



Michigan Natural Features Inventory

Discover. Define. Deliver.

**HUMAN WELL-BEING DEPENDS ON NATURE!
THINK GLOBALLY! ACT LOCALLY!**

Annual Report 2018



MICHIGAN NATURAL FEATURES INVENTORY

A Program of Michigan State University Extension

FROM THE MNFI DIRECTOR

This year in our annual report, we focus on the dependence of human well-being on functioning ecosystems and how MNFI's work contributes to supporting that relationship in Michigan.

Many of you may not be familiar with the concept of "ecosystem services", or "nature's contributions to people" - the idea that ecosystems provide both tangible and intangible benefits to humans, such as timber, water, and medicines, as well as providing cultural and spiritual benefits. As indicated by Sir Robert Watson's accompanying letter, this relationship has gained widespread recognition and is of global concern.

While we in Michigan, like many other places worldwide, have an abundance of natural resources, the ecosystems these represent face continuing threats. The threats - climate change, habitat destruction, over exploitation - all seem like "big picture" issues. Yet, we must remember that these threats reflect the aggregation of many small actions - driving to the store for a single item, building a new house, buying food products not sustainably produced. Just as the big picture issues result from adding up small actions, solutions to these issues can also be at least partially addressed by adding up small actions - drive less, lessen your ecological footprint, buy sustainably-produced foods.

But probably most important of all is to develop your understanding of how the world works and how you affect it . . . and act accordingly. In the following pages, we examine our activities in the context of ecosystem services and how this relates to the more expansive concept of "nature's benefits to people", as well as another area of global interest, the United Nations' Sustainable Development Goals. So, read on and view our work from a slightly different perspective.

Brian J. Klatt, Ph.D., Director
Michigan Natural Features Inventory

FROM THE CHAIR OF IPBES

Biodiversity and nature's contributions to people sound, to many people, academic and far removed from our daily lives, but nothing could be further from the truth. They are the bedrock of our food, clean water, and energy. They also play a critical role in regulating our climate, air quality, floods, and pollination services, and are at the heart not only of our survival, but of our cultures, identities and enjoyment of life.

As Chair of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), I have been fortunate to work with hundreds of the world's most talented natural scientists, social scientists, scholars from the humanities, policy experts, and holders and experts of indigenous and local knowledge to synthesize the available information on the status of trends and the underlying drivers of change of biodiversity on a global scale. The results are very concerning.

Biodiversity - the essential variety of life forms on Earth (genes, species, and ecosystems) - continues to decline in every region of the world, significantly reducing nature's capacity to contribute to people's well-being. This alarming trend endangers economies, livelihoods, and the quality of life of people everywhere. The best available evidence, gathered by the world's leading experts, points us now to a single conclusion: we must act to halt and reverse the unsustainable use of nature - or risk not only the future we want, but even the lives we currently lead.

Fortunately, the evidence also shows that we know how to protect and partially restore our vital natural assets. Biodiversity can be conserved and sustainably used with more integrated multi-sectoral policies, institutional arrangements, adequate financing, use of appropriate technologies, and behavior changes leading to sustainable production and consumption. Equally important are more collaborative, inclusive, participatory, and decentralized governance systems, involving governments, the private sector, and civil society. It is important to recognize that the loss of biodiversity, like climate change, is not simply an environmental issue, but a development, economic, social, security, moral, and equity issue.

Organizations like the Michigan Natural Features Inventory are on the front lines of the effort to conserve and restore our natural systems. By inventorying what biodiversity resources exist, documenting changes to those resources, assessing threats, and conducting research into how our ecosystems function, they help develop the knowledge that can inform policymakers as to ways to stem the decline of biodiversity. I am grateful to MNFI for its direct participation in the IPBES Assessment for the Americas (<https://www.ipbes.net/assessment-reports/americas>). Without the voluntary participation of scientists from organizations like MNFI, the production of the four regional assessments, the land degradation and restoration assessment, and the upcoming global assessment would not be possible. We are facing a global crisis that has local ramifications, but working together, we can strive to address it.

The words of Rene Dubos ring truer today than ever before, "Think globally, act locally".

Sir Robert T. Watson, Chair
Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems (IPBES)



Allegan State Game Area
Photo by: Aaron Kortenhoven

Our Mission

To guide the conservation and stewardship of Michigan's biodiversity by providing the highest quality scientific expertise and information.

Our Vision

To be the authoritative source of information on biodiversity that is widely used to conserve Michigan's unique natural heritage for current and future generations.

MSU Extension Mission

Michigan State University Extension helps people improve their lives through an educational process that applies knowledge to critical issues, needs and opportunities.

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On the Cover

Ecologist Joshua Cohen at Scott Point Wooded Dune and Swale Complex in the Lake Superior State Forest in Mackinac County

Photo by: Clay Wilton

MICHIGAN STATE UNIVERSITY | Extension

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THE YEAR IN REVIEW: 2018 PRESENTATIONS, OUTREACH, AND EDUCATION

Professional Groups

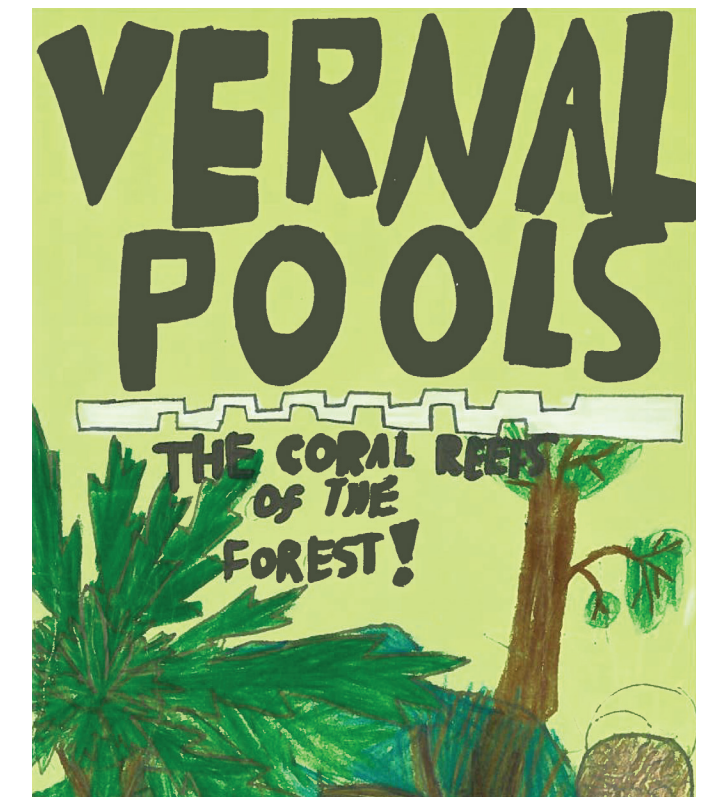
- Eco-Action Conference, Lake Michigan College
- Ecological Society of America Members, New Orleans, Louisiana
- Kellogg Biological Station Workshops
- Michigan Eastern Massasauga Working Group
- Michigan Department of Environmental Quality, Aquatic Nuisance Control Program
- Michigan Department of Natural Resources – Wildlife Division
- Michigan Department of Natural Resources – Wildlife Division and Forest Resources Division
- Michigan Department of Natural Resources and Michigan Department of Environmental Quality, Michigan State University Extension
- Michigan State University Extension Educators and Specialists
- NatureServe, Lansing, Michigan
- Tribal Natural Resource Departments, Bay Mills, Michigan
- US Fish and Wildlife Service, Professional Biologists and Researchers, Milwaukee, Wisconsin
- US Fish and Wildlife Service, Science Team and Midwest Marsh Bird Working Group Joint Venture, Milwaukee, Wisconsin
- US Fish and Wildlife Service Working Group

Conservation Organizations and Interested Citizens

- Audubon Society of Kalamazoo
- CISMA (Cooperative Invasive Species Management Area) Partners and Municipal Staff, St. Johns, Michigan
- Conservation Organizations; Federal, State and Local Governments; and Tribal Natural Resource Departments, Charlevoix, Michigan
- Conservation Stewards Program, Algonac State Park, Algonac, Michigan
- Conservation Stewards Program, Pierce Cedar Creek Institute, Hastings, Michigan
- JLW (Jackson, Lenawee and Washtenaw) CISMA, Jackson Master Gardeners, Men’s garden club, the Stewardship Network and Jackson County Conservation District, Jackson, Michigan
- Master Gardeners and Other Groups, South Haven, Michigan
- Michigan Botanical Club, Kalamazoo, Michigan
- Pierce Cedar Creek Institute, Hastings, Michigan
- Muskegon/Southwest Michigan Vernal Pool Patrol, Lansing Community College
- Saginaw Bay CISMA, Saginaw Bay, Michigan
- Stewardship Network Resource Managers, Land Conservancy Members and Academics, Lansing, Michigan
- Vernal Pool Patrol, West Olive, Michigan
- Washtenaw County/Southeast Michigan Vernal Pool Patrol, Lansing Community College
- Washtenaw County Conservation Stewards, Independence Park, Whitmore Lake, Michigan
- Washtenaw County Conservation Stewards, Saline Liberty School, Joan Rodman Plant Preserve, Lodi Township, Michigan
- Washtenaw County Conservation Stewards, Sharon Mills City Park, Nan Weston Nature Preserve, and Leonard Preserve, Manchester, Michigan

Students and Teachers

- Michigan Science Teachers Association Annual Conference, Lansing, Michigan
- Michigan State University Botany Class
- Michigan State University Wetland Ecology Class
- Michigan State University Class FW 419 Applications of Geographic Information Systems to Natural Resources Management
- Michigan State University Forestry High School Program
- Middle and High School Science Teachers, Gibraltar, Michigan
- Voyager Elementary School, 5th Graders, Howell, Michigan



Above: Vernal Pools booklet created by Adyson Sykes
Left: Botanist Phyllis Higman discussing seed collection with a Detroit teacher at Lake Erie Metropark in Wayne County
Photo by: Daria Hyde

MNFI Student Project on Vernal Pools

“I enjoy everything about learning about Vernal Pools. They can spark anybody’s interest and make them want to find out [more] immediately! The impact it had on me (and probably many others) made me think about how many things in this world are hidden (like the vernal pool) but can only be found if someone cares. A lot like all of the people out there who want to protect vernal pools and the life inside of them!”

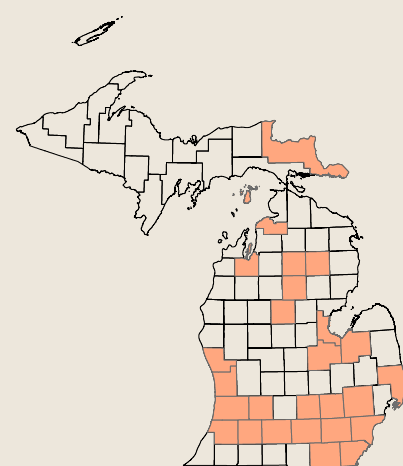
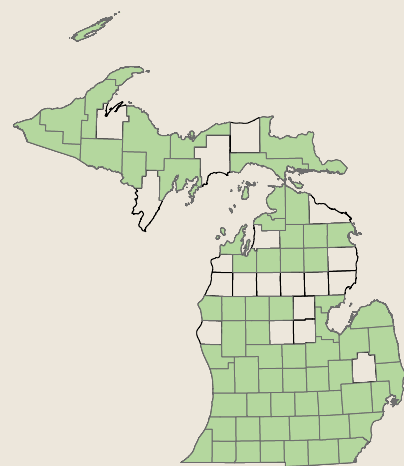
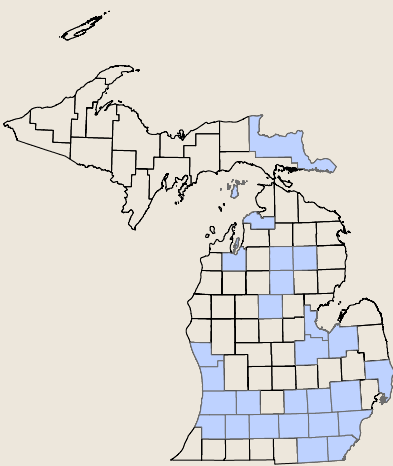
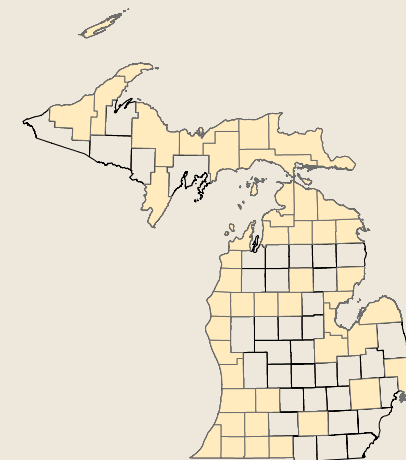
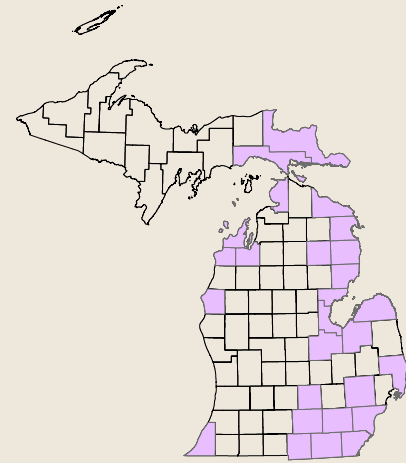
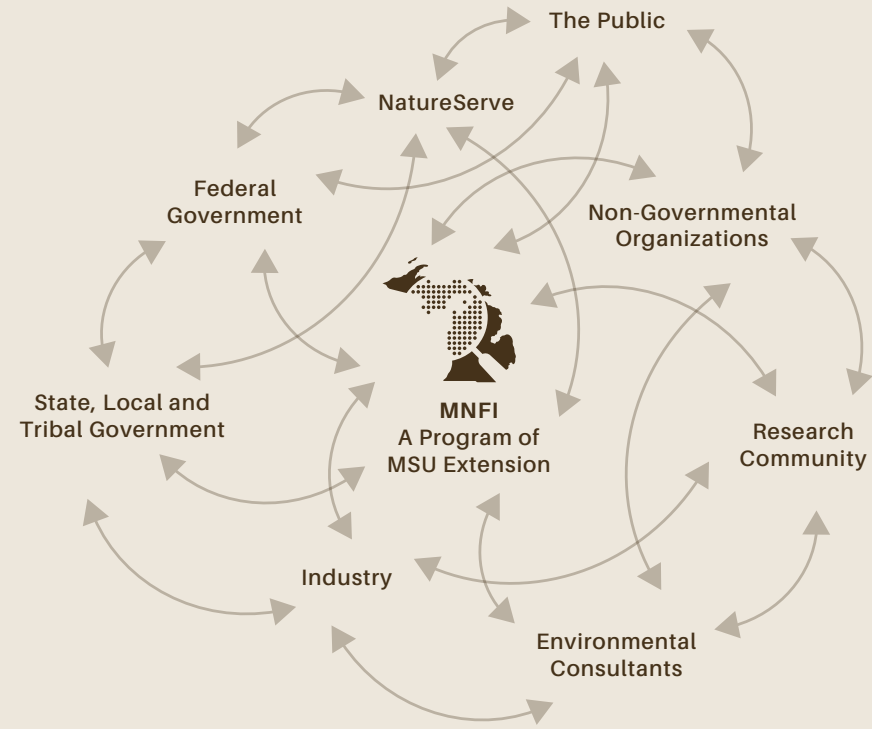
Adyson Sykes, 5th Grade Participant

“Our 5th grade students were first introduced to Vernal Pools when Ms. Daria Hyde visited us. Instantly, I saw their curiosity sparked when learning of the important animals and biodiversity that these wetlands provided. As they continued their research, their fascination only grew and grew as they learned that their real world audience would be scientists from Michigan State University. Learning about Vernal Pools gave my students valuable research skills and motivation to help our local ecosystems and animals. I am excited for them to see a Vernal Pool in real life and truly connect the information from their research to their senses. Once they experience the magic of these ecosystems, we can then become true activists and conservationists.”

**Anthony Bonanni, Teacher
Voyager Elementary School, Howell, Michigan**

59 Projects, More Than 150 Partners, and the General Public

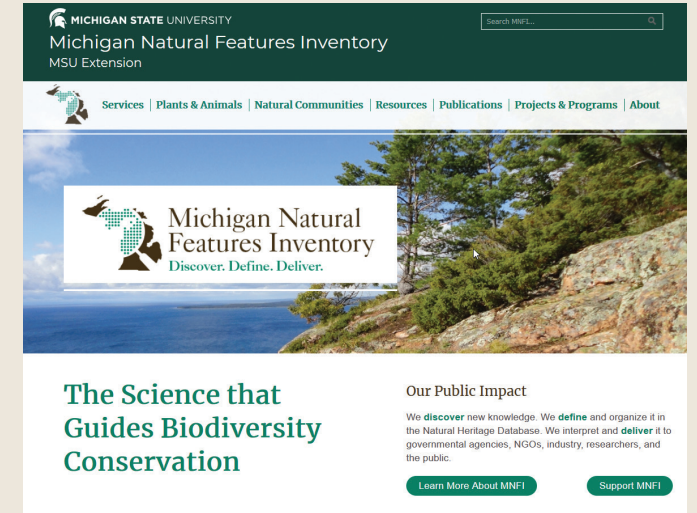
Our work includes Surveys, Rare/Threatened/Endangered Species Inventories, Habitat Assessments, Invasive Species Monitoring, Land Use Planning, and Citizen Science.



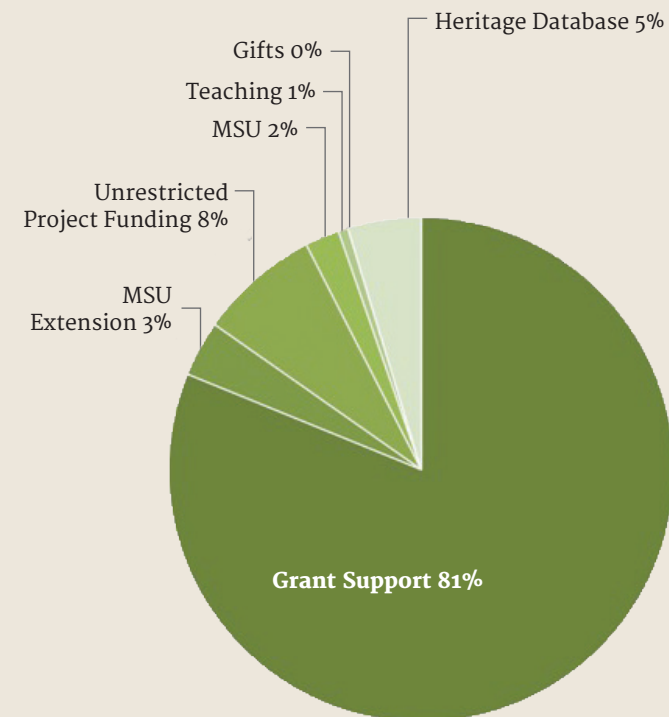
■ Invasive Species
 ■ Research
 ■ Partnerships
 ■ Planning
 ■ Education and Outreach

The MNFI Website Has a New Look!

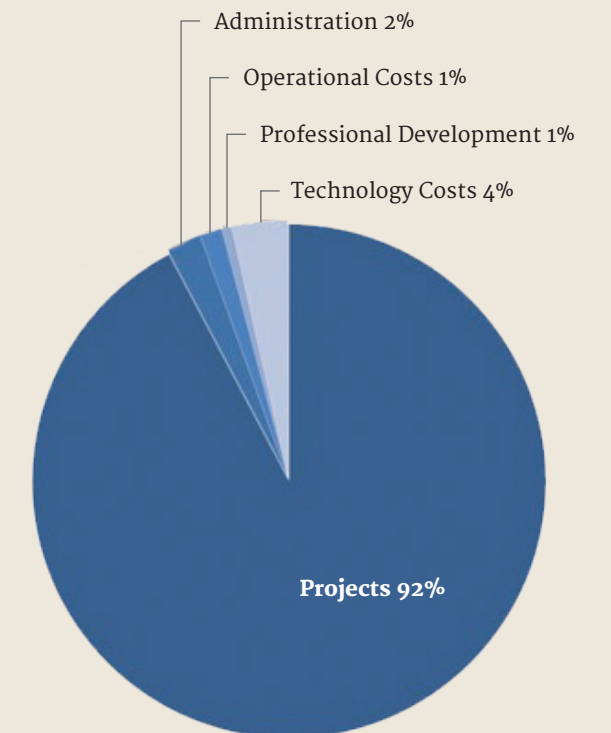
- Access to all the information you are used to seeking!
- Improved access for the general public!
- Additional information and resources!
- Check it out: <https://mnfi.anr.msu.edu/>



Funding: \$4,232,950



Expenses: \$4,201,058



THE NATURAL HERITAGE DATABASE

In 2018, the database grew to 19,809 records with a net increase of 767 records.



The database includes records for federally listed species

Federal Endangered (LE): Any species in danger of becoming extinct throughout all or a significant portion of its range—legally protected by the Endangered Species Act
18 Species, 547 Records

Federal Threatened (LT): Any species at risk of becoming endangered within the foreseeable future—legally protected by the Endangered Species Act
11 Species, 753 Records

(above)
 Huron Pines AmeriCorps Member Kailyn Atkinson setting turtle traps at The Nature Conservancy's Squaw Bay Preserve in Alpena County
 Photo by: Yu Man Lee

Featured Listed Species



Blanchard's Cricket Frog
(Acris blanchardi)

T-Michigan Threatened

At 0.6-1.5" long, this small frog's distinctive breeding call consists of a rapid series of metallic clicks. It inhabits the open edges of permanent water bodies, and is considered to be the most aquatic of North American treefrogs. Wetland creation or restoration as well as the avoidance of chemical pollutants from adjacent agricultural or developed areas help protect this threatened species.



Dwarf Lake Iris
(Iris lacustris)

LT - Federal Threatened
T - Michigan Threatened

The deep blue, iris-like flowers grow in dense, 6" clumps along the calcareous shores of the Great Lakes in Northern Michigan. This low-growing perennial with shallow rhizomes flowers mostly in semi-open old beach ridges or behind open dunes. Shoreline development and off-road vehicle use have caused disturbance and destruction of habitat.



Eastern Elliptio Mussel
(Elliptio complanata)

SC-Michigan Special Concern

Growing up to 5" in length, the Eastern elliptio mussel is rare in the state. The few documented populations are found in the Upper Peninsula and the northern part of the Lower Peninsula in stable shoals of lakes and river-lakes. Their presence is usually an indicator of good water quality. They face threats such as invasive species, habitat loss, and water quality alterations.



Northern Long-Eared Bat
(Myotis septentrionalis)

LT - Federal Threatened
SC-Michigan Special Concern

This medium-size bat at 3-3.7" long with a 9-10" wingspan is distinguished by its long ears. This species has dramatically declined due to white-nose syndrome, a disease which has killed millions of bats across North America. Bats provide ecological services to humans by eating insects, which can harm agricultural crops. Their guano (droppings) provide nutrients to other species.



Prothonotary Warbler
(Protonotaria citrea)

SC-Michigan Special Concern

Like most songbirds, the Prothonotary warbler sings most actively near sunrise in their floodplain/swamp forest habitat. Bright golden yellow on the head, breast, and belly, and white undertail coverts make it easy to spot. Found mostly in the southern half of the Lower Peninsula, it is the only warbler in Michigan to nest in cavities left in older trees. Preservation of habitat will help protect this species.



Secretive Locust or Michigan Bog Grasshopper
(Appalachia arcana)

SC-Michigan Special Concern

It is mostly the females who are secretive, remaining hidden lower down in trees and shrubs. The males can be found sunning at the tips of branches of leatherleaf and on trunks and branches of pine and tamarack mid-morning or early evening. This short-winged grasshopper does not sing or fly. It is a Michigan endemic, found nowhere else in the world. It occurs only at about 30-40 locations in the Grayling Outwash Plains region of the Northern Lower Peninsula.

(top to bottom)
 Photo by: Andy Reago & Chrissy McClarren via Flickr, Joshua Mayer via Flickr, Peter Badra

(top to bottom)
 Photo by: U.S. Fish and Wildlife Service, Aaron Kortenhoven, David Cuthrell

Explore Michigan's Rare Species and Natural Communities at: mnfi.anr.msu.edu

IT'S GLOBAL – IT'S LOCAL

HUMAN WELL-BEING DEPENDS ON NATURE FUNCTIONING WELL

International Response to a Global Issue

The immense variety of living species, collectively known as biodiversity, is fundamental to human survival – physically, culturally, and psychologically. Nature contributes to people, and their well-being, in material, non-material and regulating ways, providing habitat for wildlife, food, medicine, shelter, and wide variety of other benefits, including support for jobs and the economy. While not all of nature's benefits can be cast in terms of dollars, especially when considering cultural benefits, the economic value of those that can have been valued in the trillions of dollars on a global scale. The value of ecosystem services to people for the entire Americas region is estimated at \$24.3 trillion (equivalent to the gross domestic product). Of that, \$5.3 trillion is attributable to the United States.

In its quest to strengthen the interface between science and policy, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), an independent body consisting of individual countries with the support of the United Nations, began work in 2014 on four major regional assessments of the status and trends of biodiversity in Africa, the Americas, Asia and the Pacific, and Europe and Central Asia.

MNFI Director Brian Klatt joined more than 1,000 experts worldwide to glean and assess information from thousands of scientific studies and governmental, indigenous and local knowledge sources. MNFI had a direct role in the Assessment for the Americas, with Dr. Klatt leading development of the technical report chapter on assessing future trends of biodiversity and ecosystem services. He also served as a primary author on the report's Summary for Policy Makers and helped establish critical definitions as part of the IPBES glossary team.

Limestone Bedrock Lakeshore in Lake Superior State Forest on Drummond Island in Chippewa County
Photo by: Jesse Lincoln

Summary reports for policymakers for each region present important key messages, offer background information, and provide examples of policy options, which include enabling factors and country-level challenges. The reports were approved by the 129 member nations on March 24, 2018, in Medellin, Colombia. The full IPBES regional reports provide comprehensive in-depth information and conclusions about each region's land-based, freshwater and coastal biodiversity, as well as the state of ecosystem functioning and nature's contributions to people (NCPs).

The Americas Regional Assessment

Endowed with much greater capacity than the global average to contribute to human quality of life, the majority of countries in the Americas also use nature more intensively than the global average and exceed nature's ability to renew itself.

Some areas of the Americas have made progress in stemming the rate of declining biodiversity and ecosystem conditions and the many species at high risk of extinction. Trends in population and demographics, economic growth, habitat degradation, human-induced climate change, and air pollution are just some of the drivers impacting biodiversity and ecosystems. Many approaches have been used to address these drivers. Some are effective, some ineffective, and many are hampered by inconsistent governance.

From Global to Local

While Michigan is not addressed specifically in the report, it is located in the vast temperate and boreal forests and woodlands of the United States and Canada and is included in the treatment of the Laurentian Great Lakes. The state enjoys high biocapacity and access to the Great Lakes, which account for 21 percent of the earth's surface fresh water.

Dr. Klatt concludes that the "take home" message from the assessment is a mixture of good and bad news, reflecting the complexity of the natural world and the trade-offs inherent to the various ecosystem services nature provides.

Thus, while forested area in Michigan has increased in the last 50 years, diversity of those forests is less than what was originally found in the state. While modern forestry practices focus on sustainable production of wood and wood products, modeling suggests that diversity will continue to be impacted. The net loss of wetlands in Michigan has vastly decreased, but the quality of the remaining wetlands continues to be impacted, and constructed wetlands (i.e. mitigation wetlands) do not provide the same level of functions as natural wetlands.

So too, while point-source pollution of the Great Lakes has been enormously decreased, both the Great Lakes and inland surface waters continue to be impacted by invasive species and agricultural runoff. Finally, agroecosystems have contributed enormously to human well-being by supplying food. They are large source of nutrient enrichment to surface waters and negatively impact soil formation.

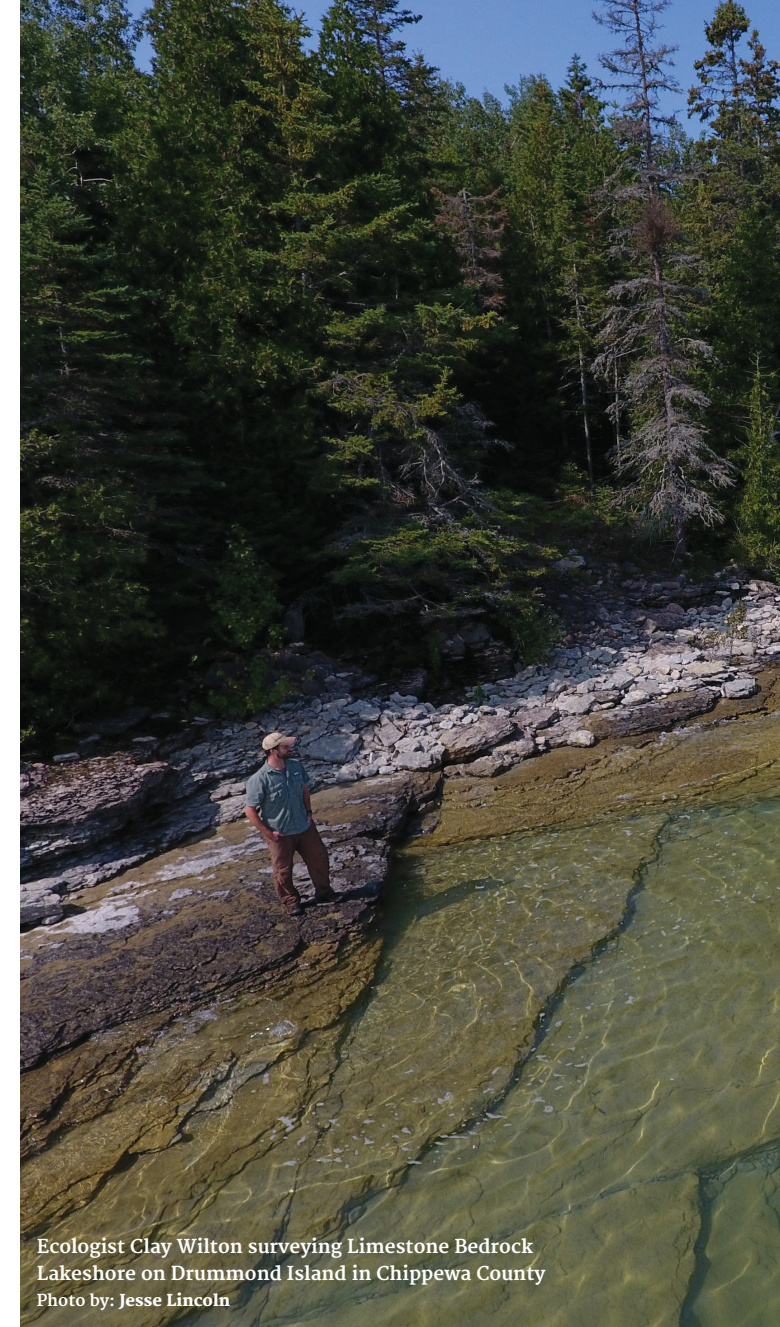
Increasing global demand for food, water and energy intensifies the ecological footprint of the Americas. Without sustainable practices, the negative consequences for NCPs will impact quality of life and the availability of future options.

MNFI Discovers, Defines and Delivers

Nature's Contributions to People (NCPs) and Sustainable Development Goals (SDGs) set a framework for policymakers to make informed decisions with impact on the environment.

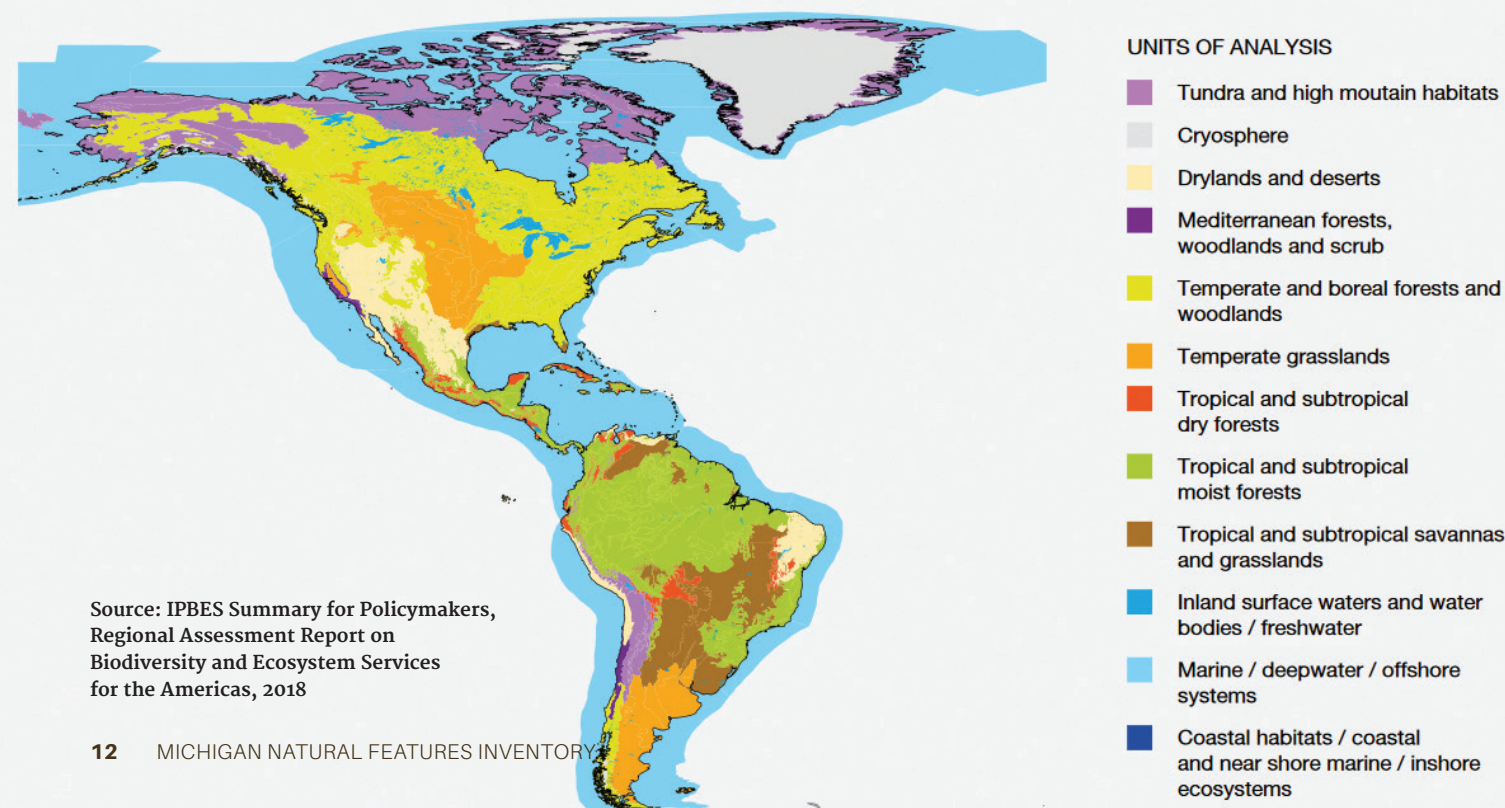
From its research, field work, and stewardship of the Natural Heritage Database, MNFI delivers scientific information to governmental and non-governmental agencies, the private sector and their environmental consultants, fellow researchers, the public, and the NatureServe Network international database.

As with the collective effort of the hundreds of IPBES scientists, working with a wide range of partners from many disciplines, organizations, and perspectives, MNFI's research, consulting services, and conservation planning services inform decisions with impact on biodiversity and ecosystems.



Ecologist Clay Wilton surveying Limestone Bedrock Lakeshore on Drummond Island in Chippewa County
Photo by: Jesse Lincoln

Figure SPM 2 Units of Analysis of the Americas assessment. Source: Adapted from Olson et al. (2001), World Wildlife Fund (2004 and 2012), and Marine Regions (2016).⁹



Source: IPBES Summary for Policymakers, Regional Assessment Report on Biodiversity and Ecosystem Services for the Americas, 2018

Setting Sustainable Development Goals

In 2015, all UN member states adopted 17 Sustainable Development Goals (SDGs) as part of its 2030 Agenda for Sustainable Development, which provides a shared blueprint for peace and prosperity for the people and the planet. The SDGs are a call to action for global partnership to provide strategies to deal with the intersecting issues of humans and nature.

- | | |
|---|---|
| 1. No Poverty | 10. Reduced Inequalities |
| 2. Zero Hunger | 11. Sustainable Cities and Communities |
| 3. Good Health and Well-being | 12. Responsible Consumption and Production |
| 4. Quality Education | 13. Climate Action |
| 5. Gender Equality | 14. Life below Water |
| 6. Clean Water and Sanitation | 15. Life on Land |
| 7. Affordable and Clean Energy | 16. Peace, Justice, and Strong Institutions |
| 8. Decent Work and Economic Growth | 17. Partnerships to Facilitate SDGs |
| 9. Industry, Innovation, and Infrastructure | |

DISCOVERING, DEFINING, DELIVERING

Nature's Multiple Contributions to People



A marsh wren at St. John's Marsh in St. Clair County
Photo by: Aaron Kortenhoven

Nature by Nature is Complex and Interrelated

So, it should not be surprising to find that any given ecosystem, plant community, or species can provide benefits in more than one of the three groupings of Nature's Contributions to People (NCPs): material, non-material, and regulating.

Michigan's wetlands, for example, provide benefits in all these categories. They are critical to fish spawning and waterfowl breeding, which support populations of both game and non-game species, i.e., material benefit. From a non-material standpoint, they are important to our state's tribal residents in maintaining cultural identity, such as through harvesting of wild rice. And they are important in regulating various processes, such as capturing sediment and contaminants before they enter surface waters.

It is for these benefits, and many others (recreation, aesthetics, education, etc.) that legal protection is extended to many wetlands in Michigan. This legal protection is the main reason why the preservation of North American wetlands was recognized as one of the bright spots in the IPBES reports.

Recognition that Michigan's natural areas provide a wide array of ecosystem services is integral to management of those areas by the Federal government, state agencies, land conservancies, municipalities, conservation organizations and the public.

Nature's Contributions to People

Material Contributions:

- Food and feed
- Materials and assistance
- Energy
- Medicinal, biochemical and genetic resources

Non-Material Contributions:

- Learning and Inspiration
- Supporting identities
- Physical and psychological experiences

Regulating Contributions:

- Maintenance of options
- Climate regulation

- Regulation of freshwater quantity, flow and timing
- Regulation of freshwater and coastal water quality
- Regulation of hazards and extreme events
- Habitat creation and maintenance
- Regulation of air quality
- Regulation of organisms detrimental to humans
- Pollination and dispersal of seeds and other propagules
- Regulation of ocean acidification
- Formation, protection and decontamination of soils and sediments.

One of MNFI’s long-term projects is the Integrated State Land Inventory for the Michigan Department of Natural Resources (see story on Muskegon State Game Area). The word “integrated” reflects the fact our state lands are managed for many uses: preservation of rare species like the Kirtland’s Warbler, but also for timber, game, camping, hiking, sightseeing (who doesn’t enjoy Michigan’s fall colors?!), etc. Of course, maximizing the benefits through land management “is the trick”. Multiple benefits frequently breed competing interests, which is why it is so important to have the best scientific information available to everyone involved.

The Answers are in the Details

State Game Areas Provide Important Ecosystem Services

The 15,691-acre Muskegon State Game Area is public land acquired through tax reversion and revenue from hunting licenses. The area is managed to promote habitat of game species, but also to support significant high-quality natural communities, provide myriad benefits to non-game species, and offer critical ecosystem services. These services include flood mitigation, maintenance of water quality for Muskegon Lake, and the protection of the economically-significant fisheries that rely on the health of the river. Its extensive natural cover and high-quality ecosystems protect and maintain the contributions to people provided by those ecosystems.

These projects support Sustainable Development Goals (SDGs):

- #3 Good Health and Well-being
- #6 Clean Water and Sanitation
- #9 Industry, Innovation, and Infrastructure
- #11 Sustainable Cities
- #12 Responsible Consumption and Production
- #13 Climate Action
- #14 Life below Water
- #15 Life on Land
- #17 Partnerships to Facilitate SDGs

New Data Informs Management Decisions

MNFI conducted an in-depth inventory of this area for the Michigan Department of Natural Resources in order to provide data, assessments, and recommendations to best manage it. Comprehensive site summaries were conducted for 12 varied natural communities. Of the ten new ones identified, all are vulnerable or imperiled by factors such as altered hydrology, forest fragmentation, protracted fire suppression, and invasive species.

Seventeen vernal pools were also identified. These “coral reefs of the forest” provide a nursery for organisms at the base of the food chain.

MNFI conducted surveys of rare animals, including birds, reptiles and amphibians, and mussels. The surveys revealed occurrences of four rare animals and eight rare plants not previously documented.

The study concluded with recommendations for management of: buffers between natural communities, prescribed burns, tree maturation, subcanopy treatment, invasives, and damage from heavy equipment or off road vehicles.

Integrated Inventory Project

Project Partners

- MDNR Wildlife Division
- MNFI

MNFI Team

- Peter J. Badra
- Tyler J. Bassett
- Joshua G. Cohen, *Principal Investigator*
- Ashley A. Cole-Wick
- David L. Cuthrell
- Helen D. Enander
- Rachel A. Hackett
- Brian J. Klatt
- Aaron P. Kortenhoven
- Yu Man Lee
- Jesse M. Lincoln
- Michael J. Monfils
- Rebecca L. Rogers
- Logan M. Rowe
- Clay M. Wilton

Setting a Course for Marsh Bird Conservation

Wetland Birds in Decline

Much remains unknown about the best approach to conserve marsh birds. The goal of MNFI’s project was to evaluate marsh bird use of wetlands managed primarily for waterfowl using data from surveys in Michigan, Ohio, and Wisconsin. Using aerial imagery, wetland areas at 726 survey points in the three states were categorized as impounded (where levees and structures control the water level) or unimpounded. The study also considered surrounding land cover variables, such as emergent wetland, developed open space, open water, and upland forest.

Recommending a Long-Term Experimental Approach

MNFI found significantly greater abundance, naïve occupancy, and model-estimated occupancy in impounded compared to unimpounded wetlands for most of the 12 species examined. These included the Pied-billed Grebe, American Bittern, Least Bittern, Virginia Rail, American Coot, Sandhill Crane, Marsh Wren, and Swamp Sparrow.

More study is needed to determine the factors driving occurrence patterns, best management strategies, and their effects on the various bird populations. Recommendations included documenting recent management actions at survey points, increasing the use of volunteers to collect environmental

Marsh Bird Use of Impounded and Unimpounded Wetlands of the Great Lakes Region: An Assessment to Inform Future Management and Monitoring

Project Partners

- MSU Department of Fisheries and Wildlife
- Midwest Avian Data Center
- Ohio Department of Natural Resources
- Point Blue Conservation Science
- Wisconsin Department of Natural Resources
- Citizen Scientists
- US Fish and Wildlife Service (funding)

MNFI Team

- Michael J. Monfils, *Principal Investigator*

and habitat information, and developing an experimental management and monitoring program. As part of the final report, MNFI provided a conceptual design for the monitoring program.

Ongoing Study of Pollinators

Wild bees help pollinate Michigan’s billion dollar agriculture industry. Work continued in 2018 to record occurrence, restoration of habitat, and assessment of management actions for two declining species: the Yellow-banded bumble bee and the Rusty-patched bumble bee.

Butterflies are also important pollinators. Ongoing studies of Mitchell’s Satyr, Poweshiek Skipperling, Swamp Metalmark and Karner Blue butterflies document occurrences and assess threats to habitats critical to their survival.



Northern Wet Meadow on Beaver Island in Charlevoix County
Photo by: Tyler Bassett

DISCOVERING, DEFINING, DELIVERING Nature's Regulating Contributions to People

Ecosystem services, by definition, result from processes: soil formation, carbon storage, stormwater storage, groundwater recharge/discharge, sediment capture, shoreline stabilization, habitat creation, etc. These processes are inherent in the ecosystem itself and regulate a related process that produces benefits. Carbon storage relates to climate change mitigation, stormwater storage to downstream flood protection, sediment capture to water quality protection. Although some of these processes result in benefits outside the ecosystem, some processes remain within it and help maintain the ecosystem itself.

The simple fact that plants grow results in creation of wildlife habitat that may or may not reinforce the process. Fruit-producing shrubs attract birds which disperse the shrubs seeds near or far. These same shrubs also attract herbivores that may decimate the shrubs in harsh winters. It is important to understand the processes within ecosystems in order to manage them for the long-term. Read more below as to the fascinating role of fire in regulating ecosystems.

Photo by: Southwest Michigan
Land Conservancy

Fire is a Friend. . . to Ecosystem Regulation

Historically speaking, fires caused by lightning and humans provided essential regulation of several Southern Lower Michigan ecosystem types. Fires reduce colonization by trees and shrubs, foster regeneration of fire-dependent species, and maintain nature's open structure. For example, suppression of fire causes wetlands to convert to shrub-carr and swamp forests. Oak savanna and prairie ecosystems become closed-canopy forest, where shade-tolerant species regenerate but oak trees do not. Such changes significantly reduce species and structural diversity.

Rx: "Prescribed Burns"

Human-managed burns help provide essential regulation to natural areas by:

- Decreasing the cover of invasive woody species
- Increasing the cover of native grasses and forbs
- Reducing litter levels, allowing sunlight to reach the soil surface and stimulate seed germination and plant establishment
- Elevating plant nutrients such as nitrogen, phosphorus, potassium, calcium, and magnesium
- Increasing plant biomass, flowering, and seed production
- Rejuvenating seed banks to help maintain species diversity
- Protecting fire-dependent host plants for rare insects and critical habitat for game species
- Promoting regeneration of desired tree species

Where to Burn?

MNFI worked with staff from the Michigan Department of Natural Resources Wildlife Division to develop an assessment process for prescribed burns for lands under their management.

The assessment model incorporates variables from three scales:

- Landscape level: physiographic region, surficial geology, and circa 1800 vegetation
- Stand level: fire frequency, fire dependence, departure from historic disturbance regime, aspect slope, natural community element occurrence, stand age, and stand size
- Within-stand level: species and rare species occurrence data

Fire need scores were assigned to 18,654 stands. Information at this level allows for aggregation to larger scales, such as groups of stands, compartments, state game areas, and regions. The model generates summary graphics showing the proportion of fire need scores by acreage and management area. With this information, resource managers can now answer the question.

This project supports Sustainable Development Goals (SDGs):

- #3 Good Health and Well-being
- #4 Quality Education
- #12 Responsible Consumption and Production
- #15 Life on Land
- #17 Partnerships to Facilitate SDGs

Prescribed Fire Needs Assessment: 2018 Activity Report

Project Partners

- MDNR Wildlife Division
- MNFI

MNFI Team

- Joshua G. Cohen, *Principal Investigator*
- Clay M. Wilton
- Helen D. Enander



Above: Matthew Lewis of Michigan Aerospace Corporation collecting imagery to identify spotted knapweed within Open Dunes at Wilderness State Park
Photo by: Josh Cohen

Finding and Analyzing Invasive Species

Threats to Ecological Integrity

The establishment and spread of invasive species degrade native biodiversity by altering an ecosystem’s structure and function; displacing critical habitat for native species; interrupting food webs; altering soils, hydrology, and disturbance regimes; compromising pollinator services; changing microclimates; despoiling recreational resources; and degrading the economy. The environmental cost within the United States has been estimated at more than \$120 billion per year.

Michigan’s globally rare, coastal natural communities are vulnerable to this threat and are a high priority for stewardship. Long-term monitoring of these ecosystems

offers the opportunity to detect invasive species early enough to identify them and initiate rapid response. It can also gauge the efficacy of management actions. Current on-the-ground monitoring is costly and time-consuming, as well as potentially harmful to fragile ecosystems.

Drones: A Gift to Research

New drone technology offers a remote sensing alternative. MNFI conducted a comprehensive study of uncrewed aircraft systems (UAS) and machine learning to monitor for invasive species within rare and Great Lakes endemic coastal ecosystems. The goal was to develop a systematic, effective,

efficient, repeatable, affordable, and autonomous monitoring protocol that allows for easy deployment, flexible mission planning, and the acquisition of data that can be tailored to the need and mapped with precision.

The team utilized low cost drones, high-resolution, visible spectrum imagery, and deep learning algorithms. The unique partnership between MNFI and Michigan Aerospace Corporation (MAC) brought together scientists with expertise in ecology, biodiversity conservation, computer programming, remote sensing, and deep learning. Through this project, MNFI and MAC developed a novel but scientifically credible and affordable method for rapidly and precisely monitoring invasive plant species in some of the Michigan’s highest priority stewardship sites.

The monitoring platform comprises:

- UAS capable of collecting high-resolution imagery in a precise and repeatable manner,
- Software enabling ecologists to annotate this imagery to identify invasive plant species of interest,
- Neural network-based algorithms for identifying targeted invasive plant species in the images, and
- Software for generating georeferenced probability maps of invasive plant species infestations.

These site specific georeferenced maps quantify invasive plant species density and distribution and provide resource managers with actionable insight to gauge risk to the site, plan biodiversity restoration, and evaluate the efficacy of control efforts.

Taking the Study of Michigan’s Dunes to the Next Step

Michigan’s iconic dunes provide significant non-material as well as regulating NCPs. These rare and beautiful coastal ecosystems are critical components of the state’s economy, cultural identity, and recreational assets.

Work continued in 2018 on the coast resiliency project. The research, lessons, and GIS methodology developed in the study of Northwest Lower Michigan coastal dunes was applied to the rest of the state’s shoreline. As a result, the state has the best available information on the extent and diversity of sand dunes, a prototype methodology to measure the health of an individual dune system, and health index scores for 18 dune sites along Lake Michigan. The study also generated spatial information on erosion for the entire Lower Peninsula and a portion of the Lake Superior shorelines.

This project supports Sustainable Development Goals (SDGs):

- #3 Good Health and Well-being
- #4 Quality Education
- #8 Decent Work and Economic Growth
- #12 Responsible Consumption and Production
- #15 Life on Land
- #17 Partnerships to Facilitate SDGs

Development of an Automated Monitoring Platform for Invasives in Coastal Ecosystems

Project Partners

- MNFI
- Michigan Aerospace Corporation
- MDNR Coastal Zone Management Program

🔍 MNFI Team

- Joshua G. Cohen, *Principal Investigator*
- Rachel A. Hackett
- Phyllis J. Higman

Spatial Data to Improve Coastal Resiliency and Better Inform Local Decision-Making

Project Partners

- MDNR Coastal Zone Management Program
- MDEQ Oil, Gas and Minerals Division
- Archives of Michigan
- The Nature Conservancy
- Michigan Environmental Council
- MSU Department of Geography, Environment, and Spatial Sciences
- United States Geological Survey

🔍 MNFI Team

- John J. Paskus, *Principal Investigator*
- Helen D. Enander
- Joshua G. Cohen

DISCOVERING, DEFINING, DELIVERING

Nature's Non-Material Contributions to Human Life

Nature Fundamental to Body and Soul

Humans value nature for various reasons, but many, if not most, recognize a value that goes beyond the mere provision of food, fiber, or building materials. Just as people around the world will stop to enjoy a sunset, we also stop to appreciate the beauty of a cardinal against snow covered branches, rippling waves of grass in a meadow, and the towering grandeur of mature forests. These speak to our soul. Aesthetic enjoyment of nature is as much a "nature's benefit to people" as is any of the material benefits, and they add immeasurably to human

well-being. For many people, the non-material benefits of nature are even more fundamental than aesthetic enjoyment. They are literally essential to existence. Such is the case for many groups of indigenous people, including Michigan's tribal members. For many cultures, their very identity is inseparable from nature.

When MNFI provides information that contributes to the conservation of biodiversity, it is for the benefit of all, from the weekend bird watcher to the tribal elder, and it comes not only from MNFI scientists, but also citizen science and holders of indigenous knowledge.

Poor Conifer Swamp survey work being conducted by the Little Traverse Bay Bands of Odawa Indians Natural Resources Department and MNFI
Photo by: Bill Parsons



Above: Rich Conifer Swamp training conducted at Bay Mills Community College
Photo by: Josh Cohen

Combining the Power of Tribal Knowledge and Western Science

The collaborative Climate Change Adaptation Project sought to ensure the long-term cultural and natural resource goals for tribal lands essential for food, and cultural and spiritual identity. The inter-tribal adaptation working group included Anishinaabe and Western scientists, cultural leaders and community members from nine participating tribes, the Northern Institute of Applied Climate Science and MNFI, as well as other cultural, tribal, public, and university consultants.

Working Together

Biological and cultural experts shared knowledges, identified needs and opportunities for key forest understory species and plant communities, conducted vulnerability assessments and developed adaptation strategies to manage these plants and communities throughout future climate-driven change.

Preserving Michigan's Natural Features for One and All

Michigan's State Trails provide people with recreational access to state's wide ranging natural beauty. MNFI conducted natural features surveys along four trails in Northern Lower Michigan for the Michigan Department of Natural Resources, Parks and Recreation Division. Results provided baseline information on high-quality natural communities, rare species habitat, targeted rare species of plants and animals to inform management decisions for the North Central, North Eastern, North Western, and Pere Marquette State Trails.

This project supports Sustainable Development Goals (SDGs):

- #1 No Poverty
- #2 Zero Hunger
- #3 Good Health and Well-being
- #4 Quality Education
- #8 Decent Work and Economic Growth
- #10 Reduced Inequalities
- #12 Responsible Consumption and Production
- #15 Life on Land
- #16 Peace, Justice and Strong institutions
- #17 Partnerships to Facilitate SDGs

Inter-Tribal Council Report: 2017-2018 Forest Understory Adaptation Project

Inter-Tribal Council of Michigan facilitated a collaborative project with:

- Bay Mills Indian Community
- Lac Vieux Desert Band of Lake Superior Ojibwe
- Pokagon Band of Potawatomi
- Saginaw Chippewa Indian Tribe natural resource programs

Assistance From:

- MNFI
- Northern Institute for Applied Climate Science

🔍 MNFI Team

- Joshua G. Cohen, *Principal Investigator*
- Rachel A. Hackett

Natural Features Inventory of the North Central, North Eastern, North Western, and Pere Marquette State Trails

Project Partners

- MNFI
- MDNR

🔍 MNFI Team

- Joshua G. Cohen, *Principal Investigator*
- Peter J. Badra
- Helen D. Enander
- Rachel A. Hackett
- Aaron P. Kortenhoven
- Yu Man Lee

2018 PUBLICATIONS



Kirtland's warbler (*Setophaga kirtlandii*)
Federal and State Endangered
Photo by: Aaron Kortenhoven



A: Monarch butterfly (*Danaus plexippus*)
Photo by: David Cuthrell

B: Vermilion Waxcap (*Hygrocybe miniata*)
Photo by: Aaron Kortenhoven

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MNFI staff in a Granite Bedrock Glade in
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Photo by: Jesse Lincoln



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