A Natural Features Inventory of Newaygo County, Michigan

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Michigan Natural Features Inventory
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The Fremont Area Community Foundation

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MICHIGAN STATE UNIVERSITY EXTENSION

Michigan Natural Features Inventory

Cover photo: Beverly Walters, Michael Penskar, and Bradford Slaughter surveying the Michigan Nature Association's Newaygo Prairie Nature Sanctuary. Photo: E. Schools.

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Purpose and overview

The overall project goal is to provide information that will aid land use planning efforts in Newaygo County. To accomplish this goal, The Fremont Area Community Foundation (FACF) funded the Michigan Natural Features Inventory (MNFI) to perform surveys for high quality natural communities and rare plants. In addition to the survey effort, MNFI created Geographic Information System (GIS) layers and GIS-based models to assist decision makers in making informed land use planning decisions.

MNFI, a program of the Michigan State University Extension, is Michigan's Natural Heritage Program. MNFI catalogs and maintains a statewide database of rare species and high quality examples of natural community types. MNFI has over 25 years of experience performing field surveys for Michigan's rarest biota and natural communities. The MNFI database conforms to the Natural Heritage data standards set forth by NatureServe (www.natureserve.org). Natural community taxonomy is based on a current version of Michigan's Natural Community Classification (MNFI 2006).

Two ongoing projects, funded by the Michigan Department of Natural Resources (MDNR), are complementing the survey effort funded by FACF. Both projects have increased MNFI presence in Newaygo County and have supplemented the information gained from the surveys funded by FACF.

One project is funded under the MDNR Landowner Incentive Program (LIP). Under the LIP program, MNFI biologists work directly with LIP biologists and private landowners doing habitat restoration projects on private lands. Part of this work entails performing surveys for rare species and high quality natural communities.

The second project is designed to use predictive models to determine areas of high ecological integrity and then testing those models with field surveys. The testing is done using a systematic sampling methodology. While statewide in nature, the initial project focus is Newaygo County, specifically to supplement the project funded by FACF.

Survey Methodology

Prior to field surveys, MNFI ecologists interpreted aerial photographs and identified 800 sites harboring natural communities of potentially high quality. These sites ranged in size from less than one acre to over 2,000 acres. MNFI biologists then prioritized sites for field survey by assessing the condition, size, and landscape context of each delineated site. Primary emphasis for field survey was placed on state- or globally-rare natural community types (see Appendix 1). Secondary emphasis was placed on the most pristine examples, as determined by interpretation of aerial photographs, of less imperiled natural community types, such as bog and dry-mesic northern forest. In addition to surveying previously unexplored areas, MNFI ecologists resurveyed high quality natural community occurrences already documented in the Natural Heritage database, many of which were last surveyed in the late 1980s or early 1990s. MNFI botanists explored a number of sites specifically for the presence of rare plant species of likely occurrence.

Sites identified for possible field survey were located on both public and private lands. MNFI identified approximately 400 private landowners to contact for property access and sent letters requesting permission to access land for surveys to 60 of these landowners. In addition to mailing letters, MNFI requested permission of landowners attending a meeting arranged by the Land Conservancy of West Michigan in White Cloud to conduct field surveys on their properties. Towards the close of the 2006 field season, MNFI contacted additional private landowners, focusing on tracts that appeared to harbor under-surveyed natural

community types. In total, eleven landowners allowed access to their lands for surveys, and MNFI visited eight of these properties.

In preparation for botanical surveys, MNFI botanists obtained plant species distribution information from the University of Michigan's Online Atlas of Michigan Plants (http://herbarium.lsa.umich.edu/website/michflora/). The atlas listed a total of 737 plant species documented as occurring in Newaygo County. MNFI botanists also queried the database for plant species known from the counties adjacent to Newaygo County. Comparing the two data sets allowed MNFI botanists to determine which species were most likely to be found that had not been previously documented from Newaygo County.

MNFI ecologists and botanists conducted field surveys during the periods of August-September 2005 and May-September 2006. MNFI biologists took detailed notes on vegetative structure, plant species composition and relative abundances, natural and human disturbances, and associated landforms and soils at each site. Sites were then assigned to a natural community type or types based on Michigan's Natural Community Classification (MNFI 2006). Surveyors also documented general management recommendations (e.g., invasive species control, application of prescribed fire) for each site. The sites that MNFI ecologists determined to be of high quality were graded based on condition, landscape context, and size, and entered into the Natural Heritage database as natural community element occurrences (hereafter referred to as occurrences).

Plant survey data were entered into MDNR's Floristic Quality Assessment system (Herman, et al. 2001) to generate a list of the plant species present at each site. The system also uses information on individual plant species to assign each one a score and this is used to calculate the Floristic Quality Index (FQI). The FQI can then be used to compare the relative floristic quality of various natural areas. In addition, MNFI biologists collected voucher specimens for plants new to Newaygo County. Voucher specimens of rare plants were collected under an MDNR Threatened and Endangered Species Permit. Voucher specimens will be submitted to the University of Michigan Herbarium to document the occurrence of these species in Newaygo County.

MNFI biologists entered all natural community and rare plant occurrences into the MNFI Natural Heritage database. This process entailed digitally mapping the spatial extent of the occurrence in a geographic information system (GIS) and entering tabular information from field forms.

Model Methodology

The MNFI Natural Heritage database utilizes Natural Heritage methodology and data standards originally designed by The Nature Conservancy and now maintained by NatureServe (www.natureserve.org). The MNFI database is more than a presence/absence database. Among other information, it contains dates of sightings, global and state imperilment rankings for species, and a quality ranking for individual occurrences. The MNFI database is continually being updated and is the most complete record of Michigan's sensitive species and natural features.

Natural Heritage scientists designed the Natural Heritage databases and methodology to be used for conservation planning efforts, not for land use planning efforts. While Natural Heritage data should be considered in land use planning efforts, various issues limit the direct usefulness of the data. The primary issue is the sensitive nature of rare species' locations. The organisms tracked by MNFI are Michigan's rarest and most sensitive biota. Some of these species, both plants and animals, are targeted by unscrupulous collectors.

For some species, indiscriminate distribution of their location information can be detrimental to their long term survival. Another issue is the ambiguous nature of biological information. Nuances such as mapping mobile organisms, different levels of species imperilment, and the importance of older records can make these data difficult for the non-biologist to use and interpret. To get around these issues, MNFI has created models based on the Natural Heritage database that facilitate incorporation of this information into land use planning efforts.

The first model, termed the probability model, shows the likelihood of finding a rare species or natural community in any given area. MNFI modelers designed the model for land use planning efforts to delineate those areas where there is a high likelihood of encountering a rare species or a high quality natural community. Modelers designed the second model, termed the biodiversity value model, to help prioritize areas for conservation.

The models are produced using three different cell resolutions; square mile, square quarter mile, and square quarter-quarter mile. The finest resolution cells, square quarter-quarter mile, are 40 acres in size. The results of both models are available in the same dataset. Each cell has an attribute for the probability of having an occurrence and the biodiversity value of the cell.

Probability model

Despite its name, the model is not probabilistic in the sense that it provides a statistical probability of an occurrence. The underlying assumption is that the more recent a known occurrence has been observed, the more likely it is to still exist. Factors considered in the model are the spatial extent (mapping uncertainty) of the occurrences, the presence of potential habitat within the known spatial extent, and the date the occurrence was last observed. The model uses the appropriate habitat within the known extent of an occurrence to effectively change the known spatial extent of the occurrence. The model then uses the age of each record to determine the likelihood of the species still being present, with recent sightings given a higher likelihood of still existing. The model considers occurrences last observed prior to 1970 to have a low probability of still existing, occurrences last observed between 1970 and 1982 to have a moderate probability of still existing, and occurrences last observed from 1982 to the present day to have a high likelihood of still existing. The model makes no distinction between animal or plant occurrences. Also, a higher probability supercedes a lower probability. For instance, if an area contains a low probability occurrence and a high probability occurrence, the model assigns a high probability to the area.

Biodiversity value model

The biodiversity value model scores areas for their contributions to biodiversity. It does this by calculating a biodiversity value for each occurrence within an area and then summing the values of all the occurrences within the area. Factors considered in calculating the biodiversity value of each occurrence include the species' global imperilment, state imperilment, the quality rank assigned to each occurrence, and the last observed date of the occurrence. Like the probability model, the biodiversity value model also utilizes the presence of potential habitat within the known spatial extent of the occurrence. The biodiversity value is an open ended scale with zero representing no known occurrences or no appropriate habitat within the area.

Potential conservation area model

In addition to models based on the Natural Heritage database, MNFI produced a GIS model termed the Potential Conservation Areas (PCA) model. The PCA model uses patches of contiguous natural habitat to define areas, and then scores the areas for various landscape metrics. The model uses a methodology initially designed for Oakland County. Because the model uses contiguous natural habitat patches to define areas, it is not as effective in a county with large areas of contiguous habitat such as Newaygo County.

Survey Results

MNFI biologists surveyed 109 sites identified from aerial photographs as potentially harboring high quality natural community occurrences. A total of 212 visits were made to these sites during the 2005 and 2006 surveys (Appendix 2).

High quality natural communities

MNFI ecologists documented a total of 17 different natural community types in Newaygo County (Table 1). From the 109 sites surveyed, MNFI biologists documented a total of 23 new natural community occurrences, representing 11 natural community types.

In addition to surveying for new natural community occurrences, MNFI biologists revisited 15 of the 19 previously documented natural community occurrences in the county. The remaining four occurrences are dry sand prairies in private ownership that MNFI biologists did not gain permission to resurvey.

The yellow flowered creeping St. John's-wort (*Hypericum adpressum*) is locally common in some of the coastal plain marshes of Sherman and Everett Townships. This rare plant was first discovered in Michigan during MNFI's plant surveys and it is now listed as State Threatened. The nearest known population is in northern Indiana. Photo: B. Slaughter

Our 2005 and 2006 field survey work brings the total number of known natural community occurrences in Newaygo County to 42, representing a total of 13 natural community types (Table 2). Natural community occurrences are currently known from 15 of Newaygo County's 24 townships (Table 2). For descriptions of the natural community types represented by high quality occurrences in Newaygo County, see Appendix 3. Table 3 lists publicly accessible occurrences of 6 natural community types characteristic of Newaygo County.

Rare plants

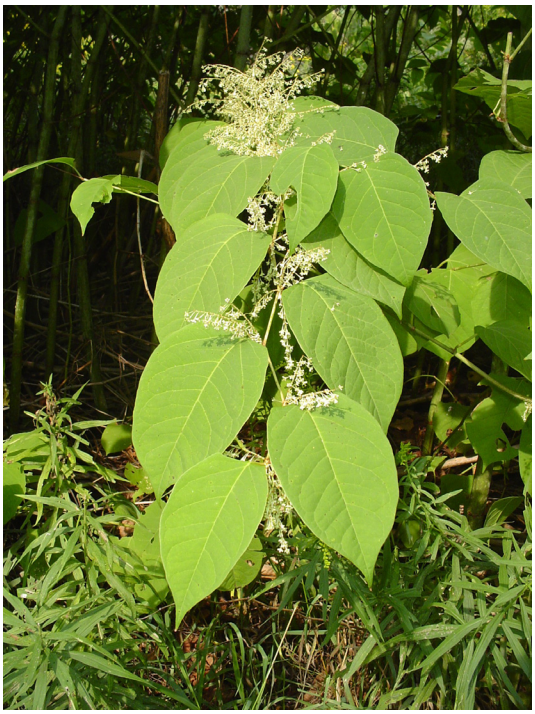
During the 2005 and 2006 surveys, MNFI biologists located 32 new populations of rare plants. These 32 new populations represent 16 different plant species. In addition to these new populations, surveyors revisited 17 known rare plant populations and updated population information for each of these occurrences. Four of the new records and four of the updates were the result of surveys being conducted in the county as part of the two aforementioned MDNR-funded projects. Nine of the rare plant populations represent occurrences of six species that had not been previously documented in the county. Rare plant occurrences are known from 9 of Newaygo County's 24 townships (Table 4).

Of particular note, MNFI botanists discovered creeping St. John's-wort (*Hypericum adpressum*), a rare plant species previously undocumented in Michigan. Creeping St. John's-wort is associated with coastal plain marsh, an unusual habitat harboring populations of many rare plants that exist in Michigan far from the core of their ranges along the Atlantic and Gulf coastal plains. Although locally abundant in several of the Newaygo County marshes, this plant with large golden yellow flowers had apparently escaped detection previously because it is similar to other more common species. It is known from only 50 sites throughout its range in Eastern North America, the nearest being in northern Indiana. Creeping St. John's-wort has been given the protected status of Threatened in Michigan.

Creeping St. John's-wort (*Hypericum adpressum*) is similar to other more common plants, which explains how these bright yellow flowers could remain hidden "in plain sight". Photo: D. Spalink.

Non-native invasive species

Three species known to be highly invasive in natural areas in North America were also newly documented for the county, including Japanese knotweed (*Polygonum cuspidatum*), common reed (*Phragmites australis*), and autumn olive (*Elaeagnus umbellata*). Common St. John's-wort (*Hypericum perforatum*), spotted knapweed (*Centaurea maculosa*) and reed canarygrass (*Phalaris arundinacea*) were also encountered frequently in our surveys. However, in general, invasive species have relatively marginal impacts on natural areas in the county compared to their impacts in southern Lower Michigan. One particularly aggressive invasive plant of forested natural communities, garlic mustard (*Alliaria petiolata*), was not observed during our surveys, and several other aggressive invasive species were observed only locally and/or in small numbers.



Japanese knotweed (*Polygonum cuspidatum*) was located at several sites in the southeastern Newaygo County. This species, and several others known to be invasive in natural areas elsewhere, were newly recorded in the county, but in general terrestrial invasive plant species currently have minimal impact in the county's natural areas. Photo: M. Kost.

Newaygo County flora update

As a result of this project, a total of 219 new species were collected (Appendix 4), bringing the total known flora of Newaygo County to 956 species, an increase of 30%. These new records include several state-listed plant species, including whorled mountain mint (*Pycnanthemum verticillatum*), tall green milkweed (*Asclepias hirtella*), and water-parsnip (*Berula erecta*). MNFI biologists also collected relatively common species that had not previously been recorded in Newaygo County, including many asters and the difficult to identify, under-collected grasses and sedges. This botanical work has expanded the known ranges of many plants and is a significant contribution to the understanding of plant distributions throughout the state.

State-listed as Special Concern, whorled mountain-mint (*Pycnanthemum verticillatum*) occurs in intermittent wetlands in Lilley and Merrill Townships. These sites provided the first records of this species in Newaygo County. Its leaves give off a pleasant peppermint aroma when rubbed. Photo: R. O'Connor.

Model Results

Probability model

Figure 1 shows the results of the probability models prior to the 2005 and 2006 surveys and Figure 2 shows the results of the probability model following the 2005 and 2006 surveys. Both figures use the 40 acre, square quarter-quarter mile, resolution cells. There are 14,030 40-acre cells that are within or partially within Newaygo County.

Prior to MNFI surveys, 10,404 cells (74.2%) had a "No Status" value, 1,794 cells (12.8%) had a "Low" value, 114 cells (0.8%) had a "Moderate" value, and 1,718 cells (12.2%) had a "High" value.

After surveys, 10,288 cells (73.3%) had a "No Status" value, 1,699 cells (12.1%) had a "Low" value, 109 cells (0.8%) had a "Moderate" value, and 1,934 cells (13.8%) had a "High" value.

Biodiversity value model

Figure 3 shows the results of the biodiversity value model prior to the 2005 and 2006 surveys. Figure 4 shows the results of the biodiversity value model following the 2005 and 2006 surveys. Both figures use the 40 acre, square quarter-quarter mile, resolution cells.

After the MNFI surveys, 10,632 cells (75.8%) remained the same. 1,661 cells (11.8%) increased in value. 1,737 cells (12.4%) reduced in value. This reduction is attributed to species being removed from listing, the global or state imperilment ranking being reduced, or more finely resolved demarcation of the spatial extent for occurrences known prior to the surveys.

Generally MNFI considers a biodiversity value in the 20 - 30 range or higher to be a significant value. Prior to MNFI surveys, 243 cells had a value greater than or equal to 20, 161 cells had a value greater than or equal to 25, and 118 cells had a value greater than or equal to 30. After surveys, 334 cells had a value greater than or equal to 20, 211 cells had a value greater than or equal to 25, and 148 cells had a value greater than or equal to 30. Figure 5 shows the areas that scored 20 or higher in the model.

Potential conservation areas model

Figure 6 shows the results of the PCA model. The model produced a total of 946 different sites. There are 14 sites in the highest priority category. The highest priority sites range from 2,475 acres to 4,789 acres in size, with a total acreage of 48,773 acres. In the moderate priority category there are 224 sites. The moderate priority sites range from 28 acres to 4,939 acres in size, with a total acreage of 166,394 acres. There are 708 sites in the lowest priority category. The lowest priority sites range from 20 acres to 966 acres in size, with a total acreage of 72,161 acres. A total of 287,328 acres fall into a PCA model category.

Discussion

Biodiversity of Newaygo County

Following the 2005 and 2006 surveys, Newaygo County is now known to harbor high quality occurrences of 13 natural community types. This places Newaygo County 9th out of Michigan's 84 counties in the number of natural community types within the county represented by at least one occurrence, indicating both the diversity of natural community types represented in the county and the high level of survey effort in the county by MNFI staff in 2005 and 2006. The list of natural community types represented by at least one occurrence in Newaygo County can be compared to the list of natural communities thought to occur in Newaygo County to focus future survey efforts on those community types not currently represented in the Natural Heritage database for Newaygo County.

The range of climatic and soil conditions in Newaygo County contribute to the high botanical diversity in the area. Cooler temperatures and nutrient poor, acid sands in the northern region support northern forest types, while warmer temperatures and rich loamy soil in the southern region support southern forest types. Thus, a diversity of natural communities and vascular plant species are represented in Newaygo County. Several species reach their northern or southern range limits in Newaygo County. For example, paw-paw (*Asimina triloba*) is a small understory tree of rich woods and ravines that is more common in milder climates. A reproducing population located along Brooks Creek in southern Newaygo County is near the northern limit of its range. Green dragon (*Arisaema dracontium*), a close relative of Jack-in-the-pulpit, is another plant with more southern affinities found in a floodplain forest, this one along the Big South Branch of the Pere Marquette River in northern Newaygo County. Plants of northern affinity reaching their southern range limits in Newaygo County include sweet-coltsfoot (*Petasites frigidus*), which was found in two locations in Newaygo County, 60 miles south of its documented range in Michigan; balsam fir (*Abies balsamea*), rare and local in conifer-dominated swamps; and spurred gentian (*Halenia deflexa*), which was found in a hemlock-dominated swamp near White Cloud .

Of particular importance to biodiversity conservation in both Newaygo County and at the statewide level is the presence of 6 occurrences of coastal plain marsh, a state- and globally-imperiled natural community type (see Appendix 3). Newaygo County harbors nearly 500 acres of

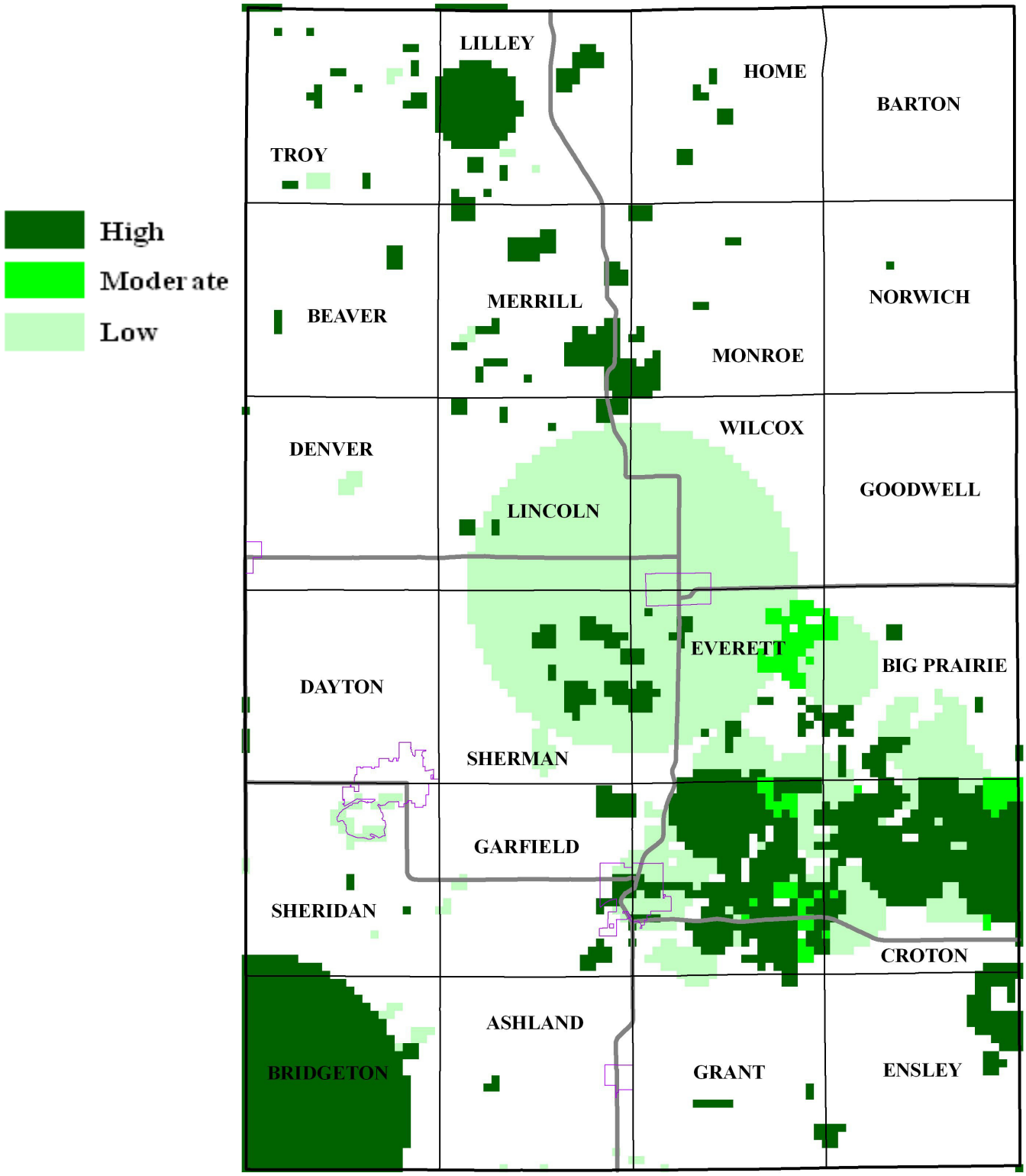


Figure 1. Likelihood of a rare species or high quality natural community occurrence based on the Michigan Natural Features Inventory Natural Heritage database of known occurrences before surveys in 2005 and 2006.

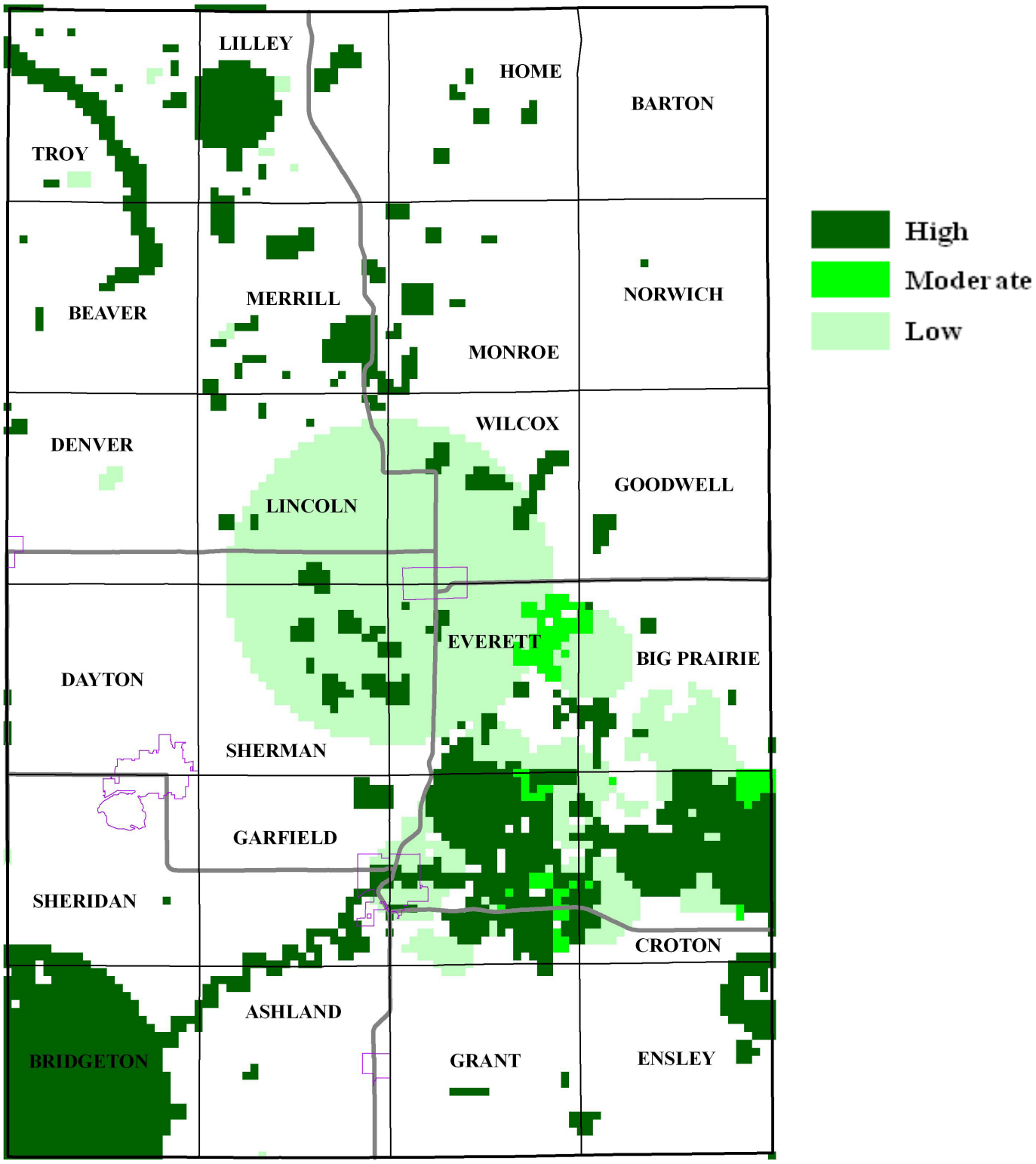


Figure 2. Likelihood of a rare species or high quality natural community occurrence based on the Michigan Natural Features Inventory Natural Heritage database of known occurrences after surveys in 2005 and 2006.

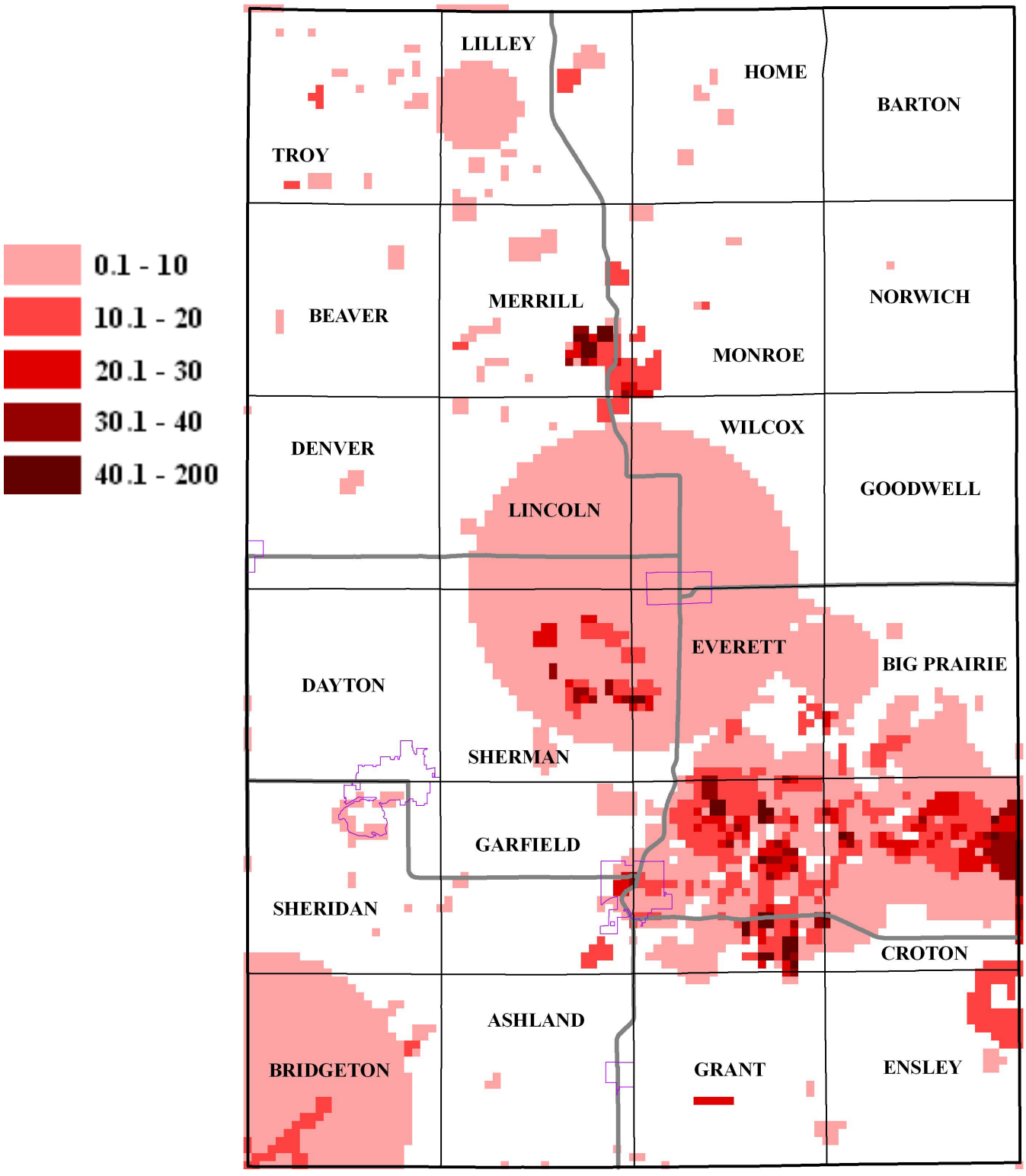


Figure 3. Newaygo County biodiversity value scores before the 2005 and 2006 MNFI surveys for rare plants and natural communities. Higher scores indicate the presence of very rare species or concentrations of less rare species.

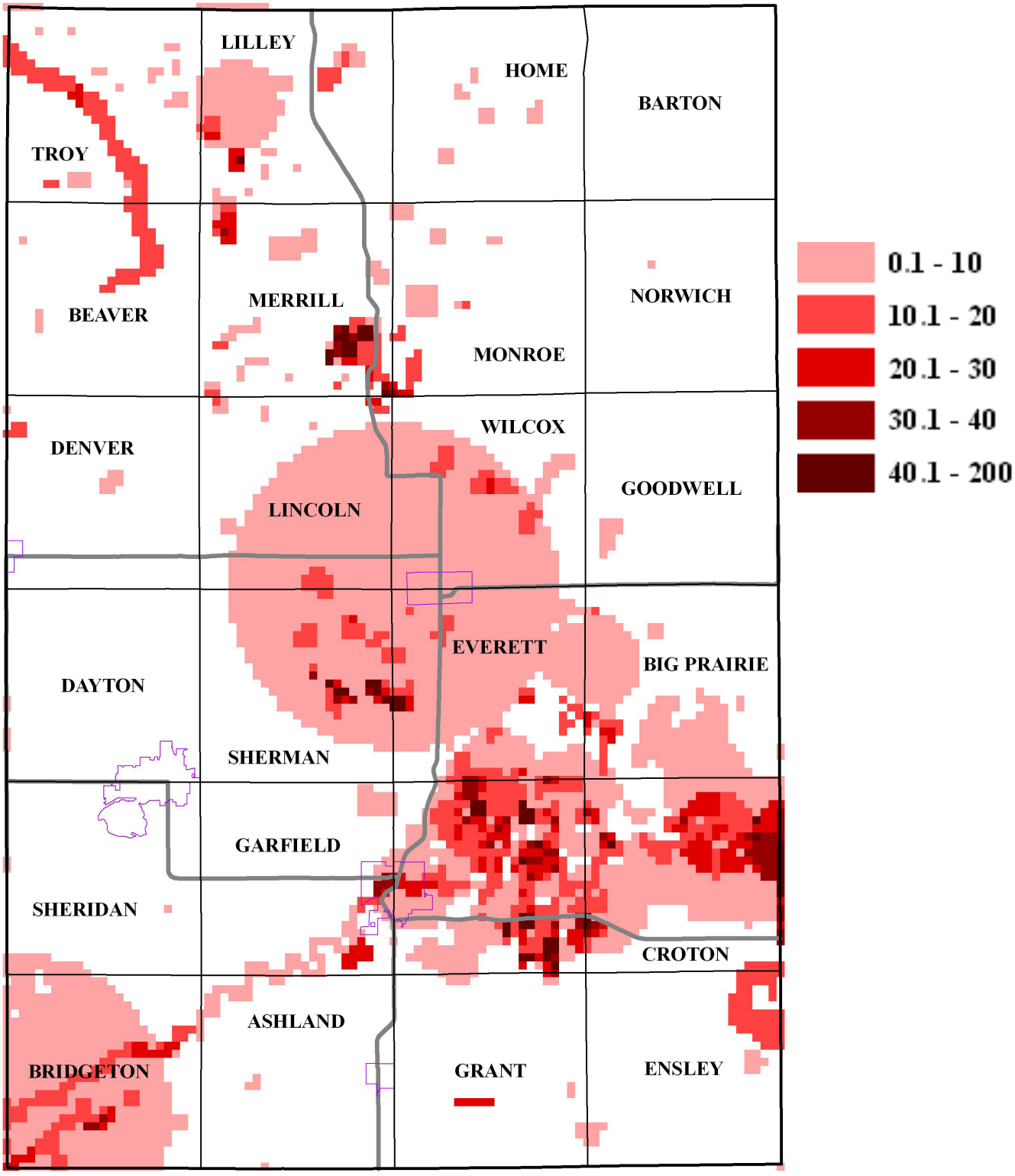


Figure 4. Newaygo County biodiversity value scores after the 2005 and 2006 MNFI surveys for rare plants and natural communities. Higher scores indicate the presence of very rare species or concentrations of less rare species.

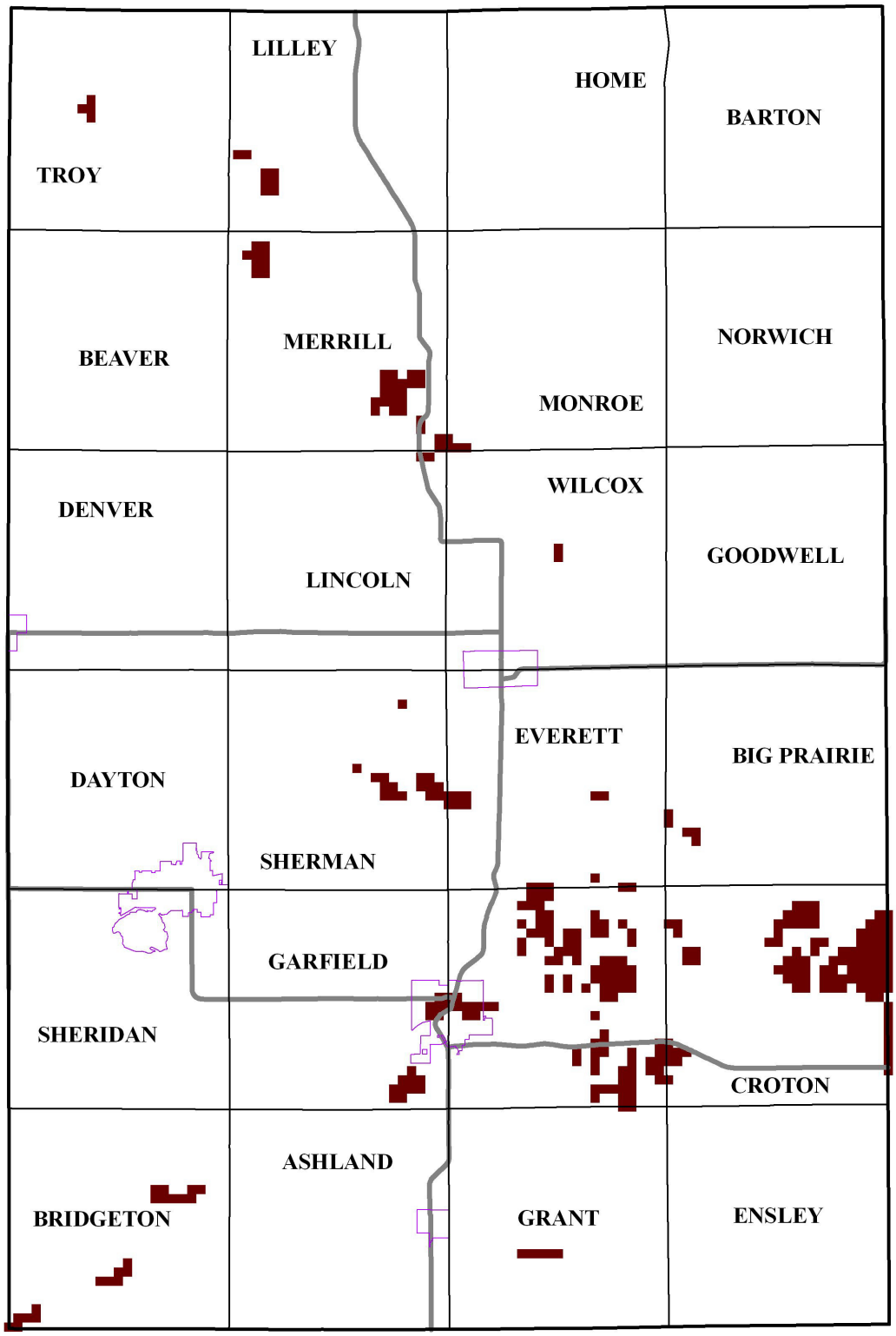


Figure 5. Newaygo County biodiversity value scores higher than 20 after the 2005 and 2006 MNFI surveys for rare plants and natural communities.

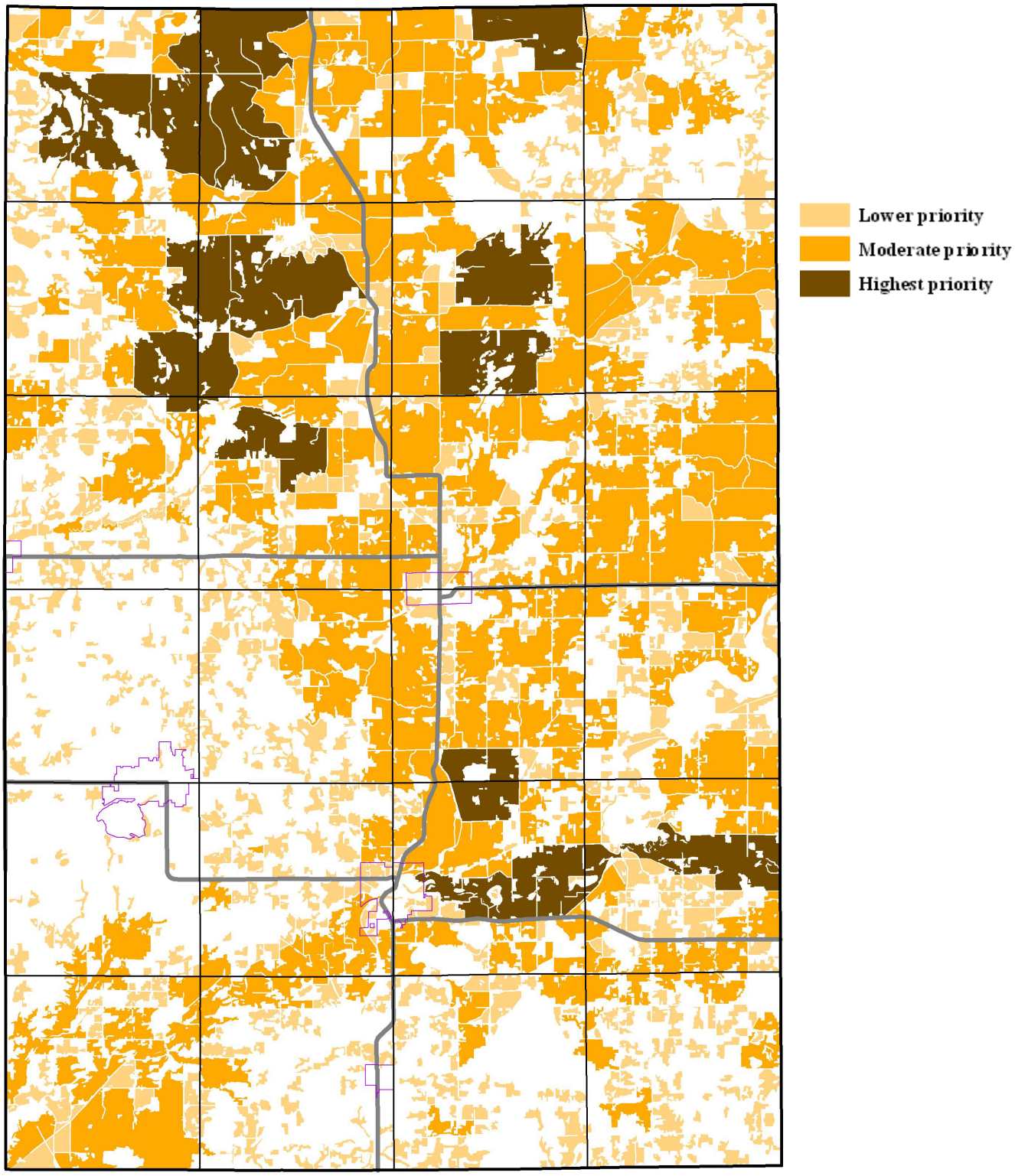


Figure 6. Prioritized potential conservation areas in Newaygo County.

coastal plain marsh, representing approximately 20% of the known coastal plain marsh acreage in Michigan, and trails only Allegan County in its number of documented coastal plain marsh occurrences. These marshes are the preferred habitat for 16 of the 32 rare plant species known to occur in Newaygo County. The coastal plain marshes south and east of Little Robinson Lake are of particular conservation significance due to their high diversity, abundance of rare plant species, and forested landscape context. Much of this acreage is in public ownership. The coastal plain marshes associated with Loon Lake and Leaf Lake, both in northern Newaygo County, are also of statewide significance. A portion of the coastal plain marsh in the Loon Lake area is in private ownership, and represents an opportunity to work with landowners in the area to protect the integrity of the marshes.

Dry sand prairie, a state-imperiled, globally-rare natural community, is also concentrated in Newaygo County. Nine of the 16 known Michigan occurrences, covering a total of 327 acres, or 60% of the remaining acreage statewide, occur in the county. Unfortunately, our 2005-2006 surveys revealed significant degradation of many remnants since they were originally surveyed between 1980 and 1990. The combined effects of ORV use and invasive species, combined with the lack of stewardship or management at several sites, threatens the survival of rare plant and animal species associated with dry sand prairie. The same issues of soil disturbance and invasive species threaten the associated oak-pine barrens natural community, two occurrences of which were documented in our surveys. As of 2006, two dry sand prairie remnants, one owned by Brooks Township and the other owned by the Michigan Nature Association, are being managed using the techniques of invasive species control, shrub and tree removal, and prescribed fire to maintain and enhance grassland flora and fauna. Several remaining dry sand prairie remnants are partially or completely in private ownership, and require management and stewardship to ensure their continued viability.

Several high quality examples of more common, widespread natural community types were documented in Newaygo County in 2005-2006. The Big South Branch of the Pere Marquette River in northern Newaygo County supports a high quality, mature second-growth floodplain forest that harbors over 350 vascular plant species, making it the most diverse natural community in Newaygo County. Bogs, swamp forests dominated by conifers and/or hardwoods, and upland oak-pine forests (dry-mesic northern forest) are just some of the other natural community types contributing to the diversity of Newaygo County. For a complete description of natural community types represented by at least one occurrence in Newaygo County, see Appendix 3.

Conservation efforts in Newaygo County should focus on protecting and managing intact examples of rare natural community types and high quality examples of more common natural communities. Many otherwise high quality wetlands and wetland

Side-oats grama (*Bouteloua curtipendula*) is one of Michigan's rarest grass species. Development and fire suppression of its native dry prairie habitat has eliminated many occurrences. One of the best remaining populations is found in Brooks Township. Photo: B. Slaughter.

complexes documented in our surveys suffer from the lack of an upland buffer, or from the significant degradation of the upland forests or oak-pine barrens bordering these wetlands. Restoring upland natural communities is important for the protection of wetland species and functions. Land acquisition efforts for the conservation of biodiversity should be tailored to representing the full range of natural community types in Newaygo County, and to protect the integrity of high quality natural community occurrences that are currently only partially protected. For example, several element occurrences of hardwood-conifer swamp have portions in both public and private ownership. Degradation of those portions of the wetland in private ownership has the potential to degrade those portions of the wetland in public ownership due to the shared hydrology of the entire wetland. Some natural community types are poorly represented, or not represented, on public land. For example, mesic northern forest, an upland forest community dominated by beech, sugar maple, and hemlock, is concentrated in areas of fertile soils that are currently in active agriculture. Protection of this natural community type requires working with private landowners. A conservation approach of acquiring, protecting, and managing high quality examples of the full range of natural community types in Newaygo County, in addition to protecting and restoring areas of lower ecological quality that serve as buffer or linkages among high quality sites, will ensure the viability of Newaygo County's biodiversity for future generations to study and enjoy.

Outreach and collaboration

The MNFI surveys in Newaygo County drew the interest of a number of professional and amateur naturalists. Sedge expert Dr. Tony Reznicek from the University of Michigan Herbarium accompanied MNFI botanists for several days to help with surveys in some coastal plain marshes. He located several of the spike rushes that were new to the county. Dr. Dave Warners from Calvin College, a former student of Dr. Reznicek's, also participated in these surveys. Maggie Hostetler, a former resident of Newaygo County who spent a day with MNFI botanists, does photo-monitoring of ecological restoration for Ann Arbor's Natural Area Preservation program. Kay Cummings, Michigan State University Extension Director in Newaygo County, supplied letters of support for the project. Ryan Coffey, land use educator for Michigan State University Extension in Newaygo County, accompanied MNFI biologists as they surveyed his neighbor's property along the Flinton Creek. Connie Crancer, Natural Areas Specialist for University of Michigan's Botanical Gardens and Arboretum, spent several days observing MNFI botanical survey techniques. Linda Sanderson is a student at Ferris State University who assisted on several ecological surveys. Rhoda De Zoete from the Land Conservancy of West Michigan provided assistance with landowner contacts and setting up a public meeting in White Cloud. Rod Denning, Grand Valley State University, Annis Water Resources Institute, supplied GIS land cover data. Annis Water Resources Institute and the Michigan State University Geographic Information Science Research & Outreach Services group collaborated to produce the data under Building a Sustainable Future for the Muskegon River Watershed: A Decentralized Approach - A Project of: The Muskegon River Watershed Partnership funded by the Wege Foundation. Curtis M. Breuker, GIS Coordinator for Newaygo County IS/GIS, supplied parcel data and aerial photographs.

The MNFI surveys have also attracted the attention of several groups. The Michigan Botanical Club will be visiting several sites MNFI identified as of interest in Newaygo County during their statewide meeting in the spring of 2007. Also, the Nature Conservancy has requested MNFI survey data for the floodplain forest along the Big South Branch of the Pere Marquette River. MNFI survey efforts in Newaygo County have the potential to assist in conservation and land use planning not only within the county, but well beyond the confines of its political borders.

Caveats

While these surveys are extensive, they do not represent a complete or exhaustive survey of Newaygo County natural features. MNFI field surveyors visited only 109 of the 800 potential sites delineated from aerial photographs. In addition, the project did not include surveys for rare animals. An exhaustive survey would include more time for natural community surveys and also include animal surveys.

Acknowledgements

Fremont Area Community Foundation made this project possible through their generous support. The Fremont Area Community Foundation is located in Fremont, Michigan and serves all of Newaygo County. The Foundation was created in 1972 and now has assets of approximately $200 million. The Foundation makes grants in the areas of Arts & Culture, Education, Community Development, Health, Human Services, and the Environment. A special acknowledgement goes to Kathy Huschke of the Foundation for her help in making the project possible.

The MNFI project team consisted of Edward Schools, Bradford Slaughter, Beverly Walters, Michael Kost, and Michael Penskar. Numerous other MNFI staff made valuable contributions to this project. In particular, Helen Enander provided GIS advice and assistance; John Paskus assisted with designing GIS models; Daniel Spalink helped with plant surveys and data processing; Jacqueline Courteau, Rebecca Schillo, Phyllis Higman, and Tyler Bassett contributed field work; Ryan O'Connor performed field surveys under the LIP project that complemented surveys funded by FACF; Chris Weber helped digitize potential natural community occurrences; and Rebecca Rogers and Kim Borland processed natural community and rare plant element occurrences. Administrative support was provided by Patrick Brown, Lyn Scrimger, Sue Ridge, and Connie Brinson.

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Tables

Table 1. Natural Community types visited during surveys in 2005 and 2006.

Community name	State Rank	Global Rank
Bog	S4	G3
Coastal plain marsh	S2	G2
Dry sand prairie	S2	G3
Dry-mesic northern forest	S3	G4
Emergent marsh	S4	GU
Hardwood-conifer swamp	S3	G4
Intermittent wetland	S3	G2
Lakeplain wet-mesic prairie	S1	G1?
Mesic northern forest	S3	G4
Northern shrub thicket	S5	G4
Northern wet meadow	S4	G4
Oak-pine barrens	S2	G3
Poor conifer swamp	S4	G4
Relict conifer swamp	S3	G3
Rich conifer swamp	S3	G4
Southern floodplain forest	S3	G3?
Southern swamp	S3	G3

Table 2. Natural community occurrences in Newaygo County. Those in bold are a result of the 2005 and 2006 surveys.

Township	Survey site	Natural community type	EO #	EO Rank
Big Prairie	**36th Street Oak-Pine Barrens -- Newaygo County**	Oak-pine barrens	29	CD
Bridgeton	**Lowe Lake Swamp -- Muskegon State Game Area**	Hardwood-conifer swamp	26	C
	Muskegon State Game Area	Lakeplain wet-mesic prairie	29	B
	Muskegon State Game Area	Oak-pine barrens	25	C
Brooks	Section 27 Bowl Prairie	Dry sand prairie	1	CD
	Finger Prairie	Dry sand prairie	2	C
	Coolbough Natural Areas -- Ore-Ida Prairie	Dry sand prairie	3	B
	High Rollway Prairie	Dry sand prairie	4	C
	Foss Park Prairie	Dry sand prairie	5	C
	Newaygo Prairie Nature Sanctuary	Dry sand prairie	7	C
	Newaygo Prairie -- USFS	Dry sand prairie	8	C
	West Tract Forest	Dry-mesic northern forest	9	BC
	Brooks Lake	Rich conifer swamp	24	C
Croton	Pine-Pettit Marsh	Coastal plain marsh	30	BC
	Croton Bowl Prairie	Dry sand prairie	6	C
Denver	**Kirchner Lake**	Relict conifer swamp	18	B
Everett	Little Robinson Lake Opportunity Area -- East	Coastal plain marsh	26	B
	Fry Lake	Coastal plain marsh	42	BC
	Twinwood Lake North	Hardwood-conifer swamp	35	C
	Twinwood Lake North	Northern shrub thicket	6	B
	Toft Lake Swamp	Relict conifer swamp	32	CD
Goodwell	**Dudgeon Swamp**	Hardwood-conifer swamp	24	BC
Home	**Toman Lake**	Poor conifer swamp	24	B
Lilley	**Leaf Lake**	Coastal plain marsh	43	B
	Triple Lakes Creek Northeast	Rich conifer swamp	55	C
Lincoln	**Rattlesnake Creek Swamp**	Hardwood-conifer swamp	25	C

Table 2 cont.,

Township	Survey site	Natural community type	EO #	EO Rank
Merrill	Richmond Lake	Bog	66	B
	Nichols Lake South	Bog	92	BC
	Loon Lake	Coastal plain marsh	29	BC
	Indian Lake Southwest	Dry sand prairie	15	B
	Nichols Lake South	Intermittent wetland	32	B
	Indian Lake	Intermittent wetland	33	BC
	Heald Creek	Rich conifer swamp	56	C
Monroe	**Pierce Drive Bog**	Bog	82	B
	Hayes Road Bog	Bog	93	C
Sherman	Alley Lake	Bog	67	BC
	Little Robinson Lake Opportunity Area -- West	Coastal plain marsh	28	B
	Pearl Lake	Poor conifer swamp	16	BC
Troy	**Big South Branch Pere Marquette River -- Newaygo County**	Floodplain forest	46	AB
Wilcox	**Mudget Lake Bog**	Bog	83	BC
	Mullen Creek Swamp	Hardwood-conifer swamp	27	BC
	Fivemile Creek Swamp	Hardwood-conifer swamp	34	BC

Table 3. Publically accessible natural communities.

Natural community type	Site	Township	Ownership	Directions
Bog	NCCS Camp Newaygo Wetlands Trail	Garfield	NCCS Camp Newaygo	From M-37 N of Newaygo, take M-82 W 0.2 miles to Old M-37. Follow N ca. 2.5 miles. Turn W on gravel road that accesses Pickerel Lake. Look for sign and parking area N of road.
Coastal plain marsh	Loon Lake	Merrill	Huron-Manistee National Forest	From M-37 N of White Cloud, take 6 Mile Rd. E ca. 0.7 miles. Lake/marsh is N of road.
Dry sand prairie	Newaygo Prairie Nature Sanctuary	Brooks	Michigan Nature Association	From M-37 N of Newaygo, take Croton Dr. ca. 4 miles E to Poplar Ave. Follow N ca. 1 mile; look for preserve sign E of road.
Hardwood-conifer swamp	Dudgeon Swamp	Goodwell	Huron-Manistee National Forest	From M-37 N of White Cloud, take Monroe St. E 4.5 miles to Pine Ave. Follow S 1.5 miles to 1 Mile Rd., E ca. 0.6 miles. Swamp is N of road.
Poor conifer swamp	NCCS Camp Newaygo Wetlands Trail	Garfield	NCCS Camp Newaygo	From M-37 N of Newaygo, take M-82 W 0.2 miles to Old M-37. Follow N ca. 2.5 miles. Turn W on gravel road that accesses Pickerel Lake. Look for sign and parking area N of road.
Southern floodplain forest	Pere Marquette River -- Big South Branch	various	Huron-Manistee National Forest	Several publicly accessible areas. Large stretches of public land can be accessed N and S of 13 Mile Rd. at the river crossing.

* The bog and poor conifer swamp associated with the NCCS Camp Newaygo Wetlands Trail are not element occurrences, but are accessible, characteristic examples of these natural community types.

Table 4. Newaygo County rare plant element occurrences by township.

Surveys to update known populations: 17
Surveys to record new populations: 32
Total surveyed 2005 and 2006: 49 of 115 (new county total)

* new species to Newaygo County
** new species to Michigan

SCIENTIFIC NAME	COMMON NAME	STATUS	EO NUMBER	UPDATE	NEW
Big Prairie					
Geum triflorum	PRAIRIE AVENS	T	9	X	
Linum sulcatum	GROOVED YELLOW FLAX	SC	22		X
Psilocarya scirpoides	BALD-RUSH	T	32		X
Rhynchospora macrostachya	TALL BEAK-RUSH	SC	62		X
Bridgeton					
Asclepias hirtella *	TALL GREEN MILKWEED *	T	23		X
Asclepias hirtella *	TALL GREEN MILKWEED *	T	24		X
Brooks					
Aster sericeus	WESTERN SILVER-LEAVED ASTER	T	1	X	
Aster sericeus	WESTERN SILVER-LEAVED ASTER	T	8	X	
Eleocharis melanocarpa	BLACK-FRUITED SPIKE-RUSH	SC	38	X	
Geum triflorum	PRAIRIE AVENS	T	24	X	
Geum triflorum	PRAIRIE AVENS	T	25	X	
Geum triflorum	PRAIRIE AVENS	T	15	X	
Linum sulcatum	GROOVED YELLOW FLAX	SC	21		X
Prunus alleghaniensis var. davisii	ALLEGHANY PLUM	SC	99		X
Prunus alleghaniensis var. davisii	ALLEGHANY PLUM	SC	2	X	
Sisyrinchium strictum	BLUE-EYED-GRASS	SC	10		X
Croton					
Prunus alleghaniensis var. davisii	ALLEGHANY PLUM	SC	100		X
Psilocarya scirpoides	BALD-RUSH	T	33		X
Pycnanthemum verticillatum	WHORLED MOUNTAIN MINT	SC	16		X
Everett					
Eleocharis melanocarpa	BLACK-FRUITED SPIKE-RUSH	SC	55		X
Eleocharis tricostata	THREE-RIBBED SPIKE-RUSH	T	6	X	
Hypericum adpressum **	CREEPING ST JOHN'S-WORT **	T	1		X
Polygala cruciata	CROSS-LEAVED MILKWORT	SC	15	X	
Rhexia virginica	MEADOW BEAUTY	SC	29	X	
Rhynchospora macrostachya	TALL BEAK-RUSH	SC	30	X	
Rhynchospora macrostachya	TALL BEAK-RUSH	SC	54	X	
Lilley					
Berula erecta *	WATER-PARSNIP *	T	49		X
Eleocharis atropurpurea *	PURPLE SPIKE-RUSH *	E	3		X
Eleocharis melanocarpa	BLACK-FRUITED SPIKE-RUSH	SC	54		X
Hemicarpha micrantha (Lipocarpa m.)	DWARF-BULRUSH	SC	48		X
Rhynchospora macrostachya	TALL BEAK-RUSH	SC	61		X
Merrill					
Berula erecta *	WATER-PARSNIP *	T	48		X
Eleocharis melanocarpa	BLACK-FRUITED SPIKE-RUSH	SC	53		X
Psilocarya scirpoides	BALD-RUSH	T	34		X
Pycnanthemum verticillatum	WHORLED MOUNTAIN MINT	SC	15		X
Pycnanthemum verticillatum	WHORLED MOUNTAIN MINT	SC	14		X
Rhexia virginica	MEADOW BEAUTY	SC	44	X	
Rhynchospora macrostachya	TALL BEAK-RUSH	SC	64		X
Rhynchospora macrostachya	TALL BEAK-RUSH	SC	65		X
Sherman					
Eleocharis microcarpa *	SMALL-FRUITED SPIKE-RUSH *	E	2		X
Hypericum adpressum **	CREEPING ST JOHN'S-WORT **	T	2		X
Potamogeton bicupulatus (P. capillaceus)	WATERTHREAD PONDWEED	T	12		X
Potamogeton bicupulatus (P. capillaceus)	WATERTHREAD PONDWEED	T	13		X
Psilocarya scirpoides	BALD-RUSH	T	36		X
Rhexia virginica	MEADOW BEAUTY	SC	31	X	
Rhynchospora macrostachya	TALL BEAK-RUSH	SC	55	X	
Schoenoplectus torreyi (Scirpus t.)	TORREY'S BULRUSH	SC	15		X
Schoenoplectus torreyi (Scirpus t.)	TORREY'S BULRUSH	SC	14	X	
Wilcox					
Poa paludigena *	BOG BLUEGRASS *	T	29		X

Appendix 1
Natural Heritage Global and State Element Ranking Criteria

GLOBAL RANKS

- **G1** = critically imperiled globally because of extreme rarity (5 or fewer occurrences range-wide or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
- **G2** = imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
- **G3** = either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g. a single western state, a physiographic region in the East) or because of other factor(s) making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.
- **G4** = apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.
- **G5** = demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.
- **GH** = of historical occurrence throughout its range, i.e. formerly part of the established biota, with the expectation that it may be rediscovered (e.g. Bachman's Warbler).
- **GU** = possibly in peril range-wide, but status uncertain; need more information.
- **GX** = believed to be extinct throughout its range (e.g. Passenger Pigeon) with virtually no likelihood that it will be rediscovered.

STATE RANKS

- **S1** = critically imperiled in the state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation in the state.
- **S2** = imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.
- **S3** = rare or uncommon in state (on the order of 21 to 100 occurrences).
- **S4** = apparently secure in state, with many occurrences.
- **S5** = demonstrably secure in state and essentially ineradicable under present conditions.
- **SA** = accidental in state, including species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds or even thousands of miles outside their usual range.
- **SE** = an exotic established in the state; may be native elsewhere in North America (e.g. house finch or catalpa in eastern states).
- **SH** = of historical occurrence in state and suspected to be still extant.
- **SN** = regularly occurring, usually migratory and typically nonbreeding species.
- **SR** = reported from state, but without persuasive documentation which would provide a basis for either accepting or rejecting the report.
- **SRF** = reported falsely (in error) from state but this error persisting in the literature.
- **SU** = possibly in peril in state, but status uncertain; need more information.
- **SX** = apparently extirpated from state.

Appendix 2
Surveyed Site Details

Newaygo County Sites Surveyed by MNFI 2005 and 2006

Total # sites surveyed - 109

Total # site visits - 212

Township	Site	Site code	Surveyors	Date
Barton	# sites surveyed - 1 # visits - 1			
	Grass Lake-Pease Creek	L-WPL-10	Walters, Spalink	9/14/2006
Beaver	# sites surveyed - 4 # visits - 5			
	Big South Branch Pere Marquette R N of 10 Mile	L-BSW-1	Walters, Spalink	5/31/2006
	Big South Branch Pere Marquette R Stone Rd	L-BSW-1	Walters, Spalink	5/31/2006
	Big South Branch Pere Marquette R Stone Rd	L-BSW-1	Walters, Spalink	9/14/2006
	Crosswell Swamp	L-WUSE-1	Walters, Spalink	6/1/2006
	Island Lake	A-16	Slaughter	9/12/2006
Big Prairie	# sites surveyed - 3 # visits - 9			
	36th Street Oak-Pine Barrens	H-9	Walters, Spalink	6/15/2006
	36th Street Oak-Pine Barrens	H-9	Courteau, Slaughter	6/21/2006
	36th Street Oak-Pine Barrens	H-9	Walters	8/25/2006
	36th Street Oak-Pine Barrens	H-9	Walters, Spalink, Hostetler	8/29/2006
	36th Street Oak-Pine Barrens	H-9	Kost, Slaughter	9/27/2006
	Harness Marsh	L-BPS-6	Kost, Penskar, Walters, Slaughter	9/1/2005
	Harness Marsh	L-BPS-7	Kost, Penskar, Walters, Slaughter	9/1/2005
	Harness Marsh	L-BPS-2	Kost, Penskar, Walters, Slaughter	9/1/2005
	Oxbow Swamp	L-TCN-2	Walters	7/21/2006
Bridgeton	# sites surveyed - 11 # visits - 14			
	Brooks Creek- 100th St	L-FRE-2	Walters, Spalink	9/19/2006
	Brooks Creek- 108th St	L-FRE-2	Walters, Spalink	9/21/2006
	Brooks Creek- 112th St	L-FRE-2	Walters, Spalink, Slaughter	8/31/2006
	Brooks Creek- 124th St	L-FRE-2	Walters, Spalink, Slaughter	8/31/2006
	Lowe Lake Swamp -- Muskegon State Game Area	L-BGN-1	Slaughter	9/14/2005
	Muskegon SGA Intermittent Wetland 1	U-6	Bassett, Slaughter	8/22/2005
	Muskegon SGA Intermittent Wetland 2	U-9	Slaughter	8/26/2005
	Muskegon SGA Intermittent Wetland 3	U-5	Bassett, Slaughter	8/22/2005
	Muskegon SGA Intermittent Wetland NE	U-8	Bassett, Slaughter	8/23/2005
	Muskegon SGA Oak-Pine Barrens	L-BGN-4	Bassett, Slaughter	8/22/2005
	Muskegon SGA Oak-Pine Barrens	L-BGN-4	Walters	6/23/2006
	Muskegon SGA Section 28 Lakeplain Prairie	L-BGN-2	Bassett, Slaughter	8/23/2005
	Muskegon SGA Section 28 Lakeplain Prairie	L-BGN-2	Walters, Spalink	7/20/2006
	Muskegon SGA Section 28 Lakeplain Prairie	L-BGN-2	Walters, Crancer	9/22/2006
Brooks	# sites surveyed - 14 # visits - 18			
	Brooks Lake	S-189	Slaughter	7/26/2006
	Coolbough Natural Areas	F-14	Walters, Spalink	9/21/2006
	Croton Road and Bigelow Creek	U-20	O'Connor	5/9/2006
	Finger Prairie	G-2	Slaughter	7/21/2006
	Muskegon River Dry-Mesic Forest	S-194	Bassett, Slaughter, Higman	9/13/2005
	Muskegon River Floodplain- Hazelwood Ave.	G-12	Courteau	8/23/2006
	Newaygo Prairie -- USFS	U-3	Slaughter	9/8/2005
	Newaygo Prairie Nature Sanctuary	G-14	Slaughter	9/8/2005
	Newaygo Prairie Nature Sanctuary	G-14	O'Connor	5/9/2006
	Newaygo Prairie Nature Sanctuary	G-14	Walters, Spalink, Hostetler	8/29/2006
	Oak Ave - 88th St	U-18	O'Connor	6/14/2006
	Poplar Rd Oak-Pine Barrens	G-15	Slaughter	9/20/2005
	Poplar Rd Oak-Pine Barrens	G-15	Walters	6/30/2006

Township	Site	Site code	Surveyors	Date
	Poplar Rd Oak-Pine Barrens	G-15	Courteau	7/16/2006
	Section 27 Bowl Prairie	G-10	Walters	9/1/2006
	Spruce Ave	U-19	O'Connor	6/13/2006
	Thornapple Rd Oak-Pine Barrens	G-9	Walters	6/16/2006
	West Tract Forest	U-1	Courteau, Slaughter	6/23/2006
Croton	# sites surveyed - 4 # visits - 6			
	52nd St Barrens	I-9	Courteau	8/23/2006
	Little Muskegon River Mesic Forest	L-TCS-1	Walters, Spalink	6/29/2006
	Little Muskegon River Mesic Forest	L-TCS-1	Courteau	8/23/2006
	M-82 - Newcosta Rd	U-17	O'Connor	5/9/2006
	Pine-Pettit Marsh	G-7	Bassett, Slaughter	9/12/2005
	Pine-Pettit Marsh	G-7	Slaughter	7/19/2006
Denver	# sites surveyed - 2 # visits - 2			
	Kirchner Lake East	A-8	Slaughter	9/25/2006
	Kirchner Lake South	A-8	Slaughter	9/25/2006
Everett	# sites surveyed - 7 # visits - 22			
	Bigelow Creek-Poplar Ave	U-4	Courteau	7/26/2006
	Fry Lake Coastal Plain Marsh	G-24	Slaughter	9/6/2005
	Fry Lake Coastal Plain Marsh	G-24	Penskar, Walters	9/29/2005
	Gustafson Marsh	S-110	Slaughter	9/7/2005
	Little Robinson Lake Opportunity Area -- East	L-WCS-10	Walters, Spalink	7/19/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-9	Walters, Spalink	7/19/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-6	Walters, Spalink	7/19/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-7	Walters, Spalink	7/19/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-8	Walters, Spalink	7/19/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-5	Walters, Spalink	7/19/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-6	Slaughter, Courteau	8/12/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-7	Slaughter, Courteau	8/12/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-8	Slaughter, Courteau	8/12/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-9	Slaughter, Courteau	8/12/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-13	Walters, Spalink	8/14/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-6	Walters, Spalink, Penskar, Courteau, Reznicek, Warners	8/17/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-5	Walters, Spalink, Penskar, Courteau, Reznicek, Warners	8/17/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-10	Slaughter	8/28/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-5	Slaughter	8/28/2006
	Toft Lake	F-19	Courteau, Slaughter	6/1/2006
	Twinwood Lake North Hardwood-conifer Swamp	L-NEW-11	Kost, Slaughter	8/9/2006
	Twinwood Lake North Northern Shrub Thicket	L-NEW-11	Slaughter	9/20/2005
Garfield	# sites surveyed - 1 # visits - 1			
	Camp Newaygo-Pickerel Lake Bog	L-NEW-10	Penskar, Walters, Schools, Slaughter	9/30/2005
Goodwell	# sites surveyed - 3 # visits - 5			
	Carey Lake NW	L-BPN-18	Penskar, Walters	9/29/2005
	Cypress Ave Dry-Mesic Forest	L-BPN-39	Walters, Spalink	6/8/2006
	Dudgeon Swamp	L-BPS-3	Kost, Penskar, Walters, Slaughter	9/1/2005
	Dudgeon Swamp	L-BPS-3	Walters, Spalink	6/8/2006
	Dudgeon Swamp	L-BPS-3	Walters, Spalink	8/28/2006
Home	# sites surveyed - 3 # visits - 4			
	13 Mile Rd Bog	S-049	Walters, Spalink	6/26/2006
	13 Mile Rd Bog	S-049	Courteau, Slaughter	6/26/2006
	Honeysuckle Dr Dry-Mesic Forest	L-MAR-9	Walters, Spalink	6/26/2006
	Toman Lake	G-31	Slaughter, Schillo	9/8/2006

Township	Site	Site code	Surveyors	Date
Lilley	# sites surveyed - 7 # visits - 13			
	Amaung Lake	U-11	Slaughter	9/22/2005
	Leaf Lake Coastal Plain Marsh	L-WUE-1	Penskar, Walters	8/10/2005
	Leaf Lake Coastal Plain Marsh	L-WUE-1	Walters, Slaughter	8/29/2005
	Leaf Lake Coastal Plain Marsh	L-WUE-1	Walters, Spalink, Penskar, Courteau, Reznicek, Warners	8/18/2006
	Leaf Lake East Bog	L-WUE-31	Walters, Slaughter	8/29/2005
	Leaf Lake West	L-WUE-2	Penskar, Walters	8/10/2005
	Styles Swamp	L-BSE-1	Slaughter	9/15/2005
	Styles Swamp	L-BSE-1	Walters, Spalink	6/5/2006
	Triple Lakes Creek Northeast	L-BSE-9	Walters, Spalink	5/25/2006
	Triple Lakes Creek Northeast	L-BSE-9	Slaughter	6/20/2006
	Triple Lakes Creek Northeast	L-BSE-9	Walters, Spalink, Slaughter	7/18/2006
	Walkup Lake NW	L-WUE-36	Penskar, Walters	8/10/2005
	Walkup Lake NW	L-WUE-33	Penskar, Walters	8/10/2005
Lincoln	# sites surveyed - 5 # visits - 13			
	5 Mile Rd West	L-WUSE-52	Penskar, Walters	8/12/2005
	Egg Lake West	L-WUSE-8	Penskar, Walters	8/12/2005
	Egg Lake West	L-WUSE-8	Schillo, Slaughter	9/5/2006
	Loon Lake Coastal Plain Marsh	L-WPK-14	Walters, Spalink	8/23/2006
	Loon Lake Coastal Plain Marsh	L-WPK-13	Walters, Spalink	8/23/2006
	Loon Lake Coastal Plain Marsh	L-WPK-12	Walters, Spalink	8/23/2006
	Loon Lake Coastal Plain Marsh	L-WPK-16	Walters, Spalink	8/23/2006
	Loon Lake Coastal Plain Marsh	L-WPK-17	Walters, Spalink	8/23/2006
	Loon Lake Coastal Plain Marsh	L-WPK-15	Walters, Spalink	8/23/2006
	Loon Lake Coastal Plain Marsh	S-071	Walters, Spalink	9/18/2006
	Loon Lake Coastal Plain Marsh	S-073	Walters, Spalink	9/18/2006
	Loon Lake South Bog	L-WPK-49	Walters, Spalink	8/23/2006
	Pinchtown Swamp	S-068	Kost, Slaughter	8/9/2006
Merrill	# sites surveyed - 11 # visits - 23			
	11 Mile Rd Swamp	L-WUSE-59	Walters, Spalink	6/27/2006
	Heald Creek	L-WUSE-57	Walters, Spalink	6/27/2006
	Heald Creek	L-WUSE-57	Walters, Spalink	7/20/2006
	Heald Creek	L-WUSE-57	Slaughter, Sanderson	7/20/2006
	Indian Lake North lakeshore	L-WUSE-28	Penskar, Walters	8/11/2005
	Indian Lake North lakeshore	L-WUSE-28	Kost, Penskar, Walters, Slaughter	8/31/2005
	Indian Lake North lakeshore	L-WUSE-28	Walters, Spalink	9/19/2006
	Indian Lake Southwest	L-WUSE-30	Slaughter, Schillo	9/5/2006
	Indian Lake Southwest	L-WUSE-30	Walters, Spalink	9/19/2006
	Indian Lake West Prairie	L-WUSE-39	Walters, Spalink	6/2/2006
	Loda Lake Coastal Plain Marsh	L-WUSE-40	Penskar, Walters, Slaughter	9/28/2005
	Loon Lake Coastal Plain Marsh	L-WPK-1	Slaughter	9/7/2005
	Loon Lake Coastal Plain Marsh	L-WPK-1	Walters, Spalink	8/23/2006
	Loon Lake Coastal Plain Marsh	L-WPK-1	Schillo, Slaughter	9/6/2006
	Nichols Lake South	L-WUE-4	Penskar, Walters	8/11/2005
	Nichols Lake South	L-WUE-4	Kost, Penskar, Walters, Slaughter	8/30/2005
	Nichols Lake South	L-WUE-6	Courteau, Slaughter	8/22/2006
	Nichols Lake South	L-WUE-5	Courteau, Slaughter	8/22/2006
	Nichols Lake South	L-WUE-4	Courteau, Slaughter	8/22/2006
	Nichols Lake South	L-WUE-3	Courteau, Slaughter	8/22/2006
	Nichols Lake South Bog	L-WUE-8	Kost, Penskar, Walters, Slaughter	8/30/2005
	Richmond Lake Bog	L-WPK-39	Kost, Slaughter	9/28/2006
	Shelley Lake	L-WPK-20	Slaughter	7/10/2006

Township	Site	Site code	Surveyors	Date
Monroe	# sites surveyed - 6 # visits - 9			
	Evergreen Dr - 17 Mile Rd Bog	L-WPK-37	Kost, Penskar, Walters, Slaughter	9/1/2005
	Hayes Road Bog	L-WPK-50	Slaughter, Bassett	9/26/2005
	Loon Lake Coastal Plain Marsh	L-WPK-3	Schillo, Slaughter	9/6/2006
	Loon Lake Coastal Plain Marsh	L-WPK-7	Schillo, Slaughter	9/6/2006
	Loon Lake Coastal Plain Marsh	L-WPK-8	Schillo, Slaughter	9/6/2006
	Oxford Swamp West	L-WPK-33	Walters, Spalink	6/19/2006
	Oxford Swamp West	L-WPK-33	Walters, Spalink	9/13/2006
	Pierce Drive Bog	L-WPK-35	Slaughter, Bassett	9/26/2005
	Thornapple Ave Conifers	L-WVS-6	Slaughter	9/11/2006
Norwich	# sites surveyed - 4 # visits - 4			
	Cypress Rd N. of 9 Mile Rd	U-16	Penskar, Kost, Walters	9/2/2005
	Ewing Creek	L-WVE-6	Penskar, Kost, Walters	9/2/2005
	Hungerford Lake	U-15	Penskar, Kost, Walters	9/2/2005
	Lynn Dr S of 9 Mile Rd	U-14	Penskar, Kost, Walters	9/2/2005
Sherman	# sites surveyed - 8 # visits - 37			
	Alley Lake	E-7	Schillo	9/7/2006
	Baseline Road-Rattlesnake Creek	U-13	Walters, Spalink	5/24/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-1	Slaughter	9/23/2005
	Little Robinson Lake Opportunity Area -- East	L-WCS-1	Penskar, Walters	9/29/2005
	Little Robinson Lake Opportunity Area -- East	L-WCS-4	Walters, Spalink	7/19/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-1	Walters, Spalink, Schools	8/3/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-3	Walters, Spalink, Schools	8/3/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-2	Walters, Spalink, Penskar, Courteau, Reznicek, Warners	8/17/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-1	Walters, Spalink, Penskar, Courteau, Reznicek, Warners	8/17/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-4	Walters, Spalink, Penskar, Courteau, Reznicek, Warners	8/17/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-4	Slaughter	8/28/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-1	Slaughter	8/28/2006
	Little Robinson Lake Opportunity Area -- East	L-WCS-3	Slaughter	8/29/2006
	Little Robinson Lake Opportunity Area -- West	L-WCS-30	Walters, Spalink	7/19/2006
	Little Robinson Lake Opportunity Area -- West	L-WCS-26	Walters, Spalink	7/19/2006
	Little Robinson Lake Opportunity Area -- West	L-WCS-36	Walters, Spalink	7/19/2006
	Little Robinson Lake Opportunity Area -- West	L-WCS-28	Walters, Spalink	7/19/2006
	Little Robinson Lake Opportunity Area -- West	L-WCS-29	Walters, Spalink	7/19/2006
	Little Robinson Lake Opportunity Area -- West	L-WCS-28	Walters, Spalink, Penskar, Courteau, Reznicek, Warners	8/17/2006
	Little Robinson Lake Opportunity Area -- West	L-WCS-29	Walters, Spalink, Penskar, Courteau, Reznicek, Warners	8/17/2006
	Little Robinson Lake Opportunity Area -- West	L-WCS-25	Walters, Spalink, Penskar, Courteau, Reznicek, Warners	8/17/2006
	Little Robinson Lake Opportunity Area -- West	L-WCS-23	Slaughter	8/28/2006
	Little Robinson Lake Opportunity Area -- West	L-WCS-39	Slaughter	8/29/2006
	Little Robinson Lake Opportunity Area -- West	L-WCS-28	Slaughter	8/29/2006
	Little Robinson Lake Opportunity Area -- West	L-WCS-25	Slaughter	8/29/2006
	Little Robinson Lake West Complex	L-WCS-31	Walters, Spalink	7/19/2006
	Little Robinson Lake West Complex	L-WCS-53	Walters, Spalink	7/19/2006
	Little Robinson Lake West Complex	L-WCS-27	Walters, Spalink	7/19/2006
	Little Robinson Lake West Complex	L-WCS-34	Walters, Spalink	7/19/2006
	Little Robinson Lake West Complex	L-WCS-47	Slaughter	8/29/2006
	Little Robinson Lake West Complex	L-WCS-38	Slaughter	8/29/2006
	Little Robinson Lake West Complex	L-WCS-27	Slaughter (check date)	8/29/2006
	Pearl Lake	U-2	Schillo, Slaughter	9/7/2006
	Rattlesnake Creek Floodplain	L-WCN-2	Walters, Spalink	5/27/2006

Township	Site	Site code	Surveyors	Date
	Rattlesnake Creek Floodplain	L-WCN-2	Walters, Spalink	8/16/2006
	Rattlesnake Creek Swamp	L-WCN-1	Slaughter, Higman	9/21/2005
	Rattlesnake Creek Swamp	L-WCN-1	Walters, Spalink	6/20/2006
Troy	# sites surveyed - 10	# visits - 17		
	16 Mile Rd Oak-Pine Barrens	U-10	Walters, Slaughter	8/30/2005
	18 Mile Rd Oak-Pine Barrens	A-23	Walters, Spalink	6/21/2006
	18 Mile Rd Oak-Pine Barrens	A-23	Courteau, Slaughter	8/21/2006
	18 Mile Rd Swamp	S-039	Walters, Spalink	6/21/2006
	18 Mile Rd Swamp	S-039	Walters, Spalink	8/21/2006
	18 Mile Rd Swamp	S-039	Courteau, Slaughter	8/21/2006
	Big South Branch Pere Marquette R 13 Mile Rd	L-BSW-1	Penskar, Walters	8/11/2005
	Big South Branch Pere Marquette R 13 Mile Rd	L-BSW-1	Kost, Penskar, Walters, Slaughter	8/31/2005
	Big South Branch Pere Marquette R N of 16 Mile	L-BSW-1	Walters, Spalink	6/17/2006
	Big South Branch Pere Marquette R S of Dickinson	L-BSW-1	Penskar, Walters	9/29/2005
	Big South Branch Pere Marquette R W of Dickinson	L-BSW-1	Walters, Spalink	6/6/2006
	Big South Branch Pere Marquette R W of Dickinson	L-BSW-1	Walters, Spalink	8/21/2006
	Green Avenue Oak-Pine Barrens	U-12	Slaughter	9/27/2005
	Styles Swamp West	L-BSE-11	Walters, Spalink	7/17/2006
	Styles Swamp West	L-BSE-12	Walters, Spalink	7/17/2006
	Walkers Corners Intermittent Wetlands	B-11b	Slaughter	9/27/2005
	Walkers Corners Intermittent Wetlands	B-11b	Walters, Spalink	6/5/2006
Wilcox	# sites surveyed - 5	# visits - 9		
	Fivemile Creek Swamp	G-30	Slaughter, Courteau	6/7/2006
	Fivemile Creek Swamp	G-30	Slaughter, Courteau	6/13/2006
	Fivemile Creek Swamp	G-30	Walters, Spalink	6/14/2006
	Fivemile Creek Swamp	G-30	Walters, Spalink	8/30/2006
	Flinton Creek Floodplain Forest	F-23	Walters, Spalink, Slaughter, Coffey	9/12/2006
	Flinton Creek Mesic Northern Forest	F-23	Walters, Spalink, Slaughter, Coffey	9/12/2006
	Mudget Lake Bog	L-WPK-42	Slaughter	9/7/2005
	Mullen Creek Swamp	L-WVS-1	Bassett, Slaughter	9/12/2005
	Mullen Creek Swamp	L-WVS-1	Walters, Spalink	6/29/2006

Appendix 3
Natural Community Descriptions

Natural Communities of Newaygo County, Michigan

The following is a description of the 13 natural community types currently represented in Newaygo County by at least one occurrence in the MNFI statewide database of state-listed vascular plants, animals, and high quality natural community occurrences. The general descriptions follow the current draft list and descriptions of Michigan's Natural Communities (MNFI 2006). Description of landscape setting, dominant and characteristic plant species, and associated rare plant species are specific to Newaygo County occurrences for each natural community type.

Hardwood-conifer swamp

Hardwood-conifer swamp is a commonly occurring forested wetland community type in Newaygo County, occupying shallow to deep, slightly acidic to mildly alkaline muck soils in poorly-drained outwash plains and in the floodplains of small streams. Typical canopy dominants in Newaygo County are hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), northern white-cedar (*Thuja occidentalis*), red maple (*Acer rubrum*), and yellow birch (*Betula alleghaniensis*). Common understory species include red maple, black ash (*Fraxinus nigra*), and paper birch (*Betula papyrifera*). Common shrubs include blue-beech (*Carpinus caroliniana*), tag alder (*Alnus rugosa*), Michigan holly (*Ilex verticillata*), dogwoods (*Cornus* spp.), alder-leaved buckthorn (*Rhamnus alnifolia*) and spicebush (*Lindera benzoin*). The ground layer ranges from lush and diverse in canopy gaps to sparse and species-poor under dense stands of hemlock. Typical ground layer species on wet, saturated mucks include skunk-cabbage (*Symplocarpus foetidus*), cinnamon fern (*Osmunda cinnamomea*), sensitive fern (*Onoclea sensibilis*), woodfern (*Dryopteris* spp.), sedges (*Carex* spp.), northern bugle weed (*Lycopus uniflorus*), jack-in-the-pulpit (*Arisaema triphyllum*), rough goldenrod (*Solidago rugosa*), and fowl manna grass (*Glyceria striata*). Species associated with hummocks and decomposing wood include goldthread (*Coptis trifolia*), naked miterwort (*Mitella nuda*), dwarf raspberry (*Rubus pubescens*), Canada mayflower (*Maianthemum canadense*), starflower (*Trientalis borealis*), bluebead-lily (*Clintonia borealis*), bunchberry (*Cornus canadensis*), gay-wings (*Polygala paucifolia*), and several species of orchids. Newaygo County hardwood-conifer swamps are diverse natural communities, typically harboring between 100 and 200 vascular plant species based on field surveys. One state-listed vascular plant species, bog bluegrass (*Poa paludigena*), is documented from hardwood-conifer swamps in Newaygo County. A total of 6 occurrences of hardwood-conifer swamp were documented as a result of field surveys (Table 2). All of these sites were characterized by mature second-growth stands of native conifers, high heterogeneity, and relatively unaltered hydrology.

Cinnamon fern (Osmunda cinnamomea) is one of the most characteristic ground layer plant species of hardwood-conifer swamps. Twinwood Lake, Everett Township. Photo: B. Slaughter.

Rich conifer swamp

Rich conifer swamp is a rarely occurring forested wetland community type in Newaygo County, occupying deep neutral to moderately alkaline peat and muck soils in poorly drained outwash plains and at the base of end moraines, associated with groundwater seepage. Northern white-cedar (*Thuja occidentalis*) is strongly dominant in the canopy. Other common tree species include tamarack (*Larix laricina*), white pine (*Pinus strobus*), black ash (*Fraxinus nigra*), quaking aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), and, occasionally, balsam fir (*Abies balsamea*). Hemlock (*Tsuga canadensis*) is present but never dominant. Shrub and ground layer species composition is similar to that of hardwood-conifer swamps. Compared to hardwood-conifer swamps in Newaygo County, rich conifer swamps have greater canopy dominance by northern white-cedar, deeper peat soils, more active groundwater seepage, and more extensive moss coverage in the ground layer. Characteristic ground layer species common in rich conifer swamps but rare in hardwood-conifer swamps in Newaygo County include round-leaved sundew (*Drosera rotundifolia*), creeping snowberry (*Gaultheria hispidula*), twinflower (*Linnaea borealis*), false mayflower (*Smilacina trifolia*), and, locally, the state-threatened water parsnip (*Berula erecta*), which is found in seeps and cold-water streams. Newaygo County rich conifer swamps are diverse natural communities, typically harboring between 100 and 200 vascular plant species based on field surveys. A total of 2 occurrences of rich conifer swamp were documented as a result of field surveys, and one previously documented occurrence was revisited (Table 2). All of these sites were characterized by mature second-growth stands of native conifers, high heterogeneity, and relatively unaltered hydrology.

Relict conifer swamp

Relict conifer swamps are characterized by patchy canopies dominated by tamarack (*Larix laricina*), a short-lived deciduous conifer typically found in areas of groundwater seepage along small streams or lakeshores. Canopy gaps allow light-requiring plant species to persist alongside shade-tolerant species, leading to the high diversity of these systems. Kirchner Lake drainage, Denver Township. Photo: B. Slaughter.

Relict conifer swamp is a rarely occurring forested wetland community in Newaygo County, occupying deep neutral to mildly alkaline peat and muck soils bordering kettle lakes. Seepage of nutrient-rich groundwater and the presence of marl deposits are characteristic of this natural community type. Tamarack (*Larix laricina*) is strongly dominant in the canopy. Other common tree species include black ash (*Fraxinus nigra*), yellow birch (*Betula alleghaniensis*), red maple (*Acer rubrum*), and American elm (*Ulmus americana*). Relict conifer swamps are characterized by patchy tree cover, allowing for the development of a diverse association of light-requiring shrubs, including poison sumac (*Toxicodendron vernix*), tag alder (*Alnus rugosa*), Michigan holly (*Ilex verticillata*), dogwoods (*Cornus* spp.), alder-leaved buckthorn (*Rhamnus alnifolia*), and swamp rose (*Rosa palustris*). The ground layer flora of relict conifer swamps supports both light-requiring and shade-tolerant species, associated with open and shaded microhabitats, respectively. Characteristic species in Newaygo County include sedges (*Carex* spp.), fowl manna grass (*Glyceria striata*), skunk-cabbage (*Symplocarpus foetidus)*, side-flowering aster (*Aster lateriflorus*), pitcher-plant (*Sarracenia purpurea*), and many of the ground layer plants listed for hardwood-conifer swamp.

Of note is the diversity and importance of woody and non-woody vines, including hog-peanut (*Amphicarpaea bracteata*), groundnut (*Apios americana*), wild yam (*Dioscorea villosa*), virgin's bower (*Clematis virginiana*), Virginia creeper (*Parthenocissus quinquefolia*), poison-ivy (*Toxicodendron radicans*), and riverbank grape (*Vitis riparia*). No state-listed vascular plant species are documented from relict conifer swamps in Newaygo County. Two occurrences of relict conifer swamp were surveyed in 2006, including one new occurrence and one previously documented occurrence (Table 2). These are currently the northernmost known relict conifer swamp occurrences in Michigan. Both sites are characterized by high diversity (100-120 vascular plant species), high heterogeneity, and unaltered hydrology. One of the two occurrences was recently flooded by beaver activity and is expected to convert to shrub or sedge dominance when water levels drop.

Floodplain forest

Floodplain forest is found along streams of third order or greater in Newaygo County, including the Muskegon River, White River, Pere Marquette River, and Brooks Creek. Floodplain forests harbor the greatest vascular plant species diversity of any natural community type in Newaygo County due to the impacts of the stream channel on soil characteristics and vegetative zonation. Characteristic tree species in Newaygo County floodplain forests include silver maple (*Acer saccharinum*), red maple (*A. rubrum*), sugar maple (*A. saccharum*), white ash (*Fraxinus americana*), green ash (*F. pennsylvanica*), black ash (*F. nigra*), basswood (*Tilia americana*), beech (*Fagus grandifolia*), and red oak (*Quercus rubra*). Locally, conifers dominate, including hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), and northern white-cedar (*Thuja occidentalis*). Sycamore (*Platanus occidentalis*) and hackberry (*Celtis occidentalis*), more typical of floodplain forests in southern lower Michigan, are local in Newaygo County. Other species more typical of southern lower Michigan documented in our Newaygo County surveys include paw-paw (*Asimina triloba*) and green dragon (*Arisaema dracontium*). Understory and ground layer dominants vary among zones. No state-listed vascular plant species are currently documented from floodplain forests in Newaygo County. One occurrence of floodplain forest was surveyed in 2006, located along the Big South Branch of the Pere Marquette River (Table 2). This site is notable for its mature second-growth trees, excellent zonation, and unaltered, sinuous stream channel. Over 350 vascular plant species have been documented from this occurrence.

The Big South Branch of the Pere Marquette River, shown here in Troy Township, is associated with a high-quality occurrence of floodplain forest. To date, over 350 vascular plant species have been documented from this system, including species normally found much further south, such as the green dragon (*Arisaema dracontium*). Photo: B. Slaughter.

Bog

Bogs are a widespread, common wetland community type in Newaygo County, typically occupying small ice block depressions on sandy outwash plains and coarse-textured end moraines. Bogs are characterized by a deep, extremely acidic sphagnum peat substrate, which occasionally occurs as a floating mat at the margin of open water. The sphagnum-dominated substrate typically supports a dense cover of leatherleaf (*Chamaedaphne calyculata*) and scattered trees, including tamarack (*Larix laricina*), black spruce (*Picea mariana*), white pine (*Pinus strobus*), and jack pine (*P. banksiana*). Other plant species typically found in the leatherleaf-dominated bogs include blueberries (*Vaccinium angustifolium*, *V. corymbosum*, *V. myrtilloides*), swamp-laurel (*Kalmia polifolia*), Virginia chain-fern (*Woodwardia virginica*), and tawny cotton-grass (*Eriophorum virginianum*). Many occurrences contain zones dominated by the sedges *Carex oligosperma* and *C. lasiocarpa*, with scattered individuals of Canadian rush (*Juncus canadensis*) and three-way sedge (*Dulichium arundinaceum*). Shallow, quaking sphagnum mats add to the diversity of some bogs, and are characterized by a beak-rush (*Rhynchospora alba*), sundews (*Drosera intermedia* and *D. rotundifolia*), large cranberry (*Vaccinium macrocarpon*), small cranberry (*V. oxycoccos*), pitcher-plant (*Sarracenia purpurea*), yellow-eyed-grass (*Xyris* spp.), wild calla (*Calla palustris*), cotton-grasses (*Eriophorum* spp.), and bog rosemary (*Andromeda glaucophylla*). One state-listed plant species, waterthread pondweed (*Potamogeton bicupulatus*), is currently documented from Newaygo County bogs. Overall, most Newaygo County bogs are characterized by low diversity, typically harboring 20-40 vascular plant species. Six occurrences of bog were surveyed in 2005 and 2006, including 4 new occurrences and 2 previously documented occurrences (Table 2). Five of these sites are characterized by heterogeneous zonation and minimal human disturbance. One site has been locally impacted by ditching, but represents one of the largest bogs currently known in the state.

Quaking mat zone of a sphagnum bog on Richmond Lake (Merrill Township). Note the presence of open pools and scattered "islands" supporting shrubs, including leatherleaf (*Chamaedaphne calyculata*), and scattered trees, primarily white pine (*Pinus strobus*) and tamarack (*Larix laricina*). Photo: B. Slaughter.

Bogs occur on deep, highly acidic sphagnum peat, and support relatively few plant species due to their extreme acidity. Cold water and low levels of oxygen contribute to the slow rate of decomposition in bogs, which is responsible for the preservation of "bog bodies," mummified human bodies that have to date been discovered in peat bogs in Europe and Florida, most dating to over 2000 years old. Nichols Lake South, Merrill Township. Photo: B. Slaughter

Northern shrub thicket

Northern shrub thicket is a commonly occurring shrub-dominated wetland community in Newaygo County, occupying shallow to deep, slightly acidic to mildly alkaline muck soils in the floodplains of small streams. Tag alder (*Alnus rugosa*) is strongly dominant, with Michigan holly (*Ilex verticillata*) also important. In the one example surveyed in Newaygo County, black ash (*Fraxinus nigra*) saplings were common, and isolated hummocks support living specimens of white pine (*Pinus strobus*), suggesting succession to hardwood-conifer swamp, from which this community likely derived following beaver flooding. Characteristic ground layer species include sedges (especially *Carex lacustris*, *C. stricta*, *C. bromoides*, and *C. comosa*), blue-joint grass (*Calamagrostis canadensis*), wool-grass (*Scirpus cyperinus*), bulrush (*S. atrovirens*), joe-pye-weed (*Eupatorium maculatum*), boneset (*E. perfoliatum*), false nettle (*Boehmeria cylindrica*), southern blue-flag (*Iris virginica*), and rough goldenrod (*Solidago rugosa*). Newaygo County northern shrub thickets are characterized by moderate to high diversity, containing many plants associated with both forested and non-forested wetlands. No state-listed vascular plant species are documented from northern shrub thickets in Newaygo County. One occurrence of northern shrub thicket was surveyed in 2005 (Table 2). This site is characterized by excellent zonation, high diversity, and minimal human impacts.

Poor conifer swamp

Small kettle-hole lakes are common in Newaygo County, often supporting bog and poor conifer swamp communities. Here, at Toman Lake (Home Township), whorled loosestrife (*Decodon verticillatus*) rings the open water, and is surrounded by a forested zone of black spruce (*Picea mariana*) and tamarack (*Larix laricina*). Photo: B. Slaughter.

Poor conifer swamp is a widespread forested wetland community type in Newaygo County, typically occupying small ice block depressions on sandy outwash plains and coarse-textured end moraines. Like bogs, poor conifer swamps are characterized by a deep, extremely acidic sphagnum peat substrate. Poor conifer swamp often occurs as a small zone within open bogs, although some examples are large enough to be considered natural community element occurrences. Characteristically, conifers provide >50% canopy coverage. The most important species are tamarack (*Larix laricina*) and black spruce (*Picea mariana*), often associated with white pine (*Pinus strobus*), jack pine (*P. banksiana*), and red maple (*Acer rubrum*). Shrubs are important to locally dominant, primarily represented by leatherleaf (*Chamaedaphne calyculata*), but also including blueberries (*Vaccinium angustifolium*, *V. corymbosum*, *V. myrtilloides*), bog laurel (*Kalmia polifolia*), huckleberry (*Gaylussacia baccata*), and mountain holly (*Nemopanthus mucronatus*). Typical ground layer species are the same as for bog, with the addition of the sedge *Carex trisperma* as an important ground layer species and creeping snowberry (*Gaultheria hispidula*) as an occasional ground layer species in the dense shade of conifers. Newaygo County poor conifer

swamps are characterized by low diversity, harboring 30-50 vascular plant species. No state-listed vascular plant species are currently documented from poor conifer swamps in Newaygo County. Two occurrences of poor conifer swamp were surveyed in 2006, including one new occurrence and one previously documented occurrence (Table 2). These sites are characterized by dense conifer canopies with no evidence of logging and minimal human disturbance.

Pitcher-plant (*Sarracenia purpurea*) is a common insectivorous plant of bogs, poor conifer swamps, and relict conifer swamps in Newaygo County. Insects provide a source of nitrogen and phosphorus, two important plant nutrients of otherwise limited availability in highly acidic habitats. Pitcher-plant is shown here with creeping snowberry (*Gaultheria hispidula*) and large cranberry (*Vaccinium macrocarpon*) in a poor conifer swamp at Pearl Lake, Sherman Township. Photo: B. Slaughter.

Very few plant species grow in the dense shade of black spruce (*Picea mariana*) and tamarack (*Larix laricina*). Rooted in sphagnum hummocks, these small trees are over 60 years old. Pearl Lake, Sherman Township. Photo: B. Slaughter.

Intermittent wetland

Intermittent wetland is a locally common herb-dominated wetland community type in Newaygo County, typically occupying strongly acid to neutral, saturated sands or thin mucks over sands in kettle depressions on sandy glacial outwash. Intermittent wetlands experience fluctuating water levels seasonally and from year to year, leading to the development of multiple vegetative zones associated with varying levels of soil moisture and inundation (MNFI 2006). Typical herbaceous species of the shallow water zone include sweet-scented waterlily (*Nymphaea odorata*), pickerel weed (*Pontederia cordata*), hardstem bulrush (*Schoenoplectus acutus*), bladderworts (*Utricularia* spp.), and mermaid-weed (*Proserpinaca palustris*). Saturated to slightly inundated zones are characterized by the sedge *Carex oligosperma*, twig-rush (*Cladium mariscoides*), three-way sedge (*Dulichium arundinaceum*), Canadian rush (*Juncus canadensis*), and, occasionally, the state-listed tall beak-rush (*Rhynchospora macrostachya*). The ecotone between the wetland and upland is typically characterized by a relatively narrow grass-dominated zone on moist sands. Important species in this zone include blue-joint grass (*Calamagrostis canadensis*), cordgrass (*Spartina pectinata*), meadowsweet (*Spiraea alba*), steeplebush (*S. tomentosa*), swamp dewberry (*Rubus hispidus*), northern bugle-weed (*Lycopus uniflorus*), southern blue-flag (*Iris virginica*), and lance-

leaved violet (*Viola lanceolata*). Newaygo County intermittent wetlands exhibit a range of diversity depending on the degree of zonal development, with the most diverse examples harboring over 75 vascular plant species. Two state-listed vascular plant species, tall beak-rush and whorled mountain mint (*Pycnanthemum verticillatum*), are currently documented from intermittent wetlands in Newaygo County. A total of 2 occurrences of intermittent wetland were documented as a result of field surveys (Table 2). These sites are characterized by heterogeneous zonation, high diversity, and minimal human impacts.

Coastal plain marsh

Coastal plain marsh is a locally occurring herb-dominated wetland community type in Newaygo County, typically occupying strongly acid to medium acid, saturated sands or thin mucks over sands in kettle depressions on sandy glacial outwash. Coastal plain marshes experience fluctuating water levels seasonally and from year to year, leading to the development of multiple vegetative zones associated with varying levels of soil moisture and inundation (MNFI 2006). Species composition is similar to that found in intermittent wetlands, with the distinction that coastal plain marshes are characterized by the presence of many plant species typical of the northern Atlantic coastal plain, some of which dominate specific zones within the community type. Common indicators of coastal plain marsh in Newaygo County include bushy aster (*Aster dumosus*), several spike-rushes (e.g., *Eleocharis melanocarpa*, *E. robbinsii*, *E. tricostata*), pipewort (*Eriocaulon aquaticum*), coastal plain flat-topped goldenrod (*Euthamia remota*), autumn sedge (*Fimbristylis autumnalis*), brown-fruited rush (*Juncus pelocarpus*), panic grass (*Panicum spretum*), meadow beauty (*Rhexia virginica*), beak-rushes (*Rhynchospora capitellata*, *R. fusca*, *R. macrostachya*, *R. scirpoides*), tooth-cup (*Rotala ramosior*), bulrush (*Schoenoplectus smithii*), hyssop hedge nettle (*Stachys hyssopifolia*), lance-leaved violet (*Viola lanceolata*), and yellow-eyed grass (*Xyris torta*). Newaygo County coastal plain marshes exhibit a range of diversity depending on the degree of zonal development, with the most diverse examples harboring over 100 vascular plant species, but typical examples harboring 50-75 species. 16 state-listed vascular plant species are currently documented from coastal plain marshes in Newaygo County. A total of 6 occurrences of coastal plain marsh were surveyed in 2005 and 2006, including 2 new occurrences and 4 previously documented occurrences (Table 2). These sites are characterized by heterogeneous zonation, high richness of indicator species, and minimal to moderate human disturbance.

Coastal plain marshes experience seasonal and year to year fluctuations of the water table, leading to the development of diverse plant zonation. In the left photograph, the lake bottom at Loon Lake (Merrill Township) was completely exposed in late summer 2005. Note the cracked, bare mud and drying leaves of sweet-scented waterlily (*Nymphaea odorata*) and yellow pond-lily (*Nuphar advena*). In right photograph, from late summer 2006, water levels were much higher. Many state-listed plant species are associated with coastal plain marshes in Newaygo County. Photos: B. Slaughter.

Lakeplain wet-mesic prairie

Lakeplain wet-mesic prairie is a rare and local grass-dominated wetland community type in Newaygo County, occupying small depressions in glacial lakeplain in the southwestern portion of the county. This community type is situated on strongly acid loamy sands mixed with small amounts of organic matter. The single element occurrence (EO) in Newaygo County, discovered in 2005, consists of three small, isolated pockets buffered by early-successional oak-aspen forest and degraded oak-pine barrens. Grasses are strongly dominant, including blue-joint grass (*Calamagrostis canadensis*), cordgrass (*Spartina pectinata*), little bluestem (*Schizachyrium scoparium*), poverty grass (*Danthonia spicata*), big bluestem (*Andropogon gerardii*), and Indian grass (*Sorghastrum nutans*). The sedge *Carex pensylvanica* is locally common. Forbs are sparse to locally common, and include bushy aster (*Aster dumosus*), lakes flat-topped goldenrod (*Euthamia remota*), hyssop hedge-nettle (*Stachys hyssopifolia*), marsh blazing-star (*Liatris spicata*), tall green milkweed (*Asclepias hirtella*), flowering spurge (*Euphorbia corollata*), and old field balsam (*Gnaphalium obtusifolium*). Just over 80 vascular plant species were documented from the one occurrence surveyed in 2005-2006. One state-listed vascular plant species, tall green milkweed, is currently documented from lakeplain wet-mesic prairie in Newaygo County. The one known occurrence is remarkably undisturbed, though ORV damage and shrub encroachment due to fire suppression have impacted one of the three openings (Table 2).

Lakeplain wet-mesic prairie is a critically imperiled natural community at the state and global levels. In 2005, nearly 15 acres of high quality lakeplain wet-mesic prairie were discovered in the Muskegon State Game Area (Bridgeton Township). The above photo depicts the largest and least disturbed prairie opening. Dominant grasses in the foreground are Indian grass (Sorghastrum nutans), cordgrass (Spartina pectinata), and blue-joint grass (Calamagrostis canadensis). Other prairie openings contain an abundance of the prairie forb, marsh blazing-star (Liatris spicata). Photo: B. Slaughter.

Two populations of the state-threatened tall green milkweed (*Asclepias hirtella*) were discovered in Newaygo County in 2005. The last known occurrence of this species in the area prior to its discovery in the Muskegon State Game Area (Bridgeton Township) was documented from Muskegon County in 1901. Photo: B. Slaughter.

Oak-pine barrens

Oak-pine barrens was a common upland savanna community type in Newaygo County prior to European settlement in the mid 1800s, but now exists only as isolated, small, degraded remnants. This community type is situated on strongly acid to medium acid loamy sands on level, well drained sandy outwash plains and on sandy lakeplain in the southwestern portion of the county (MNFI 2006). Species composition is similar to that for dry sand prairie, but oak-pine barrens are characterized by greater canopy coverage, typically between 5-60% (MNFI 2006). Many prairie species that prefer open conditions are uncommon or absent at the present time, largely due to shrub and tree encroachment caused by fire suppression. Vascular plant diversity ranges from low in fire-suppressed occurrences to high (over 100 species) in more open occurrences. Two state-listed vascular plant species, prairie-smoke (*Geum triflorum*) and grooved yellow flax (*Linum sulcatum*), are currently documented from oak-pine barrens in Newaygo County. A total of 2 occurrences of oak-pine barrens were documented as a result of field surveys (Table 2). These sites are characterized by restorable remnant openings with good representation of prairie species.

Dry sand prairie

One of the best-known prairie remnants in Michigan is this Brooks Township site owned by the Michigan Nature Association, a 30-acre dry sand prairie that reestablished on plowed soil following agricultural abandonment of this site in the 1880s. Dry sand prairies harbor many state-listed plant species, but are best known for supporting populations of the Federally Endangered karner blue butterfly (*Lycaeides melissa samuelis*). Photo: B. Slaughter.

Dry sand prairie was a common grass-dominated upland community type in Newaygo County prior to European settlement in the mid 1800s, but now exists only as isolated, small, degraded remnants. This community type is situated on strongly acid to medium acid loamy sands on level, well drained sandy outwash plains (MNFI 2006). Trees and shrubs are scattered but do not exceed 10% cover. Common trees include black oak (*Quercus velutina*), hill's oak (*Q. ellipsoidalis*), white oak (*Q. alba*), white pine (*Pinus strobus*), and jack pine (*P. banksiana*). Shrubs include the state-listed Alleghany plum (*Prunus alleghaniensis* var. *davisii*), sand cherry (*P. pumila*), pasture rose (*Rosa carolina*), northern dewberry (*Rubus flagellaris*), and bearberry (*Arctostaphylos uva-ursi*). The ground layer is typically dominated by the sedge *Carex pensylvanica* and by grasses, including poverty grass (*Danthonia spicata*), little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), June grass (*Koeleria macrantha*), Indian grass (*Sorghastrum nutans*), three-awned grass (*Aristida purpurascens*), and porcupine grass (*Stipa spartea*). Characteristic forbs include goat's-rue (*Tephrosia virginiana*), sand coreopsis (*Coreopsis lanceolata*), hairy beard-tongue (*Penstemon hirsutus*), prairie-smoke (*Geum triflorum*), bastard-toadflax (*Comandra umbellata*), horsemint (*Monarda punctata*), wormwood (*Artemisia campestris*), thimbleweed (*Anemone cylindrica*), prairie cinquefoil (*Potentilla arguta*), prickly-pear (*Opuntia humifusa*), hairy bush-clover (*Lespedeza hirta*), round-headed bush-clover (*L. capitata*), prairie heart-leaved aster (*Aster ooletangiensis*), heath aster (*A. ericoides*), western silver-leaved aster (*A. sericeus*), rough blazing star (*Liatris aspera*), cylindrical blazing star (*L. cylindracea*), old-field goldenrod (*Solidago nemoralis*), and annual false foxglove (*Aureolaria pedicularia*). Newaygo County dry sand prairies typically harbor around 100 vascular plant species. 10 state-listed vascular plant species are currently documented from dry sand prairies in Newaygo County. A total of 5 occurrences of dry sand prairie were surveyed in 2005 and 2006, each of which had been previously documented (Table 2). Four other existing occurrences on private land were not resurveyed as part of this study. These 9 sites are characterized by native grass and sedge dominance and presence of indicator forbs.

Dry-mesic northern forest

Dry-mesic northern forest is a widespread, common forested upland community type in Newaygo County, especially well-developed on sandy outwash plains. Circa 1800, white pine (*Pinus strobus*) was an important canopy constituent of this community type. However, due to extensive logging in the 1800s, subsequent slash fires, and forest management practices since that time, oaks, including black oak (*Quercus velutina*), hill's oak (*Q. ellipsoidalis*), and white oak (*Q. alba*) now dominate most of the second-growth forests in Newaygo County. Understory and ground layer species are remarkably uniform across examples of this community type in Newaygo County. Important understory trees include red maple (*Acer rubrum*), sassafras (*Sassafras albidum*), and, locally, white pine. Common shrubs include witch-hazel (*Hamamelis virginiana*), serviceberry (*Amelanchier* spp.), flowering dogwood (*Cornus florida*), huckleberry (*Gaylussacia baccata*), and blueberry (*Vaccinium angustifolium*). The ground layer is almost uniformly dominated by the sedge *Carex pensylvanica*, bracken fern (*Pteridium aquilinum*), and poverty grass (*Danthonia spicata*), with common forbs including cow-wheat (*Melampyrum lineare*), tick-trefoil (*Desmodium glutinosum*, *D. nudiflorum*), Canada mayflower (*Maianthemum canadense*), starflower (*Trientalis borealis*), partridge berry (*Mitchella repens*), bedstraw (*Galium circaezans*, *G. pilosum*, *G. triflorum*), poke milkweed (*Asclepias exaltata*), and, in openings, common rockrose (*Helianthemum canadense*) and black oatgrass (*Stipa avenacea*). Diversity is typically low. No state-listed vascular plant species are currently known from dry-mesic northern forests in Newaygo County. Although many upland forests were surveyed in 2005-2006, only one small stand, previously documented, is of element occurrence quality, characterized by mature, large diameter oaks and supercanopy white pines (Table 2).

Forests of white pine (*Pinus strobus*), white oak (*Quercus alba*), black oak (*Q. velutina*), and northern pin oak (*Q. ellipsoidalis*) covered much of Newaygo County circa-1800. Following removal of white pine during the logging era of the mid- to late-1800s, oaks came to dominate the regenerating forests, such as the above example in northern Newaygo County. Photo: Jacqueline Courteau.