern Canada. Elevated loon Hg exposure has also been associated with negative effects in the laboratory and the field. In this presentation we summarize laboratory and field data from the north central U.S. and Canadian Maritimes to 1) compare mercury exposure profiles for these two common loon populations, 2) examine consistency among thresholds of Hg toxicity measured in the laboratory and field, and 3) estimate the potential population-level effects of Hg exposure on these loon breeding populations.

Controlled laboratory dosing studies were conducted at the USGS Upper Midwest Environmental Sciences Center during 1999 - 2003, and established a LOAEL for MeHg fed to common loon chicks at 0.4 ug MeHg/g wet weight fish. Preliminary results from a common loon/MeHg egg injection pilot study conducted in Wisconsin in 2005 indicate that reduced loon embryo survival may be associated with *in ovo* egg Hg concentrations of ≥ 0.9 ppm Hg wet-weight per gram of egg content, although sample sizes are small.

Field studies conducted in Wisconsin and the Canadian Maritimes show that common loons exhibit zero productivity when fish Hg levels exceed the laboratory LOAEL of 0.4 ug MeHg/g wet weight. Further, loons nesting in the Canadian Maritimes have the highest blood and egg Hg levels measured in North America, median levels are 2-4x greater than in Wisconsin. We explore the potential population impact of this differential Hg exposure in Wisconsin vs. the Canadian Maritimes using projection matrix modeling.



Poster Abstract

Reconstructing Pre-European Settlement Forest Structure for the Bayfield Peninsula, Wisconsin at a Fine-Scale

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Knowledge of historic ecosystem structure and processes are often necessary for understanding natural variability and ecosystem management. The Public Land Survey (PLS) is the primary source of information of forest structure prior to European settlement for the state of Wisconsin because it was collected systematically, and over the whole state. While the coverage of the PLS data is extensive, it was intended for the purpose of parceling the territory for grant, sale, and settlement, not for ecological uses. Prior reconstructions using PLS data have resulted in coarse grained maps only because of the wide spacing of the survey points and the fact that these studies do not employ other data that is abiotic by nature. However, we were able to reconstruct pre-settlement forest structure at a fine scale (≤ 1 -ha) for the Bayfield Peninsula by utilizing logistic regression to incorporate PLS data, topographic data (10-meter DEM), and detailed soils data (SSURGO).

Such a map should be ideal to answer questions that prior cover maps were too coarse to answer. Such questions include: How did the pre-settlement structure and composition of a forested watershed affect underlying base and peak flows? Will the restoration of conifers to riparian zones in composition and numbers that approximate historical conditions before major logging took place, ameliorate peak and flashy flows?



Managing for an Exotic Wetland Invader: Glossy Buckthorn

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Glossy buckthorn (*Frangula alnus* Miller) is an exotic species that has become a major invasive plant within wetlands of Seney National Wildlife Refuge and elsewhere in the Midwest. Where buckthorn becomes established, it out-competes natural vegetation (e.g., *Alnus*, *Betula*, *Prunus*, and *Salix* species) and can become a monoculture. Invasion of glossy buckthorn along wetland areas has resulted in decreased plant species diversity and altered hydrology, with implications for wildlife habitat management and restoration. Management is critical to minimize the spread of this species to other wetland areas currently unaffected by the plant and to restore those areas presently impacted. The objectives of this research were to test the efficacy of different management actions on seedlings and mature glossy buckthorn shrubs. Stump application of 20% glyphosate alone proved ineffective one year after treatment with no difference in sprout density between herbicide, scorching with a propane torch, or controls. Additional low-volume broadcast application of 5% glyphosate to resprouts the following year significantly reduced sprout density as compared to scorching and controls, with no difference between scorch treatments and the controls. Low-volume broadcast herbiciding was the only effective treatment for controlling seedlings. It appears the most effective management option for reducing glossy buckthorn is repetitive herbicide application, possibly for greater than two years. In addition to implementation of treatments, monitoring and follow-up are critical for ensuring an effective glossy buckthorn management program.



Poster Abstract

Methylmercury Relationships between Sediments and Resident Benthic Macroinvertebrates in Chequamegon Bay (WI), Lake Superior

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We are investigating whether methylmercury (MeHg) concentrations of the resident benthic macroinvertebrate community reflects the MeHg concentrations and production rates of local sediments from contrasting locations within Chequamegon Bay, Lake Superior. Sediment cores, porewater, and benthic macroinvertebrates were collected in the summer of 2005. The top 5-20 centimeters of intact sediment cores were either homogenized or sectioned and analyzed for MeHg. Preliminary results indicate that MeHg concentrations of homogenized sediments range from 0.016 – 0.607 ng g⁻¹ (dry weight) among sampling sites. Similar to previous MeHg measurements (2003 and 2004) in homogenized samples, concentrations were greatest near riverine influenced coastal wetlands, intermediate in the coastal wetland without a tributary influence, and lowest near the center of the bay. Within core MeHg variations were as high as 28-fold, with maximum concentrations occurring at a variety of depths. Porewater concentrations of sulfate, sulfide, and dissolved organic carbon, as well as sediment organic carbon content were also measured. Sediment MeHg concentration was positively correlated with sediment organic carbon content ($r^2 = 0.55$) and porewater sulfide concentration ($r^2 = 0.76$), and negatively correlated with porewater dissolved organic carbon ($r^2 = 0.91$). Methylmercury production rates in sediments will be estimated by stable mercury isotope additions to sediment cores. Benthic macroinvertebrate sampling included larval mayflies and caddisflies, bivalves, and amphipods. Analysis of MeHg body burdens of benthic macroinvertebrates are planned for spring of 2006.



Cost-effective Use of Tourist Exlosures for the Rejuvenation of *Ammophila breviligulata* on Minnesota Point

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There are many obstacles to sand dune restoration and erosion control along Lake Superior's Minnesota Point in Duluth, Minnesota. Most have human origins. This restoration project combines inexpensive tourist exclosures, an ongoing public-awareness campaign, and propagated/rejuvenated state-listed beach grass in a plan now proven to be both cost-effective and successful. Annual coordinated tree-plantings, fencing installations and maintenance, and detritus removal are now established routines. Wooden boardwalks and dune bridges have recently been incorporated, with an immediate, measurable benefit. The results of this work are visible using historic and annual photographic comparisons. Chronic problems include invasive exotics, vandalism to structures and planted areas, wind erosion and seasonal climate variations. These variables affect the success/failure ratio of transplanted or introduced vegetation, as do incompatible methodology, lack of water and suitability of plant material. Other problems are bureaucratic or political, including overlapping city and state jurisdictions and a complex permitting process. This is a local issue with global ties. Concerns about threatened and invasive beach grass species, public access and overuse, and diminishing Great Lakes dune habitats makes this type of restoration project a priority.



Poster Abstract

Restoration and Bioengineering at Apostle Islands National Lakeshore

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Beginning in 2000, Apostle Islands NL began working with the Natural Resource Conservation Services' Rose Lake Plant Materials Center on a variety of restoration projects and two large bioengineering projects. Projects include: sandscape restoration on Oak, Raspberry and South Twin Islands; cabin site restoration on the Mainland, Long, Otter, Rocky, Sand and South Twin islands; and bioengineering on eroding bluffs in front of historic light stations on Raspberry and Outer Islands. In addition to propagating native plant materials, NRCS has provided technical expertise in the fields of bioengineering and restoration. The U.S. Fish and Wildlife Service's Great Lakes Coastal Program provided funding for sandscape restoration and Northland College classes and volunteers have assisted with planting. Local growers were also used for plant propagation. Methods used for sandscape and cabin site restoration include: collection of native plant materials from the park during late summer; propagation over the winter; and planting in late spring/early summer. Transplanting of saplings was also done, especially for cabin site restoration, and floating boardwalks have successfully been used to direct visitor traffic on sandscapes. For both slope stabilization projects, a rock revetment at the base of the slope and drainage trench on the bluff was installed prior to the use of bioengineering. A variety of soil bioengineering (live stakes and plants, brush layers, fascines) and bio-technical engineering (log cribs, slope grids) techniques are being used on these slopes. Follow-up monitoring is an important component of these projects and continues to be done to assess effectiveness of the various restoration efforts.



Influence of Prescribed Forest Fire on the Mobilization of Mercury in the Boundary Waters Canoe Area Wilderness

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In an effort to elucidate the impact of forest fires on mercury (Hg) mobilization, the North Central Research Station and the Superior National Forest established a plan to monitor Hg changes in various environmental media during prescribed forest fire operations in the Boundary Waters Canoe Area Wilderness (BWCAW) in the Superior National Forest. A prescribed fire burning program was developed in response to a major blowdown event that occurred in July, 1999. About 75,000 of the 1.1 million acres of the BWCAW will be burned as strategic patches in the blowdown area over a five to seven year period to reduce fuel loads, providing a rare opportunity to study Hg in a wilderness that is dominated by lakes and wetlands, and also relatively unaffected by human activities. In this study we will gather soil, water, fish, and throughfall chemistry information before and after burns in lakes that are both inside and outside of watersheds where prescribed burn activities occur. The goal of the study is to determine if there is an effect of burning forest materials on fish Hg concentration, and if so, to suggest mitigation strategies.

Preliminary data show important characteristics in the natural variation of total mercury (THg) in fish, lake water, upland soil, and throughfall. We have found statistically significant ($p < 0.001$) differences in fish and upland soil (O-horizon) total mercury (THg) at several lakes. This natural variation may show a positive relationship ($r = 0.70$, $p = 0.01$) between upland soil and fish THg. We have also been able to identify a regression model that predicts the time series variation of lake water THg using water chemistry parameters. This model may further enable us to isolate forest fire impacts on Hg mobilization. Currently, fire impact evaluation is limited; however, initial data suggests THg enhancement in throughfall and wet deposition follows the onset of local forest fire.



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