# Indiana Dunes Science Conference:
## Celebrating 100 Years of Research in the Indiana Dunes

**April 6, 2016**

8:30 a.m. – 5:00 p.m.

**IVY Tech Community College**
**Valparaiso Campus**
3100 IVY Tech Drive
Valparaiso, IN 46383

# Celebrating 100 Years of Research in the Indiana Dunes

2016 is the 100th anniversary of the National Park Service as well as the 50th anniversary of Indiana Dunes National Lakeshore! What better way to celebrate than to learn about the park through the lens of scientific investigation?

The Indiana Dunes Science Conference provides a forum for information and idea sharing between researchers and managers. It also provides opportunities for resource managers, their cooperators, and members of the local community to exchange information about natural and cultural resource research, monitoring, and managmenet activities relevant to Indiana Dunes National Lakeshore.

Conference steering committee members include: **Joy Marburger**, formerly of the National Park Service Great Lakes Research and Education Center; **Noel Pavlovic**, USGS Great Lakes Science Center Lake Michigan Ecological Research Station; **Desiree Robertson**, IVY Tech Community College – Valparaiso Campus; **Noe de la Sancha**, Chicago State University; **Michael Siola**, Chicago State University; and **Wendy Smith**, National Park Service Great Lakes Research and Education Center.

**Conference Sponsors:**

**NPS Indiana Dunes National Lakeshore**
**NPS Great Lakes Research and Education Center**
**USGS Great Lakes Science Center, Lake Michigan Ecological Research Station**
**Dunes Learning Center**

**Conference Host:**

**IVY Tech Community College – Valparaiso Campus**

# 2016 Indiana Dunes Science Conference: Celebrating 100 Years of Research in the Indiana Dunes

**Ivy Tech Community College –Valparaiso Campus Auditorium**

**April 6 - 8:30 a.m. – 5:00 p.m.**

**8:15 Registration**

**8:45 Welcome**

**8:50 -** *Aco Sikoski, President, Ivy Tech Community College – Valparaiso Campus*

**9:00 -** *Paul Labovitz, Superintendent, Indiana Dunes National Lakeshore*

## Oral Presentations

**9:10 A Look Back**


The Ecology of Indiana Dunes - Past, Present and Future Research and Conservation Directions - *Noel B. Pavlovic, U.S.G.S. Great Lakes Science Center*.....10

Sand Mining in and around the Indiana Dunes National Lakeshore - *Kenneth J. Schoon, Indiana University Northwest* .....12

Investigations of the Hydrologic Resources of the Indiana Dunes National Lakeshore near Great Marsh, 1992 through 2015 - *David C. Lampe, USGS Indiana-Kentucky Water Science Center*.....7


**10:10 Break**

**10:25 Biodiversity**


Exploring Mayfly, Stonefly, and Caddisfly Biodiversity at the Indiana Dunes National Lakeshore –*Desiree Robertson, Field Museum of Natural History & Ivy Tech Community College; R. Edward DeWalt and Eric South, University of Illinois; Joy Marburger and Wendy Smith, Indiana Dunes National Lakeshore; Victoria Brinson, Volunteer*.....11

New Insights into the Fungal Biodiversity of the Indiana Dunes National Lakeshore - *Peter Avis, Indiana University Northwest*.....1

Maximization of species richness as a conservation goal during management of Indiana Dunes landscapes - *Ralph Grundel and Noel Pavlovic, U.S.G.S. Great Lakes Science Center*.....6

Assessing the Condition of Miller Woods using an index of biotic integrity for vernal ponds and small palustrine wetlands based on fish, crayfish, and amphibian assemblages, Southern Lake Michigan - *Thomas P. Simon, Indiana State University and Charles C. Morris, Indiana Dunes National Lakeshore*.....13

***11:45 Panel Discussion***

**12:00 Lunch and Poster Session**

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**1:00 Implications for Management**

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A Comprehensive Survey for Early Detection and Response to Invasive Species in Indiana's Lake Michigan tributaries - *Thomas P. Simon, Indiana State University*.....14

Edaphic Analogy: A Rapid Method for Restoration Analysis and Planning Used at Indiana Dunes National Lakeshore – *John P. Tandarich, Wilbur Wright City College of Chicago; Daniel Mason, Indiana Dunes National Lakeshore*.....16

Simulating the Disturbance of Wildlife by Recreating Humans to Improve Park Management - *Patrick Andrew Zollner, Purdue University*.....17

Application of Prior Regional Hydrologic Studies at Indiana Dunes to Focus Scientific Inquiry- *Paul M. Buszka, U.S.G.S. Indiana-Kentucky Water Science Center*.....3

**2:40 Break**

**2:55 Challenges and Solutions**

Fluorescent Signatures of Micro-Plastics Contained in Sediments from Beaches of Southern Lake Michigan - *Cesar A. Garcia and Zoran Kilibarda, Indiana University*.....4
*Northwest*

Climate Change in the Great Lakes Dunes: Responses of the Plant Community at Sleeping Bear Dunes National Lakeshore - *Lukas Bell- Dereske and Jennifer Rudgers, University of New Mexico*.....2

Resilience to Climate Variation in Great Lakes National Parks - *Adam Griffith, University of North Carolina at Charlotte; Ralph Grundel and Noel Pavlovic, U.S.G.S. Great Lakes Science Center*.....5

Citizen Science and Wetland Monitoring: the Cattail Case Study - *Joy Marburger, Purdue University Northwest; Beth Middleton, U.S.G.S. National Wetlands Research Center*.....8

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***4:20 Panel Discussion***

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## Poster Presentations

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# New Insights into the Fungal Biodiversity of Indiana Dunes National Lakeshore

**Investigator:** Peter Avis, Indiana University Northwest, Gary, IN 46408 (pavis@iun.edu)

**Main Research Question and Importance**: Indiana Dunes National Lakeshore is home to impressive fungal communities. Historically, these fungi have been studied with macroscopic and morphological based surveys. Though these surveys have generated impressive descriptions and uncovered a very large number of the park's fungi, additional DNA-based methods can be used to more completely document fungal communities. In order to best manage and conserve these organisms, knowing what fungi are present is essential.

**Summary of Methods and Results:** This presentation will present recent findings generated by next generation DNA sequencing conducted at contrasting habitats across the park including Mt. Baldy, Headquarter Woods and Miller Woods. This set of studies utilized several on-going studies at these sites to document over 1000 species of fungi.

**Management Implications:** The more complete list of fungi known to inhabit the park and how they are related to important ecological processes like nutrient cycling, plant productivity and decomposition will provide not only important highlights about the park's attributes but will also guide management.

*One of many oak leaf decomposer fungi in Indiana Dunes National Lakeshore.*

# Climate Change in the Great Lakes Dunes: Responses of the Plant Community at Sleeping Bear Dunes National Lakeshore

**Investigators:** Lukas Bell-Dereske* and Jennifer Rudgers, University of New Mexico, Albuquerque, NM 87131 (ldereske@unm.edu)

**Main Research Question and Importance:**
The Great Lakes region is likely to face large shifts in temperatures and precipitation due to climate change, which could lead to huge shifts in the dune ecosystems. Annual precipitation is predicted to increase (up 25%). However, the prediction for the change of precipitation during the growing season varies from a 40% increase to a nearly 50% decrease in total precipitation. Possibly of more concern are the predicted changes in extreme weather events the region will face in the future. The region may see an increase in extreme rain events (top 5% wettest days) of over 40%. It is not clear how the fragile Great Lakes dune plant community will respond to this altered precipitation regime. Additionally, interactions between plant species may alter the response of the community to climate change.

**Summary of Methods and Results:**
In 2012, we established an experiment in Sleeping Bear Dunes National Lakeshore manipulating plant community interactions and the precipitation regime. We manipulated plant community interactions by growing plant species in the presence of conspecifics or in the presence of other plant species. Additionally, plant communities either received an increase of 30% growing season precipitation (based on 1970-2000 average precipitation) in weekly or monthly rain events (mimicking a 40% increase in extreme rain events) with a third treatment of ambient precipitation as a control. In general, interactions with other plant species increased the productivity of the plant community. We also found that the main dune builder in the system, American beachgrass, was not strongly affected by the altered precipitation regimes. However, the other species in the community had differential responses to the altered precipitation with a woody species increasing and grasses decreasing under the large monthly rain events.

**Management Implications:**
Dunes provide recreational benefits, such as the stunning Sleeping Bear Dunes National Lakeshore as well as acting as storm breaks along the shoreline and protecting inland areas. An important question facing land managers and parks within the Great Lakes region is how shifts in climate will affect restoration in the Great Lakes dune ecosystem. Our research shows that planting higher diversity plant communities results in faster establishment. Additionally, the most common dune plant species used in restoration of coastal dunes seems to be resistant to changes in precipitation regimes.

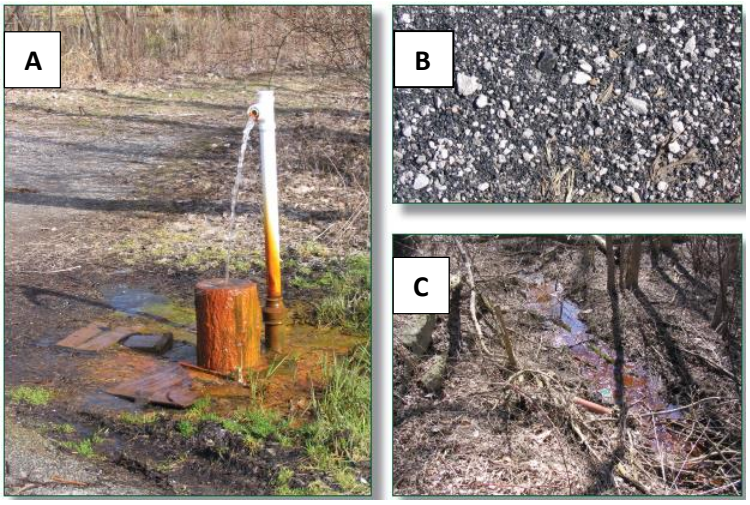
*Plant community plots at Sleeping Bear Dunes National Lakeshore.*

# Application of Prior Regional Hydrologic Studies at Indiana Dunes to Focus Scientific Inquiry

**Investigator:** Paul M. Buszka, U.S. Geological Survey, Indiana-Kentucky Water Science Center, 5957 Lakeside Blvd., Indianapolis, IN 46278 (pmbuszka@usgs.gov)

**Main Research Question and Importance:**
Regional groundwater and water-quality investigations from the 1970's to about 1992 by Robert Shedlock, Mark Hardy and many other U.S. Geological Survey scientists at Indiana Dunes National Lakeshore (INDU) have yielded insights about characteristics of groundwater flow and quality that have been useful in addressing various other questions important to area water resources. Three examples of studies are presented to indicate how findings of the hydrogeology at INDU determined by prior regional studies can focus directions of scientific inquiry to address water resource issues of management and societal importance.

**Summary of Methods and Results:**
An evaluation of published studies at INDU was done to form a foundation of understanding of how they shaped future hydrogeological investigations. For example, the framework of aquifers and groundwater flow at INDU described by Shedlock and others (1992) was used by Shedlock (1993) and Watson and others (2001) along with the occurrence of tritium depleted groundwater to identify groundwater discharges from relatively older flow systems to shallow groundwater that sustains Cowles Bog and the Great Marsh. Relatively higher concentrations of boron in groundwater from a deep, confined glacial aquifer and in surface water downstream from a local fly ash landfill described by Shedlock and others (1992) and Hardy (1981) were used to design a method using boron stable isotopes and tritium concentrations to distinguish sources of groundwater to wells near Beverly Shores and Pines, Indiana (Buszka and others 2004). Flow directions identified as a part of the regional hydrogeologic study were used to evaluate how road-deicer applied to US-12 migrates with shallow groundwater and is diluted as it flows toward the Great Marsh (Watson and others, 2001).




*Photographs showing examples of potential sources of boron in shallow ground water at and near Indiana Dunes National Lakeshore, Indiana: (A) A natural source of boron in artesian flow from a well completed in the basal sand aquifer near Beverly Shores; (B) an example of coal-combustion product at land surface near the Town of Pines; and (C) a suspected seep of domestic-wastewater-affected ground water at Beverly Shores. (Photographs by Lee R. Watson, March 28, 2005.)*

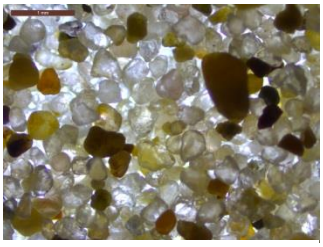
**Management Implications:**
Outcomes from these three examples of studies indicate how scientists have made use of prior studies at INDU to focus directions of scientific inquiry to address issues of park management and societal importance.

# Fluorescent Signatures of Micro-plastics Contained in Sediments from Beaches of Southern Lake Michigan

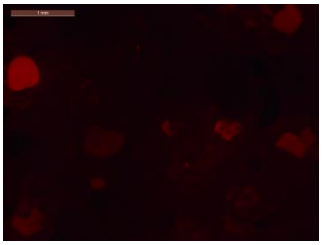
**Investigators:** Cesar A. Garcia[1*] and Zoran Kilibarda[2], Indiana University Northwest, Gary, IN 46408 ([1]cesgarci@iun.edu) ([2]zkilibar@iun.edu)

**Main Research Question and Importance:**
Various plastic materials including bags, smoking related material, bottles, bottle caps, and personal hygiene items were the primary type of anthropogenic debris collected along strand line at five Indiana beaches (Whihala, Marquette Park, Portage Lakefront and Riverwalk, Porter, and Dunbar) of southern Lake Michigan. We assume that this material will degrade into micro-plastics and mix with a natural beach sediment. In addition to this, some micro-plastics that are used in cosmetics and other industries are released into the environment. Examining sediment samples from beaches of southern Lake Michigan under a fluorescent microscope may help to determine if they contain micro-plastics.

**Summary of Methods and Results:**
We examined small fragments (<2mm) of known plastics to determine their behavior under red (650nm), green (510nm) and blue (475nm) fluorescence. Hard plastics such as that found in mouthpieces from swisher cigars and in tampon applicators have strongest green fluorescence. Disposable water bottles and their caps have strongest blue fluorescence. Styrofoam has a very weak fluorescent signal and is detectable under blue light. The most commonly found waste, plastic bags, could not be detected with fluorescent light. Household products such as soaps that contain micro-plastics have strongest red fluorescence. Once we established a fluorescent signatures database of common plastics, we examined swash line beach sediment under the fluorescent microscope and found that in some areas up to 6% of fluorescent micro-plastic particles were present. When examined under plain light these particles did not differ from the rest of grains. Larger (2-3mm in diameter) recognizable plastic spherules also have a bright red signature under fluorescent light.



*Sediments in plain light.*



*Sediments in red light.*

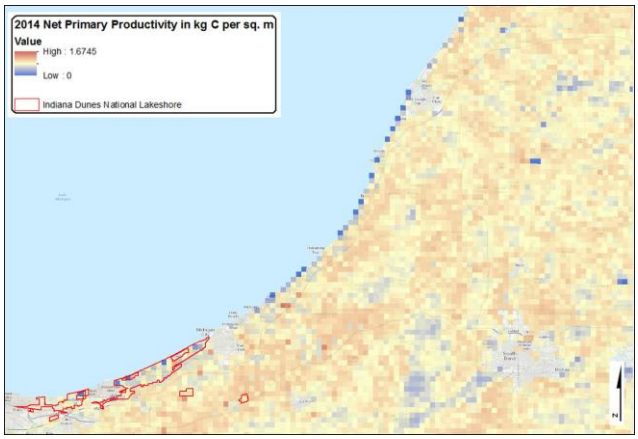
**Management Implications:**
We conclude that fluorescence microscopy is a very powerful tool in detecting micro-plastics in sediments that otherwise might look natural and environmentally clean. This technology can help us assess environmental health. Our future work would include quantification of micro-plastics present in beach sediments during various seasons as well as following the major storms.

# Resilience to Climate Variation in Great Lakes National Parks

**Investigators:** Adam D. Griffith*, University of North Carolina at Charlotte, Charlotte, NC 28223 (adamdgriffith@gmail.com); Ralph Grundel[1], and Noel Pavlovic[2], US Geological Survey, Chesterton, IN 46304 ([1]rgrundel@usgs.gov) ([2]npavlovic@usgs.gov )

**Main Research Question and Importance:**
Two impacts of climate change in the United States are warmer temperatures and more variability in precipitation resulting in stressful conditions for many plant species, particularly those living at the limits of their geographic range. U.S. National Parks are often floristically rich and many contain rare species. Some plant communities are naturally more resilient to variations in temperature and precipitation and continue to thrive despite sub-optimal conditions. Given predictions of larger variation in temperature and precipitation, this research seeks to identify plant communities that exhibit this resilience to harsh conditions in Great Lakes National Parks.

**Summary of Methods and Results:**
Remote sensed products, such as the enhanced vegetation index (EVI), normalized difference vegetation index (NDVI), or estimates of net primary productivity (NPP) can serve as substitutes for actual plant productivity. Factors affecting stability of those indices through time can provide insight into how plant communities might change with predicted global climate change conditions. This research combined past temperature and precipitation data (from PRISM Climate Group) and NPP data (from NASA MODIS 17A) with a focus on 5 Great Lakes National Parks. Through co-analysis of 10-15 years of climate data and NPP data, we calculated the average change in NPP over time for all 1-km grid cells in those parks. Patterns of high temperature and low rainfall coincided with lower plant productivity across multiple spatial scales and we identified areas where resilience is high. These areas maintain stable productivity through adverse conditions.




*Net Primary Productivity (NPP) near Lake Michigan is highly variable. Note the low productivity vegetation closest to the lake indicating poor, sandy soils. Some of the low productivity sites, however, exhibited high resilience to changes in temperature and precipitation.*

**Management Implications:**
Managers are in need of accurate predictions of potential climate change impacts as they try to make efficient management and conservation decisions. This could include setting restoration priorities or intentionally taking a passive approach to management in other areas. Over the 15-year period of study, patterns of weather effects on productivity emerged and provided potential opportunities for making productivity-based management decisions that incorporate consideration of future climate change. Our measure of ecosystem resilience represents an improvement over current resilience metrics due to incorporation of climate variables and can be applied to any non-urban area in the US.

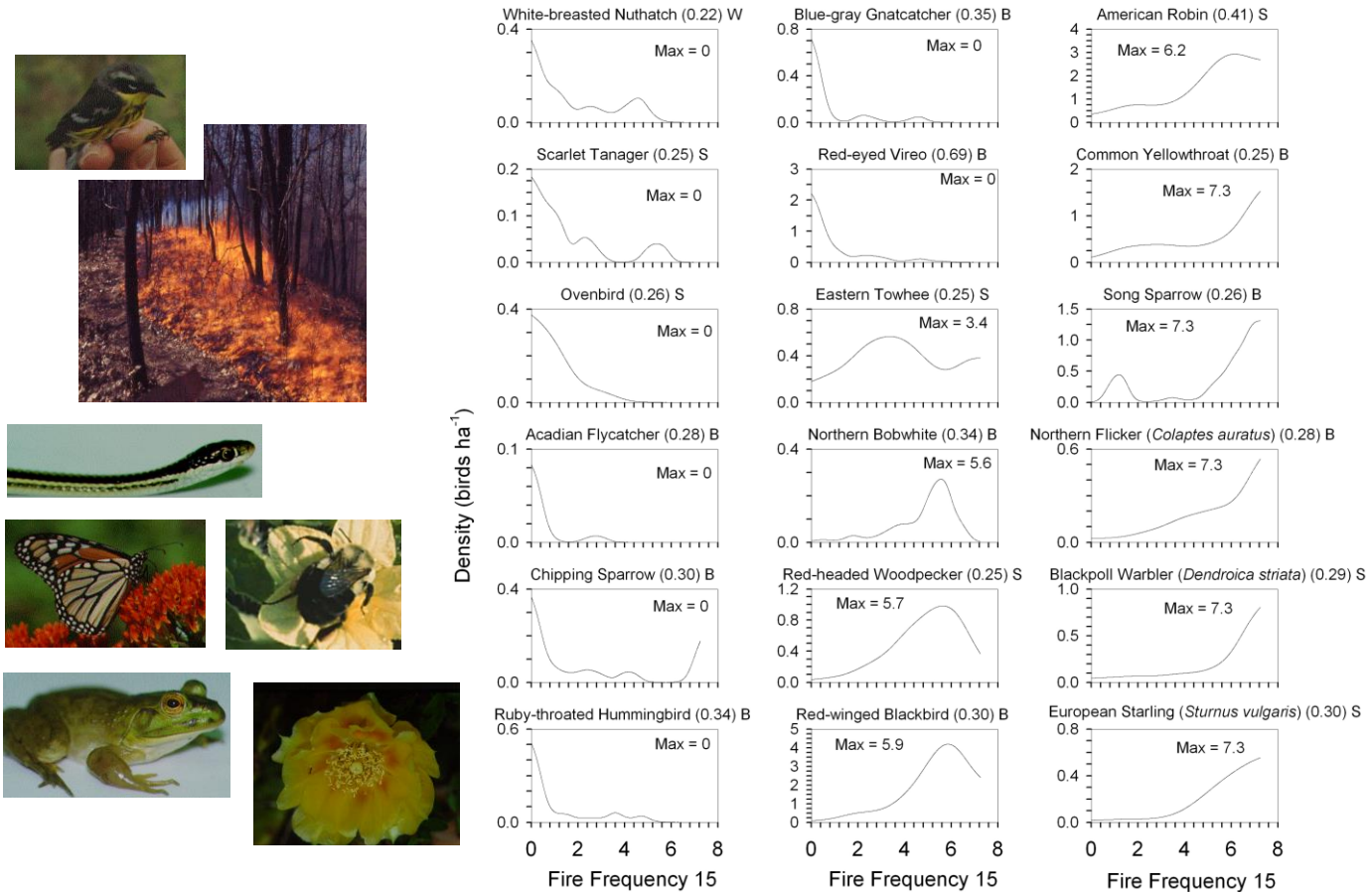
# Maximization of Species Richness as a Conservation Goal during Management of Indiana Dunes Landscapes

**Investigators:** Ralph Grundel[1]* and Noel Pavlovic[2], US Geological Survey, Chesterton, IN 46304 ([1]rgrundel@usgs.gov), ([2]npavlovic@usgs.gov)

**Main Research Question and Importance:**
Park managers often make management decisions based on attempts to maximize the number of species that might use a restored or managed landscape. We examine the value of using species richness as a conservation goal at Indiana Dunes.

**Summary of Methods and Results:**
We examined richness of amphibians, reptiles, birds, bees, butterflies, and plants across a woody vegetation gradient at Indiana Dunes to determine how distribution of these groups varied across this management gradient.

**Management Implications:**
Maximum richnesses of these taxa do not coincide suggesting that you cannot simultaneously manage to maximize species richness of multiple animal and plant groups at Indiana Dunes.




*Management often strives to maximize species diversity. However, it can be difficult to maximize diversity for many different groups of animals and plants simultaneously because different groups respond differently to habitat conditions.*

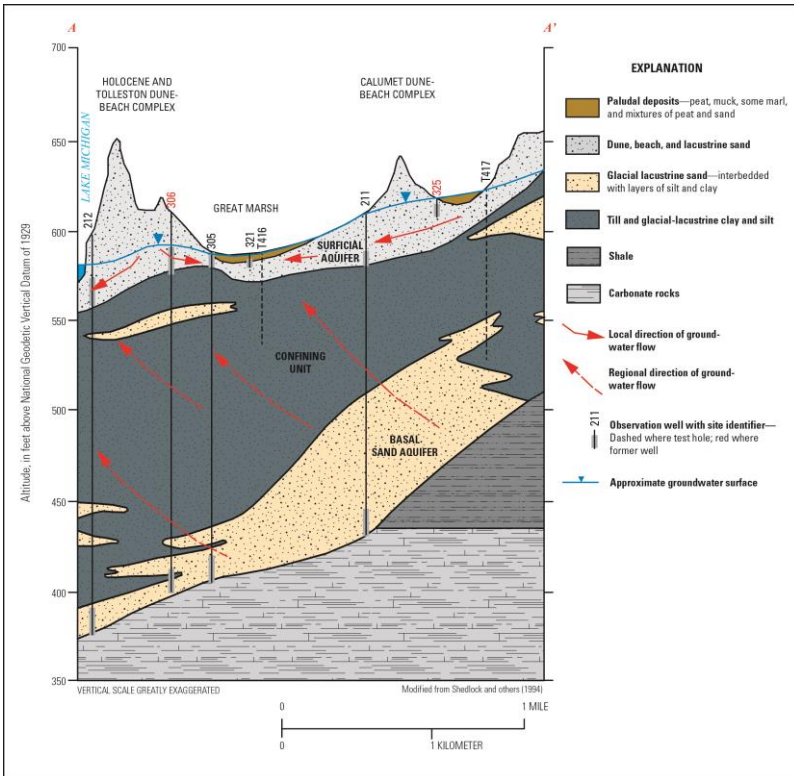
# Investigations of the Hydrologic Resources of Indiana Dunes National Lakeshore near the Great Marsh,1992 through 2015

**Investigator:** David C. Lampe, USGS Indiana-Kentucky Water Science Center, Indianapolis, IN 46278 (dclampe@usgs.gov)

**Main Research Question and Importance:**
The connectivity between the groundwater and surface-water resources of Indiana Dunes National Lakeshore (INDU) is responsible for the many wetlands and diverse ecology found within the park. Investigating this complex relationship between the natural lands of INDU and the diverse, highly modified land uses that surround it has been a subject of 13 previous studies authored by the U.S. Geological Survey (USGS) Indiana Water Science Center. Although some studies have characterized the general hydrogeology and hydrochemistry, most have dealt with the specific interactions of the groundwater and surface-water resources of Great Marsh and the surrounding lands.

**Summary of Methods and Results:**
The USGS has used multiple techniques to investigate the water resources of INDU. Specifically, the resources of the Great Marsh have been evaluated through the collection and interpretation of groundwater and surface-water levels and hydrologic modeling. The results of investigations in the Derby Ditch and Brown Ditch basins will be presented to illustrate how the water resources of the Great Marsh interact with the surrounding infrastructure and land uses.

**Management Implications:**
An understanding of the water resources of the park assists INDU in managing its resources, especially when planning restoration activities designed to reestablish degraded or destroyed wetlands near infrastructure and other land uses that could be affected by changing water levels.




*Example hydrologic section showing the presence of the surficial and basal sand aquifers beneath the Great Marsh and local and regional directions of groundwater flow.*

# Citizen Science and Wetland Monitoring: the Cattail Case Study

**Investigators:** Jov Marburger*, Purdue University Northwest, Westville, IN (jemarbur@pnc.edu); Beth Middleton[1] and Craig Conzelman, USGS National Wetlands Research Center, Lafayette, LA ([1]MiddletonB@usgs.gov)

**Main Research Question and Importance:**
Past research on cattail populations in national parks involved collection of morphological data and development of molecular markers to identify hybrid cattail (*Typha* spp.) and the parental taxa, broadleaf cattail (*T. latifolia*) and narrowleaf cattail (*T. angustifolia*). The collection of this data and assessment of cattail taxa at a landscape level can be time consuming for scientists.

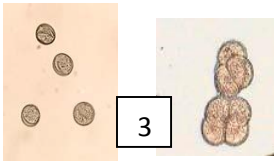
**Summary of Methods and Results:**
We recruited a network of volunteers to help collect population-wide data, as well as give volunteers training in botanical research. The camaraderie established among the volunteers and scientists was another benefit. A website was developed in collaboration with the USGS National Wetlands Research Center. A training program is being developed that will establish leaders in data collection and entry into the website. Several volunteers and teachers have already participated in the training. I developed a method for field identification of cattail taxa based on pollen type. These data can also be entered into the website. A simple water-proof microscope is now available for pollen analysis. It can be taken into the field to analyze the pollen taken from individual plants. Pollen can also be collected and stored in a cooler and analyzed later indoors.

**Management Implications:**
The developments and accomplishments described here help managers by creating an easier method to identify cattail species and hybrids.

*Figure 1. Volunteers measure cattail in Everglades NP.*

*Figure 2: Mature male inflorescence with pollen being shed.*

*Figure 3. Pollen of T. angustifolia (left) and T. latifolia (right)*




*Cattail Monitoring Website: http://nwrcwebapps.cr.usgs.gov/cattail/*

# Cowles Bog Wetland Complex: Glory; Demise; Resuscitation

**Investigator:** Daniel Mason, Indiana Dunes National Lakeshore, Porter IN 46304 (daniel_mason@nps.gov)

**Main Research Question and Importance:** Cowles Bog Wetland Complex (CBWC) is inclusive of a National Natural Landmark: Cowles Bog. During the early 20th century the presence of exceptional wetland plant assemblages stimulated the use of the complex as an outdoor laboratory by universities in Chicago and visitation by the 1913 International Phytogeographic Excursion to America. Extreme human induced stressors in the 1960's destroyed over 1,000 acres of adjacent wetland to the west and thrusted CBWC into a negative trajectory resulting in a pitiful desert of hybrid cattail. In 2002, investigations were initiated to determine if the historic glory of CBWC could be resuscitated**.**

**Summary of Methods and Results:**
Inventory at CBWC included vegetation, seedbank, hydrology, soil classification, and soil and water chemistry. Experiments were conducted to determine best methods for neutralizing a seedbank dominated by hybrid cattail and best methods for eradicating cattail. Existing and desired plant assemblages and methods to achieve the desired plant assemblages were identified.

**Management Implications:** CBWC can be restored. Management actions to accomplish restoration of CBWC will be determined by the funding stream.

*Cowles Bog Wetland Complex Early 20th century*

*Cowles Bog Wetland Complex 2002*

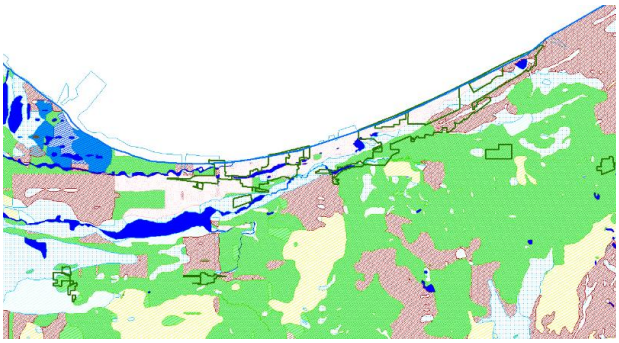
# The Ecology of Indiana Dunes - Past, Present and Future Research and Conservation Directions

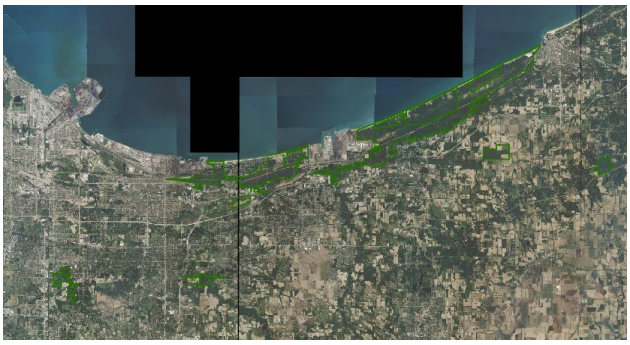
**Investigator:** Noel B. Pavlovic, U.S. Geological Survey, Lake Michigan Ecological Research Station, Chesterton, IN 46304 (npavlovic@usgs.gov)

**Main Research Question and Importance**:
I will discuss the history of ecological research and conservation in the dunes and look at possible future directions for research and conservation. It is important to look back and understand where we have been to be better informed about where we are going.

**Summary of Methods and Results:**
I will address the history of research at the Indiana Dunes, framing it in the context of the development of science. I will analyze the history of publication in the Dunes in relation to productivity, diversity of fields and frequency of terms used in paper titles to understand where we have been and what it reveals about the research in the park. I will address current issues and conservation and restoration needs. Lastly, I will discuss where we might be headed in the future.

**Management Implications:**
I will discuss how this will transform park management.





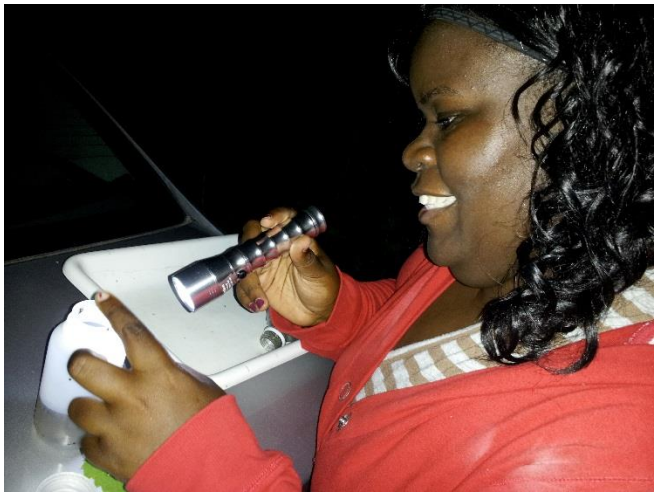
*This is a presettlement vegetation map of Northwest Indiana placing the Indiana Dunes in its former context (left). The figure to the right shows the current context of the park.*

# Exploring Mayfly, Stonefly, and Caddisfly Biodiversity in Indiana Dunes National Lakeshore

**Investigators:** Desiree R. Robertson*, Field Museum of Natural History, Chicago, Illinois 60605 (drobertson@fieldmuseum.org); R. Edward DeWalt, University of Illinois, Illinois Natural History Survey, Champaign, IL 61820 (dewalt@illinois.edu); Eric J. South, University of Illinois, Urbana, IL 61801; Joy E. Marburger, Purdue University Northwest, Westville, IN (jemarbur@pnc.edu); Wendy W. Smith, Great Lakes Research and Education Center, Indiana Dunes National Lakeshore, Porter, IN 46304 (wendy_w_smith@nps.gov); Victoria Brinson, Volunteer

**Main Research Question and Importance:** Aquatic insects play a vital role in the ecology of aquatic food webs and are an important food source for birds, bats, and other organisms. In addition to their ecological importance, stoneflies, mayflies, and caddisflies (collectively termed "EPT") are useful biological indicators of water quality. We conducted the first ever inventory of EPT in Indiana Dunes National Lakeshore (INDU) and asked the following questions: 1) Which EPT species are present and what is their distribution in INDU? 2) How does the diversity of EPT species within INDU protected areas compare to that outside of park boundaries? 3) Are trends in EPT diversity related to size and waterbody type? 4) Are there any species of conservation significance inhabiting INDU?

**Summary of Methods and Results:** With the assistance of a dedicated team of volunteer citizen scientists, we collected several thousand specimens over the summer of 2013. Volunteers set up ultraviolet pan traps at 19 sites. Samples were sorted to order by volunteers and then further sorted and identified to species by taxonomic experts. Seventy-eight EPT species were recovered: 12 mayflies, two stoneflies, and 64 caddisflies. Compared to the known fauna from Indiana, caddisflies contributed only 32.7% of known state fauna, mayflies and stoneflies contributed 8.4% and 2.3%, respectively. Species diversity generally increased with stream size. Seven new state records were recovered, including 1 possible new species.



*A volunteer citizen scientist examines specimens collected from a UV light trap at Indiana Dunes National Lakeshore.*

**Management Implications:** Many EPT species undoubtedly have been lost in the region due to a century of habitat loss and degradation. While protection of unique flora and fauna is the mission of NPS managed properties, aquatic communities of INDU are subject to degradation because of the mosaic of public and private properties surrounding the park. Our research provides managers with valuable baseline data that will serve as a vital resource for monitoring changes in diversity and distribution over time, and designing strategies that best protect EPT species.

# Sand Mining in and around Indiana Dunes National Lakeshore

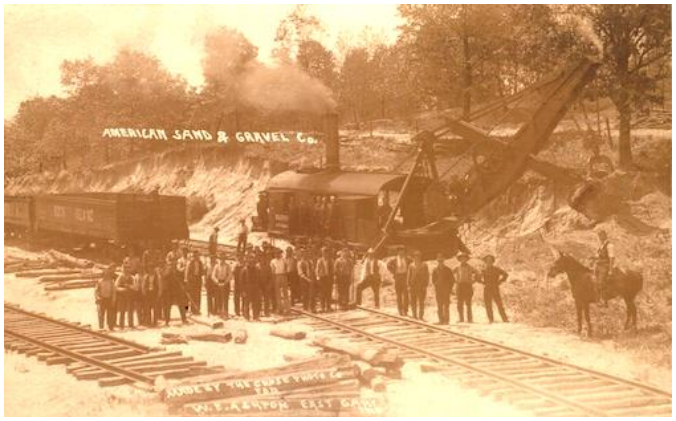
**Investigator:** Kenneth J. Schoon, Indiana University Northwest, Gary, IN 46410 (kschoon@iun.edu)

**Main Research Question and Importance:**
Which locations within and around Indiana Dunes National Lakeshore have been sand mined? With this information, the National Lakeshore staff can more accurately interpret both the landscapes and history of the Park.

**Summary of Methods and Results:**
Historical materials were found through a search of published professional literature as well as newspaper articles and archival notes of geologists. Old topographic maps and photographs were compared with recent ones. People familiar with the sand mining business were interviewed. Photographs were collected. Current conditions were confirmed on site.

Large-scale mining of Northwest Indiana sand began as railroad lines were first built across the region in 1850-51. Railroads run more efficiently when tracks are level. Therefore, to make the ground*, sand removed from the rail lines' rights of way when it was too high was used to fill low areas* leve. The same was done when highways, cities, and subdivisions were built.

Railroads were soon making money by hauling sand from the Duneland area to eager customers in both Indiana and Illinois. The sand was used for fill, for making glass and concrete, as an abrasive, for making lime bricks as well as molds and casts. For about 120 years, sand mining was a big and profitable business and provided a source of income for many families.



*American Sand and Gravel Company, Miller, Indiana , ~1910.*

During that time much sand was removed and the landscapes were altered.

Sand mining continued as Congress debated establishing a Dunes National Park. It only ceased as the National Park Service began purchasing land after the Lakeshore was approved.

**Management Implications:**

Some past sand exavations, such as the ones at West Beach are well known to local environmentalists and Park employees. Others, particularly smaller excavations or those done a century ago or more, are not generally known. Knowledge of previous mining locations affects how staff interprets the landscape; it also helps determine where to construct buildings if it is desired to place them on previously disturbed land. This research helps to fill in the gaps.

# Assessing the Condition of Miller Woods Using an Index of Biotic Integrity for Vernal Ponds and Small Palustrine Wetlands Based on Fish, Crayfish, and Amphibian Assemblages, Southern Lake Michigan

**Investigators:** Thomas P. Simon*, Indiana State University, Terre Haute, IN 47809 (thomas.simon@indstate.edu); Charles C. Morris, Indiana Dunes National Lakeshore, Porter, IN 46304 (charles_morris@nps.gov)

**Main Research Question and Importance:**
An index of biotic integrity (IBI) was used to evaluate the condition of vernal ponds and small palustrine wetlands along the Indiana Dunes National Lakeshore 15 years after the initial survey was conducted. Crayfish, fish, and amphibian assemblages were included in the index to assess wetland habitats ranging from waterbodies < 5 ha to 40 ha in size.

**Summary of Methods and Results:**
We used a 3 m common sense minnow seine with 3 mm bar mesh to collect amphibians, crayfish and fish from each of the 62 wetlands. Sampling was conducted between mid-June and mid-July. A three-person crew sampled all habitats in each wetland including littoral zones, deep pools, submerged vegetation beds, and backwaters or coves. Species composition and relative abundance data was based on enumeration, measurement of total length ranges, and batch weight of all individuals for each species (Gerking, 1955; Smith, 1979; Page, 1985; Minton, 1998). Data recorded for each survey included the number of each species of crayfish, fish and amphibian captured; sampling section length, which depended on the size of the pond; sampling site location; duration of sampling effort; and habitat conditions. General population data were gathered on all species captured in seining surveys. Relative abundance was expressed as catch-per-unit of effort (CPUE), that is, the number of organisms captured per three, 5 m seine hauls. Individuals in the catch were assigned to various guilds (species composition, tolerance, trophic, and reproductive) to assess the structure and function of wetland communities.

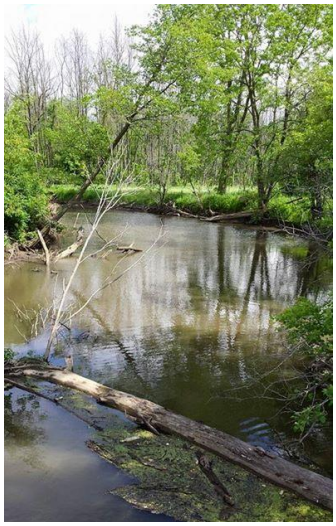
**Management Implications:**
We found that the IBI scored the most recent site condition as poorer than the original baseline assessment. The original score distribution of the index for Miller Woods was skewed to the low end of biological integrity with increased distance from Lake Michigan and proximity to edges.

*Middle Grand Calumet Lagoon, Indiana Dunes National Lakeshore is the largest of the Miller Woods subunit wetlands.*

# A Comprehensive Survey for Early Detection and Response to Invasive Species in Indiana's Lake Michigan Tributaries

**Investigator:** Thomas P. Simon, Indiana State University, Terre Haute, IN 47809 (thomas.simon@indstate.edu)

**Main Research Question and Importance:** Our goal was to conduct a comprehensive survey for early detection and response to invasive species in Indiana's Lake Michigan tributaries.



*Salt Creek is a tributary of the East Branch Little Calumet River.*

**Summary of Methods and Results**:
Fish and crayfish community structure and function in the Lake Michigan basin were determined from daytime inventories conducted between May and September 2015. Complete community sampling was required to characterize sites and determine long-term patterns in aquatic community dynamics. Electrofishing was done in an upstream direction parallel to shore for minimum distances of 50 m for at least 300 seconds (Simon and Stewart 1999; Simon and Morris 2012). All habitats encountered were sampled including riffle, run, and pools; woody debris; aquatic macrophyte beds; rip-rapped sea walls and breakwaters; bank and shoreline; and artificial substrates. Stunned crayfish and fish were netted and placed into a live well for identification, enumeration, and batch weighing. Fish were inspected for gross external deformities, eroded fins, lesions, and tumors (DELT) and released. Smaller species such as minnows, darters, and sculpins were identified to verify that no young-of-the-year of invasive species were present and then released.

**Management Implications:**
The Lake Michigan basin represents an important aquatic habitat for Northwest Indiana. The tributary watersheds form the primary connection for many Great Lake fishes and are particularly important to conserving and restoring regional native species diversity. Sites include tributaries and the main channels of the Grand Calumet, Little Calumet, Trail Creek, and Galien rivers watersheds. During the 2015 sampling 10,326 fish individuals from 74 species and 949 crayfish individuals from 7 species were collected. Four native fish species dominated—Green sunfish (n=1,478), Creek chub (n=1,235), Central mudminnow (n=1,024), and Scaly darter (n=873)—with another 4 species occurring commonly represented by White sucker (n=691), Yellow bullhead (n=682), Bluegill (n=679), and Bluntnose minnow (n=547). Exotic fish species included Round goby (n=397), Common carp (n=174), Goldfish (n=107), Brown trout (n=19), and Oriental weatherfish (n=4). During the 2015 sampling 2 non-indigenous crayfish species comprised 55.22%, while 5 native crayfish comprised 44.78%. Nonindigenous crayfish species included Rusty crayfish (n=522) and Louisiana Red swamp crayfish (n=2). No individuals of Bighead carp, Silver carp, Grass carp, or Black carp were collected, observed, or detected during the current study.

*Common carp was the most common exotic species collected during the 2015 survey.*

# Access to Research through the Great Lakes Research and Education Center

**Investigator:** Wendy W. Smith, Great Lakes Research and Education Center, Indiana Dunes National Lakeshore, Porter, IN 46304 (wendy_w_smith@nps.gov)

**Main Research Question and Importance:**
Researchers investigating natural and cultural resources and resource issues in national parks uncover new information about park resources with each investigation. The research itself as well as the information it yields is interesting to both park staff and the public, and can be critically important to park management. Unfortunately, research findings are often not communicated with park staff or the public in meaningful ways. Current research findings must be shared with these audiences to ensure the best possible resource stewardship and continued support for research in the future.

**Summary of Methods and Results:**
The Great Lakes Research and Education Center provides opportunities related to park research for resource managers, teachers, students, and the general public in and around Indiana Dunes National Lakeshore and ten other national parks in the Western Great Lakes Region. GLREC staff members work with researchers to facilitate that sharing through education, interpretation, citizen science, and outreach endeavors. These efforts involve collaboration between the National Park Service and partner organizations. Examples of potential projects include brochures and articles for newsletters and websites; distance learning presentations; conferences; webinars; videos; staff training; public workshops; teacher workshops; citizen science projects; and the development of interpretive and educational activities and programs that can be conducted by national park interpretive staffs and educators across the region.

*Volunteer citizen scientists collect data for a research project exploring the impact of climate on sugar maple sap at Indiana Dunes National Lakeshore.*

**Management Implications:**
A society that responsibly stewards its resources and heritage requires that resource management and policy be informed by scientific knowledge. It also requires that the public understands how science works and what science can reveal about threats to our natural and cultural resources. The Great Lakes Research and Education Center facilitates the use of science to manage resources and enrich visitor, local community, and employee experiences.

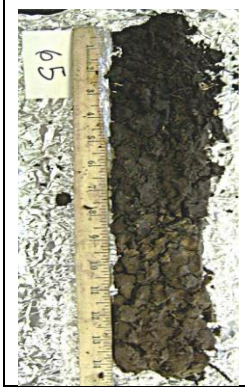
# Edaphic Analogy: A Rapid Method for Restoration Analysis and Planning Used at Indiana Dunes National Lakeshore

**Investigators:** John P. Tandarich*, Wilbur Wright City College of Chicago, IL (jtandarich@ccc.edu); Daniel Mason, Indiana Dunes National Lakeshore, Porter, IN 46304 (daniel_mason@nps.gov)

**Main Research Question and Importance:** A recent U.S. National Research Council report recommended to the Nation that certain restoration goals be met by 2012, specifically: 810,000 ha of lakes, 645,000 km of rivers and streams, and 4,100,000 ha of wetlands. Given the considerable geographic extent of these needs, it is desirable to have a rapid tool or method of landscape analysis that can assist in variable scale restoration planning. This particularly applies to Indiana Dunes National Lakeshore where restoration is ongoing.

**Summary of Methods and Results:** The authors use a method called edaphic analogy that employs correspondences of native plant communities and the classification of supporting soil series, called edaphic analogs, to supplement vegetative information and give greater spatial resolution to the vegetation boundaries found on the plats and notes of the U.S. General Land Office. As soils retain the imprint of the native vegetation under which they formed, even when that vegetation is completely removed, we used edaphic analogs with soil maps in a GIS format to extrapolate native vegetation communities over areas devoid of native plant growth, such as places where the vegetative cover has been disturbed, destroyed or replaced.

**Management Implications:** We found that, for restoration planning, edaphic analogs: 1) were the most direct means, 2) can be thematically depicted using the mapping units shown on published soil maps, and 3) could be used with soil maps to pinpoint potential areas to be searched for intact native plant communities. For specific projects, we suggest that on-site soil mapping, done at a larger scale than the published soil maps, provide the most direct and accurate input of edaphic analogs for a restoration plan. This is because the mapping units of published soil surveys contain inclusions of different soils that might be too coarse for restoration planning of small areas. We find that soil taxonomic classification to the subgroup level and native plant communities are the most useful means for extrapolating edaphic analogs regionally.

| **Sample Point 65** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Map Unit Name (Series and Phase): Pinhook mucky sandy loam | | | | | | | Drainage Class: Poor (Water Table ≤ 30.5 cm) | | | | |
| Taxonomy (Subgroup): Mollic Endoaqualf | | | | | | | Vegetation Class: Wet Savanna | | | | |
| Edaphic Analog: Wet Savana/Mollic Endoaqualf | | | | | | | Hydric Soil: Yes | | | | |
| Profile Description: | | | | | | | | | | | |
| Profile Photograph | Depth (cm) | | Soil Horizon | | Matrix Color (Munsell Moist) | | Mottle Colors (Munsell Moist) | | Mottle Abundance/Size | | Texture, Concretions, Structure, etc. |
|  | | | | | | | | | | | |
| | 0-10 | | OA | | 10YR 2/1 | | | | | | Mucky sandy loam |
| | 10-20 | | A | | 10YR 3/1 | | | | | | Sandy loam |
| | 20-25 | | EA | | 10YR 5/2 & 10YR 3/1 | | | | | | Sandy loam |
| | 25-38 | | Bg | | 10YR 4/1 | | | | | | Sandy loam |

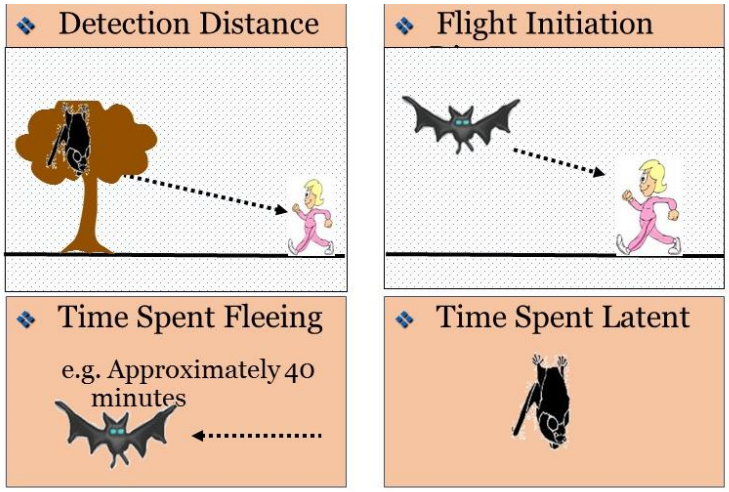
*Example description of a soil series and determined edaphic analog.*

# Simulating the Disturbance of Wildlife by Recreating Humans to Improve Park Management

**Investigator:** Patrick Andrew Zollner, Purdue University, West Lafayette, IN 47907 (pzollner@purdue.edu)

**Main Research Question and Importance:**
Human recreation on public lands has burgeoned as more people turn to the outdoors for leisure time activities ranging from mountain biking to birding, from hiking to using motorized vehicles. More than 292,000,000 visitors generated an estimated $30 billion in economic activity around National Parks in the United States alone during 2014. Though outdoor recreation has become an important part of our culture and economy, the increasing frequency of human-wildlife interactions, direct or indirect, can have serious fitness consequences for many species, thereby reducing the value of public lands for both wildlife habitat and visitors. Currently, there is lack of systematic scientific understanding of the dynamics between and within recreation and wildlife communities. Ultimately, our ability to sustain responsible recreation on public lands while maintaining the health of the natural systems therein relies on a better understanding of interactions and better tools for developing scenarios and forecasting consequences of management decisions.

**Summary of Methods and Results:**
Simulation of Disturbance Activity (SODA) is a flexible, spatially-explicit, individual-based model designed to investigate wildlife responses to disturbance by recreationists. In this talk examples of applications of SODA to learn about human wildlife conflict will be illustrated based upon a series of case studies. These case studies include the disturbance of Karner blue butterflies at Indiana Dunes National Lakeshore by pedestrians as well as implications on song birds of adding mountain bike recreation into Fort Harrison State Park. These case studies illustrate the relevance of this modelling approach to addressing real world issues in park management by illustrating how such tools can be used to compare the relative effectiveness of management scenarios such as alternative pathway designs and buffer sizes. I conclude by discussing future directions to expand the scope and relevance of this tool by explicitly incorporating empirical data from natural resources social science to inform the parameterization of more sophisticated human agents in this model.




**Management Implications:**
This work addresses a pressing need to develop tools and approaches that investigate the interactions of wildlife and human actors in a modeling environment to maximize inference and better inform management and policy decisions. Such a tool will be invaluable in identifying win win scenarios that accommodate the demands of recreating humans without compromising the status of wildlife populations.

# Quantifying Interactions of Surface and Groundwater in an Interdunal Wetland, Weiland Ditch, Indiana Dunes National Lakeshore

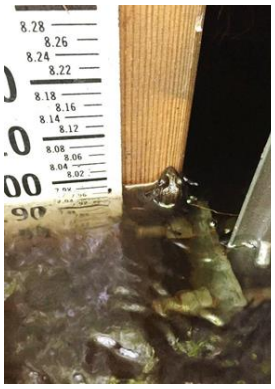
**Investigators:**
Travis R. Cole[1]* and David C. Lampe[2], U.S. Geological Survey Indiana-Kentucky Water Science Center, Indianapolis, IN 46278 ([1]tcole@usgs.gov), ([2]dclampe@usgs.gov)

**Main Research Question and Importance:**
Wetland restoration activities typically raise surface-water levels, create perennial ponds and have the potential to raise groundwater levels in neighboring areas. Monitoring of hydrologic conditions before wetland restoration allows the National Park Service and the U.S. Geological Survey (USGS) to assess baseline conditions, and to analyze possible effects on water levels and plant communities when restoration is implemented.

**Summary of Methods and Results:**
Wieland Ditch, an upstream portion of the Derby Ditch watershed, is a planned focus of wetland restoration by Indiana Dunes National Lakeshore (INDU). During parts of 2014 and 2015, hydrologic information was obtained throughout this watershed to increase understanding of surface water and groundwater interactions in and near the proposed restoration area. Water levels were continuously recorded in 15 groundwater wells, and surface-water discharge out of Wieland Ditch was calculated at a USGS stream gage downstream from the proposed restoration area. Discharge (flow volume) for Wieland Ditch was calculated from October 12, 2014 through September 16, 2015 using a stage-discharge (water level-streamflow) relationship created from direct discharge measurements at the stream gage. Transects of wells with pressure transducers were installed to measure groundwater levels and compare differences with surface-water levels near Weiland Ditch and closer to the topographic boundary of the watershed. Precise level surveys of surface-water and groundwater reference points were done and are the key to interpreting water-level gradients of less than 0.05 ft/mile that are common in local wetlands.

**Management Implications:**
A controlled surface-water release in Weiland Ditch was monitored before and after the removal of a beaver dam during a period of no rainfall. Groundwater level responses during the release indicated stream reaches where groundwater levels fluctuate directly with surface-water levels in Wieland Ditch. Additional interactions of surface-water features and groundwater were explored by comparing data collected by previous nearby studies in the Derby Ditch Watershed. Similar data have been used to calibrate hydrologic models elsewhere in INDU to evaluate areas that might be inundated or affected by restoration-related increases in surface-water or groundwater levels.

*Monitoring well # 630 in the wetland off of county road N375E south of Wieland Ditch.*



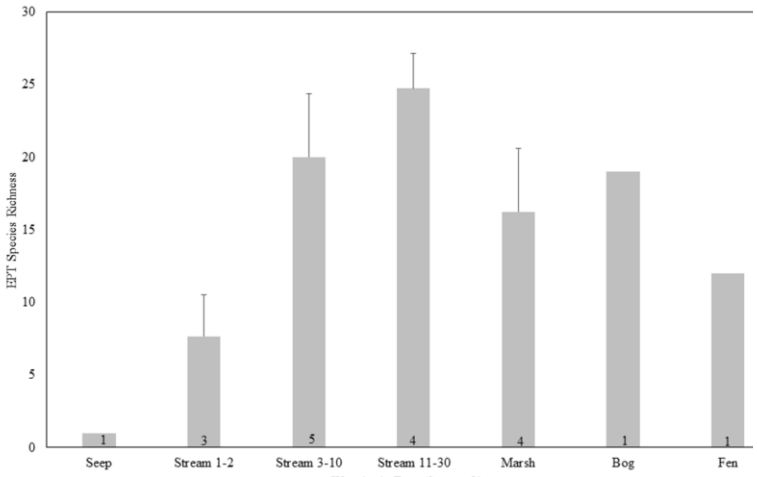
*A frog by one of the staff gages used in calculating surface water discharge from Wieland Ditch.*

# Inventory of Mayflies, Stoneflies, & Caddisflies in Indiana Dunes National Lakeshore: Comparison to Regional Species Pool

**Investigators:** R. Edward DeWalt*, University of Illinois, Prairie Research Institute, Illinois Natural History Survey, Champaign, IL 61820 (dewalt@illinois.edu); Eric J. South, University of Illinois at Urbana-Champaign, Urbana, IL 61801; Desiree R. Robertson, Field Museum of Natural History, Chicago, Illinois 60605 (drobertson@fieldmuseum.org); Joy E. Marburger Purdue University Northwest, Westville, IN (jemarbur@pnc.edu); Wendy W. Smith, Great Lakes Research and Education Center, Indiana Dunes National Lakeshore, Porter, IN 46304 (wendy_w_smith@nps.gov);Victoria Brinson, Ford Heights, IL 60411

**Main Research Question and Importance:**
United States National Parks have protected natural communities for one hundred years. One objective of National Parks is to protect unique regional fauna and flora. Indiana Dunes National Lakeshore (INDU) is a park unit along the southern boundary of Lake Michigan in Indiana, USA. While managers know vertebrates and often plants that inhabit their parks, most insect species are unknown to them. We conducted an inventory of three orders of environmentally sensitive aquatic insects (mayflies, stoneflies and caddisflies) within the park, compared assemblages across waterbodies, and then compared the list of species to lists these insects known to inhabit Indiana.

**Summary of Methods and Results:**
An inventory of 19 sites, consisting of a seep, 12 streams, four marshes, a bog, and a fen were examined for mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) (EPT taxa). Volunteers and authors collected 35 ultraviolet light traps during summer 2013 and supplementary benthic and adult sampling added species not attracted by lights or that were only present in colder months. Seventy-eight EPT species were recovered: 12 mayflies, two stoneflies, and 64 caddisflies. The EPT richness found at INDU was a low proportion of the number of species known from Indiana: caddisflies contributed only 32.7% of known state fauna, mayflies and stoneflies contributed 8.4% and 2.3%, respectively. Site EPT richness ranged from one for a seep to 34 for an 8 m-wide stream. Richness in streams generally increased with stream size. Seven new state records and rare species are reported. The number of EPT species at INDU is slightly larger than that found at Isle Royale National Park in 2013, and the community composition and evenness between orders were different.




*A comparison of EPT species richness in different types of waterbodies sampled within Indiana Dunes National Lakeshore.*

**Management Implications:**
Indiana Dunes National Lakeshore now knows where mayflies, stoneflies, and caddisflies are the richest and could institute protections against erosion and call for greater treatment of effluents from wastewater treatment plants that discharge into streams the travel through the park.

# Learning by Serving: Undergraduate Students Monitor the Efficacy of Trail Closure Methods for Indiana Dunes National Lakeshore

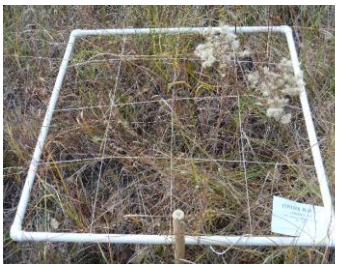
**Investigators:** Laurie S Eberhardt*, Valparaiso University, Valparaiso, IN 46383 (Laurie.Eberhardt@valpo.edu); Kimberly Swift[1], Laura A Brennan[2], and John R Kwilosz[3], Indiana Dunes National Lakeshore, 1100 North Mineral Springs Road Porter, IN 46304 ([1]Kimberly_Swift@nps.gov), ([2]Laura_Brennan@nps.gov), ([3]John_R_Kwilosz@nps.gov)

**Main Research Question and Importance:**
Management of Indiana Dunes National Lakeshore (INDU) requires stewardship of rare habitats while at the same time providing public access for recreation. The park creates designated trails for public access but often people stray from these trails and make what are called 'informal social trails'. These social trails can cross delicate ecosystems and damage fragile vegetation. At the West Beach unit of INDU, different methods have been used to close numerous social trails and enhance vegetation recovery. Monitoring of vegetation recovery on former trails is needed to determine which closure method is most effective in protecting the fragile dune habitats. We asked how trails are recovering and if such monitoring efforts can be effectively accomplished by novice undergraduate science students visiting the INDU during autumn and spring 3-hour laboratory sessions.

**Summary of Methods and Results:**
We studied the efficacy of three trail closure methods (seeded and covers, post and cable, and snow fencing) by monitoring the vegetation cover on and at edges of trails over time. Data were collected by undergraduate students from Valparaiso University during Autumn 2013 and 2015 and Spring 2014 and 2015 using simple meter-squared moveable quadrats divided into 4x4 grids. Students followed protocols to place the grids in the center of each trail and at a designated 'control' location nearby but away from each trail and then counted grids containing vegetation. All three closure methods show vegetation recovery over the period of study with seeded and covered appearing to be most consistently effective and snow fence showing the most variability perhaps reflecting the placement of snow fence on social trails in particularly exposed areas.

**Management Implications:**
Understanding which type of closure method is most effective for vegetation recovery on former social trails can help INDU make decisions about how to close future trails. In addition, involving undergraduates in a partnership to collect monitoring data on trail closure helps to engage and educate them on the importance of protecting park resources and staying on designated trails in their future visits to National Parks.

*Sampling grid on old trail showing some vegetation recovery*



*Sampling grid on control plot off trail showing expected vegetation cover in area of trail*

# Surveying Dragonfly Biodiversity at Indiana Dunes National Lakeshore

**Investigators:** Erin K. Grey[1]* and Yuri Lopez[2], Governors State University, University Park, IL 60484 ([1]egrey@govst.edu), ([2]yurilopez88@gmail.com)

**Main Research Question and Importance:**
Dragonflies are fascinating insects that can also be good indicators of water quality. They can be difficult to survey, however, given the speed of adults and the lack of good keys for their aquatic nymph stage. Our study has two goals: (1) develop and apply standardized, repeatable survey methods to measure dragonfly diversity at Indiana Dunes National Lakeshore (INDU) and (2) compare traditional and genetic survey methods to determine which most easily and accurately estimates dragonfly diversity.

**Summary of Methods and Results:**
We conducted traditional and genetic surveys of dragonfly nymphs and adults at 6 sites in INDU in summer 2015. Traditional survey methods involved dip-netting four times for aquatic nymphs and visual surveys for adults across varying lengths of time starting at 10 a.m. on warm sunny days. Genetic survey methods included barcoding specimens using the COI gene, and collecting environmental DNA then applying species-specific probes to detect the presence of three key species. Water quality parameters of temperature, pH, and dissolved oxygen were also taken prior to each survey.

Our adult survey found a total of 16 adult species across all sites, and species accumulation curves indicate that 1-1.5 hours of visual surveys on days are sufficient for capturing adult richness at a site. Additionaly, a strong positive correlation between adult species richness and water pH was found. Many nymphs were unidentifiable to species, yet overall dragonfly and damselfly nymphs appear to be more abundant in different types of water – dragonfly nymphs in warmer, well-oxygentated waters and damselfly nymphs in cooler and less oxygenated waters. Genetic analyses are still underway, but preliminary data suggest that genetic barcoding can aid substantially in the identification of unknown specimens, and that environmental DNA surveys for common species such as the Green Darner are just as accurate as traditional survey methods.

*Geological Society of America MOSAICS in Science intern and Governors State University Masters student Yuri Lopez conducting a traditional adult dragonfly survye in the Indiana Dunes National Lakeshore in summer 2015.*

**Management Implications:**
Accurately and easily surveying dragonfly and damselfly can help park scientists better gauge aquatic habitat quality and monitor changes in biodiversity over time. Here we developed standardized traditional survey methods for nymphs and adults which are relatively quick and easy to complete. Genetic survey methods, which we are in the process of testing, have the potential to be even easier and faster, plus requiring less taxonomic expertise.

# Methylmercury Pollution in the Wetlands of Indiana Dunes National Lakeshore and Northwestern Indiana: An Overview of Field Investigations

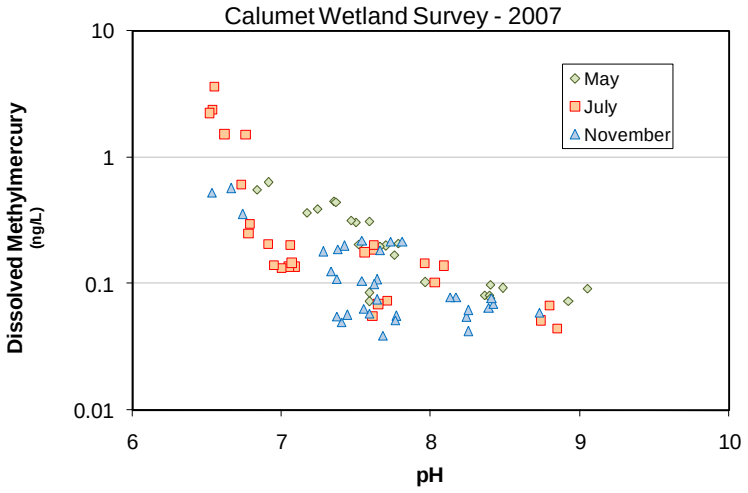
**Investigator:** Robert J.M. Hudson, University of Illinois at Urbana-Champaign, Urbana, IL 61801 (rjhudson@illinois.edu)

**Main Research Question and Importance:**
The Indiana Dunes and Northwestern Indiana have historically been subjected to high atmospheric deposition fluxes of sulfur and mercury, two elements that synergistically stimulate methylmercury production and bioaccumulation. In order to better understand how this has affected the area, my research group has conducted studies of wetlands designed to characterize the spatial and seasonal variations in methylmercury levels in their water, sediments and fish over the last decade.

**Summary of Methods and Results:**
The doctoral, masters-level, and undergraduate students who benefitted from working at Indiana Dunes National Lakeshore (INDU) observed trends that are consistent with those observed elsewhere, i.e., the highest production of methylmercury occurred in wetlands of low pH. We also found high levels of dissolved methylmercury in a restored wetland, but not in the fish there. We only found evidence for Hg levels in fish higher than EPA standards at one wetland in Gary.

**Management Implications:**
Understanding methylmercury production and bioaccumulation in specific areas of the park will help managers understand the environmental health of park resources. This work also provided crucial support for our successful efforts to develop a new method for analyzing methylmercury in environmental samples.

We are grateful to Indiana Dunes National Lakeshore and to Dr. Joy Marburger, Research Coordinator during the time we were working at INDU, for allowing us the use of the field lab and for providing access to sites within INDU.



# USGS-NPS Partnership: 20 Years of Aquatic Research in Service to the Great Lakes Region

**Investigators:** Meredith B. Nevers[1*], Murulee N. Byappanahalli[2], and Kasia Kelly[3]; U.S. Geological Survey, Lake Michigan Ecological Research Station, Chesterton, IN 46304 ([1]mnevers@usgs.gov), ([2]byappan@usgs.gov), ([3]kkelly@usgs.gov)

**Main Research Question and Importance:**
Aquatic scientists at the USGS Lake Michigan Ecological Research Station (LMERS) have a mission to help protect Great Lakes coastal ecosystems, with particular care for public lands. They have a long history of protecting and enhancing aquatic systems for visitors' enjoyment, and make a practice of looking for ways they can use their expertise to help managers care for park resources and provide safe visitor experiences.

**Summary of Methods and Results:**
LMERS aquatic research projects have ranged from direct products for resource managers across all Great Lakes parks to hands-on training in using genetic/molecular tools in recreational water quality assessment for Sleeping Bear Dunes National Lakeshore. Other efforts have been targeted to specific needs for science assessment or management strategies, including evaluating the response of benthic invertebrates to beach nourishment activities at Mt. Baldy Beach, Indiana Dunes National Lakeshore. LMERS scientists have also been involved in investigating the pathways leading to bird botulism outbreaks in Sleeping Bear Dunes National Lakeshore; the resulting research provided evidence for botulism toxin gene presence in decaying *Cladophora* algae mats. Wide-ranging comprehensive studies have been carried out in support of the National Park Service's need to evaluate the status and trends of zooplankton, phytoplankton, and benthic macroinvertebrate communities along with water and sediment chemistry in selected inland lakes of the Great Lakes Cluster National Parks. Multiple investigations of microbial ecology of riparian, beach and wetland natural habitats have benefited the National Parks by identifying sources of fecal indicator bacteria and associated ecology. Similarly, hydrodynamic modeling of river outfalls was critical to establish potential influences and sources of contaminants from river water to adjacent National Park beaches.

*USGS scientists prepare for an early morning field experiment examining sunlight inactivation of bacteria, at Portage Lakefront and Riverwalk, Indiana Dunes National Lakeshore.*

**Management Implications:**
This overview of 20 years of aquatic research highlights individual projects and demonstrates ways national park managers have benefited from this USGS-NPS partnership.