Natural Community Surveys of Potential Ecological Reference Areas on State Forest Lands




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Cover photos of potential ecological reference areas: top left, Pretty Lakes Pinery, a dry-mesic northern forest from northern Luce County, Newberry Forest Management Unit (FMU); top right, Stevenson's Fen, a northern fen from Presque Isle County, Atlanta FMU; lower left, Walloon Lake, a mesic northern forest from Charlevoix County, Gaylord FMU; and lower right, Rabbit Bay, a sandstone lakeshore cliff from Houghton County, Baraga FMU (Photos by Joshua G. Cohen).

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ACKNOWLEDGMENTS

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INTRODUCTION

A natural community is defined as an assemblage of interacting plants, animals, and other organisms that repeatedly occurs under similar environmental conditions across the landscape and is predominantly structured by natural processes rather than modern anthropogenic disturbances. Protecting and managing representative natural communities is critical to biodiversity conservation, since native organisms are best adapted to environmental and biotic forces with which they have survived and evolved over the millennia (Kost et al. 2007). According to the DNR Conservation Area Management Guidelines and Work Instruction 1.4 on Biodiversity Management on State Forest Land, high-quality (A- or B-ranked) natural communities that are critically imperiled, imperiled, or rare (G1, G2, G3, S1, S2, or S3; see Appendix 1 for definition of global and state ranks) qualify for consideration as Ecological Reference Areas (MDNR 2005).

During the summers of 2006 and 2007, MNFI scientists conducted surveys of 180 high-quality natural communities meeting these criteria that had been previously identified on State Forest land. According to MNFI's natural community classification there are 76 natural community types in Michigan (Kost et al. 2007). Thirty-seven different natural community types are represented in the 180 element occurrences surveyed. Surveys assessed the current ranking and classification of these occurrences and detailed the vegetative structure and composition, landscape and abiotic context, threats, ecological boundaries, and management needs and restoration opportunities. The primary goal of this two-year survey effort was to provide resource managers and planners with standardized, baseline information on each potential ecological reference area. This baseline information is critical for facilitating site-level decisions about biodiversity stewardship, monitoring the success of future management, and informing landscape-level biodiversity planning efforts. This report summarizes the findings of MNFI's surveys, synthesizes general trends in threats to groups of natural communities, provides site-specific management recommendations aimed at protecting biodiversity, and discusses a strategy for prioritization of stewardship and conservation effort and the future need for systematic inventory for natural communities.

METHODS

Site Preparation

Site preparation involved the creation of Arcview GIS projects utilizing several layers, including the intersection of MNFI's natural community database (MNFI 2008) and the state forest compartment boundaries, topographic maps, 1998 Digital Orthographic photos, MNFI's circa 1800 vegetation map (Comer et al. 1995), Rockford PLAT maps, and state forest compartment maps (CAD maps). For each of the 180 high-quality occurrences, a site package was printed that included the polygon of the natural community overlying the aforementioned data layers and a copy of the existing Element Occurrence Record. In addition, for each site the original community field forms (if extant) were scanned and then printed. For occurrences with comprehensive plant lists, species lists were entered into Floristic Quality Software and Floristic Quality indices and lists were generated and printed. In addition to printed site packages, digital site packages were created for use with handheld GPS units and ArcPad. The element occurrence polygons, compartment boundary maps, topographic maps, PLAT maps, landtype association maps, geology maps, and digital orthographic photos were saved to one- and four-GB cards compatible with HP iPAQ units.

Field Surveys

Natural Heritage and MNFI methodology considers three factors to assess a natural community's ecological integrity or quality: size, landscape context, and condition (Faber-Langendoen et al. 2008). If a site meets defined requirements for these three criteria (MNFI 1988) it is categorized as a high-quality example of that specific natural community type, entered into MNFI's database as an element occurrence, and given a rank based on the consideration of its size, landscape context, and condition. Growing season surveys were conducted to assess the condition and classification of the sites, while a combination of ground surveys, aerial

photographic interpretation, and Geographic Information System (GIS) analysis were employed to determine the size and the landscape context of the sites. Ecological surveys were conducted from June 6, 2006 through September 15, 2006 and from June 5, 2007 through September 22, 2007. During 2006, MNFI ecologists and botanists visited 91 of the 180 sites, and in 2007, the remaining 89 sites were visited. Typically, a minimum of a day was spent for each site. Many sites occur on multiple ownerships; however, surveys were restricted to public portions of the occurrences. For each site visited, an Ecological Community Field Survey Form was completed. Surveys involved:

a) compiling comprehensive plant species lists
b) describing site-specific structural attributes and ecological processes
c) measuring tree diameter at breast height (DBH) of representative canopy trees and aging canopy dominants (where appropriate)
d) analyzing soils and hydrology
e) noting current anthropogenic disturbances
f) evaluating potential threats
g) ground-truthing aerial photographic interpretation using Global Positioning Systems (both Garmin and HP iPAQ units were utilized)
h) taking digital photos and GPS points[1]
i) surveying adjacent lands when possible to assess landscape context
j) evaluating the natural community classification
k) assigning element occurrence ranks
l) noting management needs and restoration opportunities

Following completion of the field surveys, the collected data were analyzed and transcribed to update the element occurrence records in MNFI's statewide biodiversity conservation database (MNFI 2008). Information from the 2006 and 2007 field surveys and from surveys conducted prior to this project was used to produce site descriptions, threat assessments, and conservation and management recommendations for each natural community occurrence, which appear within the following Results section.

RESULTS

For each survey year, a table was generated, which lists the sites that were visited, their previous element occurrence ranks, and their current element occurrence ranks (Tables 1 and 2). The Results contain a section for each of these communities organized alphabetically by community type and then by element occurrence. At the beginning of each grouping of communities there is an overview of the natural community type, which was adapted from MNFI's natural community classification (Kost et al. 2007). Based on survey findings several sites were re-classified as different natural community types and these changes are explicitly noted. For each site summary, the following information is provided:

a) site name
b) natural community type
c) global and state rank
d) current element occurrence rank
e) locational information
f) digital photograph(s) (available for all but eight occurrences)
g) detailed site description
h) threat assessment
i) management recommendations

[1] Digital cameras and GPS units were utilized for the majority of sites. Inclement weather occasionally prevented their use.

Community Type	EO ID	County	Survey Site	PRIOR EO RANK	CURRENT EO RANK	Surveyors**
Alvar	12028	Chippewa	JONES LAKE ALVAR	B	B	DA
Bog	3580	Luce	BARCLAY LAKE BOG #1	B	B	BS and JGC
Bog	3580	Luce	BARCLAY LAKE BOG #2	B	B	BS and JGC
Bog	11974	Crawford	BEST BOG	BC	B	JGC and RS
Bog	12097	Charlevoix	FOX LAKE BOG BEAVER ISLAND	B	AB	JGC and CW
Bog	15963	Cheboygan	LAKE SIXTEEN BOG	B	B	JGC and RS
Bog	15964	Otsego	LANSING CLUB POND EAST	BC	BC	JGC
Bog	11575	Grand Traverse	LONG LAKE	BC	B	JGC and AB
Bog	1747	Crawford	LOVELL'S BOG	BC	B	RS and BS
Bog	8430	Grand Traverse	NORTH LOST LAKE BOG	B	AB	JGC and AB
Bog	11717	Mackinac	RYERSE LAKE	A	AB	MK and RS
Bog	16139	Michaud Lake	TIGHE LAKE	NA	BC	MK, RS, and BS
Boreal Forest	6311	Charlevoix	FRENCH BAY BEAVER ISLAND	C?	C	JGC and CW
Boreal Forest	8473	Mackinac	LIMEKILN POINT BOREAL FOREST BOIS BLANC ISLAND	A	A	JGC and RS
Coastal Fen	1936	Alpena	EL CAJON BAY	A	A	JGC, RS, BS
Dry Northern Forest	14558	Luce	BLIND SUCKER CREEK	BC	B	MK, RS, and BS
Dry Northern Forest	10262	Crawford	CRAWFORD RED PINES	BC	BC	JGC
Dry Northern Forest	11065	Roscommon	ROSCOMMON RED PINES	AB	AB	JGC
Dry Northern Forest	2709	Schoolcraft	SOUTHSIDE BRIDGE RED PINES	BC	BC	AB
Dry Sand Prairie	5909	Crawford	SHUPAC LAKE	AB	AB	RS and BS
Dry-Mesic Northern Forest	10971	Schoolcraft	NEGRO CREEK	B	D	AB
Dry-Mesic Northern Forest	4499	Cheboygan	PIGEON RIVER PINES	BC	BC	JGC and JC
Dry-Mesic Northern Forest	9259	Charlevoix	POINTE LA PAR BEAVER ISLAND	A	AB	JGC and CW
Dry-Mesic Northern Forest	3934	Grand Traverse	SAND LAKES	BC	BC	JGC and JC
Dry-Mesic Northern Forest	13195	Emmet	WILDERNESS STATE PARK/NEBO TRAIL	B	B	JGC and JC
Floodplain Forest	10646	Clare	MUSKEGON RIVER/GREEN CREEK NORTH	BC	B	JGC
Floodplain Forest	6095	Clare	MUSKEGON RIVER/HUCKLEBERRY TRAIL	BC	BC	JGC
Floodplain Forest	930	Iosco	VANETTEN LAKE	B	BC	RS and BS
Great Lakes Marsh	1919	Grand Traverse	PETOBEGO POND	AB	AB	JGC and AB
Great Lakes Marsh	4290	Alpena	SQUAW BAY	B	B	RS and BS
Intermittent Wetland	660	Cheboygan	BLACK LAKE FOREST MARSH	AB	AB	JGC and MP
Intermittent Wetland	3851	Cheboygan	DUCK LAKE	B	AB	JGC and RS
Intermittent Wetland	9538	Crawford	FROG LAKES COMPLEX	B	B	RS and ROC
Intermittent Wetland	4173	Mackinac	JACKSON TRAIL	B	AB	JGC and MP
Intermittent Wetland	7851	Crawford	LAKE MARGRETHE NORTH	BC	B	BS and RS
Intermittent Wetland	11227	Presque Isle	LAKE SIXTEEN	AB	B	JGC and RS
Intermittent Wetland	4653	Schoolcraft	MICHAUD LAKE	B	BC	MK, RS, and BS
Intermittent Wetland	7652	Cheboygan	MUD LAKE	B	B	MK and RS
Intermittent Wetland	10643	Schoolcraft	NINE MILE LAKE	AB	AB	MK, RS, and BS
Limestone Bedrock Glade	9612	Delta	GARDEN GLADE SE	A	AB	RS and AB
Limestone Bedrock Glade	6511	Presque Isle	GRAND LAKE GLADE	B	BC	RS and BS
Limestone Bedrock Glade	5952	Delta	KREGG BAY GLADE	B	B	MK, RS, and BS
Limestone Bedrock Glade	4734	Chippewa	SEAMAN'S POINT ALVAR	B	AB	DA
Limestone Bedrock Glade	142	Delta	SUCKER LAKE	AB	AB	MK and RS
Limestone Bedrock Lakeshore	8109	Chippewa	BASS BAY LIMESTONE BEDROCK LAKESHORE	A	A	DA
Limestone Bedrock Lakeshore	3190	Chippewa	GRAND MARAIS LIMESTONE BEDROCK LAKESHORE	A	A	DA
Limestone Bedrock Lakeshore	7753	Chippewa	HURON BAY LIMESTONE BEDROCK LAKESHORE	A	A	DA
Limestone Bedrock Lakeshore	1924	Delta	KREGG BAY NE	B	B	RS

Table 1. Summary of 2006 Survveys.

Community Type	EO ID	County	Survey Site	PRIOR EO RANK	CURRENT EO RANK	Surveyors**
Limestone Bedrock Lakeshore	10606	Delta	POINT DETOUR	A	A	MK and RS
Limestone Bedrock Lakeshore	5883	Chippewa	SEAMAN'S POINT LIMESTONE BEDROCK LAKESHORE	B	A	DA
Limestone Cliff	9208	Alpena	EL CAJON BAY	B	B	JGC and RS
Limestone Cobble Shore	4632	Mackinac	BOIS BLANC ISLAND	B	B	JGC and RS
Limestone Cobble Shore	372	Chippewa	WARNER COVE LIMESTONE COBBLE BEACH	BC	BC	DA
Mesic Northern Forest	10486	Luce	BARFIELD LAKES	AB	AB	JGC and CW
Mesic Northern Forest	9668	Mackinac	BOIS BLANC ISLAND	AB	AB	JGC and RS
Mesic Northern Forest	10987	Mackinac	CUT RIVER GORGE	BC	BC	JGC, CW, RS, and MK
Mesic Northern Forest	14559	Menominee	JEAN WORTH TRACT	BC	BC	CW
Mesic Northern Forest	7658	Mackinac	LIME KILN POINT BOIS BLANC ISLAND	BC	BC	JGC and RS
Mesic Northern Forest	626	Charlevoix	MARTIN'S BLUFF BEAVER ISLAND	B	B	JGC and CW
Mesic Northern Forest	2836	Luce	PARCELL LAKES	BC	BC	CW
Mesic Northern Forest	13253	Chippewa	SCOTTY BAY NORTH	BC	C	JGC and CW
Mesic Northern Forest	15791	Charlevoix	WALLOON LAKE STATE FOREST	B	B	JGC, MK, and RS
Muskeg	2367	Mackinac	JACKSON TINDLE ROAD MUSKEG	BC	B	JGC and MP
Muskeg	10471	Chippewa	PRISON CAMP MUSKEG	A	A	JGC, BS, and MK
Northern Fen	4661	Crawford	BARKER CREEK FEN	BC	B	JGC and RS
Northern Fen	9558	Grand Traverse	ROOT LAKE	AB	BC	JGC and AB
Northern Fen	13159	Grand Traverse	SAND LAKES	B	AB	JGC and AB
Northern Fen	15803	Presque Isle	STEVENSON'S FEN	B	B	JGC and RS
Northern Hardwood Swamp	7693	Manistee	SELMA SWAMP	B	C	JGC and AB
Oak-Pine Barrens	12308	Grand Traverse	CARPENTER CREEK NORTH AND SOUTH	B	B	JGC and JC
Open Dunes	10808	Charlevoix	MCFADDEN POINT BEAVER ISLAND	B	C	JGC and CW
Patterned Fen	9938	Luce	MCMAHON LAKE	A	A	JGC and MP
Patterned Fen	8139	Luce	SLEEPER LAKE	A?	A	JGC and MP
Pine Barrens	NA	Luce	DANAHER PLAINS	BC	Removed	AB
Pine Barrens	16049	Crawford	FROG LAKE BARRENS	AB	AB	RS and BS
Pine Barrens	10013	Otsego	LITTLE BEAR LAKE BARRENS	AB	BC	JGC
Pine Barrens	15942	Crawford	SHUPAC LAKE BARRENS	BC	BC	RS and BS
Pine Barrens	5074	Grand Traverse	WALTON	BC	C	JGC and AB
Pine Barrens	6486	Grand Traverse	WALTON MARSH	BC	BC	JGC and AB
Poor Fen	2988	Charlevoix	EGG LAKE	B	B	JGC and CW
Poor Fen	9790	Mackinac	JACKSON TRAIL	AB	AB	JGC and MP
Poor Fen	10005	Crawford	LOVELL'S FEN	AB	B	RS and BS
Rich Conifer Swamp	5676	Luce	BARFIELD LAKES	AB	A	MK, RS, and BS
Rich Conifer Swamp	317	Mackinac	CENTER CEDAR SWAMP	AB	AB	JGC and RS
Rich Conifer Swamp	5676	Alpena	EL CAJON BAY	B	B	JGC. RS, BS
Rich Conifer Swamp	964	Alger	NOBLE LAKE	AB	B	AB
Rich Conifer Swamp	15952	Montmorency	SAGE LAKE CEDAR SWAMP	BC	BC	JGC
Sinkhole	8704	Presque Isle	ROCKPORT KARST	A	A	JGC and RS
Wooded Dune and Swale Complex	3085	Delta	PORTAGE BAY	A	AB	MK, RS, and BS
Wooded Dune and Swale Complex	403	Alpena	SQUAW BAY	BC	BC	RS and BS
Wooded Dune and Swale Complex	8136	Emmet	STURGEON BAY	A	A	JGC and JC

Table 1 (continued). Summary of 2006 Surveys.

** Key to surveyors. AB = Adrienne Bozic, Ecologist; BS = Bradford Slaughter, Ecologist, BW = Beverly Walters, Botanist; CW = Christopher Weber, Ecologist; DA = Dennis Albert, Ecologist; JC = Jacqueline Courteau, Ecologist; JGC = Joshua Cohen, Ecologist; MK = Michael Kost, Ecologist; JL = Jeffrey Lee, Ecologist; MP = Mike Penskar, Botanist; RO = Ryan O'Connor, Botanist; RS =Rebbeca Schillo, Ecologist

Community Type	EO ID	County	Survey Site	PRIOR EO RANK	CURRENT EO RANK	Surveyors**
Alvar	2305	Delta	ESCANABA RIVER (CORNELL)	B	AB	BS
Alvar	2492	Marquette	ESCANABA RIVER NORTH	B	BC	BS
Alvar	2121	Chippewa	MAXTON PLAINS	A	A	BS
Alvar	2121	Chippewa	MAXTON PLAINS EAST	B	A	BS
Alvar	2121	Chippewa	MIDDLE MAXTON PLAINS	A	A	BS
Bog	8926	Luce	BARFIELD LAKES	BC	AB	JGC and BW
Dry Northern Forest	12024	Luce	BARCLAY LAKE JACK PINES	BC	BC	JGC
Dry Northern Forest	1762	Schoolcraft	SUNKEN LAKE RED PINES	B	B	JGC
Dry-Mesic Northern Forest	9666	Luce	BEAVERTOWN LAKES	AB	AB	JGC
Dry-Mesic Northern Forest	993	Marquette	BRYAN CREEK	BC	B	BS
Dry-Mesic Northern Forest	14560	Schoolcraft	HARTMAN WHITE PINE	B	BC	JGC
Dry-Mesic Northern Forest	15922	Marquette	LANDON LAKE PINES	B	B	JGC
Dry-Mesic Northern Forest	7990	Luce	NORTH BRANCH LAKES WHITE PINES	BC	BC	JGC
Dry-Mesic Northern Forest	15950	Luce	PRETTY LAKE PINERY	AB	AB	JGC
Dry-Mesic Northern Forest	2929	Marquette	SILVER LEAD CREEK	BC	BC	JGC
Dry-Mesic Northern Forest	12496	Luce	SWAMP LAKES	AB	AB	JGC
Floodplain Forest	13437	Manistee	MANISTEE RIVER STATE GAME AREA	B	B	BW
Granite Bedrock Glade	4782	Marquette	BIG BAY SOUTH OUTCROPS	AB	AB	JGC
Granite Bedrock Glade	9902	Marquette	LOST CREEK OUTCROPS	B	B	JGC
Granite Bedrock Glade	2328	Dickinson	LOST LAKE OUTCROPS	A	A	BS
Granite Bedrock Glade	2171	Marquette	POWELL TOWNSHIP OUTCROPS	B	AB	JGC
Granite Cliff	6523	Marquette	MULLIGAN CLIFFS	A	A	JGC
Great Lakes Marsh	2797	Mackinac	EPOUFETTE BAY	BC	BC	BS
Great Lakes Marsh	11423	Marquette	INDEPENDENCE LAKE	B	B	JGC
Great Lakes Marsh	12046	Mackinac	KENYON BAY + WEST	B	B	BS
Great Lakes Marsh	11784	Chippewa	MUNUSCONG AND LITTLE MUNUSCONG RIVERS	A	A	BS
Great Lakes Marsh	9211	Chippewa	PAW POINT, SCOTT POINT	BC	BC	BS
Great Lakes Marsh	6629	Baraga	PEQUAMING MARSH	BC	B	MK
Great Lakes Marsh	11784	Chippewa	PICKFORD POINT	BC	A	BS
Great Lakes Marsh	8882	Houghton	PORTAGE RIVER MARSH	B	B	JGC
Great Lakes Marsh	8300	Houghton	STURGEON RIVER	B	B	JGC
Hardwood-Conifer Swamp	10054	Luce	BEAVERTOWN LAKES	B	AB	JGC
Hillside Prairie	5050	Menominee	PEMENE FALLS	B	BC	BS
Interdunal Wetland	11037	Mackinac	BIG KNOB CAMPGROUND	AB	AB	JGC
Interdunal Wetland	12340	Mackinac	INLAND HARBOR	B	B	JGC
Intermittent Wetland	323	Chippewa	PRISON CAMP INTERMITTENT WETLAND	AB	A	JGC
Intermittent Wetland	4977	Luce	SWAMP LAKES	AB	A	JGC
Limestone Bedrock Glade	8641	Chippewa	THE ROCK	BC	B	BS
Limestone Bedrock Lakeshore	2258	Delta	SUMMER ISLAND	A	AB	JGC and BW
Limestone Cliff	5671	Chippewa	MARBLEHEAD	A	A	BS
Limestone Cliff	15586	Delta	SUMMER ISLAND	A	A	JGC and BW
Limestone Cobble Shore	3957	Mackinac	SEINER'S POINT	B	AB	JGC
Limestone Lakeshore Cliff	9467	Delta	BURNT BLUFF	B	AB	JGC and BW
Mesic northern forest	7496	Baraga	CRAIG LAKE	AB	AB	JGC
Mesic northern forest	3138	Marquette	HARLOW LAKE	AB	B	JGC
Mesic northern forest	8524	Luce	LITTLE TWO-HEARTED LAKES	BC	AB	JGC
Muskeg	7430	Luce	BEAVERTOWN LAKES	A	A	JGC and BS

Table 2. Summary of 2007 Surveys.

Community Type	EO ID	County	Survey Site	PRIOR EO RANK	CURRENT EO RANK	Surveyors**
Northern Fen	16603	Delta	BIG BAY DE NOC	NA	A	BS
Northern Fen	14562	Menominee	WIREGRASS LAKE	AB	B	BS
Oak-Pine Barrens	11124	Menominee	SHAKEY LAKES	A	BC	BS
Open Dunes	1910	Mackinac	INLAND HARBOR	BC	B	JGC
Patterned Fen	32	Schoolcraft	CREIGHTON MARSH	A	A	JGC and BS
Patterned Fen	6951	Schoolcraft	MARSH CREEK	A	A	JGC and BS
Patterned Fen	4963	Schoolcraft	NEGRO CREEK	B?	AB	JGC and BW
Poor Fen	13552	Chippewa	MUNUSCONG RIVER	AB	AB	JGC
Rich Conifer Swamp	15953	Charlevoix	BEAR RIVER SWAMP	B	B	JGC and JL
Rich Conifer Swamp	10789	Luce	BEAVERTOWN LAKES	B	AB	JGC
Rich Conifer Swamp	13062	Schoolcraft	CEDAR ISLAND	AB	AB	JGC
Rich Conifer Swamp	12248	Montmorency	GREEN SWAMP	B	B	BS
Rich Conifer Swamp	8824	Mackinac	JACKSON TINDLE ROAD	B	BC	BS
Rich Conifer Swamp	9448	Marquette	KATE'S LAKE	A	BC	BS
Rich Conifer Swamp	14555	Marquette	LITTLE WEST BRANCH	BC	BC	JGC
Rich Conifer Swamp	8154	Emmet	MINNEHAHA CREEK	B	B	JGC and DA
Rich Conifer Swamp	4139	Wexford	PINE RIVER SWAMP NORTH BRANCH	B	BC	BS
Rich Conifer Swamp	8303	Crawford	TROUT UNLIMITED	B	B	JGC
Rich Conifer Swamp	6020	Kalkaska	WATSON SWAMP	B	AB	BS
Sandstone Lakeshore Cliff	9468	Houghton	RABBIT BAY - JACOBSVILLE	B	AB	JGC
Sinkhole	13582	Chippewa	THE ROCK-DRUMMOND ISLAND	A	AB	BS
Volcanic Bedrock Glade	6892	Keweenaw	FISH COVE	A	A	MK and BW
Volcanic Bedrock Lakeshore	2123	Keweenaw	BETE GRISE, BEAR BLUFF	B	A	MK and BW
Volcanic Bedrock Lakeshore	2311	Keweenaw	BIG BAY WEST	B	A	MK and BW
Volcanic Bedrock Lakeshore	10595	Keweenaw	KEWEENAW POINT, HIGH ROCK, KEYSTONE BAY	B	A	MK and BW
Volcanic Bedrock Lakeshore	2311	Keweenaw	KEYSTONE POINT	B	A	MK and BW
Volcanic Bedrock Lakeshore	9280	Keweenaw	MANITOU ISLAND	A	A	MK and BW
Volcanic Lakeshore Cliff	12518	Keweenaw	MANITOU ISLAND	A	A	MK and BW
Wet-Mesic Sand Prairie	2078	Crawford	PORTAGE CREEK COMPLEX	AB	B	BS
Wooded Dune and Swale Complex	6496	Mackinac	BETHLEHEM TRACT	A	B	JGC
Wooded Dune and Swale Complex	11401	Delta	BIG BAY DE NOC	AB	B	BS
Wooded Dune and Swale Complex	6497	Mackinac	BIG KNOB CAMPGROUND	AB	AB	JGC
Wooded Dune and Swale Complex	3631	Houghton	GRAND TRAVERSE BAY	BC	BC	MK and BW
Wooded Dune and Swale Complex	7333	Schoolcraft	GULLIVER LAKE DUNES	B	BC	JGC
Wooded Dune and Swale Complex	7311	Marquette	IRON RIVER	B	BC	JGC
Wooded Dune and Swale Complex	3390	Marquette	LITTLE PRESQUE ISLE POINT	BC	BC	JGC
Wooded Dune and Swale Complex	10522	Houghton	LITTLE TRAVERSE BAY	BC	BC	JGC
Wooded Dune and Swale Complex	4993	Mackinac	SCOTT POINT	AB	AB	JGC
Wooded Dune and Swale Complex	9523	Mackinac	SEINER'S POINT	AB	B	JGC
Wooded Dune and Swale Complex	2834	Chippewa	ST. VITAL BAY	B	B	BS
Wooded Dune and Swale Complex	986	Schoolcraft	THOMPSON	BC	C	BS
Wooded Dune and Swale Complex	562	Mackinac	WEST EPOUFETTE	BC	B	BS

Table 2 (continued). Summary of 2007 Surveys.

** Key to surveyors. AB = Adrienne Bozic, Ecologist; BS = Bradford Slaughter, Ecologist, BW = Beverly Walters, Botanist; CW = Christopher Weber, Ecologist; DA = Dennis Albert, Ecologist; JC = Jacqueline Courteau, Ecologist; JGC = Joshua Cohen, Ecologist; MK = Michael Kost, Ecologist; JL = Jeffrey Lee, Ecologist; MP = Mike Penskar, Botanist; RO = Ryan O'Connor, Botanist; RS =Rebbeca Schillo, Ecologist

SITE SUMMARIES

ALVAR (ALVAR GRASSLAND)

Overview: Alvar is a grass- and sedge-dominated community, with scattered shrubs and sometimes trees. The community occurs on broad, flat expanses of calcareous bedrock (limestone or dolostone) covered by a thin veneer of mineral soil, often less than 25 cm deep. Alvars are only known from three areas of the world: the Basaltic region of northern Europe, Counties Clare and Galway of northwest Ireland, and the Great Lakes region south of the Canadian Shield. In Michigan, most of the sites occur in the Upper Peninsula along the shorelines of Lake Huron and Lake Michigan, in a band from Drummond Island to Cedarville, west to Seul Choix Point on the Garden Peninsula. Alvar also occurs farther west and inland along the Escanaba River. In the Lower Peninsula, alvar occurs on Thunder Bay Island and along the Lake Huron shoreline near Rogers City, Alpena, and Thompson's Harbor. The plant community is also referred to as alvar grassland (Kost et al. 2007).

1. Escanaba River (Cornell)

Natural Community Type: Alvar
Rank: G2? S1, globally imperiled and critically imperiled in the state
Element Occurrence Rank: AB
Location: Escanaba Forest Management Unit, Compartment 110, and Private Land
Element Occurrence Identification Number: 2305

Site Description: This unique alvar grassland occurs within the floodplain of the Escanaba River on thin soils over slightly sloping Ordovician limestone. The alvar occurs along the banks of the river for approximately six miles on both sides and is approximately 65 to 200 m wide with some areas of exposed bedrock. The thin soils are alkaline (pH 7.7) sandy loams and loams.

The site is characterized by distinctive vegetative zonation, which parallels the river, and high plant species diversity. Areas closest to the river are characterized by exposed limestone pavement with scattered vegetation including cut grass (*Leersia oryzoides*) and cordgrass (*Spartina pectinata*). Alvar grassland is concentrated on the gentle south-facing slopes on the north side of the river and is dominated by several native grasses including prairie dropseed (*Sporobolus heterolepis*, state special concern), little bluestem (*Andropogon scoparius*), big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), and occasionally mat muhly (*Muhlenbergia richardsonis*, state threatened) in moister areas. Common forbs include northern bedstraw (*Galium boreale*), wild bergamot (*Monarda fistulosa*), and upland white goldenrod (*Solidago ptarmicoides*). This zone is particularly well developed on state-owned land in section 34. The grassland areas south of the river on mesic to wet-mesic substrate lack prairie dropseed and Indian grass and have a greater concentration of moisture-loving calciphiles, including grass-of-Parnassus (*Parnassia glauca*), Ohio goldenrod (*Solidago ohioensis*), false asphodel (*Tofieldia glutinosa*), Kalm's lobelia (*Lobelia kalmii*), and dwarf Canadian primrose (*Primula mistassinica*). Many of these species occur in seepy areas, which locally support butterwort (*Pinguicula vulgaris*, state special concern). Areas along the river with shallow mineral soils over bedrock support a northern wet meadow or wet prairie zone dominated by bluejoint grass (*Calamagrostis canadensis*), tussock sedge (*Carex stricta*), and cordgrass. In places, reed canary grass (*Phalaris arundinacea*) is dominant, often to the exclusion of the aforementioned species. Exposed pavement areas are local, supporting vegetation in cracks and fissures and at the high water mark. Characteristic species in areas of exposed bedrock include hair grass (*Deschampsia cespitosa*), wild chives (*Allium schoenoprasum* var. *sibiricum*, state threatened), and bulrushes (*Juncus alpinus* and *J. nodosus*). South of the river there is a band of limestone bedrock glade on a slope below boreal forest. This alvar glade is locally dominated by dwarf lake iris (*Iris lacustris*, federal/state threatened). Several other rare species noted within the glade include Richardson's sedge (*Carex richardsonii*, state special concern), Alpine

sainfoin (*Hedysarum alpinum*, state endangered), butterwort, and Cooper's milk vetch (*Astragalus neglectus*, state special concern), which also occurs in the alvar grassland. Aspect is an important determinant of community structure with the south-facing slopes north of the river supporting more prairie-like associations and the north-facing slopes south of the river containing numerous seeps and high concentration of species typical of protected lakeshores, including dwarf lake iris and butterwort.

Threats: Human or human-induced impacts to this system include grazing (cattle), nutrient inputs, and off-road vehicle damage. Deer browse is significantly impacting several species, including the only known occurrence of Alpine sainfoin in Michigan. This species was severely browsed, with few fruiting stems remaining on browsed plants. In addition, invasive species are locally common, particularly reed canary grass. Canada bluegrass (*Poa compressa*) is locally abundant on disturbed (grazed) upper slopes, particularly north of the river.

Management Recommendations: The main management needs are to restrict off-road vehicle access and control populations of non-native species, especially reed canary grass. The site should be monitored for invasive species encroachment and deer herbivory. Increasing the amount of late-successional habitat in the adjacent landscape will help reduce deer browse pressure. Reducing deer densities in the general landscape is recommended. Establishing deer exclosures around the locations of the Alpine sainfoin may be merited given that this is the only documented population of this state endangered plant in Michigan. Portions of the alvar and surrounding uplands that occur on private lands could be protected through acquisition or the establishment of conservation easements.

This unique alvar occurs along the Escanaba River on thin soils over slightly sloping limestone bedrock. Photo by Bradford S. Slaughter.

2. Escanaba River North

Natural Community Type: Alvar
Rank: G2? S1, globally imperiled and critically imperiled in the state
Element Occurrence Rank: BC
Location: Gwinn Forest Management Unit, Compartment 87, and Private Lands
Element Occurrence Identification Number: 2492

Site Description: This unique alvar grassland occurs within the floodplain of the Escanaba River on thin soils over flat to stepped dolomite pavement. The alvar occurs along the banks of the river for approximately two miles on both sides and is approximately 30 to 200 m wide with some areas of exposed bedrock (10-20 meter wide band along the river). The thin soils are circumneutral to alkaline. The site occurs adjacent to rich conifer swamp and early-successional upland forest.

The site is characterized by distinctive vegetative zonation and high plant species diversity. The largest zone is a broad band of northern wet meadow, which occurs on shallow (20-30 cm deep) mineral and mineral/organic soils. Prevalent species in the northern wet meadow include cordgrass (*Spartina pectinata*), bluejoint grass (*Calamagrostis canadensis*), and tussock sedge (*Carex stricta*). Reed canary grass (*Phalaris arundinacea*) also occurs within this zone. Scattered shrubs within this zone include tag alder (*Alnus rugosa*), willows (*Salix* spp.), and meadowsweet (*Spiraea alba*). These shrubs also form scattered patches of northern shrub thicket. Common forbs include grass-leaved goldenrod (*Euthamia graminifolia*), late goldenrod (*Solidago gigantea*), and joe-pye-weed (*Eupatorium maculatum*). Areas with dry soils over the underlying pavement are diverse with characteristic species including hair grass (*Deschampsia cespitosa*), grass-leaved goldenrod, northern bedstraw (*Galium boreale*), cordgrass, big bluestem (*Andropogon gerardii*), Kalm's lobelia (*Lobelia kalmii*), common water horehound (*Lycopus americanus*), bulrushes (*Juncus* spp.), harebell (*Campanula rotundifolia*), and wild chives (*Allium schoenoprasum* var. *sibiricum*, state threatened). Wet areas of pavement are dominated by bulrushes (*Juncus alpinus* and *J. nodosus*), sedges (*Carex flava* and *C. cryptolepis*), cordgrass, golden-seeded spike-rush (*Eleocharis elliptica*), and horsetails (*Equisetum* spp.)

Threats: Human or human-induced impacts to this system include past grazing (cattle) and off-road vehicle damage. In addition, invasive species, particularly reed canary grass, are locally common.

Management: The main management needs are to restrict off-road vehicle access and control populations of non-native species, especially reed canary grass. The site should be monitored for invasive species encroachment and deer herbivory. Portions of the alvar and surrounding uplands that occur on private lands could be protected through acquisition or the establishment of conservation easements.

Flat to stepped dolomite pavement characterizes this unique alvar, which occurs along the Escanaba River. Photos by Bradford S. Slaughter.

3. Jone's Lake (Drummond Island)

Natural Community Type: Alvar
Rank: G2? S1, globally imperiled and critically imperiled in the state
Element Occurrence Rank: B
Location: Sault Sainte Marie Forest Management Unit, Compartment 12
Element Occurrence Identification Number: 12028

Site Description: The site consists of several patches of alvar and scrubby limestone bedrock glade on the upper slopes overlooking Jones Lake. Knobs and low ridges of limestone support boreal forest with alvar and alvar glade occurring on south-facing slopes. Lower slope positions are characterized by swamp forests. The southern alvar patch grades to northern wet meadow along Parish Lake and to hardwood-conifer swamp with northern white-cedar (*Thuja occidentalis*) and balsam poplar (*Populus balsamifera*) to the north. Narrow areas of both northern fen and northern wet meadow occur along the lake edges. The sloping pavement is covered by 15 to 20 cm of circumneutral soils and there are many scattered boulders throughout the site.

Poverty grass (*Danthonia spicata*) and ebony sedge (*Carex eburnea*) dominant the dense herb layer with Hill's thistle (*Cirsium hillii*, state special concern) abundant throughout, and Alaska orchid (*Piperia unalascensis*, state special concern) also common. Areas of limestone bedrock glade are characterized by scattered white spruce (*Picea glauca*), northern white-cedar, quaking aspen (*Populus tremuloides*), and paper birch (*Betula papyrifera*). Alvar glade openings are surrounded by boreal forest dominated by white spruce, northern white-cedar, quaking aspen, and paper birch.

Threats: Off-road vehicles and invasive plants are the primary threats to this site

Management Recommendations: The main management needs are to restrict off-road vehicle use and control populations of non-native species, especially bull thistle (*Cirsium vulgare*). Efforts to control invasive species and off-road vehicles should be monitored. Fire management would likely improve habitat for Hill's thistle and other alvar plants.

Jones Lakes is characterized by pockets of alvar surrounded by limestone bedrock glade. Photo by Dennis A. Albert.

4. Maxton Plains (Drummond Island)

Natural Community Type: Alvar
Rank: G2? S1, globally imperiled and critically imperiled in the state
Element Occurrence Rank: A
Location: Sault Sainte Marie Forest Management Unit, Compartment 2 and Private Lands
Element Occurrence Identification Number: 2121

Site Description: This element occurrence represents three separate sites that were combined into one: Maxton Plains, Middle Maxton Plains, and Maxton Plains East. They will be referred to in this site summary as Site A, Site B, and Site C, respectively. These large alvar openings occur on Drummond Island on shallow soils (both mineral and organic) over south-tilting Engadine dolomite. There are numerous areas of exposed dolomite bedrock in addition to bare soils and boulders. Where the thin soils have accumulated they are circumneutral to alkaline (pH 7.2-8.0) and include muck and Detour stony loam. The soils are typically 9 cm deep but there are areas where soil depth approaches 20 cm. In the spring there are areas where water pools in shallow depressions in the bedrock and there are several small drainages within the alvar openings. The alvar pockets are surrounded by boreal forest.

These thin-soil alvar openings are dominated by grasses, sedges, and lichens with spike-rushes prevalent in the wettest areas. Although each opening has its own character, a few broad dominance patterns emerge at the landscape scale. Dry rises are typically dominated by little bluestem (*Andropogon scoparius*) and poverty oats (*Danthonia spicata*) with bastard toadflax (*Comandra umbellata*) as a common forb and bearberry (*Arctostaphylos uva-ursi*) locally important. Mesic flats are dominated by prairie dropseed (*Sporobolus heterolepis*, state special concern), with non-native grasses locally common. Wet-mesic to wet depressions and flats are dominated by flattened spike-rush (*Eleocharis compressa*, state threatened) and hair grass (*Deschampsia cespitosa*) with Richardson's sedge (*Carex richardsonii*, state special concern) locally important. Wettest areas of alvar with standing water are dominated by bluejoint grass (*Calamagrostis canadensis*) and golden-seeded spike-rush (*Eleocharis elliptica*) with wild blue flag (*Iris versicolor*) and willows (*Salix* spp.) common. In addition to these zones, there are areas of dolomite pavement dominated by creeping juniper (*Juniperus horizontalis*) with patchy cover of prairie dropseed, little bluestem, bulrush sedge (*Carex scirpoidea*, state threatened), and shrubby cinquefoil (*Potentilla fruticosa*). Within areas dominated by grasses, there are groves of scattered and small-diameter quaking aspen (*Populus tremuloides*) and white spruce (*Picea glauca*) with common juniper (*Juniperus communis*) in the shrub layer. Within Site A, flattened spike-rush dominates the wet depressions. Characteristic species within this site include lichens, little bluestem, balsam ragwort (*Senecio pauperculus*), prairie-smoke (*Geum triflorum*, state threatened), and Crawe's sedge (*Carex crawei*). Site B is the driest and most diverse of the openings with common species including bastard toadflax, bearberry, bulrush sedge, balsam ragwort, and field chickweed (*Cerastium arvense*). Richardson's sedge, flattened spike-rush, and Hill's thistle (*Cirsium hillii*, state special concern) also occur within Site B. These rare plants, in addition to prairie dropseed, also occur in Site C. Common species in Site C include common juniper, creeping juniper, bastard toadflax, and Kalm's brome (*Bromus kalmii*).

Threats: The main threats to these alvar openings are posed by non-native invasive plants and off-road vehicle damage. Off-road vehicle damage alters the hydrology through rutting. Invasive species are found throughout but are concentrated along roads and trails. Non-native plants documented during surveys include Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*P. pratensis*), common St. John's-wort (*Hypericum perforatum*), ox-eye daisy (*Chrysanthemum leucanthemum*), timothy (*Phleum pratense*), quack grass (*Agropyron repens*), wild carrot (*Daucus carota*), spotted knapweed (*Centaurea maculosa*), and hawkweeds (*Hieracium* spp.). These invasives could be further spread by off-road vehicle activity. Rock cairns occur throughout the site. Removal of rocks reduces habitat for insects (i.e., ants), which bears depend on as a food source.

Management Recommendations: The main management needs are to restrict off-road vehicle use and control populations of non-native species, especially spotted knapweed. Efforts to control invasive species and off-road vehicles should be monitored. Fire management should be investigated and may improve habitat for Hill's thistle and other alvar plants. The rock cairns should be dismantled. Portions of the alvar and surrounding landscape that occur on private lands could be protected through acquisition or the establishment of conservation easements.

Maxton Plains supports extensive alvar grassland occurring over dolomite bedrock. Photos by Bradford S. Slaughter.

BOG

Overview: Bog is a nutrient-poor peatland characterized by acidic, saturated peat and the prevalence of sphagnum mosses and ericaceous shrubs. Bogs occur in depressions in glacial outwash and sandy glacial lakeplains and in kettles on pitted outwash and moraines. Bogs frequently occur as a floating mat on the margins of lakes and ponds. Fire and flooding are the main natural disturbance factors (Kost et al. 2007).

5. Barclay Lake Bogs

Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and apparently secure within the state
Element Occurrence Rank: B
Location: Newberry Forest Management Unit, Compartments 39 and 41
Element Occurrence Identification Number: 3580

Site Description: This element occurrence represents two separate bog sites that were combined into one element occurrence (Barclay Lake Bog #1 and Barclay Lake Bog #2). The two separate small bogs occur within depression within pitted outwash plain. For both bogs, the organic soils are characterized by deep (> 1 m), acidic (pH 4.0-4.5) sphagnum peat (with leaves and woody debris throughout profile). Upland sandy ridges with jack pine (*Pinus banksiana*) and red pine (*P. resinosa*) surround the bogs. Portions of this forest are classified as high-quality dry northern forest.[2]

The southern bog contains four distinct zones: poor conifer swamp, shrub-dominated bog, sedge-dominated bog, and a quaking bog mat. The narrow band of poor conifer swamp occurs near the upland and is dominated by black spruce (*Picea mariana*), tamarack (*Larix laricina*), jack pine, and red maple (*Acer rubrum*). Understory and low shrub species of the poor conifer swamp include mountain holly (*Nemopanthus mucronata*), Labrador tea (*Ledum groenlandicum*), and leatherleaf (*Chamaedaphne calyculata*), while the ground cover is dominated by sphagnum mosses, pitcher-plant (*Sarracenia purpurea*), and three-seeded sedge (*Carex trisperma*). The shrub-dominated bog is characterized by scattered black spruce and is dominated by leatherleaf, sphagnum mosses, bog laurel (*Kalmia polifolia*), bog rosemary (*Andromeda glaucophylla*), pitcher-plant, and tawny cotton-grass (*Eriophorum virginicum*). The sedge-dominated bog mat occurs closer to the lake, with widely scattered black spruce, tamarack, and white pine (*Pinus strobus*), and clumps of leatherleaf, bog laurel, and bog rosemary. This zone is dominated by few-seed sedge (*Carex oligosperma*), few-flower sedge (*Carex pauciflora*), small cranberry (*Vaccinium oxycoccos*), sphagnum mosses, and pitcher-plant. The quaking bog mat occurs along the lakeshore and has sparse shrubs (i.e., leatherleaf and bog rosemary). Prevalent species occurring on the quaking mat include white beak-rush (*Rhynchospora alba*), large cranberry (*Vaccinium macrocarpon*), pitcher-plant, bog buckbean (*Menyanthes trifoliata*), yellow-eyed grass (*Xyris montana*), round-leaved sundew (*Drosera rotundifolia*), and spoon-leaf sundew (*D. intermedia*).

The northern bog is more open, less complex in general, and mostly dominated by leatherleaf with bog rosemary and few-seed sedge also important. Portions of the northern bog mat have a savanna-like structure with small-diameter jack pine (10-20 cm DBH). Low areas, including sphagnum-filled bog pools, are occasional. Thirty-nine vascular plant species were noted in 2006 survey.

Threats: Uplands adjacent to the bogs could be harvested, which would moderately influence the peat chemistry along the bog margins. Due to the proximity of the bog to a road, off-road vehicle damage is a potential threat to the site. Fire suppression in the general landscape has likely increased the fire rotation of these peatlands.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the bog as well as the surrounding uplands. Maintaining a forested buffer surrounding the bog will help ensure the stability of the bog's hydrologic regime. Monitoring for non-native invasive species should be implemented to ensure that they do not spread into the bog from the adjacent roads.

[2] Barclay Lakes Jack Pine dry northern forest

The southern bog in the Barclay Lake Bog complex is characterized by a distinctive floating bog mat that supports a high diversity of herbaceous species. Photos by Joshua G. Cohen.

6. Barfield Lakes (Bog)

Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and apparently secure within the state
Element Occurrence Rank: AB
Location: Newberry Forest Management Unit, Compartment 3
Element Occurrence Identification Number: 8926

Site Description: This large bog complex occurs on poorly drained lakeplain with sandy dune ridges surrounding the wetlands. This site consists of numerous lake-filled bogs and peatlands of varying age and development. The oldest areas support treed bog or muskeg while the youngest areas support intermittent wetland. Bogs predominate and are characterized by deep (> 1 m), acidic (pH 4.5-5.0), saturated sphagnum peats and well-developed sphagnum hummock and hollow microtopography, which generates fine-scale gradients of soil moisture and soil chemistry. Beaver channels and deer trails also create unique microsites that increase the structural diversity of the site.

Both graminoid- and ericaceous-dominated bogs occur with a scattered and stunted conifer canopy composed of black spruce (*Picea mariana*), tamarack (*Larix laricina*), and white pine (*Pinus strobus*). Canopy coverage is < 5% with trees 5 to 20 cm in DBH and 5 to 20 ft tall. The sparse tall shrub layer is dominated by black spruce, tamarack, and white pine with mountain holly (*Nemopanthus mucronata*) and wild-raisin (*Viburnum cassinoides*) occurring along the upland margin where the canopy and understory become denser. The low shrub layer is dominated by leatherleaf (*Chamaedaphne calyculata*) and sweet gale (*Myrica gale*) with sweet gale most prevalent along the pond/lake margins. Additional characteristic low shrubs include bog laurel (*Kalmia polifolia*), bog rosemary (*Andromeda glaucophylla*), low sweet blueberry (*Vaccinium angustifolium*), and Labrador tea (*Ledum groenlandicum*). Labrador tea is concentrated along the upland margin. The ground cover is overwhelmingly dominated by few-seed sedge (*Carex oligosperma*) with small cranberry (*Vaccinium oxycoccos*) and large cranberry (*V. macrocarpon*) being abundant. Additional characteristic species include pitcher-plant (*Sarracenia purpurea*), white beak-rush (*Rhynchospora alba*), round-leaved sundew (*Drosera rotundifolia*), spoon-leaf sundew (*D. intermedia*), three-way sedge (*Dulichium arundinaceum*), and arrow-grass (*Scheuchzeria palustris*). Floating mats along the margins of the ponds/lakes are diverse with sundews, white beak-rush, bog buckbean (*Menyanthes trifoliata*), twig-rush (*Cladium mariscoides*), and arrow-grass. Areas of muskeg or treed bog (where lake-filling has occurred for the longest period of time) are characterized by a greater canopy coverage (10-25%) of scattered stunted conifers (black spruce, tamarack, and white pine) with ericaceous low shrub cover (leatherleaf, bog rosemary, bog laurel, and blueberries) and few-seed sedge and small cranberry. Areas of intermittent wetland are characterized by a greater prevalence of graminoids, namely twig-rush, three-way sedge, and bluejoint grass (*Calamagrostis canadensis*).

Threats: Off-road vehicle damage is a potential threat to the wetlands situated close to the road.

Management Recommendations: The main management recommendation is to allow natural processes (i.e., fire and beaver flooding) to operate unhindered. Wildfires should be allowed to burn the bog as well as the surrounding uplands. Vehicular traffic should be avoided through this peatland. Forested inclusions (dry-mesic northern forest on dune ridges and poor conifer swamp) adjacent to the bog should be left uncut and the bog pockets should be buffered to prevent changes to the peatland hydrology. Aerial photographic interpretation indicates that high-quality forested ecosystems occur to the north and a high-quality muskeg occurs to the south. These ecosystems should be surveyed and protected if they are high quality.

Barfield Lakes consists of numerous lake-filled bogs and peatlands of varying age and development that are surrounded by pine-dominated dry-mesic northern forest. Photos by Joshua G. Cohen.

7. Best Bog

Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and apparently secure within the state
Element Occurrence Rank: B
Location: Grayling Forest Management Unit, Compartment 278
Element Occurrence Identification Number: 11974

Site Description: This bog occurs in a shallow basin in a sandy outwash plain. Jack pine (*Pinus banksiana*) and red pine (*P. resinosa*) forest occur in the adjacent uplands. Soils are consistently 50 to 60 cm of inundated organics (mostly fibric peat) over coarse-textured acidic (pH 4.0-4.5) sands.

The site is characterized by several ecological zones including an open water lake, a quaking mat, and an expansive, graminoid-dominated zone. The open water pond supports submergent vegetation with sweet-scented water-lily (*Nymphaea odorata*) dominant. The small zone of quaking bog mat near the lake is dominated by few-seed sedge (*Carex oligosperma*), round-leaved sundew (*Drosera rotundifolia*), and white beak-rush (*Rhynchospora alba*). The expansive, graminoid-dominated zone is characterized by few-seed sedge with scattered sphagnum mounds dominated by leatherleaf (*Chamaedaphne calyculata*) and small cranberry (*Vaccinium oxycoccos*). Small forested islands within the bog are dominated by red pine, jack pine, black spruce (*Picea mariana*), tamarack (*Larix laricina*), and leatherleaf.

Threats: Due to the proximity of the bog to a road, off-road vehicle damage is a potential threat to the site.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the bog as well as the surrounding uplands. Maintaining a forested buffer surrounding the bog and culverts under the road at the south end of the wetland will help ensure the stability of the bog's hydrologic regime.

Sphagnum mounds are dispersed throughout the graminoid-dominated wet areas. Photo by Joshua G. Cohen.

8. Fox Lake Bog (Beaver Island)

Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and apparently secure within the state
Element Occurrence Rank: AB
Location: Gaylord Forest Management Unit, Compartments 67 and 68, and Private Lands
Element Occurrence Identification Number: 12097

Site Description: This large (close to 200 acre) ombrotrophic bog occurs on poorly drained lakeplain with deep sphagnum peats overlying sands. The sphagnum peats are strongly acidic and saturated with inundated peats occurring along the margins of Fox Lake. The lakeplain is level but diverse microtopography occurs due to sphagnum hummock and hollow development. Slightly less acidic conditions occur along the bog margin and along the floating bog mat adjacent to Fox Lake.

The bog is characterized by a scattered canopy of stunted conifers with tamarack (*Larix laricina*), black spruce (*Picea mariana*), white pine (*Pinus strobus*), and, locally, red pine (*P. resinosa*). The canopy becomes denser, taller and more closed along the bog margin where the the bog mat is grounded or where paludification has occurred. The noted tree species also occur in the tall shrub and sapling layer. Along the bog margin where there is some groundwater influence, mountain holly (*Nemopanthus mucronata*) and winterberry (*Ilex verticillata*) are locally dominant. Leatherleaf dominates the continuous and closed low shrub layer. Other prevalent ericaceous shrubs include bog laurel (*Kalmia polifolia*), Labrador tea (*Ledum groenlandicum*), and bog rosemary (*Andromeda glaucophylla*). Low sweet blueberry (*Vaccinium angustifolium*) and Canada blueberry (*V. myrtilloides*) are locally dominant where the bog mat is grounded. The herbaceous layer is dominated by few-seed sedge (*Carex oligosperma*) along with sheathed cotton-grass (*Eriophorum spissum*). Wintergreen (*Gaultheria procumbens*) and small cranberry (*Vaccinium oxycoccos*) are common throughout. The floating bog mat adjacent to Fox Lake in the northwestern corner of the peatland supports higher biodiversity, characterized by the aforementioned species along with white beak-rush (*Rhynchospora alba*), twig-rush (*Dulichium arundinaceum*), pitcher-plant (*Sarracenia purpurea*), and round-leaved sundew (*Drosera rotundifolia*). Over fifty species were identified during the survey.

Threats: Uplands adjacent to and within the bog could be harvested, which would moderately influence the peat chemistry along the bog margin. The pine and aspen sand dune island within the bog could be harvested. Logging traffic could compact the peat and cause rutting. Reed canary grass (*Phalaris arundinacea*) could spread where the anthropogenic disturbances impact the hydrology and soil chemistry.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the bog as well as the surrounding uplands. Maintaining a forested buffer surrounding the bog will help ensure the stability of the bog's hydrologic regime. Portions of the bog and surrounding landscape that occur on private lands could be protected through acquisition or the establishment of conservation easements.

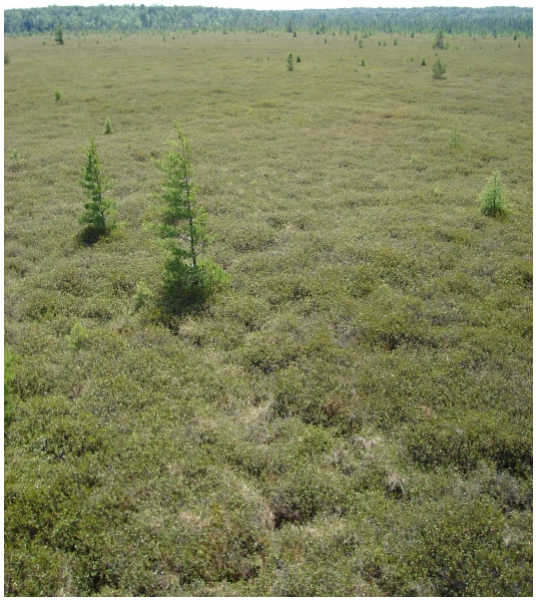


Photo by Joshua G. Cohen.

9. Lake Sixteen Bog

Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and apparently secure within the state
Element Occurrence Rank: B
Location: Pigeon River Forest Management Unit, Compartment 3, and Gaylord Forest Management Unit, Compartment 182
Element Occurrence Identification Number: 15963

Site Description: This small site occurs in a circular kettle depression and ranges from open bog to treed bog surrounding an alkaline lake. The bog includes both areas of grounded bog mat and floating bog mat adjacent to the lake. Areas of grounded bog mat have deep (> 1 m), acidic (pH 4.0-6.0), fibric, sphagnum peat with the water table at 30 cm. The floating bog mat adjacent to the lake is characterized by saturated fibric peat that is slightly acidic to circumneutral (pH 6.5-7.0). Several deer trails pass through the bog and cause sphagnum mat compaction and thereby linearly raise the water table.

The bog is characterized by a scattered and stunted conifer canopy with black spruce (*Picea mariana*) and tamarack (*Larix laricina*). These tree species are also prevalent in the tall and low shrub layers. Ericaceous shrubs dominate the low shrub layer with leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), and bog rosemary (*Andromeda glaucophylla*). The ground layer is dominated by graminoids and a thick continuous sphagnum carpet. Prevalent graminoids include few-seed sedge (*Carex oligosperma*), few-flower sedge (*Carex pauciflora*), tawny cotton-grass (*Eriophorum virginicum*), sheathed cotton-grass (*E. spissum*), and bulrush (*Trichophorum alpinum*). Twig-rush (*Cladium mariscoides*), mud sedge (*Carex limosa*), and wiregrass sedge (*C. lasiocarpa*) are concentrated near the lake margin. Numerous orchids were documented during the surveys including rose pogonia (*Pogonia ophioglossoides*), grass pink (*Calopogon tuberosus*), and white-fringed orchid (*Platanthera blephariglottis*).

Threats: Fire suppression in the general landscape has likely increased the fire rotation of this system.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the bog as well as the surrounding uplands. Maintaining a forested buffer surrounding the bog will help ensure the stability of the bog's hydrologic regime. Monitoring the impacts of deer herbivory and trampling is warranted to ascertain how deer are influencing the bog composition and structure. Extending the timber rotation in the surrounding uplands could help reduce overall deer densities.

Photo by Joshua G. Cohen.

10. Lansing Club Pond East

Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and apparently secure within the state
Element Occurrence Rank: BC
Location: Pigeon River Forest Management Unit, Compartment 38
Element Occurrence Identification Number: 15964

Site Description: This is an ombrotrophic bog that has completely filled a long linear kettle depression through lake filling (terrestrialization) within a broad flat outwash plain. The soils are deep, saturated, acidic sphagnum peats with a high water table. The water table is at the surface in the center of the bog and also in moat areas fringing the bog during the spring. Elsewhere the water table is 30 to 40 cm deep. Fine-scale gradients of soil moisture and chemistry associated with well-developed hummock and hollow microtopography and ecological zonation result in moderately high levels of species diversity.

There are three primary ecological zones in this wetland including a floating bog mat, a grounded bog mat, and a moat. The floating bog mat is characterized by graminoid dominance with few-seed sedge (*Carex oligosperma*) and sheathed cotton-grass (*Eriophorum spissum*) prevalent along with pitcher-plant (*Sarracenia purpurea*), large cranberry (*Vaccinium macrocarpon*), and spoon-leaf sundew (*Drosera intermedia*). The grounded bog mat is dominated by leatherleaf (*Chamaedaphne calyculata*) with scattered stunted conifers including black spruce (*Picea mariana*), white pine (*Pinus strobus*), jack pine (*P. banksiana*), and red pine (*P. resinosa*). Additional herbaceous species include arrow-grass (*Scheuchzeria palustris*) and few-flower sedge (*Carex pauciflora*). The moat, which occurs along the bog margin, supports meadowsweet (*Spiraea alba*) and mud sedge (*Carex limosa*). Four primary vegetative layers characterize the bog including a stunted and scattered canopy, a scattered sapling layer, a nearly continuous low shrub layer dominated by leatherleaf, and an herbaceous layer dominated by few-seed sedge and sphagnum mosses.

Threats: Several deer trails pass through the bog and cause sphagnum mat compaction and thereby linearly raise the water table. Deer may also browse the vegetation. Fire suppression in the general landscape has likely increased the fire rotation of this system and fire suppression may be causing the dominance of leatherleaf.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the bog as well as the surrounding uplands. Maintaining a forested buffer surrounding the bog will help ensure the stability of the bog's hydrologic regime. Monitoring the impacts of deer herbivory and trampling is warranted to ascertain how deer are influencing the bog composition and structure. The benefits of burning the bog and the surrounding uplands using prescribed fire should be evaluated.

The graminoid-dominated moat along the margin grades to a grounded bog mat dominated by leatherleaf (left photo) with sphagnum hummock and hollow microtopography (right). Photos by Joshua G. Cohen.

11. Long Lake

Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and apparently secure within the state
Element Occurrence Rank: B
Location: Traverse City Forest Management Unit, Compartment 61
Element Occurrence Identification Number: 11575

Site Description: Long Lake is a lake-filled, ombrotrophic bog that occurs in a kettle depression in a pitted outwash plain with deep, strongly acidic (pH 4.5-5.0) saturated sphagnum peats overlying acidic (pH 5.0) sands. The overall topography is flat with sphagnum hummocks and hollows providing diverse microtopography and fine-scale gradients in soil moisture and chemistry. The site is surrounded by mature second growth dry-mesic northern forest with dirt roads and trails throughout the landscape.

The bog is characterized by three primary ecological zones: a grounded mat with higher tree density, broad areas of open bog dominated by leatherleaf (*Chamaedaphne calyculata*), and a floating bog mat with increased importance of graminoids. The shrub layer is dominated by leatherleaf, bog laurel (*Kalmia polifolia*), and bog rosemary (*Andromeda glaucophylla*) with areas along the lake margin supporting whorled loosestrife (*Decodon verticillatus*) and areas along the upland margin supporting mountain holly (*Nemopanthus mucronata*), huckleberry (*Gaylussacia baccata*), and blueberries (*Vaccinium* spp.). The herbaceous layer is dominated by few-seed sedge (*Carex oligosperma*) and cotton-grasses (*Eriophorum* spp.) with twig-rush (*Cladium mariscoides*), white beak-rush (*Rhynchospora alba*), small cranberry (*Vaccinium oxycoccos*), pitcher-plant (*Sarracenia purpurea*), and round-leaved sundew (*Drosera rotundifolia*) prevalent on the floating mat adjacent to the lake. Sphagnum species dominate the ground cover throughout the site. Three-way sedge (*Dulichium arundinaceum*) is a local dominant in areas of shallow peat over sand close to the upland margin. The scattered and stunted canopy in areas of treed bog is dominated by white pine (*Pinus strobus*), black spruce (*Picea mariana*), and tamarack (*Larix laricina*) with trees ranging in DBH from 4 to 20 cm and in height from 15 to 40 ft. Over thirty vascular plant species were noted during the survey.

Threats: Due to the proximity of the bog to roads, off-road vehicle damage is a potential threat to the site. Logging of the dry-mesic northern forest surrounding the bog could alter the hydrology of the site by increasing surface run off and sedimentation into the wetland.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the bog as well as the surrounding uplands. Maintaining a forested buffer surrounding the bog will help ensure the stability of the bog's hydrologic regime.


Sundews occur in areas of floating bog mat (left), which are prevalent along the lake margins. Photos by Adrienne L. Bozic (left) and Joshua G. Cohen (right).

12. Lovell's Bog

Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and apparently secure within the state
Element Occurrence Rank: B
Location: Grayling Forest Management Unit, Compartments 266 and 267
Element Occurrence Identification Number: 1747

Site Description: This bog occurs in a shallow basin in a poorly drained pitted outwash plain surrounded by stands of managed aspen and jack pine (*Pinus banksiana*) forest. The bog is characterized by well-developed sphagnum hummock and hollow microtopography with over a meter of acidic (pH 4.0-4.5) sphagnum peat development at the north and south ends of the bog. Numerous deer trails criss-cross bog causing soil compaction.

The site contains an open water lake that is ringed by a quaking bog mat with patchy shrubs and scattered small trees on low sphagnum rises. The quaking mat is surrounded by a thin band of poor conifer swamp. The low shrub layer of the bog is dominated by leatherleaf (*Chamaedaphne calyculata*) with additional ericaceous shrubs including bog laurel (*Kalmia polifolia*), Labrador tea (*Ledum groenlandicum*), and bog rosemary (*Andromeda glaucophylla*). The ground layer is dominated by graminoids with few-seed sedge (*Carex oligosperma*) prevalent and associates including tufted bulrush (*Trichophorum cespitosum*) and green-keeled cotton-grass (*Eriophorum viridi-carinatum*). Sundews (*Drosera* spp.) are common on the quaking mat. Scattered stunted black spruce (*Picea mariana*), jack pine, and tamarack (*Larix laricina*) occur throughout the bog and within the thin band of poor conifer swamp.

Threats: Due to the proximity of the bog to a road, off-road vehicle damage is a potential threat to the site.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the bog as well as the surrounding uplands.

Leatherleaf is the overwhelming dominant of Lovell's Bog. Photo by Bradford S. Slaughter.

13. North Lost Lake Bog

Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and apparently secure within the state
Element Occurrence Rank: AB
Location: Traverse City Forest Management Unit, Compartment 61
Element Occurrence Identification Number: 8430

Site Description: This bog occupies a kettle depression in a pitted outwash plain with deep saturated sphagnum peats overlying wet sands. Both organic and mineral soils are acidic. Overall topography is flat with sphagnum hummocks and hollows providing diverse microtopography and fine-scale gradients in soil moisture and chemistry. The site is characterized by high species diversity (over 50 species) with complex ecological zonation. Minimal anthropogenic disturbance was noted. The bog is surrounded by mature second-growth dry-mesic northern forest with dirt roads and trails throughout the landscape.

Four primary ecological zones characterize the site: open bog, treed bog, floating mat, and poor fen. The open bog is characterized by deep acidic sphagnum peat dominated by leatherleaf (*Chamaedaphne calyculata*) with bog laurel (*Kalmia polifolia*) and few-seed sedge (*Carex oligosperma*). The treed bog has an open canopy (10-25%) of scattered and stunted black spruce (*Picea mariana*) and tamarack (*Larix laricina*) that range in DBH from 4 to 20 cm and in height from 15 to 40 ft. The low shrub layer in this zone is dense and dominated by ericaceous species, namely leatherleaf, bog laurel, and low sweet blueberry (*Vaccinium angustifolium*). The floating mat is extensive with 20 to 40 cm of fibric peat over water. White-beak-rush (*Rhynchospora alba*) is dominant on the mat with prevalent species including pitcher-plant (*Sarracenia purpurea*), cotton-grasses (*Eriophorum* spp.) and patches of twig-rush (*Cladium mariscoides*) and yellow-eyed grass (*Xyris torta*). Numerous pockets of poor fen occur along the wetland margin and a larger pocket of poor fen is found at the north end of the complex. Poor fen inclusions are characterized by slightly acidic sedge peats (60 cm deep) over circumneutral sand dominated by wiregrass sedge (*Carex lasiocarpa*) and bluejoint grass (*Calamagrostis canadensis*).

Threats: Due to the proximity of the bog to roads, off-road vehicle damage is a potential threat to the site. Logging of the dry-mesic northern forest surrounding the bog could alter the hydrology of the site by increasing surface run off and sedimentation into the wetland.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the bog as well as the surrounding uplands. Maintaining a forested buffer surrounding the bog will help ensure the stability of the bog's hydrologic regime.


North Lost Lake Bog is characterized by an extensive bog mat with a small central pond. Photos by Joshua G. Cohen.

14. Ryerse Lake

Natural Community Type: Bog (re-classified from Poor Fen)
Rank: G3G5 S4, vulnerable to secure globally and apparently secure within the state
Element Occurrence Rank: AB
Location: Sault Sainte Marie Forest Management Unit, Compartment 136
Element Occurrence Identification Number: 11717

Site Description: This moderate-sized peatland surrounds Ryerse Lake, an alkaline kettlehole lake occurring on a sandy lakeplain. The bog is part of a peatland complex that includes the bog in addition to pockets of poor fen along the lake margin. A quaking mat occurs along the lake margin and is characterized by acidic (pH 5.0-6.0) peats that are 45 to 60 cm deep. Where the bog mat is grounded, sphagnum mounds are more pronounced, fibric peat depths are greater (>100 cm deep), and the peats are more acidic (pH 4.0-5.5). Sphagnum peat increases in depth and acidity with distance from the lake.

In areas where the sphagnum mounds are well developed, the dominant species include ericaceous shrubs, namely leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), blueberries (*Vaccinium* spp.), and Labrador tea (*Ledum groenlandicum*), and scattered and stunted conifers, such as tamarack (*Larix laricina*) and black spruce (*Picea mariana*), and few-seed sedge (*Carex oligosperma*). Pockets of poor fen occurring along the lake margin support a diversity of species including bog buckbean (*Menyanthes trifoliata*), white beak-rush (*Rhynchospora alba*), large cranberry (*Vaccinium macrocarpon*), pitcher-plant (*Sarracenia purpurea*), round-leaved sundew (*Drosera rotundifolia*), mud sedge (*Carex limosa*), rushes (*Juncus* spp.), tawny cotton-grass (*Eriophorum virginicum*), arrow grass (*Scheuchzeria palustris*), bulrush (*Trichophorum alpinum*), bog clubmoss (*Lycopodiella inundata*), and dioecious sedge (*Carex sterilis*). Over 50 species were recorded during the survey effort. This site was previously classified as poor fen but was re-classified to bog following 2006 surveys.

Threats: Proximity to the Hiawatha trail could facilitate incursions into the peatland by off-road vehicles and invasion by non-native species.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Maintaining a forested buffer surrounding the bog will help ensure the stability of the bog's hydrologic regime. Monitoring for non-native invasive species should be implemented to ensure that they do not spread into the bog.

Photo by Michael A. Kost.

15. Tighe Lake

Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and apparently secure within the state
Element Occurrence Rank: BC
Location: Shingleton Forest Management Unit, Compartment 87
Element Occurrence Identification Number: 16139

Site Description: This moderate-sized bog occurs in a shallow depression surrounded by managed aspen and pine stands. The site is characterized by a grounded bog mat on the western side of Tighe Lake that grades to poor conifer swamp along the southern edge of the lake and a thin band of high-quality intermittent wetland along the northeastern edge of the lake[3]. Acidic (pH 4.0) sphagnum peat occurs over deep sapric peat (> 1 m deep), which overlay acidic sands (pH 5.0).

The bog mat is dominated by leatherleaf (*Chamaedaphne calyculata*) with scattered tamarack (*Larix laricina*), black spruce (*Picea mariana*), and occasional white pine (*Pinus strobus*). Trees range in height from 3 to 30 ft tall and often occur in clumps. Sweet-scented water-lily (*Nymphaea odorata*), yellow pond-lily (*Nuphar variegata*), and water shield (*Brasenia schreberi*) are common in the areas of open water with sedges (*Carex* spp.), pipewort (*Eriocaulon septangulare*), and short-fruited rush (*Juncus brachycarpus*) occurring along the lake margin.

This site was previously classified and mapped as a part of the Michaud Lake Intermittent Wetland. 2006 surveys determined that the area surrounding Tighe Lake is actually a bog and the area north of the highway adjacent to Michaud Lake is intermittent wetland.

Threats: The local hydrology of the bog may be impacted by US 2. Tighe Lake is connected to Michaud Lake by a culvert that passes under US 2. The culvert connecting Tighe Lake to Michaud Lake channels water and may be altering the surface water flow.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Maintaining a forested buffer surrounding the bog will help ensure the stability of the bog's hydrologic regime. Monitoring for non-native invasive species should be implemented to ensure that they do not spread into the bog.

[3] Michaud Lake intermittent wetland

BOREAL FOREST

Overview: Boreal forest is a conifer or conifer-hardwood forest type occurring on moist to dry sites characterized by species dominant in the Canadian boreal forest. It typically occupies upland sites along shores of the Great Lakes, on islands in the Great Lakes, and locally inland. The community occurs north of the climatic tension zone primarily on sand dunes, glacial lakeplains, and thin soil over bedrock or cobble. Soils of sand and sandy loam are typically moderately acid to neutral, but heavier soils and more acid conditions are common. Proximity to the Great Lakes results in high levels of windthrow and climatic conditions characterized by low summer temperatures and high levels of humidity, snowfall, and summer fog and mist. Additional important natural disturbance factors include fire and insect epidemics (Kost et al. 2007).

16. French Bay

Natural Community Type: Boreal Forest
Rank: GU S3, unknown status globally and vulnerable within the state
Element Occurrence Rank: C
Location: Gaylord Forest Management Unit, Compartment 69, and Private Lands
Element Occurrence Identification Number: 6311

Site Description: This boreal forest occurs on gently sloping sand dune ridges on a lakeplain along the Lake Huron shoreline in the west-central portion of Beaver Island. The soils are slightly acidic to circumneutral (pH 5.6-7.3) sands. The boreal forest is a very narrow band that is buffered by natural communities that are minimally disturbed by anthropogenic influences.

A narrow strip (two to four trees deep) of boreal forest lines the entire bay. The canopy is dominated by northern white-cedar (*Thuja occidentalis*) with white pine (*Pinus strobus*), balsam fir (*Abies balsamea*), white spruce (*Picea glauca*), black spruce (*P. mariana*), balsam poplar (*Populus balsamifera*), red oak (*Quercus rubra*), paper birch (*Betula papyrifera*), and red maple (*Acer rubrum*). Canopy trees are 20 to 60 cm in DBH. The ground cover is characterized by starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), low sweet blueberry (*Vaccinium angustifolium*), common juniper (*Juniperus communis*), bracken fern (*Pteridium aquilinum*), bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), starry false Solomon's seal (*Smilacina stellata*), and dwarf lake iris (*Iris lacustris*, federal/state threatened).

Threats: High deer densities are likely limiting tree regeneration, especially of northern white-cedar, hemlock, and white pine, and thereby altering the species composition of the ground cover and understory.

Management Recommendations: The main management recommendation is to reduce deer densities in the overall landscape by increasing the amount of late-successional habitat on the island and increasing deer harvest levels. Monitoring should be implemented for northern white-cedar and white pine regeneration in the understory.

Photo by Joshua G. Cohen.

17. Lime Kiln Point Boreal Forest

Natural Community Type: Boreal Forest
Rank: GU S3, unknown status globally and vulnerable within the state
Element Occurrence Rank: A
Location: Gaylord Forest Management Unit, Compartment 217
Element Occurrence Identification Number: 8473

Site Description: This boreal forest occurs on gently sloping lakeplain along the Lake Huron shoreline in the northeastern corner of Bois Blanc Island. The shallow (5-9 cm deep) soils are acidic (pH 5.0-5.5) humus over dolomite cobble mixed with circumneutral (pH 7.0-7.5) silty loam. The underlying dolomite ranges in size from pebbles to cobbles.

The canopy is dominated by northern white-cedar (*Thuja occidentalis*), which ranges from 20 to 70 cm in DBH. Canopy associates include paper birch (*Betula papyrifera*), white pine (*Pinus strobus*) (60-80 cm DBH), red pine (*P. resinosa*), hemlock (*Tsuga canadensis*) (60-80 cm DBH), white spruce (*Picea glauca*) (40-70 cm DBH), and quaking aspen (*Populus tremuloides*). Canopy closure ranges between 70-100%. The subcanopy is dominated by northern white-cedar and balsam fir (*Abies balsamea*), while the tall shrub layer is dominated by balsam fir, striped maple (*Acer pensylvanicum*), and mountain maple (*Acer spicatum*). The ground cover is sparse with starflower (*Trientalis borealis*), twinflower (*Linnaea borealis*), American fly honeysuckle (*Lonicera canadensis*), bluebead lily (*Clintonia borealis*), gay wings (*Polygala paucifolia*), Canada mayflower (*Maianthemum canadense*), Indian pipe (*Monotropa uniflora*), and rattlesnake plantains (*Goodyera* spp.).

With increasing proximity to the lake, the trees become smaller in diameter and density increases. Several areas have three to four terraces. Northern white-cedar, paper birch, and quaking aspen are more prevalent closer to the lake while white pine and red pine are canopy dominants along the upper terraces with occasional white spruce and hemlock. Very large-diameter trees occur along the ecotone with mesic northern forest due to the excellent growing conditions and protection from windthrow. Areas of heavy blowdown contain dense northern white-cedar regeneration.

Threats: High deer densities are likely limiting tree regeneration, especially of northern white-cedar, hemlock, and white pine, and thereby altering the species composition of the ground cover. The invasive shrub smooth tartarian honeysuckle (*Lonicera tatartica*) occurs to the north of the boreal forest in areas of blowdown and near the old lighthouse.

Management Recommendations: The main management recommendation is to reduce deer densities in the overall landscape by increasing the amount of late-successional habitat on the island and increasing deer harvest levels. Establishing deer exclosures would allow for the assessment of impacts of deer herbivory to ground cover and regeneration. Monitoring should be implemented for white pine, red pine, northern white-cedar, and hemlock regeneration in the understory. In addition, monitoring should be implemented for invasive species within the site and the population of smooth tartarian honeysuckle that is found north of the boreal forest should be controlled. Aerial photographic interpretation indicates that additional high-quality boreal forest extends to the southeast of this occurrence on private lands. Additional high-quality boreal forest on private lands could be protected through acquisition or the establishment of conservation easements.

Lime Kiln Point Boreal Forest has high levels of blowdown and a sparse ground cover. Photos by Joshua G. Cohen.

COASTAL FEN

Overview: Coastal fen is a sedge- and rush-dominated wetland that occurs on calcareous substrates along Lake Huron and Lake Michigan north of the climatic tension zone. The community occurs where marl and organic soils accumulate in protected coves and abandoned coastal embayments and grade to moderately alkaline glacial tills and lacustrine sediments lakeward. Sediments along the lakeshore are typically fine-textured and rich in calcium and magnesium carbonates. Vegetation is comprised primarily of calcicolous species capable of growing on wet alkaline substrates (Kost et al. 2007).

18. El Cajon Bay
Natural Community Type: Coastal Fen
Rank: G1G2 S2, globally imperiled and imperiled within the state
Element Occurrence Rank: A
Location: Atlanta Forest Management Unit, Compartment 107, and Private Lands
Element Occurrence Identification Number: 1936

Site Description: This expansive stretch of coastal fen occurs along El Cajon and Misery Bays. The site is characterized by extensive sand flats that are moist to saturated and have been recently exposed due to the low water levels in Lake Huron. The soils range from saturated alkaline sand in the bay to areas of dense stone and cobble mixed with sand to a thin layer of sapric peat over saturated sands and marly clay along the open wetland margin. Over 70 vascular plant species were identified during the survey.

The wetland associated with El Cajon Bay is characterized by complex ecological zonation with emergent marsh, limestone cobble shore or calcareous beach, coastal fen, and rich conifer swamp. Dominants in the emergent marsh include Baltic rush (*Juncus balticus*), hardstem bulrush (*Schoenoplectus acutus*), and softstem bulrush (*Schoenoplectus tabernaemontani*). Calcareous beaches support populations of twig-rush (*Cladium mariscoides*), Kalm's lobelia (*Lobelia kalmi*), and sedge (*Carex viridula*). Areas of coastal fen are dominated by bluejoint grass (*Calamagrostis canadensis*), shrubby cinquefoil (*Potentilla fruticosa*), Kalm's St. John's-wort (*Hypericum kalmianum*), pitcher-plant (*Sarracenia purpurea*), and low calamint (*Calamintha arkansana*). The marsh is backed by a broad zone of northern white-cedar (*Thuja occidentalis*). Populations of the non-natives dog mustard (*Erucastrum gallicum*) and wall rocket (*Diplotaxis muralis*) occur in localized areas.

Within the Misery Bay portion of the wetland, the recently exposed sand flats are mostly devoid of vegetation with pockets of Baltic rush, rushes (*Juncus* spp.), spike-rushes (e.g., *Eleocharis quinqueflora*), twig-rush and a band of hardstem bulrush along the water's edge. Inland of this zone is an extensive dry, cobbly, rocky zone that is moderately vegetated with Ohio goldenrod (*Solidago ohioensis*), purple gerardia (*Agalinis purpurea*), dwarf Canadian primrose (*Primula mistassinica*), balsam ragwort (*Senecio pauperculus*), small-fringed gentian (*Gentianopsis procera*), hair grass (*Deschampsia cespitosa*), shrubby cinquefoil, low calamint, Kalm's lobelia, and northern white-cedar seedlings. In areas this grades to low sand ridges dominated by little bluestem (*Andropogon scoparius*), grass-leaved goldenrod (*Euthamia graminifolia*), silverweed (*Potentilla anserina*), and common boneset (*Eupatorium perfoliatum*) with several non-natives including Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), purple loosestrife (*Lythrum salicaria*), and reed (*Phragmites australis*). At the southwestern portion of the bay, the coastal fen is characterized by a patchwork of marl flats and hummocks. Along the edge of the adjacent rich conifer swamp, dwarf lake iris (*Iris lacustris*, federal/state threatened) is abundant along with shrubby cinquefoil, grass-of-Parnassus (*Parnassia glauca*), pitcher-plant, asters (*Aster* spp.), Ohio goldenrod, bog goldenrod (*Solidago uliginosa*), little bluestem, and black-eyed Susan (*Rudbeckia hirta*).

Threats: Minor off-road vehicle trails occur throughout the site. In addition, there are several minor invasive species incursions. Invasive species noted during surveys included Canada thistle, bull thistle, reed, purple loosestrife, dog mustard, and wall rocket.

Management Recommendations: The primary stewardship need is to control the populations of invasive species (i.e., purple loosestrife and reed) and monitor control efforts. Maintaining a buffer of unmanaged swamp forest surrounding the coastal fen and eliminating illegal off-road vehicle activity will help reduce the possibility of additional invasive species incursions. Additional high-quality shoreline occurs to the north and south of the state property. These private lands could be protected through acquisition and/or establishment of conservation easements.

Photo by Joshua G. Cohen.

DRY NORTHERN FOREST

Overview: Dry northern forest is a pine- or pine-hardwood-dominated forest type that occurs on dry sandy sites lying mostly north of the climatic tension zone. Dry northern forest occurs principally on sandy glacial outwash and sandy glacial lakeplains, and also commonly on sand ridges within peatlands on glacial outwash or glacial lakeplains. Soils are coarse-textured, well-sorted, excessively drained dry sands with low amounts of organic matter and low water-holding capacity. The droughty soils are extremely acid to very strongly acid with low nutrient content and high frost proclivity. Two distinct variants are included within this community type, one dominated by jack pine (*Pinus banksiana*) or jack pine and hardwoods, and the other dominated by red pine (*P. resinosa*). Prior to European settlement, dry northern forest typically originated in the wake of catastrophic fire. Frequent, low-intensity ground fires maintained red pine systems (Kost et al. 2007).

19. Barclay Lake Jack Pines

Natural Community Type: Dry Northern Forest
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: BC
Location: Newberry Forest Management Unit, Compartment 39, and Private Lands
Element Occurrence Identification Number: 12024

Site Description: This large block of naturally regenerated jack pine (*Pinus banksiana*) - red pine (*P. resinosa*) forest occurs on pitted outwash of gentle to moderate topography and variable aspect. Sandy soils are acidic (pH 4.5) and of low moisture retaining capacity. Two high-quality bogs[4] occur within the forest along with numerous small treed bog depressions. In addition, the Little Two-Hearted River occurs on the eastern border of the site. Fire burned throughout the site as indicated by fire scars on large canopy trees, charcoal in soils, and charring on cut stumps. Fires likely occurred 70 to 80 years ago and likely varied from intense crown fires to surface fires depending on canopy composition, topography, and fire breaks. Senescence and windthrow have generated small coarse woody debris and small gaps in which oak and pine saplings have established.

The canopy is dominated by jack pines, which are 70 to 80 years old, 15 to 40 cm in DBH, and 30 to 40 ft tall. Canopy associates include red pine and red oak (*Quercus rubra*). Areas along the slopes above the river and the bogs exhibit increased canopy importance of red pine and white pine (*Pinus strobus*) and these areas are characterized by greater density and stature (trees are 60 ft tall compared to 30-50 ft in other areas). The canopy of the jack pine dominated forest is open, ranging from 50 to 70% closure, which allows for scattered pine and oak regeneration. The subcanopy and tall shrub layers are scattered and dominated by pines, red maple (*Acer rubrum*), and red oak. Balsam fir (*Abies balsamea*) is prevalent in the stretch close to the river and red maple and black spruce (*Picea mariana*) are most common along the bog margins. In both these areas, the density of the subcanopy and tall shrub layer increases. Also prevalent along the bog margins are mountain holly (*Nemopanthus mucronata*) in the tall shrub layer and Labrador tea (*Ledum groenlandicum*) and leatherleaf (*Chamaedaphne calyculata*) in the low shrub layer. The low shrub layer in the dry northern forest is patchy to closed and is dominated by low sweet blueberry (*Vaccinium angustifolium*) and huckleberry (*Gaylussacia baccata*) with sweetfern (*Comptonia peregrina*), pine seedlings, and oak seedlings common. The herbaceous layer is dominated by bracken fern (*Pteridium aquilinum*) with local dominance by Pennsylvania sedge (*Carex pensylvanica*) and lichens (*Cladina* spp.). Common ground cover plants include wintergreen (*Gaultheria procumbens*), trailing arbutus (*Epigaea repens*), and red oak.

Threats: The main threats to this site are logging and fire suppression.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn). If fire suppression prevents wildfires within the next four decades, prescribed fire could be employed to promote pine and oak regeneration. Red maple (*Acer rubrum*) is currently not a threat and pine regeneration, even jack pine (*Pinus banksiana*), is prevalent throughout the site. Open canopy

[4] Barclay Lakes Bogs

conditions will likely result in a surface fire with localized areas of crowning (many of the current canopy trees have fire scars on their boles indicating they survived surface fire). Following fire, monitoring should be implemented to gauge the vegetative response to fire. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for spotted knapweed (*Centaurea maculosa*) encroachment. If prescribed fire is not feasible, mechanical thinning can be employed to promote pine and oak regeneration. In the event of a harvest, red pine (*Pinus resinosa*), white pine (*P. strobus*), and red oak (*Quercus rubra*) should be retained as seed trees. In addition canopy jack pine should be retained for structural diversity. Excessive scarification and planting should be avoided and the stand should be allowed to naturally regenerate.

Barclay Lakes dry northern forest surrounds high-quality bogs and is dominated by jack pine. Photos by Joshua G. Cohen.

20. Blind Sucker Creek

Natural Community Type: Dry Northern Forest
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Newberry Forest Management Unit, Compartments 4 and 5
Element Occurrence Identification Number: 14558

Site Description: Three pockets of dry northern forest are found on rolling to fairly steep terrain separated by wetlands (i.e., bog and poor conifer swamp) grading to dry-mesic northern forest near the wetland borders. The soils are characterized by a deep needle litter and humus soil layers over strongly acidic (pH 4.0-4.5), dry, coarse-textured loamy sands. Evidence of recent fire is found throughout the site. Blind Sucker Marsh occurs to the south of the site.

The dry northern forest is composed of mature red pine (*Pinus resinosa*) (38-76 cm DBH), white pine (*Pinus strobus*) (66-103 cm DBH), and jack pine (*Pinus banksiana*) (23-33 cm DBH) with scattered pockets of older trees. Red pine–dominated forest is especially prevalent on flat to gently sloping topography with jack pine abundant on droughty ridgetops, especially on west-facing slopes. White pine and red oak (*Quercus rubra*) (35-44 cm DBH) are also important canopy and subcanopy components, while red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), and black spruce (*Picea mariana*) are locally important in the subcanopy. The canopy ranges from 35 to 75% with forest structure and tree maturity most developed in the western most pocket. Forest cover is open on ridgetops and approximately 75% in moist areas. The shrub layer includes saplings of the canopy trees, low sweet blueberry (*Vaccinium angustifolium*), Canada blueberry (*V. myrtilloides*), and huckleberry (*Gaylussacia baccata*). The ground layer includes bracken fern (*Pteridium aquilinum*) with wintergreen (*Gaultheria procumbens*), Pennsylvania sedge (*Carex pensylvanica*), trailing arbutus (*Epigaea repens*), and starflower (*Trientalis borealis*). Coarse woody debris of various ages and decay classes is common throughout.

Threats: The hiking trail that follows the ridge creates localized soil erosion and there is selective cutting for trail maintenance. In addition, fire suppression has altered the fire disturbance regime.

Management Recommendations: Prescribed fire should be employed to mimic ground fires. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. The site should be monitored for invasive species encroachment and deer herbivory.

Photo by Rebecca K. Schillo.

21. Crawford Red Pines

Natural Community Type: Dry Northern Forest
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: BC
Location: Grayling Forest Management Unit/Camp Grayling, Compartments 278 and 280
Element Occurrence Identification Number: 10262

Site Description: This is a small example (14 acres) of old-growth red pine (*Pinus resinosa*) occurring on a rise within pitted outwash plain with medium- to fine-textured acidic (pH 5.0-5.5) sands. The canopy closure ranges from 50 to 70% and canopy height is between 85 and 100 ft. Large (60-75 cm in DBH) old-growth (170-190 years old) red pines dominate the scattered canopy and supercanopy. Red pine, northern pin oak (*Quercus ellipsoidalis*), and red maple (*Acer rubrum*) are dominant in the subcanopy. Due to decades of fire suppression, red maple is prevalent in the tall shrub layer along with red pine and white pine (*Pinus strobus*) saplings. Low sweet blueberry (*Vaccinium angustifolium*) dominates the low shrub layer and bracken fern (*Pteridium aquilinum*) dominates the herbaceous layer. Characteristic ground cover species include wintergreen (*Gaultheria procumbens*), Pennsylvania sedge (*Carex pensylvanica*), starflower (*Trientalis borealis*), and red maple seedlings.

A major dirt road, the Dyer Truck Trail, intersects this site. Recent prescribed fire has occurred on the south side of this road and resulted in heavy red maple seedling and sapling mortality, as well as profuse red maple sprouting.

Threats: Continued fire suppression could favor the eventual succession to red maple. The scattered canopy, level topography, and road passing through the site allow for easy access by off-road vehicle traffic. Trails passing through the forest provide conduits for invasive and weedy native species to establish and spread throughout the site. Canada bluegrass (*Poa compressa*), St. John's-wort (*Hypericum perforatum*), and redtop (*Agrostis gigantea*) were all noted, especially along the old roads. Deer herbivory could impede white pine regeneration.

Management Recommendations: Prescribed fire should be employed to mimic ground fires in order to set back red maple saplings and seedlings as well as balsam fir (*Abies balsamea*). Due to the prevalence of red maple in the adjacent hardwood-conifer swamp, prescribed fire may need to be employed every three to five years until the mesophytic invasion is controlled. Prescribed fire management should utilize existing fire breaks and avoid the creation of new fire lines, unnecessary vehicular activity, and disturbance to the soils. If repeated fires do not control red maple, managers should investigate more intrusive measures such as girdling or removing red maple through manual cutting and herbicide. The site should be monitored for invasive species encroachment and deer herbivory. Reducing deer densities in the general landscape is recommended.


Photo by Joshua G. Cohen.

22. Roscommon Red Pines

Natural Community Type: Dry Northern Forest
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: AB
Location: Roscommon Forest Management Unit, Compartment 1
Element Occurrence Identification Number: 11065

Site Description: This old-growth dry northern forest is found on rolling outwash and ground moraine. The soils are dry, acidic sands topped by 1 to 2 cm of needle duff. Fire was historically the prevalent natural disturbance factor as indicated by the species composition and fire scars on the canopy dominants.

Five structural layers characterize the forest including canopy and supercanopy, subcanopy, tall shrub layer, short shrub layer, and ground cover. The core of the element occurrence is dominated by old-growth red pine (*Pinus resinosa*) and white pine (*P. strobus*) (140 + years old, 60-100 cm DBH, and 80-100 ft tall). Canopy associates include jack pine (*Pinus banksiana*) and northern pin oak (*Quercus ellipsoidalis*). Areas with moderate slope support pockets of white pine-dominated dry-mesic northern forest. Red pine-white pine old-growth is surrounded by smaller jack pine and northern pin oak forest, much of which is also old-growth. The subcanopy is dominated by red maple (*Acer rubrum*), the tall shrub layer is characterized by red maple, white pine, and serviceberry (*Amelanchier* sp.), the low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*), and the ground cover is dominated by bracken fern (*Pteridium aquilinum*) with wintergreen (*Gaultheria procumbens*), Pennsylvania sedge (*Carex pensylvanica*), and starflower (*Trientalis borealis*).

Threats: Continued fire suppression could favor the eventual succession to red maple. Deer herbivory could impede white pine regeneration.

Management Recommendations: Prescribed fire should be employed to mimic ground fires in order to set back red maple saplings and seedlings. Prescribed fire management should utilize existing fire breaks and avoid the creation of new fire lines, unnecessary vehicular activity, and disturbance to the soils. If repeated fires do not control red maple, managers should investigate more intrusive measures such as girdling or removing red maple through manual cutting and herbicide. The site should be monitored for invasive species encroachment and deer herbivory. Reducing deer densities in the general landscape is recommended.

Photo by Joshua G. Cohen.

23. Southside Bridge Red Pines

Natural Community Type: Dry Northern Forest
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: BC
Location: Shingleton Forest Management Unit, Compartments 29 and 35, and Private Lands
Element Occurrence Identification Number: 2709

Site Description: This mature dry northern forest occurs on a sand ridge on the Lake Algonquin plain along Stutts Creek. The soils are acidic (pH 4.5-5.0) loamy sands. Jack pine (*Pinus banksiana*) forest occurs to the northwest and southeast and poor conifer swamp occurs to the northeast and southwest.

The overstory is dominated by red pine (*Pinus resinosa*, 47 cm average DBH) with white pine (*P. strobus*) (> 50 cm DBH) and big-toothed aspen (*Populus grandidentata*). The forest is characterized by a sparse sapling layer with balsam fir (*Abies balsamea*) and red maple (*Acer rubrum*). Dominant ground cover species include bracken fern (*Pteridium aquilinum*), blueberries (*Vaccinium* spp.), wintergreen (*Gaultheria procumbens*), and rough-leaved rice grass (*Oryzopsis asperifolia*). Over 30 vascular species were noted during the surveys.

The entire area was heavily cut in the early 1900s and subsequently burned. Evidence of selective logging since that time includes old pine stumps from multiple-year cuttings (likely 20 and 70 years ago). The portion of the forest south of the South Stutts Truck Trail was clearcut in 2005, and was subsequently removed from the element occurrence acreage. The prevalence of red maple in the understory is evidence that this forest is fire suppressed.

Threats: Clearcuts in the vicinity of this forest are introducing numerous invasives. The prevalence of red maple in the understory is evidence that this forest is fire suppressed.

Management Recommendations: Commercial clearcutting has already taken place, and has removed approximately 50 acres of the forest. It is recommend that the remaining acreage be removed from production and that portions of the forest occurring on private land be acquired or protected through conservation easements. The use of prescribed fire to promote red pine regeneration should be considered. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment.

24. Sunken Lakes Red Pines

Natural Community Type: Dry Northern Forest
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Shingleton Forest Management Unit, Compartment 122
Element Occurrence Identification Number: 1762

Site Description: The site is characterized by several large stands of mature (95-130+ years old) naturally regenerated dry northern forest occurring on dry, sandy dune ridges within poorly drained lakeplain. The numerous low dune ridges are characterized by fine- to medium-textured dune sands that are acidic (pH 4.5) and well-drained. Charred snags and stumps occur throughout, indicating that the site originated following catastrophic fire.

The open canopy (50-75%) is dominated by red pine (*Pinus resinosa*) with local dominance by jack pine (*Pinus banksiana*) and large white pine (*Pinus strobus*) scattered throughout. Canopy pines range in DBH from 40 to 60 cm with DBH of jack pine ranging from 20 to 40 cm and occasional white pines ranging in DBH from 60 to 80 cm. Canopy and subcanopy associates include red oak (*Quercus rubra*), paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), and quaking aspen (*Populus tremuloides*) with black spruce (*Picea mariana*), tamarack (*Larix laricina*), and red maple common along the edges of the wetlands. The subcanopy and understory is densest along the wetland margin, where the water table is higher. Prevalent understory species include regenerating pines, serviceberry (*Amelanchier interior*), red maple, and black spruce along the low slopes. Pine regeneration is found throughout the site, likely due to the open canopy conditions on the narrow dunes and along the edges of dunes. A heavy shrub layer occurs along the wetland margin with a diversity of species including wild-raisin (*Viburnum cassinoides*), mountain holly (*Nemopanthus mucronata*), and tag alder (*Alnus rugosa*). The low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*) with local dominance by huckleberry (*Gaylussacia baccata*), Canada blueberry (*Vaccinium myrtilloides*), and serviceberry (*Amelanchier interior*). Red maple seedlings are also important in this stratum. Labrador tea (*Ledum groenlandicum*) and leatherleaf (*Chamaedaphne calyculata*) are prevalent along the wetland margin. The ground cover is dominated by bracken fern (*Pteridium aquilinum*). Characteristic herbaceous species include wintergreen (*Gaultheria procumbens*), bunchberry (*Cornus canadensis*), and Canada mayflower (*Maianthemum canadense*). Proximity of the dune ridges to the wetlands facilitates the encroachment of wetland species along the dune margins and increases the site's overall species diversity.

Threats: Logging has occurred within portions of this site and may occur in the future. Many of the dune ridges have been marked for timber harvest. Recent cutting in the northern polygon was a winter cut that yielded little to no pine regeneration.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn through wetlands and on upland dune ridges). If fire suppression prevents wildfires within the next two to four decades, prescribed fire could be employed to promote pine and oak regeneration. Monitoring for deer herbivory of pine and oak regeneration will allow for determining whether or not deer browse pressure is negatively impacting the forest. As indicated by aerial photographic interpretation, surveys should also be conducted to the east, south, southeast, and northeast for additional high-quality dry northern forest and dry-mesic northern forest. High-quality wetlands and high-quality dry northern forest surrounding the site should also be included as part of the ecological reference area.

Sunken Lakes Red Pines occus on sandy dune ridges surrounded by poorly drained lakeplain . Photos by Joshua G. Cohen.

DRY-MESIC NORTHERN FOREST

Overview: Dry-mesic northern forest is a pine or pine-hardwood forest type of generally dry-mesic sites located mostly north of the transition zone. Dry-mesic northern forest is characterized by acidic, coarse- to medium-textured sand or loamy sand and occurs principally on sandy glacial outwash, sandy glacial lakeplains, and less often on inland dune ridges, coarse-textured moraines, and thin glacial drift over bedrock. The community historically originated in the wake of catastrophic fire and was maintained by frequent, low-intensity ground fires (Kost et al. 2007).

25. Beavertown Lakes (re-classified from Dry Northern Forest)

Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Newberry Forest Management Unit, Compartments 9 and 16, and Private Lands
Element Occurrence Identification Number: 9666

Site Description: This site is a mature, naturally regenerated pine forest that occurs along sandy dune ridges within an extensive peatland complex on poorly drained lakeplain. The current canopy cohort is approximately 106 years old, having regenerated following a catastrophic fire as indicated by numerous large-diameter burnt snags occurring throughout the site. In addition, scattered old-growth canopy survivors have fire scars on their boles. Small canopy gaps generated by windthrow are most common along the edges of the dunes and early-successional species are most prone to blowdown, snap-off, and senescence. Small-diameter paper birch (*Betula papyrifera*), balsam fir (*Abies balsamea*), and aspens (*Populus* spp.) dominate the coarse woody debris loads with large-diameter pine snags and downed trees occurring less frequently. Areas along the margins of the dunes are characterized by increased moisture availability as indicated by the increase in species diversity and density in these ecotonal areas. Soils are characterized by a needle mat of variable depth (2-10 cm) over fine-textured dune sands with low water-retaining capacity. These light-colored sands are 30 to 50 cm deep and occur over slightly coarser-textured reddish sands. The entire soil profile is strongly acidic (pH 4.5-5.5). High-quality muskeg and rich conifer swamp occur adjacent to the pine-dominated dune ridges.[5]

The open canopy (50-75%) is dominated by large-diameter red pine (*Pinus resinosa*) and white pine (*P. strobus*) (40-60 cm DBH). Canopy associates include paper birch, big-toothed aspen (*Populus grandidentata*), and less frequently hemlock (*Tsuga canadensis*) and northern white-cedar (*Thuja occidentalis*). The subcanopy and tall shrub layer contain red maple (*Acer rubrum*), paper birch, balsam fir, spruces (*Picea* spp.), and northern white-cedar with black spruce (*Picea mariana*) and cedar most prevalent along the dune margins, particularly in narrow dune fingers. Pine seedlings are common in the understory layer, particularly along the dune margins and along low, narrow dune ridges with open canopy. The tall shrubs mountain holly (*Nemopanthus mucronata*) and wild-raisin (*Viburnum cassinoides*), along with Labrador tea (*Ledum groenlandicum*) in the low shrub layer, are concentrated along the peatland margin where moisture levels are higher. The low shrub layer of the dune ridges is overwhelmingly dominated by low sweet blueberry (*Vaccinium angustifolium*) and Canada blueberry (*V. myrtilloides*) with localized dominance by huckleberry (*Gaylussacia baccata*). The herbaceous layer is dominated by bracken fern (*Pteridium aquilinum*). Common herbaceous plants include wintergreen (*Gaultheria procumbens*), trailing arbutus (*Epigaea repens*), starflower (*Trientalis borealis*), bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), and Canada mayflower (*Maianthemum canadense*). Areas with open canopy are often dominated by lichens (*Cladina* spp.).

Threats: Fire suppression could result in the failure of pine to regenerate.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site and the surrounding wetlands and prohibit salvage logging). The site should be monitored to ascertain if pine is recruiting and whether or not surface fires are occurring. If no fire occurs in 20 to 40 years, then pine regeneration should be assessed, and if lacking, prescribed

[5] Beavertown Lakes Muskeg and Beavertown Lakes Rich Conifer Swamp

fire should be considered as a management option. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. As indicated by aerial photographic interpretation, surveys should also be conducted to the east, northeast, north, and west for additional high-quality dry-mesic northern forest. Finally, portions of the site occurring on private lands could be acquired or protected through conservation easements.

The pine canopy cohort at Beavertown Lakes regenerated following catastrophic fire. Photos by Joshua G. Cohen.

26. Bryan Creek

Natural Community Type: Dry-mesic Northern Forest (re-classified from Dry Northern Forest)
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Gwinn Forest Management Unit, Compartments 55 and 56
Element Occurrence Identification Number: 993

Site Description: This dry-mesic northern forest occurs on a low, sandy rise within outwash and is surrounded by younger uplands and extensive acidic peatlands (muskeg and poor conifer swamp). The soils of the dry-mesic northern forest are well-drained, acidic (pH 4.5-5.0) sands underlying the well-developed needle litter mat.

This site is dominated by red pine (*Pinus resinosa*) and white pine (*P. strobus*). Mature, tall canopy red pines are generally 110 to 130 years old. White pine dominates portions of the occurrence. The patchy subcanopy of balsam fir (*Abies balsamea*), black spruce (*Picea mariana*), and white spruce (*P. glauca*) is locally dense. Hardwoods, such as red maple (*Acer rubrum*) and paper birch (*Betula papyrifera*) are uncommon. White pine regeneration occurs throughout the site but red pine regeneration is sparse to absent. The ground layer is best developed in windthrow gaps, which are widespread but virtually absent in areas where the subcanopy is dense. The low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*) and Canada blueberry (*V. myrtilloides*). Common ground cover species include starflower (*Trientalis borealis*), bunchberry (*Cornus canadensis*), twinflower (*Linnaea borealis*), and Canada mayflower (*Maianthemum canadense*). Following 2007 surveys this site was re-classified as dry-mesic northern forest from dry northern forest.

Threats: The primary threat to the site is long-term fire suppression, which will convert the site to dominance by more mesophytic species. Continued lack of fire will likely convert red pine-dominated portions of the occurrence to white pine dominance. Invasive species are local, with minimal spread from roads noted. Non-native plants documented during 2007 surveys include Canada bluegrass (*Poa compressa*), ox-eye daisy (*Chrysanthemum leucanthemum*), common speedwell (*Veronica officinalis*), and hawkweeds (*Hieracium* spp.).

Management Recommendations: Management recommendations for this forest include the implementation of prescribed fire to encourage natural pine regeneration. Where prescribed fire is not currently feasible due to high fuel loads, use of mechanical thinning of subcanopy and understory spruce and fir could be employed prior to burning. Existing roads and natural fire breaks should be used as fire breaks and creation of new fire breaks should be avoided where possible since new disturbance to the soil can foster the spread of invasive plants. Populations of non-native invasive plants should be controlled and monitored.


Active management is required to maintian red pine as a canopy component of this site. Photos by Bradford S. Slaughter.

27. Hartman White Pine

Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Shingleton Forest Management Unit, Compartment 13, and Private Lands
Element Occurrence Identification Number: 14560

Site Description: This mature, naturally regenerated pine forest occurs in an outwash channel along the Manistique River. The current canopy cohort is approximately 130 years old, having regenerated following a catastrophic fire as indicated by the numerous large-diameter burnt snags occurring throughout the site. The mature forest is notably lacking cut stumps. Small canopy gaps generated by windthrow are most common along the edges of the complex, particularly in the southwestern corner, and early-successional species are most prone to blowdown, snap-off, and senescence. Small-diameter paper birch (*Betula papyrifera*) and balsam fir (*Abies balsamea*) dominate the coarse woody debris loads with large-diameter pine snags and downed trees occurring less frequently. Soils are characterized by an acidic (pH 5.0) needle mat of 2 to 3 cm deep over 3 to 4 cm of organics mixed with acidic sand (pH 5.0) over reddish, medium-textured sands (pH 5.0-5.5). Deeper sands are less acidic (pH 5.5). Swamp fingers within the complex are characterized by 20 cm of organic peat/muck overlying wet sands. Areas along the margins of the swamp fingers and river are characterized by increased moisture availability as indicated by an increase in density and species diversity in these ecotonal areas.

The canopy cohort is dominated by white pine (*Pinus strobus*) with areas co-dominated by red pine (*Pinus resinosa*) (40-60 cm DBH). The subcanopy is especially prevalent along the river and along margins of swamp fingers. Subcanopy species include northern white-cedar (*Thuja occidentalis*), paper birch, red maple (*Acer rubrum*), white spruce (*Picea glauca*), and black spruce (*P. mariana*). These species (excluding northern white-cedar) are prevalent in the understory along with balsam fir, which is most abundant in this stratum. The low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*) along with smooth shadbush (*Amelanchier laevis*), Canada blueberry (*Vaccinium myrtilloides*), and red maple seedlings, which are common in the ground layer as well. The herbaceous layer is dominated by bracken fern (*Pteridium aquilinum*). Additional ground layer species include wintergreen (*Gaultheria procumbens*), starflower (*Trientalis borealis*), and bunchberry (*Cornus canadensis*). Swamp fingers extending into the dry-mesic northern forest are dominated by canopy northern white-cedar with black ash (*Fraxinus nigra*), and paper birch. Tag alder (*Alnus rugosa*) is prevalent in the understory of these wetlands and characteristic ground cover species include sensitive fern (*Onoclea sensibilis*), side-flowering aster (*Aster lateriflorus*), and dwarf raspberry (*Rubus pubescens*).

Threats: Fire suppression could result in the failure of pine to regenerate. Portions of this forest that occur on private land could be logged

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site and prohibit salvage logging of windthrow). The site should be monitored to ascertain if pine is recruiting and whether or not surface fires are occurring. If no fire occurs in 20 to 40 years, then pine regeneration should be assessed, and if lacking, prescribed fire should be considered as a management option. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for spotted knapweed (*Centaurea maculosa*) encroachment. In addition, deer herbivory of pine regeneration should be monitored and deer densities should be reduced if deemed necessary. As indicated by aerial photographic interpretation, surveys should also be conducted to the west for additional high-quality dry-mesic northern forest. Portions of the forest occurring on private lands could be acquired or protected through conservation easements.

Hartman White Pine occurs along the Manistique River on a sandy outwash plain. Photos by Joshua G. Cohen.

28. Landon Lake Pines

Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Gwinn Forest Management Unit, Compartment 56
Element Occurrence Identification Number: 15922

Site Description: This old-growth, naturally regenerated white pine (*Pinus strobus*) - red pine (*P. resinosa*) forest is dominated by large-diameter trees with approximately 75% crown cover occurring on a moderate dune ridge within acidic, sandy outwash. Soils are fine- to medium-textured, acidic (pH 4.0-4.5) sands with moderate water-retaining capacity and a thick needle mat (8-15 cm deep) indicating that the site has not burned in decades.

Canopy white pine and red pine are 110 to 120 ft tall and range in diameter from 50 to 90 cm. Canopy associates include jack pine (*Pinus banksiana*) and hemlock (*Tsuga canadensis*). Subcanopy species include balsam fir (*Abies balsamea*), black spruce (*Picea mariana*), white spruce (*P. glauca*), and red maple (*Acer rubrum*). The tall shrub and sapling layers are sparse with beaked hazelnut (*Corylus cornuta*), balsam fir (including some dense patches), black spruce, white spruce, red maple, and white pine (especially along the peatland margin). The low shrub layer is prevalent with blueberries (*Vaccinium* spp.) dominant and Labrador tea (*Ledum groenlandicum*), bush honeysuckle (*Diervilla lonicera*), and American fly honeysuckle (*Lonicera canadensis*) common. The herbaceous layer is dominated by bracken fern (*Pteridium aquilinum*). Common ground layer species include wintergreen (*Gaultheria procumbens*), trailing arbutus (*Epigaea repens*), starflower (*Trientalis borealis*), bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), Canada mayflower (*Maianthemum canadense*), bluebead lily (*Clintonia borealis*), and wild sarsaparilla (*Aralia nudicaulis*). The forest grades into a high-quality muskeg to the west and north and poor conifer swamp to the east and south.

Threats: Continued fire suppression and high levels of deer herbivory could limit pine recruitment and alter species composition and structure.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site and the surrounding wetlands). The site should be monitored to ascertain if pine is recruiting and whether or not surface fires are occurring. If no fire occurs in 20 to 40 years, then pine regeneration should be assessed, and if lacking, prescribed fire should be considered as a management option. If prescribed fire is not feasible, mechanical thinning techniques should be employed to foster pine regeneration and control mesophytic invasion. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. Monitoring for deer herbivory of pine regeneration will allow for determining whether or not deer browse pressure is negatively impacting the forest. Aerial photographic interpretation and brief ground surveys indicate that a high-quality muskeg occurs to the west of the dry-mesic northern forest. This muskeg should be surveyed and considered for inclusion within the ecological reference area.

Photo by Joshua G. Cohen.

29. Negro Creek

Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: D
Location: Shingleton Forest Management Unit, Compartment 146, and Private Lands
Element Occurrence Identification Number: 10971

Site Description: This site has been logged numerous times and no longer qualifies as a high-quality dry-mesic northern forest. Timber operation within the site resulted in a high volume of logging slash, skid trails and roads, and numerous non-native plant species. Some old-growth white pines (*Pinus strobus*) remain, but the surrounding forest is highly degraded.

30. North Branch Lakes White Pines

Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Newberry Forest Management Unit, Compartments 15 and 20
Element Occurrence Identification Number: 7990

Site Description: This site is a mature, naturally regenerated pine forest occurring on flat sandy lakeplain with well-drained, acidic sandy soils. A thick needle mat (4-6 cm deep) overlays the acidic (pH 4.0-5.5) sands. Areas of forest along the margins of the bog depressions and poor conifer swamp are characterized by increased moisture availability as indicated by an increase in species diversity and density in these ecotonal areas. The current canopy cohort is approximately 100 years old, having regenerated following a catastrophic crown fire as indicated by the numerous large-diameter burnt snags occurring throughout. Mild pit and mound topography occurs throughout the site and indicates that small-scale gap dynamics (windthrow) is also an important natural disturbance factor influencing species composition, structure, and succession. Coarse woody debris is beginning to accumulate and is comprised primarily of small-diameter early-successional species, such as paper birch (*Betula papyrifera*), quaking aspen (*Populus tremuloides*), and balsam fir (*Abies balsamea*), but there are some scattered red pine (*Pinus resinosa*) and white pine (*Pinus strobus*) snags throughout.

The canopy cohort is dominated by white pine with areas co-dominated by red pine (40-60 cm DBH and 80-100 ft tall). Additional canopy associates include paper birch (*Betula papyrifera*) and quaking aspen; many of these early-successional trees are dying or are already snags. Subcanopy species include black spruce (*Picea mariana*), balsam fir, paper birch, quaking aspen, red maple (*Acer rubrum*), and white spruce (*Picea glauca*). Black spruce, red maple, and balsam fir are prevalent in the understory along with scattered white pine and localized patches of white pine and red pine regeneration (i.e., along the road margins and in windthrow gaps). The low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*) and Canada blueberry (*V. myrtilloides*) along with red maple and serviceberry (*Amelanchier* sp.). The ground layer is dominated by bracken fern (*Pteridium aquilinum*). Additional ground layer species include red maple seedlings, wintergreen (*Gaultheria procumbens*), trailing arbutus (*Epigaea repens*), starflower (*Trientalis borealis*), bunchberry (*Cornus canadensis*), and Canada mayflower (*Maianthemum canadense*). Areas with open canopy (50-75% canopy closure) are characterized by a prevalence of lichens (*Cladina* spp.). The margins of bog depressions typically support a denser understory and a low shrub layer with leatherleaf (*Chamaedaphne calyculata*) and Labrador tea (*Ledum groenlandicum*), and black spruce, red maple, and wild-raisin (*Viburnum cassinoides*), common in the tall shrub layer.

Threats: Continued fire suppression and increased deer herbivory could result in the failure of pine to regenerate.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site and the surrounding wetlands and prohibit salvage logging of windthrow). If no fire occurs in 20 to 40 years, then pine regeneration should be assessed, and if lacking, prescribed fire should be considered as a management option. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for spotted knapweed (*Centaurea maculosa*) encroachment. In addition, deer herbivory of pine regeneration should be monitored and deer densities should be reduced if deemed necessary.

Photo by Joshua G. Cohen.

31. Pigeon River Pines

Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Pigeon River Forest Management Unit, Compartment 7
Element Occurrence Identification Number: 4499

Site Description: This dry-mesic northern forest occurs on level to rolling outwash with some portions occurring on gently sloping ground moraine. Well-developed pit and mound topography occurs throughout the site. The soils are acidic sandy soils (including sands, loamy sands, and sandy loams) overlying medium- to fine-textured sands. Numerous vernal pools occur throughout the forest. Moderate groundwater influence occurs along the edge of the forest and adjacent swamp as indicated by less acidic soil conditions and presence of canopy northern white-cedar (*Thuja occidentalis*).

The canopy and supercanopy are dominated by white pine (*Pinus strobus*) and red pine (*P. resinosa*) with some pockets of quaking aspen (*Populus tremuloides*) clones. The subcanopy is dominated by red maple (*Acer rubrum*) with northern white-cedar and hemlock (*Tsuga canadensis*) also prevalent. Balsam fir (*Abies balsamea*), red maple, and white spruce (*Picea glauca*) are prevalent in the tall shrub layer. Decades of fire suppression have resulted in mesophytic invasion by red maple and balsam fir into the subcanopy and tall shrub layers. Some pockets of dense white pine regeneration occur within the understory. The low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*), American fly honeysuckle (*Lonicera canadensis*), and alder-leaved buckthorn (*Rhamnus alnifolia*). Bracken fern (*Pteridium aquilinum*) dominates the ground layer. Characteristic species of the herbaceous layer include Pennsylvania sedge (*Carex pensylvanica*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), red maple seedlings, American fly honeysuckle, and fowl manna grass (*Glyceria striata*). The ecotone of the forest and the swamp is characterized by greater species diversity with the canopy containing northern white-cedar, hemlock, and balsam poplar, and alder-leaved buckthorn prevalent in the shrub layer.

Threats: Continued fire suppression and deer herbivory are the primary threats to this site. The road that passes through the center of this site could provide access for illegal off-road vehicle activity.

Management Recommendations: Prescribed fire should be employed to mimic ground fires in order to set back mesophytic species such as red maple and balsam fir and establish conditions favorable for pine regeneration. If prescribed fire is not feasible, managers should investigate more intrusive measures such as girdling or removing red maple through manual cutting and herbicide and manually removing balsam fir. The site should be monitored for invasive species encroachment and deer herbivory. Increasing the amount of late-successional habitat in the adjacent landscape will help reduce deer browse pressure. Reducing deer densities in the general landscape is recommended.

Photo by Joshua G. Cohen.

32. Point La Par (Beaver Island)

Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Gaylord Forest Management Unit, Compartment 65, and Private Lands
Element Occurrence Identification Number: 9259

Site Description: This uneven-aged dry-mesic northern forest occurs on dune and swale topography oriented from northwest to southeast with numerous wooded swales. The soils are fine-textured dune sands that are acidic on the dune ridges with a thick needle duff. The sand in the swales is coarse textured, wet and alkaline with a high water table (40 cm). The site was likely historically burned by Native Americans.

The canopy is dominated by red pine (*Pinus resinosa*) and red oak (*Quercus rubra*) with supercanopy white pine (*Pinus strobus*), aspen (*Populus* spp.) clones, and patches of hemlock (*Tsuga canadensis*), which occur in the southern extent of the occurrence. Red maple (*Acer rubrum*) and balsam fir (*Abies balsamea*) are prevalent in the subcanopy and understory, indicating many decades of fire suppression (50-70 years). White pine dominates the understory with balsam fir locally dominant, red maple common, and red pine occasional. The scarcity of red oak in the understory layer is likely indicative of high levels of deer herbivory. The low shrub layer is dominated by blueberries (*Vaccinium* spp.) and huckleberry (*Gaylussacia baccata*). The ground layer is dominated by bracken fern (*Pteridium aquilinum*) with wintergreen (*Gaultheria procumbens*), starflower (*Trientalis borealis*), wild sarsaparilla (*Aralia nudicaulis*), and red oak and white pine seedlings.

The numerous swales, which occur between the dune ridges, are typically forested with an open canopy of small-diameter green ash (*Fraxinus pennsylvanica*) and northern white-cedar (*Thuja occidentalis*). The low shrub layer is dominated by alder-leaved buckthorn (*Rhamnus alnifolia*). Occasional tall shrubs include beaked hazelnut (*Corylus cornuta*), dogwoods (*Cornus* spp.), and buttonbush (*Cephalanthus occidentalis*). Characteristic ground cover species include tussock sedge (*Carex stricta*), fowl manna grass (*Glyceria striata*), sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), and northern bugleweed (*Lycopus uniflorus*).

Threats: Continued fire suppression and deer herbivory could negatively impact species composition, structure, and future successional trajectory. Private portions of the site could be logged or developed. Prevalence of balsam fir and red maple in the subcanopy and understory indicate fire suppression has affected the site for the past 50 to 70 years.

Management Recommendations: Prescribed fire should be employed to mimic ground fires in order to set back mesophytic species, such as red maple and balsam fir, and establish conditions favorable for pine and oak regeneration. The site should be monitored for invasive species encroachment and deer herbivory. Increasing the amount of late-successional habitat in the adjacent landscape will help reduce deer browse pressure. Reducing deer densities on the island is recommended. High-quality dry-mesic northern forest on private lands could be protected through acquisition or the establishment of conservation easements.

Photo by Joshua G. Cohen.

33. Pretty Lakes Pinery

Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Newberry Forest Management Unit, Compartments 21 and 20, and Private Lands
Element Occurrence Identification Number: 15950

Site Description: This site is a naturally regenerated white pine (*Pinus strobus*) and red pine (*P. resinosa*) forest that is dominated by medium- to large-diameter trees (40-70 cm) with 50 to 85% crown cover. The pine forest occurs on moderate inland dune ridges within acidic, sandy lakeplain dominated by peatlands and inland lakes. The soils are dune sands that are acidic (pH 4.5-5.0) and fine- to medium-textured with a 4 to 6 cm conifer needle mat overlying the mineral soil. Sands exhibit low to moderate water-retaining capacity. Some of the dune ridges in the southern portion of the occurrence are very steep. The pine ridges are embedded in high-quality wetlands with numerous bogs, intermittent wetlands, and lakes. These pine ridges regenerated following a major fire approximately 90 to 100 years ago. Numerous charred snags and stumps of the preceding cohort were found throughout and cut stumps are infrequent and localized.

The canopy of mature red pine and white pine is over 90 years old and between 80 and 100 ft tall. Many of the snags are over 90 cm while the current canopy ranges in diameter from 40 to 70 cm (suggesting that these trees have the potential to grow significantly larger). Canopy associates include paper birch (*Betula papyrifera*), big-toothed aspen (*Populus grandidentata*), and red oak (*Quercus rubra*), and less frequently northern white-cedar (*Thuja occidentalis*), hemlock (*Tsuga canadensis*), and white spruce (*Picea glauca*). The subcanopy is dominated by balsam fir (*Abies balsamea*), black spruce (*Picea mariana*), paper birch, and red maple (*Acer rubrum*). The sparse tall shrub and sapling layer contains balsam fir, black spruce, red maple, white pine, and serviceberry (*Amelanchier interior*). The low shrub layer is dense with blueberries (*Vaccinium* spp.) dominant. The herbaceous layer is dominated by bracken fern (*Pteridium aquilinum*). Common herbaceous plants include wintergreen (*Gaultheria procumbens*), trailing arbutus (*Epigaea repens*), starflower (*Trientalis borealis*), bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), Canada mayflower (*Maianthemum canadense*), and wild sarsaparilla (*Aralia nudicaulis*).

Threats: Fire suppression and increased deer herbivory could result in the failure of pine to regenerate.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site and the surrounding wetlands and prohibit salvage logging of windthrow). The site should be monitored to ascertain if pine is recruiting and whether or not surface fires are occurring. If no fire occurs in 20 to 40 years, then pine regeneration should be assessed, and, if lacking, prescribed fire should be considered as a management option. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for spotted knapweed (*Centaurea maculosa*) encroachment. Finally, portions of the dry-mesic northern forest occurring on private lands could be acquired or protected through conservation easements.

Pretty Lakes Pinery burned about 100 years ago and occurs on sandy dune ridges surrounding lakes and peatlands. Photos by Joshua G. Cohen.

34. Sand Lakes

Natural Community Type: Dry-Mesic Northern Forest (re-classified from Dry Northern Forest)
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Traverse City Forest Management Unit, Compartments 40 and 45 (Sand Lakes Quiet Area)
Element Occurrence Identification Number: 3934

Site Description: This extensive pine-oak dominated dry-mesic northern forest occurs on undulating to somewhat steep pitted outwash of variable aspect. The soils are strongly acidic medium-textured sands of low to moderate water-retaining capacity. Numerous kettle depressions occur within the forested matrix, supporting a range of open wetlands including lakes, bogs, and northern fens (several of the northern fen wetlands are part of a high-quality complex)[6].

The canopy is dominated by red pine (*Pinus resinosa*) and white pine (*P. strobus*) with red oak (*Quercus rubra*) as the primary canopy associate. Pockets of denser jack pine (*Pinus banksiana*) and aspen (*Populus* spp.) clones also occur throughout the site. The subcanopy is dominated by red oak and red maple (*Acer rubrum*). Dense white pine regeneration occurs, especially under the oak canopy, while red pine regeneration is confined to large canopy gaps and areas along roads or trails. Huckleberry (*Gaylussacia baccata*) and low sweet blueberry (*Vaccinium angustifolium*) dominate the low shrub layer, and bracken fern (*Pteridium aquilinum*) and Pennsylvania sedge (*Carex pensylvanica*) dominate the herbaceous layer. North-facing slopes support a more mesophytic mix of species with some hemlock (*Tsuga canadensis*) occurring alongside red oak and white pine. Red maple is prevalent in the subcanopy and understory due to decades of fire suppression. High levels of deer herbivory are likely limiting the recruitment of red oak and serviceberry (*Amelanchier* sp.).

Following 2006 surveys this site was re-classified as dry-mesic northern forest from dry northern forest.

Threats: Continued fire suppression could limit red oak and red pine recruitment. High deer densities are likely limiting oak recruitment and influencing understory species composition.

Management Recommendations: Periodic prescribed fire should be employed to mimic ground fires in order to set back mesophytic species, such as red maple, and establish conditions favorable for pine and oak regeneration. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. The site should be monitored for invasive species and deer herbivory. Increasing the amount of late-successional habitat in the adjacent landscape will help reduce deer browse pressure. Reducing deer densities in the general landscape is recommended.



Sand Lakes dry-mesic northern forest occurs adjacent to high-qaulity northern fens. Photos by Joshua G. Cohen.

[6] Sand Lakes Northern Fen

35. Silver Lead Creek

Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Marquette County
Element Occurrence Identification Number: 2929

This dry-mesic northern forest no longer occurs on state lands.

36. Swamp Lakes (Dry-mesic Northern Forest)

Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Newberry Forest Management Unit, Compartments 37 and 42, and Private Lands
Element Occurrence Identification Number: 12496

Site Description: This site is a naturally regenerated and regenerating uneven-aged red pine (*Pinus resinosa*) and white pine (*Pinus strobus*) forest occurring on Post-Algonquin dune ridges that range from gently rolling to steep topography and exhibit variable aspect. Height of the dune ridge varies from 10 to 40 ft. Dune ridges are oriented east-west, north-south, and northeast-southwest. Soils are medium-textured dune sands that are acidic with low to moderate water-retaining capacity. Numerous high-quality intermittent wetlands[7] surround the dune ridges. In addition, high-quality muskeg and bog are adjacent to the south.

The canopy is dominated by large (50-80 cm DBH) red pine and white pine. Old-growth pines (275-300+ years) occur scattered throughout forming a supercanopy. Numerous tall snags and large-diameter coarse woody debris increase the site's structural diversity. Canopy dominants have fire scars on their boles, indicating that surface fire or fires occurred here. Canopy associates include hemlock (*Tsuga canadensis*), which occurs on northern aspects, jack pine (*Pinus banksiana*), red oak (*Quercus rubra*), paper birch (*Betula papyrifera*), and big-toothed aspen (*Populus grandidentata*). Paper birch, big-toothed aspen, and red oak are most prevalent where fires burned intensely. Deciduous canopy associates are more prevalent in the subcanopy layer and include paper birch, red oak, big-toothed aspen, red maple (*Acer rubrum*), and American beech (*Fagus grandifolia*). Pines of all species are prevalent in the subcanopy and tall shrub layer, especially along the margins of south-facing dune slopes, where red oak is also prevalent. Subcanopy and tall shrub layer density increase along the margins of peatlands where black spruce (*Picea mariana*) and red maple are most common. The low shrub layer is dense and overwhelmingly dominated by huckleberry (*Gaylussacia baccata*). Additional low shrubs include low sweet blueberry (*Vaccinium angustifolium*), Labrador tea (*Ledum groenlandicum*), and leatherleaf (*Chamaedaphne calyculata*) along the peatland margins. Both red oak and white pine seedlings are abundant in the low shrub layer and ground cover. The primary dominants of the ground cover are bracken fern (*Pteridium aquilinum*) and wintergreen (*Gaultheria procumbens*). Characteristic ground cover species include Pennsylvania sedge (*Carex pensylvanica*), trailing arbutus (*Epigaea repens*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), and lichens (*Cladina rangifera* and *C. mitis*).

Threats: The road that accesses the site could lead to future off-road vehicle damage. Beech bark disease may eliminate beech as a component. In addition, private portions of the site could be logged.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn through this site and the surrounding wetlands). Salvage logging should be avoided as should efforts to control beech bark disease (beech is a minor component of the system). Monitoring for oak and pine regeneration over time would facilitate the assessment of whether prescribed fire is needed as a management tool. If no fire occurs in 20 to 40 years and oak and pine regeneration is lacking, then a prescribed fire could be employed to promote regeneration. If prescribed fire or wildfire occurs within the site, existing fire breaks (i.e., roads and wetlands) should be utilized and the establishment of new fire breaks should be avoided. New fire breaks could allow for spotted knapweed (*Centaurea maculosa*) encroachment. Portions of the dry-mesic northern forest occurring on private lands could be acquired or protected through conservation easements. Aerial photographic interpretation and ground-truthing indicate that additional high-quality natural communities occur south of the site. Surveys of natural communities adjacent to Swamp Lakes are needed.

[7] Swamp Lakes Intermittent Wetland

Swamp Lakes is a pine-dominated forest that occurs on sandy dune ridges surrounded by high-quality intermittent wetlands. Photos by Joshua G. Cohen.

37. Wilderness State Park/Nebo Trail Dry-mesic Northern Forest

Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Wilderness State Park and Gaylord Forest Management Unit, Compartment 118
Element Occurrence Identification Number: 13195

Site Description: This large tract of mature dry-mesic northern forest occurs on parabolic dunes (Lake Nipissing dune ridges) and regenerated naturally following circa 1900 post-logging wildfires. The soils are acidic (pH 4.0-5.5), fine-textured Aeolian sands overlain by 1 to 2 cm of needle duff. Some pockets of mesic northern forest with old-growth hemlock (*Tsuga canadensis*) and American beech (*Fagus grandifolia*) occur in valleys between the dune ridges. The site occurs southeast and east of the Big Stone Bay wooded dune and swale complex and east and northeast of the Sturgeon Bay wooded dune and swale complex.

The canopy is dominated by white pine (*Pinus strobus*), red pine (*P. resinosa*), and red oak (*Quercus rubra*). Canopy associates include paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), quaking aspen (*Populus tremuloides*), big-toothed aspen (*P. grandidentata*), and white spruce (*Picea glauca*) with tree diameters ranging from 15 to 50 cm. Cored trees were estimated to be between 80 and 105 years old with areas along steep slopes exhibiting uneven-aged structure. Numerous charred stumps occur throughout the site. Subcanopy dominants include white pine, red pine, red oak, balsam fir (*Abies balsamea*), and mountain maple (*Acer spicatum*). Excellent white pine and red pine regeneration occurs throughout the site, especially in light gaps and on slopes. The low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*) and huckleberry (*Gaylussacia baccata*). Characteristic ground cover species include bracken fern (*Pteridium aquilinum*), wintergreen (*Gaultheria procumbens*), bunchberry (*Cornus canadensis*), twinflower (*Linnaea borealis*), Canada mayflower (*Maianthemum canadense*), wild sarsaparilla (*Aralia nudicaulis*), and cow-wheat (*Melampyrum lineare*).

Threats: Deer herbivory may be limiting oak regeneration as most seedlings have been browsed and oaks within the sapling and pole-sized classes are virtually absent. Salvage harvest of windthrow in the northern portion of the forest has reduced the volume of coarse woody debris and snags. Invasive species are confined to road and trail edges and do not appear to be affecting species structure and composition in the interior. However, the trails are acting as conduits for non-native weedy species including spotted knapweed (*Centaurea maculosa*), common St. John's-wort (*Hypericum perforatum*), white sweet clover (*Melilotus alba*), and hawkweeds (*Hieracium* spp.).

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn through this site and the surrounding wetlands). Salvage logging of windthrow, which occurred in sections 25 and 35, should be avoided. Monitoring for oak and pine regeneration over time would facilitate the assessment of whether prescribed fire is needed as a management tool and whether deer herbivory is limiting regeneration. Currently, red and white pine regeneration is abundant but oak regeneration is limited by deer herbivory, suggesting that currently, reduction of deer herbivory is an immediate stewardship need. If no fire occurs in 10 to 20 years and oak and pine regeneration is lacking, then a prescribed fire could be employed to promote regeneration. If prescribed fire or wildfire occurs within the site, existing fire breaks (i.e., roads and wetlands) should be utilized and the establishment of new fire breaks should be avoided. New fire breaks could allow for spotted knapweed (*Centaurea maculosa*) encroachment.


Photo by Joshua G. Cohen.

DRY SAND PRAIRIE

Overview: Dry sand prairie is a native grassland community dominated by little bluestem (*Andropogon scoparius*), big bluestem (*Andropogon gerardii*), and Pennsylvania sedge (*Carex pensylvanica*). Vegetation is patchy and short in comparison to other prairie communities. The community occurs on loamy sands on well-drained to excessively well-drained, sandy glacial outwash plains and lakebeds both north and south of the climatic tension zone but is most common in northern Lower Michigan. Open conditions are maintained by frequent fire, droughty soils, and growing season frosts. Historically, dry sand prairie occurred in association with oak barrens, oak-pine barrens, and pine barrens (Kost et al. 2007).

38. Shupac Lake

Natural Community Type: Dry Sand Prairie
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: AB
Location: Grayling Forest Management Unit, Compartments 270 and 271
Element Occurrence Identification Number: 5909

Site Description: This dry sand prairie is a mosaic of prairie and pine barrens that occurs on a flat outwash plain with dark brown loamy sand (pH 4.5-5.0) over reddish brown coarse-textured sand mixed with cobbles and pebbles (pH 5.0-5.5). The site is surrounded by jack pine (*Pinus banksiana*) forests, plantations, and Kirtland's warbler (*Dendroica kirtlandii*, federal/state endangered) management areas.

This dry sand prairie is characterized by a scattered canopy of open-grown jack pine ranging in age up to 40 years and often forming small clumps. The tall shrub layer includes scattered juneberry (*Amelanchier arborea*) and black cherry (*Prunus serotina*). The ground layer is characterized by low species diversity and is dominated by poverty grass (*Danthonia spicata*), little bluestem (*Andropogon scoparius*), big bluestem (*Andropogon gerardii*), Pennsylvania sedge (*Carex pensylvanica*), bearberry (*Arctostaphylos uva-ursi*), and sand cherry (*Prunus pumila*). Rough fescue (*Festuca scabrella*, state threatened), Hill's thistle (*Cirsium hillii*, state special concern), and pale agoseris (*Agoseris glauca*, state threatened) are uncommon throughout the site.

Threats: Occasional invasive species, namely spotted knapweed (*Centaurea maculosa*) and common St. John's-wort (*Hypericum perforatum*), were noted along the edges of the dry sand prairie.

Management Recommendations: This site should be maintained as a dry sand prairie. Droughty soil conditions appear to be limiting tree growth but the site may also benefit from a prescribed fire. Efforts to control the populations of spotted knapweed and common St. John's-wort, which occur along the edges of the prairie, should be implemented and monitored.

Photo by Bradford S. Slaughter.

FLOODPLAIN FOREST

Overview: Floodplain forest is a bottomland, deciduous or deciduous-conifer forest community occupying low-lying areas adjacent to streams and rivers of third order or greater, and subject to periodic over-the-bank flooding and cycles of erosion and deposition. Species composition and community structure vary regionally and are influenced by flooding frequency and duration. Silver maple (*Acer saccharinum*) and green ash (*Fraxinus pennsylvanica*) are typically major overstory dominants. Floodplain forests occur along major rivers throughout the state, but are most extensive in the Lower Peninsula. Species richness is greatest in the southern Lower Peninsula, where many floodplain species reach the northern extent of their range (Kost et al. 2007).

39. Manistee River State Game Area (Floodplain Forest)

Natural Community Type: Floodplain Forest
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Manistee River State Game Area, Manistee National Forest, and Private Lands
Element Occurrence Identification Number: 13437

Site Description: This extensive silver maple (*Acer saccharinum*) and green ash (*Fraxinus pennsylvanica*) floodplain forest extends for several miles along the Manistee River, occurring in a broad outwash channel. The floodplain is influenced by spring flooding, as evidenced by high water marks, ranging from 65 to 100 cm high, on the boles of the canopy trees. Throughout the floodplain there are numerous areas with standing water. Water level fluctuation of Lake Michigan is also important in areas of floodplain forest near the river mouth. Several creeks and bayous feed into the Manistee River, which feeds into Manistee Lake, which in turn is connected to Lake Michigan. Closer to the river mouth, the canopy is open (40-60%), with numerous snags and dominance by grasses and sedges. Windthrow is common throughout the floodplain. Soils are neutral to mildly alkaline, heterogeneous (including sands, silts, loams, and clays) with organics accumulating in backswamps near the upland margin.

Within the floodplain forest, canopy dominants are silver maple and green ash. The scattered understory contains tag alder (*Alnus rugosa*), silky dogwood (*Cornus amomum*), and nannyberry (*Viburnum lentago*). Ground cover dominants include lake sedge (*Carex lacustris*), bluejoint grass (*Calamagrostis canadensis*), reed canary grass (*Phalaris arundinacea*), false nettle (*Boehmeria cylindrica*), and skunk cabbage (*Symplocarpus foetidus*). Lower slopes of the adjacent upland support hardwood-conifer swamp with some northern white-cedar (*Thuja occidentalis*) and hemlock (*Tsuga canadensis*). Northern shrub thicket (tag alder-dominated), northern wet meadow (dominated by lake sedge, bluejoint grass, and reed canary grass), and Great Lakes marsh grade into the floodplain forest near the river mouth.

Threats: Invasive species threaten to drastically alter the species composition and structure of the floodplain forest. Local infestations of Japanese barberry (*Berberis thunbergii*) were documented during 2007 surveys. Deer herbivory is also impacting species composition and structure. Alteration of the hydrology of the Manistee River through channelization or damming would severely impact fluvial processes.

Management Recommendations: The main management recommendations are to maintain the mature floodplain forest and the hydrology of the river, allow the adjacent uplands to mature to provide a buffer for the floodplain from invasive species, remove localized infestations of Japanese barberry (*Berberis thunbergii*) and monitor control efforts, and reduce high deer densities in the greater landscape and monitor impacts of deer herbivory. Portions of the floodplain forest that occur on private lands could be acquired or protected through conservation easements.

Photo by Alan J. Tepley.

40. Muskegon River/Huckleberry Trail

Natural Community Type: Floodplain Forest
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: BC
Location: Gladwin Forest Management Unit, Compartment 15, and Private Lands
Element Occurrence Identification Number: 6095

Site Description: This floodplain forest occurs in a sandy outwash channel on an island in the Muskegon River. The soils are heterogeneous with sand and sandy loam occurring on the levees, loamy sand and sandy loam found on the second bottom, and circumneutral sandy loam occurring in the first bottom. Soils throughout the site occur over sands. Many shallow pools and seasonal channels or swales occur in the first bottom, which has numerous areas with 40 to 100 cm of standing water. A large pond, which is an old oxbow, occurs in the center of the island. Portions of the island exhibit fine-scale ridge and swale microtopography. This floodplain forest is characterized by dynamic erosional and depositional fluvial processes that generate diverse ecological zonation, including a levee, a first bottom, a second bottom, meander scars, an oxbow, ridge and swale topography, and point bars. The site is characterized by high floristic diversity resulting from the complex ecological zonation and fine- and large-scale gradients in soil moisture and topography.

The first bottom is dominated by silver maple (*Acer saccharinum*) with green ash (*Fraxinus pennsylvanica*) and scattered bur oak (*Quercus macrocarpa*). The second bottom is dominated by basswood (*Tilia americana*) and red oak (*Quercus rubra*) with American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), and occasional white pine (*Pinus strobus*) and hemlock (*Tsuga canadensis*). The overall site is characterized by a tall, closed canopy with a sparse understory and a patchy, dense ground cover. Prevalent shrubs include buttonbush (*Cephalanthus occidentalis*), which occurs in swales and pools, musclewood (*Carpinus caroliniana*), prickly ash (*Zanthoxylum americanum*), and leatherwood (*Dirca palustris*). Characteristic ground cover species include sensitive fern (*Onoclea sensibilis*), fowl manna grass (*Glyceria striata*), poison ivy (*Toxicodendron radicans*), side-flowering aster (*Aster lateriflorus*), false nettle (*Boehmeria cylindrica*), ostrich fern (*Matteuccia struthiopteris*), annual bedstraw (*Galium aparine*), and white avens (*Geum canadense*).

Threats: Invasive species threaten to drastically alter the floodplain's species composition and structure. Reed canary grass (*Phalaris arundinacea*) is a local dominant, especially in areas of open to partial canopy. In addition, non-native earthworms, which were found during the survey, could alter the soil and nutrient regimes. Deer herbivory is impacting species composition and structure. Alteration of the hydrology of the Muskegon River through channelization or damming would severely impact fluvial processes.

Management Recommendations: The main management recommendations are to maintain the mature floodplain forest on the island and surrounding the island, maintain the hydrology of the river, allow the adjacent uplands to mature to provide a buffer for the floodplain from invasive species, remove the localized infestation of reed canary grass and monitor control efforts, and reduce high deer densities in the greater landscape and monitor impacts of deer herbivory. Portions of the floodplain forest that occur on private lands could be acquired or protected through conservation easements.

Huckleberry Trail floodplain forest occurs in a sandy outwash channel on an island in the Muskegon River. Photos by Joshua G. Cohen.

41. Muskegon River/Green Creek North

Natural Community Type: Floodplain Forest
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Gladwin Forest Management Unit, Compartment 14
Element Occurrence Identification Number: 10646

Site Description: This floodplain forest occurs in a sandy outwash channel on an island in the Muskegon River. The soils are heterogeneous with sand and sandy loam occurring on the levees and second bottom and sandy clay loam and sandy loam occurring in the first bottom. Soils throughout the site occur over sands. Many shallow pools occur in the first bottom with water depth typically between 70 to 100 cm. Standing water is also prevalent in the meander scars and oxbows. This floodplain forest is characterized by dynamic erosional and depositional fluvial processes that generate diverse ecological zonation, including a levee, a first bottom, a second bottom, meander scars, an oxbow, and point bars. The site is characterized by high floristic diversity resulting from the complex ecological zonation and fine- and large-scale gradients in soil moisture and topography.

The first bottom is dominated by silver maple (*Acer saccharinum*) with green ash (*Fraxinus pennsylvanica*) and bur oak (*Quercus macrocarpa*). The levee and the second bottom are dominated by basswood (*Tilia americana*), American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), and bitternut hickory (*Carya cordiformis*). The overall site is characterized by a tall, closed canopy with a sparse understory and a patchy, dense ground cover. Prevalent shrubs include buttonbush (*Cephalanthus occidentalis*) and tag alder (*Alnus rugosa*) with musclewood (*Carpinus caroliniana*), winterberry (*Ilex verticillata*), and nannyberry (*Viburnum lentago*). Characteristic ground cover species include sensitive fern (*Onoclea sensibilis*), fowl manna grass (*Glyceria striata*), side-flowering aster (*Aster lateriflorus*), false nettle (*Boehmeria cylindrica*), ostrich fern (*Matteuccia struthiopteris*), lake sedge (*Carex lacustris*), Gray's sedge (*C. grayi*), and wood nettle (*Laportea canadensis*).

Threats: Invasive species threaten to drastically alter the floodplain's species composition and structure. Reed canary grass (*Phalaris arundinacea*) is a local dominant, especially in areas of open to partial canopy adjacent to the river. In addition, non-native earthworms, which were found during the survey, could alter the soil and nutrient regimes. Deer herbivory is impacting species composition and structure. Alteration of the hydrology of the Muskegon River through channelization or damming would severely impact fluvial processes.

Management Recommendations: The main management recommendations are to maintain the mature floodplain forest on the island and surrounding the island, maintain the hydrology of the river, allow the adjacent uplands to mature to provide a buffer for the floodplain from invasive species, remove the localized infestation of reed canary grass and monitor control efforts, and reduce high deer densities in the greater landscape and monitor impacts of deer herbivory.


Photo by Joshua G. Cohen.

42. VanEtten Lake

Natural Community Type: Floodplain Forest
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: BC
Location: Grayling Forest Management Unit, Compartment 72, and Private Lands
Element Occurrence Identification Number: 930

Site Description: This floodplain forest occurs in the former channels of the Pine River in a flat, poorly drained lakeplain with sands, loamy sands, and loams. In addition to floodplain forest, the site also contains areas of northern shrub thicket, northern wet meadow, and rich conifer swamp.

The floodplain forest is dominated by an open canopy of silver maple (*Acer saccharinum*) in areas of frequent inundation. Wet swales are dominated by northern shrub thicket with nannyberry (*Viburnum lentago*), American elm (*Ulmus americana*), and black ash (*Fraxinus nigra*) and formerly flooded zones are now dominated by cattails (*Typha* spp.) and northern wet meadow species. Isolated meander scars on both sides of the river are dominated by well-developed hummock and hollow microtopography and a relatively thick well-developed moss ground layer. The floodplain forest contains extensive areas of backswamp dominated by northern white-cedar (*Thuja occidentalis*). Over 135 vascular plants were identified during the 2006 survey.

Threats: The flooding and damming of VanEtten Lake may be artificially backing up water at the southeastern edge of the floodplain forest. The powerline cut that bisects the site has locally degraded the upland and floodplain forest adjacent to it. Several invasive species were noted, including common burdock (*Arctium minus*), common mullein (*Verbascum thapsus*), Japanese barberry (*Berberis thunbergii*), and lawn prunella (*Prunella vulgaris*). Currently, common burdock is the main threat to species composition.

Management Recommendations: The main management recommendations are to maintain the mature floodplain forest and the hydrology of the river, and remove the localized infestation of non-native species, especially burdock, and monitor control efforts. In addition, portions of the floodplain occurring on private lands could be acquired or protected through conservation easements.

Photo by Bradford S. Slaughter.

GRANITE BEDROCK GLADE

Overview: Granite bedrock glade consists of an open forested or savanna community found where knobs of granitic bedrock types are exposed at the surface. The sparse vegetation consists of scattered open-grown trees, scattered shrubs or shrub thickets, and a partial turf of herbs, grasses, sedges, mosses, and lichens. Granite bedrock glades typically occupy areas of steep to stair-stepped slopes, with short cliffs, and exposed knobs of bedrock. The community occurs in the western Upper Peninsula with primary concentrations in Marquette, Baraga, and Dickinson Counties (Kost et al. 2007).

43. Big Bay South Outcrops

Natural Community Type: Granite Bedrock Glade
Rank: G3G5 S2, vulnerable to secure globally and imperiled in the state
Element Occurrence Rank: AB
Location: Gwinn Forest Management Unit, Compartment 202, and Private Lands
Element Occurrence Identification Number: 4782

Site Description: This granite bedrock glade is characterized by scattered outcrops of granite bedrock occurring in a forested landscape. Numerous bedrock knobs support several natural communities occurring on thin soils over bedrock including granite bedrock glade, dry-mesic northern forest or woodland, and mesic northern forest. Talus slopes occur at the base of the bedrock exposures. In addition to cliff exposures and shelves, numerous large boulders and small rocks occur throughout. Where organic soils have accumulated over granitic bedrock, they are thin (1-4 cm deep), acidic (pH 4.5-5.0), and characterized by low moisture availability. Strongly acidic and thin soils result in sparse, stressed vegetation. Soils accumulate along cracks, fissures, shelves, flat areas, at the base of trees, and where vegetation is concentrated. Shelves and terraces have deeper soils and support forested and woodland ecosystems. Windthrow, fire, and drought are the primary natural processes.

Areas of bedrock glade are characterized by a scattered, stunted canopy dominated by small red oak (*Quercus rubra*) (10-30 cm DBH and 15-30 ft tall) with scattered white pine (*Pinus strobus*). The canopy cover increases along the western and eastern slopes and in flat areas where soils are deeper. The understory is scattered and concentrated along fissures and flat areas with serviceberry (*Amelanchier* spp.), pin cherry (*Prunus pensylvanica*), choke cherry (*P. virginiana*), and red oak. The low shrub layer is patchy and dominated by low sweet blueberry (*Vaccinium angustifolium*) along with common blackberry (*Rubus allegheniensis*) and red raspberry (*R. strigosus*). Common juniper (*Juniperus communis*) is locally abundant. Herbaceous cover is sparse to virtually absent in places and is dominated by poverty grass (*Danthonia spicata*) and large-leaved aster (*Aster macrophyllus*). Additional species include hair grass (*Deschampsia flexuosa*), Pennsylvania sedge (*Carex pensylvanica*), harebell (*Campanula rotundifolia*), intermediate pinweed (*Lechea intermedia*), and common polypody (*Polypodium virginianum*). The non-native sheep sorrel (*Rumex acetosella*) is common throughout. Areas of exposed bedrock are dominated by a diverse array of lichens and mosses.

Threats: Portions of the outcropping that occur on private lands could be logged. Logging in surrounding valleys and slopes could increase the seed source for weedy species, which could be windblown or bird-dispersed onto the glades. A mesic northern forest just west of the polygon in section 9 is marked for harvest.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered (i.e., let wildfires burn) and to maintain a forested buffer surrounding the glades to prevent the increase of a weedy seed source. Managing the mature mesic northern forest surrounding the outcropping in section 9 as old-growth will help buffer the bedrock glades. Monitoring should be implemented for non-native plant populations and to gauge the impact of deer herbivory on red oak and white pine regeneration. A significant portion of the outcropping occurs on private lands and could be acquired or protected through conservation easements.

Big Bay South Outcrops are characterized by granite bedrock glades with thin soils and scattered and stunted vegetation. Photos by Joshua G. Cohen.

45. Lost Creek Outcrops

Natural Community Type: Granite Bedrock Glade
Rank: G3G5 S2, vulnerable to secure globally and imperiled in the state
Element Occurrence Rank: B
Location: Gwinn Forest Management Unit, Compartment 298, and Private Lands
Element Occurrence Identification Number: 9902

Site Description: This granite bedrock glade is characterized by scattered outcrops of granite bedrock occurring in a forested landscape. Numerous bedrock knobs support several natural communities occurring on thin soils over bedrock including granite bedrock glade, dry-mesic northern forest or woodland, and mesic northern forest. Talus slopes occur at the base of the bedrock exposures. In addition to cliff exposures and shelves, numerous large boulders and small rocks occur throughout the site. Where organic soils have accumulated over granitic bedrock, the soils are thin (1-4 cm deep) and acidic (pH 4.5-5.0). Soils accumulate along cracks, fissures, shelves, flat areas, at the bases of trees, and where vegetation is concentrated.

Areas of bedrock glade are characterized by a scattered, stunted canopy with red oak (*Quercus rubra*) dominant along with white pine (*Pinus strobus*) and big-toothed aspen (*Populus grandidenta*). White pine becomes more prevalent at higher elevations, likely because lower portions of the glades were more easily logged. The understory is scattered and concentrated along fissures and flat areas with serviceberry (*Amelanchier* sp.), pin cherry (*Prunus pensylvanica*), choke cherry (*P. virginiana*), red oak, and white pine. The low shrub layer is patchy and dominated by low sweet blueberry (*Vaccinium angustifolium*) with local dominance by common juniper (*Juniperus communis*), bearberry (*Arctostaphylos uva-ursi*), choke cherry, red oak, serviceberry, and bush honeysuckle (*Diervilla lonicera*). The ground cover is characterized by clumps of poverty grass (*Danthonia spicata*) and hair grass (*Deschampsia flexuosa*) with Pennsylvania sedge (*Carex pensylvanica*) also important. Characteristic herbaceous species include common polypody (*Polypodium virginianum*), large-leaved aster (*Aster macrophyllus*), bracken fern (*Pteridium aquilinum*), and rusty woodsia (*Woodsia ilvensis*). The non-native sheep sorrel (*Rumex acetosella*) is common throughout. Fruticose, foliose, and crustose lichens are prevalent on rock surfaces. Vegetation in all strata becomes denser where soils accumulate in flatter areas and along talus slopes. Areas of woodland are prevalent with 25 to 65% canopy of red oak, white pine, quaking aspen (*Populus tremuloides*), big-toothed aspen, and paper birch (*Betula papyrifera*). Woodlands support well-developed understories with red oak, serviceberry, cherries, and maples (*Acer* spp.). Low shrubs in the woodland include low sweet blueberry, red oak, and bush honeysuckle. Ground cover in the woodland is characterized by large-leaved aster, bracken fern, Canada mayflower (*Maianthemum canadense*), and wild sarsaparilla (*Aralia nudicaulis*).

Threats: The primary threats are further invasive species incursions, especially by spotted knapweed (*Centaurea maculosa*) and common St. John's-wort (*Hypericum perforatum*). Logging in the vicinity of these glades could increase the seed source for weedy and invasive species, which could be windblown or bird-dispersed onto the glades. Portions of the glade occurring on private lands could be logged.

Management Recommendations: The primary stewardship need is to control the invasive plant populations encroaching onto the glade from County Road 510, focusing on spotted knapweed and common St. John's-wort. Additional management recommendations include allowing natural processes to operate unhindered (i.e., let wildfires burn) and maintaining forested buffers surrounding the glades to help prevent the increase of a weedy seed source in the vicinity of the glades. Monitoring should be implemented for non-native plant populations and to gauge the impact of deer herbivory on red oak and white pine regeneration. A significant portion of the outcropping occurs on private lands and could be acquired or protected through conservation easements.

Lost Creek Outcrops are characterized by scattered granite bedrock occurring in a forested landscape. Photos by Joshua G. Cohen.

44. Lost Lake Outcrops

Natural Community Type: Granite Bedrock Glade
Rank: G3G5 S2, vulnerable to secure globally and imperiled in the state
Element Occurrence Rank: A
Location: Crystal Falls Forest Management Unit, Compartments 82 and 83, and Private Lands
Element Occurrence Identification Number: 2328

Site Description: This extensive area of granite bedrock glade occurs within a forested matrix of pine, oak, and aspen in an area characterized by thin drift over igneous bedrock. Numerous granitic outcrops rise dramatically from the surrounding mixed upland forest with the highest ridgetop exceeding 1300 ft. Pink quartzite occurs locally. Where organic soils have accumulated over granitic bedrock, the soils are thin (4-6 cm deep) and acidic (pH 5.0). The soils are concentrated in cracks.

Areas of bedrock glade are characterized by a scattered, stunted canopy with drought-resistant species and early-successional hardwoods. Canopy dominants include red pine (*Pinus resinosa*), white pine (*P. strobus*), paper birch (*Betula papyrifera*), and big-toothed aspen (*Populus grandidenta*). The understory is scattered and concentrated along fissures and flat areas with serviceberry (*Amelanchier* sp.) common. The low shrub layer is patchy and dominated by low sweet blueberry (*Vaccinium angustifolium*) and bush honeysuckle (*Diervilla lonicera*) important on slopes immediately below the crests of the outcropping. The ground cover is characterized by clumps of poverty grass (*Danthonia spicata*) and bracken fern (*Pteridium aquilinum*) with common polypody (*Polypodium virginianum*) locally dominant and large-leaved aster (*Aster macrophyllus*) prevalent where the canopy is denser. Additional ground cover species include Pennsylvania sedge (*Carex pensylvanica*) and rusty woodsia (*Woodsia ilvensis*). Areas of exposed granite are most prevalent on the crests of the outcropping and are colonized by lichens and mosses.

Threats: Several non-native plants were documented during the surveys including Canada bluegrass (*Poa compressa*), common mullein (*Verbascum thapsus*), and hawkweeds (*Hieracium* spp.). Logging in surrounding valleys and slopes could increase the seed source for weedy species, which could be windblown or bird-dispersed onto the glades. Deer herbivory was noted on shrubs and trees throughout the glade.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered (i.e., let wildfires burn) and to maintain a forested buffer surrounding the glades to prevent the increase of a weedy seed source. Monitoring should be implemented for non-native plant populations and to gauge the impact of deer herbivory. Portions of the outcropping occur on private lands and could be acquired or protected through conservation easements.

Photo by Bradford S. Slaughter.

46. Powell Township Outcrops

Natural Community Type: Granite Bedrock Glade
Rank: G3G5 S2, vulnerable to secure globally and imperiled in the state
Element Occurrence Rank: AB
Location: Gwinn Forest Management Unit, Compartment 205, and Private Lands
Element Occurrence Identification Number: 2171

Site Description: This granite bedrock glade is characterized by scattered outcrops of granite bedrock occurring in a forested landscape. Numerous bedrock knobs support several natural communities occurring on thin soils over bedrock including granite bedrock glade, dry-mesic northern forest or woodland, and mesic northern forest. Talus slopes occur at the base of the bedrock exposures. In addition to cliff exposures and shelves, numerous large boulders and small rocks occur throughout. Where organic soils have accumulated over granitic bedrock, the soils are thin (4-6 cm deep) and acidic (pH 4.5-5.0). Soils accumulate along cracks, fissures, shelves, flat areas, at the bases of trees, and where vegetation is concentrated. Shelves and terraces have deeper soils and support forested and woodland ecosystems. Windthrow, fire, and drought are the primary natural processes influencing the species composition and structure of the glades.

Areas of bedrock glade are characterized by a scattered, stunted canopy with red oak (*Quercus rubra*) (10-30 cm DBH) dominant along with white pine (*Pinus strobus*). A scattered understory occurs along the fissures and flat areas with serviceberry (*Amelanchier interior*), pin cherry (*Prunus pensylvanica*), black cherry (*P. serotina*), choke cherry (*P. virginiana*), and red oak. The low shrub layer occurs in patches and is dominated by Canada blueberry (*Vaccinium myrtilloides*), with local dominance by common juniper (*Juniperus communis*) and bearberry (*Arctostaphylos uva-ursi*). Additional species include raspberries (*Rubus* spp.), red oak seedlings, and serviceberries. The ground cover is sparse and patchy with poverty grass (*Danthonia spicata*), hair grass (*Deschampsia flexuosa*), Pennsylvania sedge (*Carex pensylvanica*), and rusty woodsia (*Woodsia ilvensis*). The non-native sheep sorrel (*Rumex acetosella*) is common throughout. Areas of exposed bedrock support a well-developed non-vascular flora with lichens (*Cladina* spp.) and mosses (*Polytrichum* spp.).

Areas of woodland are characterized by canopy coverage of 25 to 65%. Canopy associates include red oak, white pine, red pine (*Pinus resinosa*), and hemlock (*Tsuga canadensis*). The understory contains red oak, serviceberry, maples (*Acer* spp.), and cherries (*Prunus* spp.) Species in the low shrub layer include low sweet blueberry (*Vaccinium angustifolium*) and maple and red oak seedlings. Ground cover in the woodland is characterized by large-leaved aster (*Aster macrophyllus*) with hair grass, common polypody (*Polypodium virginianum*), Canada mayflower (*Maianthemum canadense*), and wild sarsaparilla (*Aralia nudicaulis*). Areas of mesic northern forest occur scattered within the site along the western and northern margins.

Threats: Logging in surrounding valleys and slopes could increase the seed source for weedy species, which could be windblown or bird-dispersed onto the glades. Portions of the outcropping that occur on private lands could be logged.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered (i.e., let wildfires burn) and to maintain a forested buffer surrounding the glades to prevent the increase of a weedy seed source. Managing the mature mesic northern forest surrounding the outcropping in section 36 as old-growth will help buffer the bedrock glades. Monitoring should be implemented for non-native plant populations and to gauge the impact of deer herbivory on red oak, hemlock, and white pine regeneration. A significant portion of the outcropping occurs on private lands and could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

GRANITE CLIFF

Overview: Granite cliff consists of vertical or near-vertical exposures of bedrock with sparse coverage of vascular plants, lichens, mosses, and liverworts. The community occurs in several counties of the western Upper Peninsula, including Dickinson, Gogebic, Houghton, Iron, Marquette, and Menominee. Granite cliff is composed of resistant igneous and metamorphic bedrock types of the Michigamme Highlands that formed during the Precambrian Era, approximately 3,500 to 600 million years ago. Soil development is limited to shallow organic soils that form from decaying roots and other plant material that accumulate in cracks, crevices, ledges, and flat areas or depressions in the bedrock. The thin organic soils are typically acid but can range from slightly acid to slightly alkaline depending on the rock type (Kost et al. 2007).

47. Mulligan Cliffs

Natural Community Type: Granite Cliff
Rank: G4G5 S2, apparently secure globally and imperiled in the state
Element Occurrence Rank: A
Location: Gwinn Forest Management Unit, Compartment 304, and Private Lands
Element Occurrence Identification Number: 6523

Site Description: This granite cliff system is composed of extensive stretches of tall (60-130 ft tall) cliffs with high native species diversity and well-developed ecological zonation with escarpments, west-facing cliff faces, and talus slopes. The cliff faces are very active with numerous areas of rock slide generating talus slopes at the base of steep cliffs. The scattered canopy is composed of uneven-aged trees (cored trees ranged in age from 54-296 years) due to frequent disturbance of fire, windthrow, and rock slide. Soils are very thin (1-4 cm deep), slightly acidic to alkaline organic soils, which accumulate at the base of talus slopes, on flat areas and ledges, at the upslope base of trees, on top of the escarpment, and within cracks or fissures.

Cliff faces support sparse vegetation confined to the ledges and cracks. The scattered and stunted canopy and understory layer is dominated by northern white-cedar (*Thuja occidentalis*), paper birch (*Betula papyrifera*), and red pine (*Pinus resinosa*). Red pine is more prevalent closer to the top of the escarpment. Cherries (*Prunus* spp.) and serviceberries (*Amelanchier* spp.) also occur in the tall shrub layer. Scattered clumps of low shrubs include bearberry (*Arctostaphylos uva-ursi*), common juniper (*Juniperus communis*), bush honeysuckle (*Diervilla lonicera*), cherries, and raspberries (*Rubus* spp.). Ferns are prevalent along ledges and fissures and include common polypody (*Polypodium virginianum*), rusty woodsia (*Woodsia ilvensis*), maidenhair spleenwort (*Asplenium trichomanes*), and smooth cliff brake (*Pellaea glabella*). Other species include scattered clumps of rock whitlow-grass (*Draba arabisans*, state special concern), downy Solomon's seal (*Polygonatum pubescens*), wild columbine (*Aquilegia canadensis*), and wild strawberry (*Fragaria virginiana*). Many areas of rock slides are devoid of vascular vegetation but the boulders are encrusted with lichens.

Areas of talus slope support a scattered canopy of northern white-cedar, paper birch, white spruce (*Picea glauca*), white pine (*Pinus strobus*), quaking aspen (*Populus tremuloides*), and balsam fir (*Abies balsamea*). Prevalent species in the understory include choke cherry (*Prunus virginiana*), beaked hazelnut (*Corylus cornuta*), serviceberry (*Amelanchier* sp.), northern white-cedar, and balsam fir. Many areas of talus slope are dominated by choke cherry and beaked hazelnut. The low shrub layer contains poison ivy (*Toxicodendron radicans*), choke cherry, and bush honeysuckle, which all dominate or co-dominate large areas of talus slope, particularly areas of high slope at the base of the cliff face. Thimbleberry (*Rubus parviflorus*) is also important. Ground cover of the talus slope is sparse with typical species including poison ivy and common polypody.

The escarpment on top of the cliff face is characterized by a dry-mesic northern forest with red pine and white pine along with red oak (*Quercus rubra*) and big-toothed aspen (*Populus grandidentata*). Canopy closure ranges from 65 to 75%. Understory species include regenerating pine along with cherries and serviceberry. Low sweet blueberry (*Vaccinium angustifolium*) is prevalent in the patchy low shrub layer along with bush honeysuckle, raspberries, and cherries. The ground cover is characterized by bracken fern (*Pteridium aquilinum*) along with large-leaved aster (*Aster macrophyllus*), wild sarsaparilla (*Aralia nudicaulis*), and Canada mayflower

(*Maianthemum canadense*). Rare plants observed during the survey included pine-drops (*Pterospora andromedea*, state threatened), which was found on the top of the escarpment in dry-mesic northern forest and also in a forested portion of talus slope just east of the southernmost Rocking Chair Lake, and rock whitlow-grass, which occurs along the base of the cliff face in shaded and mossy areas. Lower portions of the talus slope closer to Mulligan Creek are characterized by closed-canopy northern white-cedar forest with white spruce, white pine, paper birch, and balsam fir.

Threats: No major threats were identified during surveys. Campers have been cutting firewood and there is a blind/hut along the river in section 10. Logging in the vicinity may increase the seed source for non-native weeds that could be bird- or wind-dispersed onto the site.

Management Recommendations: The main management recommendations are to maintain a forested buffer adjacent to the cliffs to minimize the threat of invasion by non-native species, allow natural processes (i.e., fire and windthrow) to operate unhindered, and remove the illegal hut/blind. Posting signage about illegal cutting of firewood may limit the removal of coarse woody debris and conifer regeneration. Portions of the cliff occurring on private lands could be acquired or protected through conservation easements. Aerial photographic interpretation and ground-truthing indicate that additional high-quality natural communities occur throughout the Rocking Chair Lakes area. Surveys of natural communities adjacent to Mulligan Cliffs are needed.

Photo by Joshua G. Cohen.

Mulligan Cliffs is an extensive granite cliff complex with diverse ecological zonation, including talus slopes (above and below right) and vertical cliff faces (above and below left). Photos by Joshua G. Cohen.

GREAT LAKES MARSH

Overview: Great Lakes marsh is a multiseral nonforested wetland that is directly influenced by and connected to a large freshwater lake. Associated coastal features are principally freshwater deltas, riverine estuaries, coastal marshes protected by offshore bars or a barrier dune (forming a lagoon), and shallow bays on lee shores. Great Lakes marsh is an herbaceous wetland community occurring statewide along the shorelines of the Great Lakes and their major connecting rivers. Vegetational patterns are strongly influenced by water level fluctuations and type of coastal feature, but generally include the following: a deep marsh with submerged plants; an emergent marsh of mostly narrow-leaved species; and a sedge-dominated wet meadow that is inundated by storms. Seiches, storms, and water level cycles strikingly change vegetation over short periods by destroying some vegetation zones, creating others, and forcing all zones to shift lakeward or landward to accommodate water levels. Great Lakes marsh provides important habitat for migrating and breeding waterfowl, shore-birds, spawning fish, and medium-sized mammals (Kost et al. 2007).

48. Epoufette Bay

Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: BC
Location: Sault Sainte Marie Forest Management Unit, Compartment 142, and Private Lands
Element Occurrence Identification Number: 2797

Site Description: This Great Lakes marsh occurs along the active lakeplain of Epoufette Bay, which is situated along the northern shore of Lake Michigan. The marsh complex is found on eroded clay substrate. The marsh is buffered in part by boreal forest with northern white-cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), and balsam fir (*Abies balsamea*) but is also adjacent to residential development. Small islands and sand bars in the bay modify wave action and allow for the development of the marsh along the shoreline. Sand and gravel beach and limestone cobble shore occur along portions of the shoreline.

The marsh is characterized by several ecological zones including emergent marsh, northern wet meadow, northern shrub thicket, and a small amount of rich conifer swamp. Broad areas of northern wet meadow are dominated by bluejoint grass (*Calamagrostis canadensis*) and tussock sedge (*Carex stricta*). Reed canary grass (*Phalaris arundinacea*) occurs within this zone. The northern wet meadow is backed by a narrow band of northern shrub thicket dominated by sweet gale (*Myrica gale*), shrubby cinquefoil (*Potentilla fruticosa*), and meadowsweet (*Spiraea alba*). Areas of emergent marsh bordering the bay are dominated by hardstem bulrush (*Schoenoplectus acutus*), three-square (*Schoenoplectus pungens*), path rush (*Juncus tenuis*), and smartweeds (*Polygonum* spp.). Small colonies of Michigan monkey flower (*Mimulus glabratus var michiganensis*, state endangered) occur in seepage areas adjacent to the bay.

Threats: Portions of the marsh are locally dominated by non-native species (i.e., reed canary grass). In addition, ditching and dredging has occurred in the southern end of the marsh on private land. Continued residential development along the private shoreline is the primary threat to the site.

Management Recommendations: The primary stewardship need is to remove the existing population of reed canary grass. Efforts to control invasive species should be monitored. Portions of the wetland occurring on private lands could be acquired or protected through conservation easements.

This Great Lakes marsh occurs along the active lakeplain of Epoufette Bay, situated along the northern shore of Lake Michigan. Photos by Bradford S. Slaughter.

49. Independence Lake

Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: B
Location: Gwinn Forest Management Unit, Compartment 201, and Private Lands
Element Occurrence Identification Number: 11423

Site Description: This extensive wetland complex occurs on poorly drained, sandy lakeplain associated with Lake Independence, Lake Superior, Iron River, Johnson Creek, and Yellow Dog River. In addition to Great Lakes marsh, northern shrub thicket, rich conifer swamp, and hardwood-conifer swamp occur within the wetland basin. The wetland is characterized by complex ecological zonation that is structured by Great Lakes water fluctuation, beaver flooding, and the Independence Lake Dam. Soils are circumneutral mucks of variable depth overlying circumneutral to slightly acidic sands. Standing water (10-100 cm deep) occurs throughout much of the wetland with areas of both flowing and stagnant water. The wetland contains vast expanses of flood-killed swamp. In addition, windthrow is prevalent throughout flooded and non-flooded swamp forest.

Emergent vegetation occurs along the southeast shore of Independence Lake with bog buckbean (*Menyanthes trifoliata*), water smartweed (*Polygonum amphibium*), swamp candles (*Lysimachia terrestris*), three-way sedge (*Dulichium arundinaceum*), sedge (*Carex comosa*), marsh cinquefoil (*Potentilla palustris*), marsh St. John's wort (*Triadenum fraseri*), and broad-leaved cat-tail (*Typha latifolia*) as local dominants. Within the emergent marsh are pockets of submergent marsh dominated by yellow pond-lily (*Nuphar variegata*). Sweet gale (*Myrica gale*) and leatherleaf (*Chamaedaphne calyculata*) shrub thicket occur intermixed with this emergent marsh and also in areas adjacent to Iron River and just south of the nearby wooded dune and swale complex. Prevalent in the wetland complex are vast expanses of tall shrub thickets with a virtually impenetrable tangle of tag alder (*Alnus rugosa*), winterberry (*Ilex verticillata*), red-osier dogwood (*Cornus stolonifera*), and willows (*Salix* spp.). Within the areas of shrub thicket, royal fern (*Osmunda regalis*), sensitive fern (*Onoclea sensibilis*), tussock sedge (*Carex stricta*), marsh marigold (*Caltha palustris*), and bittersweet nightshade (*Solanum dulcamara*) are prevalent in the ground cover. Skullcaps (*Scutellaria* spp), common water horehound (*Lycopus americanus*), northern bugleweed (*L. uniflorus*), wild mint (*Mentha arvensis*), and tufted loosestrife (*Lysimachia thyrsiflora*) are common throughout areas of shrub thicket and forested swamp. Beaver flooding has resulted in extensive areas of flood-killed hardwood-conifer swamp and rich conifer swamp. These areas are characterized by a dead and dying canopy of northern white-cedar (*Thuja occidentalis*) and black ash (*Fraxinus nigra*), a dense understory layer with tag alder and winterberry, and a dense ground cover with local dominance shifting between royal fern, broad-leaved cat-tail, reed canary grass (*Phalaris arundinacea*), and American bur-reed (*Sparganium americanum*). Additional species include cut grass (*Leersia oryzoides*), bluejoint grass (*Calamagrostis canadensis*), lake sedge (*Carex lacustris*), and bittersweet nightshade, which occurs as a tangling vine that is likely impacting the native species it entangles. Areas of swamp forest that have not been flooded are dominated by northern white-cedar with black ash and red maple (*Acer rubrum*) and scattered yellow birch (*Betula alleghaniensis*), black spruce (*Picea mariana*), and hemlock (*Tsuga canadensis*). Tamarack (*Larix laricina*) also occurs as a local co-dominant. The understory in these swamps is patchy to dense with tag alder, winterberry, and red-osier dogwood. Characteristic ground cover species of the swamp forests include royal fern, sensitive fern, jewelweed (*Impatiens capensis*), false mayflower (*Smilacina trifolia*), oak fern (*Gymnocarpium dryopteris*), and goldthread (*Coptis trifolia*).

Threats: Purple loosestrife (*Lythrum salicaria*) was observed in one location. If this species becomes more prevalent, it could alter the species composition and structure of the site. In addition, the non-native bittersweet nightshade (*Solanum dulcamara*) has become prevalent in beaver-flooded portions of the wetland

Management Recommendations: The primary stewardship need is to remove the existing population of purple loosestrife before it can establish a stronghold and to control the existing population of bittersweet nightshade. Efforts to control invasive species should be monitored. Portions of the wetland occurring on private lands could be acquired or protected through conservation easements.

Great Lakes marsh occurs along the shore of Independence Lake. Photo by Joshua G. Cohen.

50. Kenyon Bay and West

Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: B
Location: Sault Sainte Marie Forest Management Unit, Compartment 142, and Private Lands
Element Occurrence Identification Number: 12046

Site Description: This Great Lakes marsh occurs in a protected embayment along the northern shore of Lake Michigan. The marsh complex occurs on eroded clay substrate of an active lakeplain. The soils range from calcareous beach sand to exposed limestone cobble to organic matter over sand and are slightly acidic to circumneutral (pH 6.5-7.5). Sand and gravel bars occur near the shore and help protect the wetland from direct wave action. In high water years, the marsh is highly eroded by wave action. A small island off the shore is home to a gull colony.

The marsh is characterized by several ecological zones that are patterned by the interaction of substrate, hydrology, and elevation. Vegetative zones include submergent marsh, emergent marsh, northern wet meadow, northern shrub thicket, and limestone cobble shore. Areas of submergent marsh are dominated by yellow pond-lily (*Nuphar variegata*), water milfoil (*Myriophyllum verticillatum*), and grass-leaved arrowhead (*Sagittaria graminea*). Areas of emergent marsh occurring along beach flats are dominated by sedges (*Carex* spp.), spike-rushes (*Eleocharis* spp.), bulrushes (*Juncus* spp.), smartweeds (*Polygonum* spp.), twig-rush (*Cladium mariscoides*), and hardstem bulrush (*Schoenoplectus acutus*). Areas of northern wet meadow are dominated by tussock sedge (*Carex stricta*) and bluejoint grass (*Calamagrostis canadensis*). Reed (*Phragmites australis*) and reed canary grass (*Phalaris arundinacea*) are locally important. The northern wet meadow zone is backed along the margins by northern shrub thicket dominated by shrubby cinquefoil (*Potentilla fruticosa*) and sweet gale (*Myrica gale*). In addition, areas of limestone cobble shore occur sporadically along the lakeshore and are dominated by calciphiles. Characteristic species of the limestone cobble shore include shrubby cinquefoil, silverweed (*Potentilla anserina*), dwarf Canadian primrose (*Primula mistassinica*), Indian paintbrush (*Castilleja coccinea*), bastard toadflax (*Comandra umbellata*), tickseed (*Coreopsis lanceolata*), wild columbine (*Aquilegia canadensis*), starry false Solomon's seal (*Smilacina stellata*), and northern white-cedar (*Thuja occidentalis*)

Threats: Portions of the marsh are locally dominated by non-native species (i.e., reed canary grass). In addition, a small ditch connects Kenyon Bay to Epoufette Bay. Continued residential development along the private shoreline is the primary threat to the site. Off-road vehicle damage was noted along portions of the shoreline.

Management Recommendations: The primary stewardship need is to remove the existing population of reed canary grass. Efforts to control invasive species should be monitored. Portions of the wetland occurring on private lands could be acquired or protected through conservation easements.

Photo by Bradford S. Slaughter.

51. Munuscong and Little Munuscong Rivers and Pickford Point

Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: A
Location: Sault Sainte Marie Forest Management Unit, Compartments 55 and 56, and Private Lands
Element Occurrence Identification Number: 11784

Site Description: This element occurrence represents two adjacent Great Lakes marsh sites that were combined into one: Pickford Point and Munuscong and Little Munuscong Rivers. This extensive complex includes over 2,000 acres of contiguous Great Lakes wetlands in Munuscong Bay with estuary, river mouth, and bay marsh present. The marsh complex occurs on active lakeplain and the underlying soils are predominantly circumneutral to alkaline sandy clays, with organic accumulation increasing with distance from the shore. A high-quality poor fen occurs adjacent to the marsh complex.[8]

The marsh is characterized by complex ecological zonation and high native plant species diversity. The mash includes broad, well-developed zones of emergent marsh, northern wet meadow, and northern shrub thicket. Northern shrub thicket typically occurs along the inland periphery of the marsh with broad zones of northern wet meadow and emergent marsh along the shoreline. The emergent marsh zone has increased significantly since the previous survey in the mid-1980s due to the lowering of the Great Lakes water levels. The lower lake levels have also resulted in the exposure of large expanses of wet, sparsely vegetated flats. The marsh also includes scattered pockets of submergent marsh, interdunal swales, and treed swamp. Areas of northern shrub thickets are dominated by tag alder (*Alnus rugosa*), sweet gale (*Myrica gale*), and slender willow (*Salix petiolaris*). Broad zones of northern wet meadow are dominated by tussock sedge (*Carex stricta*) and bluejoint grass (*Calamagrostis canadensis*) with wetter portions dominated by tussock sedge and lake sedge (*Carex lacustris*). Wet, recently exposed flats are dominated by rushes (*Juncus* spp.), spike-rushes (*Eleocharis* spp.), and hardstem bulrush (*Schoenoplectus acutus*). These flat areas are often separated from the wet meadow zone by stands of reed (*Phragmites australis*) and narrow-leaved cat-tail (*Typha angustifolia*). Open pools are scattered throughout the site and support submergent marsh with yellow pond-lily (*Nuphar variegata*), common arrowhead (*Sagittaria latifolia*), pickerel weed (*Pontederia cordata*), and pondweeds (*Potamogeton* spp.)

This extensive marsh complex provides excellent shorebird habitat. In addition, bald eagle (*Haliaeetus leucocephalus*, state threatened) and osprey (*Pandion haliaetus*, state threatened) were documented utilizing the wetland.

Threats: Waterfowl management, including diking and the creation of potholes, has altered plant composition, especially south of Munuscong River. In addition, portions of the northern wet meadow have been farmed. The majority of the marsh is relatively undisturbed with some scattered patches of non-native plants. Fluctuating water levels appear to be the primary disturbance affecting this site.

Management Recommendations: The primary stewardship need is to allow water level fluctuations to drive changes in species composition and structure. Future ditching should be avoided and dikes should be removed. Populations of non-native species should be monitored and controlled if necessary. Portions of the marsh occurring on private lands could be acquired or protected through conservation easements.

[8] Munuscong River poor fen

The extensive Great Lakes marsh associated with Munuscong River and Bay is characterized by complex ecological zonation and high native plant species diversity. Photos by Bradford S. Slaughter.

52. Paw Point – Scott Point

Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: BC
Location: Sault Sainte Marie Forest Management Unit, Compartments 2 and 3, and Private Lands
Element Occurrence Identification Number: 9211

Site Description: This element occurrence represents two adjacent Great Lakes marsh sites: Paw Point and Scott Point. This marsh complex occurs on active lakeplain of Drummond Island. Scott Point is a bay marsh community and Paw Point includes narrow coastal marsh, as well as river mouth marsh. The soils are typically shallow and predominantly circumneutral to alkaline organics overlying dolomite bedrock.

The marsh is characterized by several ecological zones including submergent marsh, emergent marsh, northern wet meadow, northern shrub thicket, and a small amount of treed swamp. Submergent marsh and emergent marsh occur along the shore, particularly in the narrow protected embayment just south of Maxton Plains. Broad emergent marsh occurs at both sites with pockets of submergent marsh. Typical vegetation within the submergent marsh zones include milfoils (*Myriophyllum* spp.), pondweeds (*Potamogeton* spp.), yellow pond-lily (*Nuphar variegata*), and sweet-scented water-lily (*Nymphaea odorata*). Areas of emergent marsh are dominated by hardstem bulrush (*Schoenoplectus acutus*) with low beach flats supporting spike-rushes (*Eleocharis* spp.) and twig-rush (*Cladium mariscoides*). Muskrats (*Ondatra zibethicus*) have created numerous submergent pockets within the emergent marsh. The majority of the marsh complex is dominated by northern wet meadow with dominant species including tussock sedge (*Carex stricta*), bluejoint grass (*Calamagrostis canadensis*), and wiregrass sedge (*Carex lasiocarpa*). Reed (*Phragmites australis*), reed canary grass (*Phalaris arundinacea*), and willows (*Salix* spp.) are locally important. The wetland exhibits coastal fen characteristics east of Maxton Road where tamarack (*Larix laricina*), shrubby cinquefoil (*Potentilla fruticosa*), and bog buckbean (*Menyanthes trifoliata*) are prevalent. In addition, areas of limestone cobble shore occur sporadically along the lakeshore.

Threats: Waterfowl management, including the creation of potholes, has altered plant composition and structure. The majority of the marsh is relatively undisturbed with some scattered patches of non-native plants. Fluctuating water levels appear to be the primary disturbance affecting this site.

Management Recommendations: The primary stewardship need is to allow water level fluctuations to drive changes in species composition and structure. Waterfowl potholes should be abandoned. Populations of non-native species should be monitored and controlled if necessary. Portions of the marsh occurring on private lands could be acquired or protected through conservation easements.

Photo by Bradford S. Slaughter.

53. Pequaming Marsh

Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: B
Location: Baraga Forest Management Unit, Compartment 4, and Private Lands
Element Occurrence Identification Number: 6629

Site Description: This Great Lakes marsh occupies a tombolo between the mainland and an island along the Lake Superior shoreline on poorly drained lakeplain. Organic soils are typically acidic (pH 5.0), saturated peats. The wetland is characterized by complex ecological zonation with natural communities within the wetland complex including poor fen, poor conifer swamp, rich conifer swamp, and emergent marsh along the water channel leading to Pequaming Bay.

The majority of the wetland is dominated by a large expanse of poor fen with scattered rises of peat that support poor conifer swamp vegetation. Characteristic species of the poor fen zone include wiregrass sedge (*Carex lasiocarpa*), livid sedge (*C. livida*), dioecious sedge (*C. sterilis*), sphagnum mosses (*Sphagnum* spp.), white beak-rush (*Rhynchospora alba*), and twig-rush (*Cladium mariscoides*) with leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), bog laurel (*Kalmia polifolia*), black spruce (*Picea mariana*), and tamarack (*Larix laricina*) occurring on the scattered peat rises. Areas of rich conifer swamp occur along the margin of the uplands where soil chemistry conditions become more minerotrophic. Typical species in areas of rich conifer swamp include northern white-cedar (*Thuja occidentalis*), mountain holly (*Nemopanthus mucronata*), bog birch (*Betula pumila*), black chokeberry (*Aronia prunifolia*), winterberry (*Ilex verticillata*), and tag alder (*Alnus rugosa*).

Threats: This Great Lakes marsh is flanked by roads on three sides that have altered the site's hydrology by obstructing direct access to Lake Superior water level fluctuations. In addition, the non-native reed canary grass (*Phalaris arundinacea*) occurs along the road edges but has not penetrated the wetland interior and may not due to the deeper organic soils.

Management Recommendations: The primary stewardship need is to reconnect the Great Lakes marsh to Lake Superior water level fluctuations by establishing more culverts under the roads surrounding the wetland. Control efforts should be implemented to reduce the population of reed canary grass and measures to control invasive species should be monitored. Portions of the wetland occurring on private lands could be acquired or protected through conservation easements.

Photo by Michael A. Kost.

54. Petobego Pond

Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: AB
Location: Traverse City Forest Management Unit, Compartment 61
Element Occurrence Identification Number: 1919

Site Description: Petobego Pond is a shallow, interdunal swale or lagoon with a slight gradient that is connected to Lake Michigan by a short stream but is generally isolated from the lake by a sand ridge. This Great Lakes marsh occurs on sand and clay lakeplain with alkaline mucks of variable depth (typically 20-40 cm) overlying wet sands or claypan (pH of organic and mineral soils ranges from 7.4-8.0). Exposed areas of sand occur throughout. Water depth tends to decrease closer to the upland margin. Inundated areas with 20-100 cm of water over mucks overlying sand or claypan occur throughout the complex. The marsh is characterized by high native species diversity (over 100 species were noted during the 2006 survey) and well-developed ecological zonation that is patterned by long term fluctuations in Great Lakes water levels and seasonal water level fluctuations.

Four primary vegetative zones characterize this marsh: shrub margin, northern wet meadow, emergent marsh, and sand flats. The shrub margin is typically 10 to 30 m wide and exhibits moderate to dense cover of tag alder (*Alnus rugosa*), silky dogwood (*Cornus amomum*), swamp rose (*Rosa palustris*), and willows (*Salix* spp.). A large population of rose mallow (*Hibiscus moscheutos*, state special concern) occurs within the shrub margin. The low shrub layer is characterized by sweet gale (*Myrica gale*) and shrubby cinquefoil (*Potentilla fruticosa*). The herb layer is dominated by bluejoint grass (*Calamagrostis canadensis*), goldenrods (*Solidago* spp.), silverweed (*Potentilla anserina*), and common boneset (*Eupatorium perfoliatum*). Extensive areas of northern wet meadow are dominated by tussock sedge (*Carex stricta*) and associates include bluejoint grass, twig-rush (*Cladium mariscoides*), joe-pye-weed (*Eupatorium maculatum*), swamp milkweed (*Asclepias incarnata*), beaked spike-rush (*Eleocharis rostellata*), and goldenrods. Some purple loosestrife (*Lythrum salicaria*) and reed canary grass (*Phalaris arundinacea*) are present in the wet meadow zone, though these invasives are currently a minor component. Areas of emergent marsh are dominated by hardstem bulrush (*Schoenoplectus acutus*) with local dominance by twig-rush, cat-tails (*Typha* spp.), softstem bulrush (*Schoenoplectus tabernaemontani*), brown-fruited rush (*Juncus pelocarpus*), spike-rush (*Eleocharis* spp.), and sedges (*Carex* spp.). Other associates include sedge (*Carex cryptolepis*), Kalm's lobelia (*Lobelia kalmii*), and monkey-flower (*Mimulus ringens*). Areas of standing water support dense monocultures of hardstem bulrush interspersed with aquatic plants, such as yellow pond-lily (*Nuphar variegata*) and naiads (*Najas* spp.). The sand flats are sparsely to moderately vegetated with Kalm's lobelia, asters (*Aster* spp.), and sedges. A floating mat occurs in the southwestern portion of the marsh and is dominated by wiregrass sedge (*Carex lasiocarpa*) with joe-pye-weed, broad-leaved cat-tail (*Typha latifolia*), and rose mallow.

Threats: Invasive plant species fond in the marsh include purple loosestrife, reed canary grass, and reed. Although currently only a minor disturbance, these non-native plants will likely spread and present a greater threat in the future if not eradicated. Anthropogenic disturbance seems to be limited to hunting, although the importance of the dam to the east in regulating the hydrology of the marsh is unknown.

Management Recommendations: The primary stewardship need is to control the populations of invasive species (i.e., purple loosestrife, reed canary grass, and reed) and monitor control efforts. Maintaining the roadless quality of the surrounding forest and maintaining a buffer of unmanaged forest surrounding the marsh will help reduce the possibility of additional invasive species incursions. The forested block surrounding the marsh could be consolidated by pursuing acquisition of the private lands or establishing conservation easements.

The Petobego Pond Great Lakes marsh is characterized by distinct ecological zonation with northern wet meadow and emergent marsh zones most prevalent. Photos by Joshua G. Cohen.

55. Portage River Marsh

Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: B
Location: Baraga Forest Management Unit, Compartment 58, and Private Lands
Element Occurrence Identification Number: 8882

Site Description: This extensive estuary or river mouth marsh complex occupies an old river elbow or oxbow near the mouth of the Portage River. This marsh occurs on poorly drained sandy lakeplain and is characterized by dynamic hydrology with water levels fluctuating near the river mouth and beaver influence concentrated along the channels. The wetland basin includes submergent marsh, emergent marsh, northern wet meadow, northern shrub thicket, muskeg, poor conifer swamp, and rich conifer swamp. Soils are organics of variable depth (typically > 1 m) and are slightly acidic to circumneutral (pH 5.5-7.0) and range from saturated to inundated. Northern wet meadow, northern shrub thicket, and emergent marsh tend to be slightly acidic (pH 5.5-6.5), rich conifer swamp zones tend to be slightly acidic to circumneutral (pH 6.5-7.0), and areas of muskeg tend to be more acidic (pH 5.0-5.5) with fibric peat development. Sphagnum hummock and hollow microtopography in the muskeg and conifer swamps generates fine-scale gradients of soil moisture and soil chemistry. Submergent marsh areas are inundated (1-2 m of water), northern wet meadow and emergent marsh zones are saturated to inundated (0-20 cm of water), and areas of muskeg and rich conifer swamp are saturated. Numerous channels (1 m deep and typically 1 m wide) occur throughout the slough area and contribute to the complex patterning of the slough areas.

Areas of emergent marsh and northern wet meadow are associated with the slough area and are dissected by numerous channels supporting submergent vegetation. Dominant species of this zone include tussock sedge (*Carex stricta*), wiregrass sedge (*C. lasiocarpa*), broad-leaved cat-tail (*Typha latifolia*), and bluejoint grass (*Calamagrostis canadensis*) with characteristic species including marsh fern (*Thelypteris palustris*) and marsh bell flower (*Campanula aparinoides*). Prevalent species in the submergent marsh include pickerel weed (*Pontederia cordata*), yellow pond-lily (*Nuphar variegata*), water pepper (*Polygonum hydropiperoides*), and American bur-reed (*Sparganium americanum*). Areas of emergent marsh and northern wet meadow are backed by and intermixed with northern shrub thicket dominated by tag alder (*Alnus rugosa*) and sweet gale (*Myrica gale*) with winterberry (*Ilex verticillata*), black chokeberry (*Aronia prunifolia*), and red-osier dogwood (*Cornus stolonifera*). Areas of grounded peat mat support muskeg with scattered tamarack (*Larix laricina*) (5-20 cm DBH and 5-20 ft tall), a sphagnum carpet, and heavy ericaceous shrub cover with leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), and bog laurel (*Kalmia polifolia*). Characteristic ground cover species in the muskeg include small cranberry (*Vaccinium oxycoccos*), bog buckbean (*Menyanthes trifoliata*), pitcher-plant (*Sarracenia purpurea*), few-flower sedge (*Carex pauciflora*), cotton-grasses (*Eriophorum* spp.), and false mayflower (*Smilacina trifolia*). Areas of rich conifer swamp with well-developed sphagnum hummock and hollow microtopography are characterized by an overstory of tamarack and northern white-cedar (*Thuja occidentalis*), a scattered tag alder understory, Labrador tea (*Ledum groenlandicum*) in the low shrub layer, and a diverse ground cover with royal fern (*Osmunda regalis*), dwarf raspberry (*Rubus pubescens*), sensitive fern (*Onoclea sensibilis*), fowl manna grass (*Glyceria striata*), and false mayflower.

Threats: The primary threat is posed by purple loosestrife, which occurs scattered throughout the site but is currently found in low densities. Alteration of the hydrology of the Portage River is also a threat.

Management Recommendations: The primary management recommendation is to remove the existing populations of purple loosestrife before they can establish a stronghold. Control efforts should be monitored. In addition, portions of the marsh occurring on private lands could be acquired or protected through conservation easements.

This extensive estuary or river mouth marsh complex occupies an old river elbow or oxbow near the mouth of the Portage River. Photos by Joshua G. Cohen.

56. Squaw Bay (Great Lakes Marsh)

Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: B
Location: Atlanta Forest Management Unit, Compartment 89, and Private Lands
Element Occurrence Identification Number: 4290

Site Description: This Great Lakes marsh occurs along the Lake Huron shoreline and is characterized by large expanses of recently exposed unvegetated sand flats resulting from low water levels in Lake Huron. The marsh soils are alkaline, saturated to inundated sands. The site closely resembles an interdunal wetland in vegetation, soil, and hydrology but slopes gently from a series of dunes into Lake Huron.

Large unvegetated expanses of alkaline sands grade to sparsely vegetated pockets with hardstem bulrush (*Schoenoplectus acutus*), spike-rush (*Eleocharis quinqueflora*), pondweeds (*Potamogeton* spp.), and rushes (*Juncus* spp.) with scattered pockets of denser vegetation of grass-leaved goldenrod (*Euthamia graminifolia*), goldenrods (*Solidago* spp.), sedge (*Carex viridula*), reed (*Phragmites australis*), silverweed (*Potentilla anserina*), and eastern-lined aster (*Aster lanceolatus*). Old dunes or shore ridges support more well-developed vegetation of marram grass (*Ammophila breviligulata*), sand reed grass (*Calamovilfa longifolia*), willow (*Salix* spp.), and balsam poplar (*Populus balsamifera*). Beyond the sand ridges are open, large northern wet meadow zones dominated by bluejoint grass (*Calamagrostis canadensis*) that grade into a patchwork of twig-rush (*Cladium mariscoides*), silverweed, and Kalm's lobelia (*Lobelia kalmii*).

Populations of the non-natives dog mustard (*Erucastrum gallicum*) and wall rocket (*Diplotaxis muralis*) occur in localized areas. Twig-rush, hardstem bulrush, and softstem bulrush (*Schoenoplectus tabernaemontani*) dominate near US 23. Twig-rush litter is dense and the vegetation is sparse over much of the area. Additional species include meadowsweet (*Spiraea alba*), common boneset (*Eupatorium perfoliatum*), and sweet gale (*Myrica gale*). Reed (*Phragmites australis*) has taken over an area in the eastern portion of the marsh.

Threats: Numerous invasive plants have become established within the site including reed, dog mustard, wall rocket, Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), common mullein (*Verbascum thapsus*), and prickly sow thistle (*Sonchus asper*). Illegal off-road vehicle activity, noted in portions of the site, may exacerbate invasive species incursions and locally alter hydrology. In addition, the large ditch paralleling the road may affect the marsh hydrology.

Management Recommendations: The primary stewardship need is to control the populations of invasive species (i.e., reed) and monitor control efforts. Maintaining a buffer of unmanaged swamp forest surrounding the marsh and eliminating illegal off-road vehicle activity will help reduce the possibility of additional invasive species incursions. Acquiring portions of the marsh that occur on private lands and the private parcels to the north and south of the marsh or protecting these lands through conservation easements will help protect the marsh.

Photo by Bradford S. Slaughter.

57. Sturgeon River (Great Lakes Marsh)

Natural Community Type: Great Lakes Marsh
Rank: G2 S3, globally imperiled and vulnerable within the state
Element Occurrence Rank: B
Location: Baraga Forest Management Unit, Compartment 57, and Private Lands
Element Occurrence Identification Number: 8300

Site Description: This Great Lakes marsh is an extensive estuary or river mouth marsh complex occurring between the Portage and Sturgeon Rivers, protruding into Portage Lake, and occurring on poorly drained lakeplain. The wetland basin includes submergent marsh, emergent marsh, northern shrub thicket, bog/poor fen, and floodplain forest. Soils are variable with shallow organics overlying slightly acidic sands and clays. The emergent marsh associated with the lake margin and sand bars is characterized by < 1 cm of circumneutral (pH 7.5) organics over inundated sands with < 1 to 1.5 m of standing water. Vast areas supporting a bog mat are characterized by 40 to 70 cm (some areas >1 m) of sphagnum peats (pH 5.0-5.5) over slightly acidic (pH 6.0-6.5) sands and occasionally sandy clays. Alder thickets typically have thin organics (1-2 cm, pH 5.0-5.5) over deep saturated clays or sands (>1 m deep, pH 5.0-6.0). The northern wet meadow zone typically has 70 cm of saturated sedge peats (pH 5.0-5.5) over sands (pH 6.0-6.5) and areas of swamp forest and floodplain forest have sandy clay loams and silty clay loams. The patterning of the numerous ecological zones of varying successional age depends on the proximity to the river mouth, Portage Lake, and the slough. The site is characterized by dynamic hydrology with water levels fluctuating along Lake Portage, the river mouth of Sturgeon River and slough areas, and seasonal over-the-bank flooding occurring adjacent to Sturgeon River. In addition, beaver are influencing the hydrology through dam building and flooding.

The Great Lakes marsh is characterized by diverse ecological zonation with submergent marsh, emergent marsh, northern wet meadow, northern shrub thicket, bog/poor fen, floodplain forest, and hardwood-conifer swamp. The emergent marsh zone associated with the lake margin and river mouth sandbars is dominated by hardstem bulrush (*Schoenoplectus acutus*) and softstem bulrush (*Schoenoplectus tabernaemontani*). Broad-leaved cat-tail (*Typha latifolia*), rushes (*Juncus* spp.), and American bur-reed (*Sparganium americanum*) are also important in the emergent marsh zone. Submergent marsh vegetation is concentrated in standing water (1-2 m deep) in slough areas (old river channels and fingers) with pickerel weed (*Pontederia cordata*), yellow pond-lily (*Nuphar variegata*), sweet-scented water-lily (*Nymphaea odorata*), common arrowhead (*Sagittaria latifolia*), water pepper (*Polygonum hydropiperoides*), and aquatic species, such as common waterweed (*Elodea canadensis*), water milfoil (*Myriophyllum tenellum*), and slender naiad (*Najas flexilis*). The extensive area of bog/poor fen is dominated by sweet gale (*Myrica gale*) and leatherleaf (*Chamaedaphne calyculata*). Additional species include bog rosemary (*Andromeda glaucophylla*), tag alder (*Alnus rugosa*), meadowsweet (*Spiraea alba*), wiregrass sedge (*Carex lasiocarpa*), broad-leaved cat-tail, large cranberry (*Vaccinium macrocarpon*), small cranberry (*V. oxycoccos*), bog buckbean (*Menyanthes trifoliata*), marsh fern (*Thelypteris palustris*), and sphagnum mosses.

Areas of northern wet meadow are locally dominated by bluejoint grass (*Calamagrostis canadensis*), tussock sedge (*Carex stricta*), and lake sedge (*C. lacustris*) with some areas dominated by reed canary grass (*Phalaris arundinacea*). Characteristic herbaceous species of the wet meadow zone and northern shrub thicket include common skullcap (*Scutellaria galericulata*), marsh bellflower (*Campanula aparinoides*), marsh fern, common water horehound (*Lycopus americanus*), wild blue flag (*Iris versicolor*), and cinnamon willowherb (*Epilobium coloratum*). Fowl manna grass (*Glyceria striata*) is common throughout these zones as well. Areas of northern shrub thicket are dominated by tag alder and sweet gale with tall shrub associates including winterberry (*Ilex verticillata*), willows (*Salix petiolaris* and *S. canadensis*), dogwoods (*Cornus* spp.), and meadowseet. Leatherleaf and scattered tamarack (*Larix laricina*) are locally prevalent. Floodplain forest occurs along the margins of the Sturgeon River and is characterized by a hardwood canopy with silver maple (*Acer saccharinum*) and green ash (*Fraxinus pennsylvanica*) and an understory of tag alder. Ground cover in the floodplain forest is dominated by ostrich fern (*Matteuccia struthiopteris*) and reed canary grass. Areas of swamp forest not

susceptible to over-the-bank flooding are dominated by green ash, red maple (*Acer rubrum*), black ash (*Fraxinus nigra*), and scattered clumps of conifers, especially northern white-cedar and understory balsam fir (*Abies balsamea*).

Purple loosestrife occurs throughout the site in scattered low density clumps. Reed canary grass occurs as a local dominant in areas of northern wet meadow, northern shrub thicket, and floodplain forest in the southwestern portion of the site. Eagle (*Haliaeetus leucocephalus*, state threatened), osprey (*Pandion haliaetus*, state threatened), and northern harrier (*Circus cyaneus*, state special concern) were observed during the 2007 surveys.

Threats: The primary threat is posed by purple loosestrife (*Lythrum salicaria*), which occurs scattered throughout the site but is currently found in low densities. Alteration of the hydrology of the Sturgeon and Portage Rivers is also a threat.

Management Recommendations: The primary management need is to remove the existing populations of purple loosestrife before it can establish a stronghold. Control efforts should be monitored to gauge success. In addition, several private parcels occur within the occurrence and could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

HARDWOOD-CONIFER SWAMP

Overview: Hardwood-conifer swamp is a minerotrophic forested wetland dominated by a mixture of lowland hardwoods and conifers, occurring on organic (i.e., peat) and poorly drained mineral soils throughout Michigan. The community occurs on a variety of landforms, often associated with headwater streams and areas of groundwater discharge. Species composition and dominance patterns can vary regionally. Windthrow and fluctuating water levels are the primary natural disturbances that structure hardwood-conifer swamp (Kost et al. 2007).

58. Beavertown Lakes (Hardwood-Conifer Swamp)

Natural Community Type: Hardwood-Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Newberry Forest Management Unit, Compartment 9, and Private Lands
Element Occurrence Identification Number: 10054

Site Description: This uneven-aged block of hardwood-conifer swamp occurs on poorly drained lakeplain adjacent to a steep sandy end moraine. Areas close to the slope are characterized by seeps and a water table close to the surface. Soils are deep (> 1 m), saturated peats that are slightly acidic (pH 5.5-6.0) in areas dominated by hemlock (*Tsuga canadensis*) to circumneutral (pH 6.5-7.0) in areas dominated by northern white-cedar (*Thuja occidentalis*) and tamarack (*Larix laricina*). Groundwater seepage generates minerotrophic conditions and saturated peats, especially along the upland margin. The West Branch of the Two Hearted River intersects the site. Windthrow is prevalent throughout the site (both single gaps and multiple treefall gaps) generating structural diversity at multiple scales (tip-up mounds and even-aged patches). This site is characterized by a high volume of coarse woody debris of diverse species composition, decay classes, and diameter ranges.

A narrow (30-60 m) but long band of old-growth (over 275 years old) hardwood-conifer swamp occurs along the upland margin and is dominated by northern white-cedar, hemlock, yellow birch (*Betula alleghaniensis*), and red maple (*Acer rubrum*) with scattered white pine (*Pinus strobus*), white spruce (*Picea glauca*), and tamarack. Areas closer to the river are more even-aged and more conifer-dominated with northern white-cedar and tamarack as co-dominants and canopy and subcanopy associates including red maple, black ash (*Fraxinus nigra*), and balsam fir (*Abies balsamea*). The understory is dominated by tag alder (*Alnus rugosa*) and northern white-cedar (locally). Additional understory species include striped maple (*Acer pensylvanicum*), red maple, and sugar maple (*A. saccharum*) and locally hemlock. Northern white-cedar and tag alder are locally dense in windthrow gaps. In addition, tag alder is locally dominant along the river, especially in areas with flooding from beaver dams. Species of the low shrub layer include American fly honeysuckle (*Lonicera canadensis*), northern white-cedar, maples, balsam fir, and Labrador tea (*Ledum groenlandicum*). Coarse woody debris provides an important substrate for tree seedlings and saplings. Hemlock and northern white-cedar are prevalent along nurse logs. In the ground cover, royal fern (*Osmunda regalis*) is dominant in the tamarack-northern white-cedar–dominated swamp while hairy sweet cicely (*Osmorhiza claytonii*) dominates in the hardwood-conifer swamp. Characteristic ground cover species throughout the swamp include lake sedge (*Carex lacustris*), tussock sedge (*C. stricta*), three-seeded sedge (*C. trisperma*), dwarf raspberry (*Rubus pubescens*), sensitive fern (*Onoclea sensibilis*), starflower (*Trientalis borealis*), goldthread (*Coptis trifolia*), bunchberry (*Cornus canadensis*), Canada mayflower (*Maianthemum canadense*), fowl manna grass (*Glyceria striata*), common skullcap (*Scutellaria galericulata*), and northern wood sorrel (*Oxalis acetosella*). Sphagnum carpets are locally prevalent, especially in areas where northern white-cedar and tamarack are dominant.

Threats: Portions of the site occurring on private land could be logged. Currently there is excellent northern white-cedar and hemlock regeneration but a series of mild winters could result in increased deer herbivory.

Management Recommendations: The main management recommendation is to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered (i.e., no salvage logging and allow lightning strike fires to burn). Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens to jeopardize northern white-cedar and hemlock regeneration. Maintaining large-diameter northern white-cedar and hemlock in surrounding upland forests is recommended to provide an ample seed source of conifers for swamp systems throughout the landscape. Aerial photographic interpretation indicated that additional high-quality hardwood-conifer swamp occurs to the east and west. In 2008, MNFI conducted surveys for The Nature Conservancy on private lands to the east and west of this site. These surveys confirmed that the high-quality hardwood-conifer swamp extends for several miles on either side of the state-owned land. Portions of the swamp occurring on private lands could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

HILLSIDE PRAIRIE

Overview: Hillside prairie is a grassland or savanna community that occurs on moderate to steep exposed slopes and crests of hills associated with river valleys, streams, or kettle lakes, surrounded by oak forest or oak savanna. This natural community is almost always found on south- to west-facing slopes, where exposure to sunlight is highest. Soils are typically strongly acid to neutral loamy sand or sandy loam, and often mixed with gravel. Hillside prairie is notable for supporting several state-listed plant species largely restricted to this community type (Kost et al. 2007).

59. Pemene Falls

Natural Community Type: Hillside Prairie
Rank: G3 S1, vulnerable globally and critically imperiled in the state
Element Occurrence Rank: BC
Location: Escanaba Forest Management Unit, Compartment 113
Element Occurrence Identification Number: 5050

Site Description: This small hillside prairie occurs on a steep, southwest-facing bluff overlooking the Menominee River. The soils are slightly acidic to circumneutral (pH 6.5-7.5), light to dark brown, loamy sands overlying calcareous drift. The prairie is surrounded by open groves of aspen and oak-pine forest. A Native American trail passed through this site and it is likely that Native Americans camped at this site and possibly even burned it as well. Natural disturbances observed during the surveys included erosion due to the steep slopes and beaver (*Castor canadensis*) herbivory of aspen stems.

The sandy, rocky substrate is dominated by grasses with little bluestem (*Andropogon scoparius*), big bluestem (*A. gerardii*), and Canada wild rye (*Elymus canadensis*). Richardson's sedge (*Carex richardsonii*, state special concern) and bracken fern (*Pteridium aquilinum*) are common along the woodland margin. Common shrubs include low sweet blueberry (*Vaccinium angustifolium*), sweetfern (*Comptonia peregrina*), bearberry (*Arctostaphylos uva-ursi*), and scattered prairie willow (*Salix humilis*), serviceberry (*Amelanchier* sp.), soapberry (*Shepherdia canadensis*), and choke cherry (*Prunus virginiana*). Common forbs in the prairie include northern bedstraw (*Galium boreale*), harebell (*Campanula rotundifolia*), upland white goldenrod (*Solidago ptarmicoides*), old field goldenrod (*Solidago nemoralis*), thimbleweed (*Anemone cylindrica*), and smooth aster (*Aster laevis*). Trees scattered within the site include red pine (*Pinus resinosa*), white pine (*P. strobus*), and white spruce (*Picea glauca*). Areas along the lower slopes of the hillside are characterized by more mesic conditions and support species such as tussock sedge (*Carex stricta*), cordgrass (*Spartina pectinata*), blue vervain (*Verbena hastata*), and joe-pye-weed (*Eupatorium maculatum*).

Threats: The main threats to the site are posed by erosion due to human foot traffic and non-native species invasion. Non-native species are common within the site and include Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*P. pratensis*), white sweet-clover (*Melilotus alba*), and common mullein (*Verbascum thapsus*). These species readily establish on the bare, eroded soils. Spotted knapweed (*Centaurea maculosa*) is currently uncommon.

Management Recommendations: This site should be maintained as a hillside prairie. Droughty soil conditions appear to be limiting tree and shrub growth but the site may also benefit from a prescribed fire. Prescribed fire should include the prairie and the surrounding woodlands and existing fire breaks should be employed since fire breaks within the prairie could increase the density of non-native plants associated with soil disturbance. Efforts to control the populations of non-natives (i.e., white sweet-clover, common mullein, and spotted knapweed) should be implemented and monitored.

Photo by Bradford S. Slaughter.

Pemene Falls is a small hillside prairie that occurs on a steep, southwest-facing bluff overlooking the Menominee River. Photo by Bradford S. Slaughter.

INTERDUNAL WETLAND

Overview: Interdunal wetland is a rush-, sedge-, and shrub-dominated wetland situated in depressions within open dunes or between beach ridges along the Great Lakes, experiencing a fluctuating water table seasonally and yearly in synchrony with lake level changes. This natural community is typically found in long troughs or swales between dune ridges, in wind-formed depressions at the base of blowouts, in hollows of dune fields, and in abandoned river channels that once flowed parallel to the lakeshore behind a foredune. Interdunal wetlands occur on all of the Laurentian Great Lakes. The saturated sand and pond water of interdunal wetlands along the lower Great Lakes is neutral to moderately alkaline because of traces of calcareous minerals in the lake-edge sands (Kost et al. 2007).

60. Big Knob Campground (Interdunal Wetland)

Natural Community Type: Interdunal Wetland
Rank: G2? S2, imperiled globally and in the state
Element Occurrence Rank: AB
Location: Sault Sainte Marie Forest Management Unit, Compartments 175 and 203
Element Occurrence Identification Number: 11037

Site Description: The 2.5 mile long stretch of northeast to southwest trending interdunal wetlands occurs on lakeplain along the northern shore of Lake Michigan nested within a large, high-quality wooded dune and swale complex.[9] The interdunal wetlands occur in broad flat swales behind the foredune and in narrower more trough-like swales behind the subsequent dune ridge, which is primarily forested. The Crow River intersects the site and several streams drain the ponds. Where standing water occurs, it varies in depth from 1 to 10 cm in meadow areas and deeper pools of 100 to 150 cm in the ponds. The broad areas of swale behind the foredune have a thin layer (1-2 cm) of alkaline (pH 8.0) black sand overlying lighter wet sands that are circumneutral (pH 7.0-7.5). Swales further inland are more variable in terms of soil with most having black sands over lighter sands. In addition, alkaline muck also occurs over the sands and varies in depth from 2 to 10 cm.

Broad stretches (30-50 meters wide) of interdunal wetland occurring behind the foredune are characterized by Great Lakes marsh vegetation with Baltic rush (*Juncus balticus*), tussock sedge (*Carex stricta*), and green bulrush (*Scirpus atrovirens*). The foredune supports the dune grasses marram grass (*Ammophila breviligulata*) and sand reed grass (*Calamovilfa longifolia*) along with balsam poplar (*Populus balsamifera*) seedlings and silverweed (*Potentilla anserina*). Forested dune ridges are dominated by jack pine (*Pinus banksiana*), white pine (*P. strobus*), white spruce (*Picea glauca*), tamarack (*Larix laricina*), and northern white-cedar (*Thuja occidentalis*). The swales behind the second and/or third dune ridges (which are primarily forested) are much narrower (10-20 m wide) and are more variable in terms of composition and structure. Long linear stretches of open meadow are characterized by local dominance of tussock sedge, wiregrass sedge (*Carex lasiocarpa*), and softstem bulrush (*Schoenoplectus tabernaemontani*) with prevalent forbs including silverweed, grass-of-Parnassus (*Parnassia glauca*), swamp candles (*Lysimachia terrestris*), and marsh St. John's-wort (*Triadenum fraseri*). Within more open portions, shrubs are concentrated along the ecotone of the dune ridge and the swale and stunted conifers, such as white pine, tamarack, white spruce, and black spruce (*Picea mariana*) are scattered here as well. Prevalent shrubs include sweet gale (*Myrica gale*), shrubby cinquefoil (*Potentilla fruticosa*), tag alder (*Alnus rugosa*), Kalm's St. John's-wort (*Hypericum kalmianum*), and willows (*Salix* spp.). The narrowest (5-10 m) portions of the swales, which are likely the driest areas, are often shrub-dominated with sweet gale and shrubby cinquefoil being most prevalent. Numerous ponds occur within these swales and are characterized by submergent vegetation, such as yellow pond-lily (*Nuphar variegata*) and pondweeds (*Potamogeton* spp.), and emergent vegetation, especially softstem bulrush. A large population of Houghton's goldenrod (*Solidago houghtonii*, federal/state threatened) is known from this site. Lake Huron tansy (*Tanacetum huronense*, state threatened) and Pitcher's thistle (*Cirsium pitcheri*, federal/state threatened) are prevalent along the dune ridges. In addition, dwarf lake iris (*Iris lacustris*, federal/state threatened) occurs sporadically on the more forested dune ridges.

[9] Big Knob Campground Wooded Dune and Swale Complex

Threats: The primary threat is posed by off-road vehicle damage, which would lead to rutting, hydrologic alteration, and introduction of invasive species.

Management Recommendations: The primary stewardship need is to eliminate off-road vehicle activity along the shoreline. Monitoring should be implemented for rare plant, illegal off-road vehicle activity, and invasive species.

The Big Knob Campground interdunal wetland is dominated by graminoids with woody species occurring along the margins. Photos by Joshua G. Cohen.

61. Inland Harbor (Interdunal Wetland)

Natural Community Type: Interdunal Wetland
Rank: G2? S2, imperiled globally and in the state
Element Occurrence Rank: B
Location: Sault Sainte Marie Forest Management Unit, Compartment 200, and Private Lands
Element Occurrence Identification Number: 12340

Site Description: The mile-long stretch of east-west trending interdunal wetlands occurs within a high-quality open dunes[10] along the northern shore of Lake Michigan. Three distinct swales occur within the open dunes. Swales are flat areas ranging in width from 5 to 10 m and are characterized by moist-wet sands that are slightly acidic at the mottled surface and neutral beneath. Several pools of water occur in the more inland swales.

The three swales are successionally distinct from each other with the swale closest to the shore being sparsely vegetated and dominated by Baltic rush (*Juncus balticus*), silverweed (*Potentilla anserina*), and willows (*Salix* spp.). The second and third swales exhibit denser cover and are wetter. Species dominant in these upper swales include beak-rush (*Rhynchospora capillacea*), twig-rush (*Cladium mariscoides*), and shrubby cinquefoil (*Potentilla fruticosa*), with shrubby cinquefoil increasing in importance in the uppermost swale. In addition, species diversity is highest in the third swale as fern and shrub diversity is greater. Scattered and stunted conifers, such as white pine (*Pinus strobus*) and white spruce (*Picea glauca*) occur along the fringes of the uppermost swale. Tree density, height, and diameter are greatest adjacent to the third swale.

Piping plover (*Charadrius melodus*, federal/state endangered) have been recorded nesting in these interdunal wetlands.

Threats: The primary threat to the site is off-road vehicle damage, which can cause rutting, hydrologic alteration, and introduction of invasive species

Management Recommendations: The primary stewardship need is to eliminate off-road vehicle activity along the shoreline. Portions of the wetlands occurring on private lands could be acquired or protected through conservation easements. Monitoring should be implemented for piping plover nesting success, illegal off-road vehicle activity, and invasive species.

Photo by Joshua G. Cohen.

[10] Inland Harbor Open Dunes

INTERMITTENT WETLAND

Overview: Intermittent wetland is a graminoid- and herb-dominated wetland found along lakeshores or in depressions and characterized by fluctuating water levels, both seasonally and from year to year. Intermittent wetlands occur in depressions in glacial outwash and sandy glacial lakeplains and in kettles on pitted outwash. Soils range from loamy sand and peaty sand to peaty muck and are very strongly acid to strongly acid. Intermittent wetlands exhibit traits of both peatlands and marshes, with characteristic vegetation including sedges (*Carex* spp.), rushes (*Juncus* spp.), sphagnum mosses, and ericaceous shrubs. The community occurs statewide (Kost et al. 2007).

62. Black Lake Forest Marsh

Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: AB
Location: Atlanta Forest Management Unit, Compartments 172 and 173
Element Occurrence Identification Number: 660

Site Description: This intermittent wetland occurs on flat, poorly drained lakeplain with slightly acidic mucky sands and more acidic sphagnum peat overlying moderately acidic sands. The water table fluctuates seasonally and annually creating diverse ecological zonation including submergent marsh, emergent marsh, northern wet meadow, and grounded bog mat. The water table increases in depth as one passes from the center of the wetland toward the upland margin.

Numerous shallow pools occur throughout the site and are characterized by submergent marsh dominated by sweet-scented water-lily (*Nymphaea odorata*), yellow pond-lily (*Nuphar variegata*), and water shield (*Brasenia schreberi*). Areas of emergent marsh are seasonally flooded and dominated by graminoids, especially three-way sedge (*Dulichium arundinaceum*), sedges (*Carex* spp.), twig-rush (*Cladium mariscoides*), and spike-rush (*Eleocharis smallii*). Bayonet rush (*Juncus militaris*, state threatened) is common within this zone. The northern wet meadow zone is intermittently inundated and is dominated by bluejoint grass (*Calamagrostis canadensis*) with scattered slender willow (*Salix petiolaris*). The wet meadow is backed by a grounded bog mat that is dominated by leatherleaf (*Chamaedaphne calyculata*) and sphagnum species. The microtopography of hummocks and hollows in the grounded bog zone creates microenvironments with fine-scale gradients in soil moisture and chemistry.

Threats: Significant off-road vehicle damage occurs in the southwestern portion of the site with deep ruts in the mucky soil. Off-road vehicle traffic, especially during late season and dry years could degrade the site's quality dramatically. Deer traffic has created numerous trails through the wetland, locally compacting the peat and mucks and decreasing the depth to the water table. Reed (*Phragmites australis*) and reed canary grass (*Phalaris arundinacea*) are present but may represent the native varities and do not appear to pose a serious threat to the site's composition and structure. Fire suppression in the landscape in general may have reduced the fire return interval of the peatland complex.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across this wetland). In addition, eliminating off-road vehicle traffic could likely be achieved by creating a barricade along the two track that feeds into the southwestern portion of the wetland. Monitoring populations of reed canary grass and reed should be implemented to determine if control measures are needed.

The dynamic hydrologic regime of Black Lake Forest Marsh is characterized by seasonal and yearly fluctuations in water levels. The site's hydrology has been locally impacted by off-road vehicle traffic, which has significantly altered surficial hydrology through rutting, and reduced plant density and diversity. Photos by Joshua G. Cohen.

63. Duck Lake

Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: AB
Location: Atlanta Forest Management Unit, Compartment 169
Element Occurrence Identification Number: 3851

Site Description: This intermittent wetland is found in a shallow basin on sandy lakeplain. The soils are acidic (pH 5.0-6.5) peats of varying depth and composition (including fibric, hemic, and sapric peats) that occur over moist sands. Bands of light colored sand are occasionally intermixed in the soil profile, indicating water level fluctuations. The wetland is inundated in the spring and dries in the summer. The site is characterized by concentric ecological zones patterned by the fluctuating water levels.

The small open water lake contains submergent marsh with sweet-scented water-lily (*Nymphaea odorata*) and water shield (*Brasenia schreberi*). The lake is ringed by a graminoid-dominated zone with patchy vegetation of twig-rush (*Dulichium arundinaceum*), few-seed sedge (*Carex oligosperma*), sedge (*C. flava*), hair grass (*Deschampsia flexuosa*), and northern bugleweed (*Lycopus uniflorus*). Areas of exposed mud flats support sparse vegetation with bayonet rush (*Juncus militaris*, state threatened), Canadian rush (*J. canadensis*), pipewort (*Eriocaulon septangulare*) and round-leaved sundew (*Drosera rotundifolia*). The outer ring of the wetland is shrub-dominated with well-developed sphagnum hummock and hollow microtopography. Dense ericaceous shrubs dominate this zone and include leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), blueberries (*Vaccinium* spp.), and huckleberry (*Gaylussacia baccata*).

Threats: Off-road vehicle traffic, especially during the late season and dry years could degrade the site quality dramatically by causing rutting and altering the hydrology.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across this wetland). If no wildfires occur within the site, prescribed fire should be evaluated as a management tool to express the seed bank. Maintaining a forested buffer surrounding the intermittent wetland will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. Monitoring for invasive species should be implemented. Finally, control of off-road vehicle traffic is warranted and closure of roads in the vicinity of the wetland would help reduce the threat of off-road vehicle damage.

Distinct zones of vegetation at Duck Lake intermittent wetland are patterned by the degree of water level fluctuation, peat accumulation, and organic decomposition. Photos by Joshua G. Cohen.

64. Frog Lakes Complex (Intermittent Wetland)

Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Grayling Forest Management Unit, Compartments 252 and 253
Element Occurrence Identification Number: 9538

Site Description: The Frog Lakes Complex is a series of small lakes and wet depressions formed by the melting of ice blocks on sandy glacial deposits in a pitted outwash plain. The nine intermittent wetlands are formed in small depressions and along several lake margins that experience water level fluctuations. Vegetation structure and composition indicate fluctuating water levels and several of the wetlands were dry during the August 2006 survey. Wetland soils are typically acidic (pH 5.5), fibric, sedge peat overlying sands. Alkaline sands (pH 8.0) surround Frog Lake and alkaline marl (pH 8.0) was noted in a small depression south of Frog Lake. Adjacent uplands include high-quality pine barrens and jack pine–dominated dry northern forest.

Graminoid-dominated zones within these wetlands are dominated by twig-rush (*Cladium mariscoides*), few-seed sedge (*Carex oligosperma*), bluejoint grass (*Calamagrostis canadensis*), Canadian rush (*Juncus canadensis*), and spike-rush (*Eleocharis acicularis*) with cordgrass (*Spartina pectinata*) often prevalent along the wetland margins. Other common plant species include hardstem bulrush (*Schoenoplectus acutus*), wood sage (*Teucrium canadense*), and tall goldenrod (*Solidago altissima*). Shrub-dominated zones are characterized by a dense, low ericaceous shrub layer with leatherleaf (*Chamaedaphne calyculata*) prevalent. Intermittent wetland depressions that have small areas of open water support emergent vegetaton, such as sweet-scented water-lily (*Nymphaea odorata*) and water shield (*Brasenia schreberi*). Sixty-eight plant species were documented in these wetlands.

Threats: The wetland at the southern edge of Frog Lake contains an old boat launch and the trail leading to this boat launch is lined by common St. John's-wort (*Hypericum perforatum*) and spotted knapweed (*Centaurea maculosa*). Off-road vehicle damage was noted adjacent to Frog Lake.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across these wetlands). If no wildfires occur within the site, prescribed fire should be evaluated as a management tool to express the seed bank. Maintaining a buffer of natural communities surrounding the intermittent wetland will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. Efforts to control populations of invasive plants (especially spotted knapweed) should be enacted and monitoring for invasive species should be implemented. Finally, control of off-road vehicle traffic is warranted.

The Frog Lakes Complex is composed of a series of intermittent wetlands embedded within a fire-prone landscape of high-quality pine barrens and jack pine forest. Photos by Michael A. Kost.

[11] Frog Lake Barrens pine barrens

65. Jackson Trail (Intermittent Wetland)

Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: AB
Location: Sault Sainte Marie Forest Management Unit, Compartments 103 and 117
Element Occurrence Identification Number: 4173

Site Description: This site is a series of large intermittent wetlands occurring on poorly drained, flat sandy lakeplain with muck of variable depth (typically around 5 cm) overlying inundated or saturated sands. The organic and mineral soils are circumneutral (pH 6.5-7.0). The water table within these wetlands fluctuates seasonally and annually with shallow pools of water having 40 to 80 cm of standing water. The site is characterized by several ecological zones patterned by the fluctuating water levels: submergent marsh, emergent marsh, northern wet meadow, and grounded bog mat.

Ponds in the center of the wetlands support submergent marsh vegetation with pondweeds (*Potamogeton* spp.), pipewort (*Eriocaulon septangulare*), and mermaid-weed (*Proserpinaca palustris*). These ponds are surrounded by an emergent marsh zone that is characterized by shallow waters and dominated by spike-rushes (*Eleocharis* spp.) and twig-rush (*Dulichium arundinaceum*). Seasonally inundated areas support northern wet meadow vegetation with wiregrass sedge (*Carex lasiocarpa*), few-seed sedge (*C. oligosperma*), grass-leaved goldenrod (*Euthamia graminifolia*), beak-rushes (*Rhynchospora* spp.), and a native St. John's-wort (*Hypericum* sp.). Along the upland margin is a grounded bog mat zone dominated by leatherleaf (*Chamaedaphne calyculata*) with slender willow (*Salix petiolaris*) and characterized by mild sphagnum hummock and hollow microtopography. Several islands of poor conifer swamp with tamarack (*Larix laricina*) occur within the wetland complex. Over 40 vascular plant species were noted during the 2006 survey.

Threats: Off-road vehicle trails could enter the wetland if skid trails are established in the adjacent forest. In addition, fire suppression may be reducing the fire frequency of the site.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across these wetlands). If no wildfires occur within the site, prescribed fire should be evaluated as a management tool to express the seed bank. Maintaining a forested buffer surrounding the intermittent wetland and limiting the establishment of roads and trails in the surrounding forest will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment and off-road vehicle damage. Monitoring for invasive species should be implemented.


These intermittent wetlands occur within a poorly drained lakeplain and are characterized by spring inundation and graminoid dominance. Photos by Joshua G. Cohen.

65. Lake Margrethe North

Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Grayling Forest Management Unit, Compartments 181 and 204
Element Occurrence Identification Number: 7851

Site Description: This is a large wetland complex that is found on a poorly drained outwash plain adjacent to a sandy moraine with oak and aspen forest in the surrounding uplands. The wetland contains numerous small upland rises throughout. The soils of the intermittent wetland are shallow (6-70 cm deep), acidic (pH 4.5) peats over saturated, acidic (pH 5.0) sands. Although surface soils are medium sands, there is likely a layer of heavy soils several feet below the surface that is responsible for the fluctuation of the water level. Iron mottling occurs throughout the soil profile indicating water level fluctuations.

The site contains two main vegetative zones that are patterned throughout: an open graminoid-dominated zone and a bog zone. The open graminoid-dominated zone has saturated peats and is characterized by few-seed sedge (*Carex oligosperma*), livid sedge (*C. livida*), bluejoint grass (*Calamagrostis canadensis*), wild blue flag (*Iris versicolor*), and meadowsweet (*Spiraea alba*). The bog zone is characterized by well-developed sphagnum hummock and hollow microtopography, a dense, low, ericaceous shrub layer dominated by leatherleaf (*Chamaedaphne calyculata*) with bog laurel (*Kalmia polifolia*), sheep laurel (*Kalmia angustifolia*), black chokeberry (*Aronia prunifolia*), and low sweet blueberry (*Vaccinium angustifolium*), and a scattered conifer canopy and understory of red pine (*Pinus resinosa*), white pine (*P. strobus*), and jack pine (*P. banksiana*). Inclusions of mature dry-mesic northern forest occur on sand ridges and there are also small pockets of poor conifer swamp.

A bald eagle (*Haliaeetus leucocephalus*, state threatened) nest has been documented within the complex. In addition, a population of secretive locust (*Appalachia arcana*, state special concern) occurs within the site.

Threats: Over the years, this wetland has been impacted by road construction, timber harvest, and pine plantation establishment. Road construction may have caused slight alterations in the hydrology of the system. It is also possible that the area was historically maintained in a more open condition by periodic fires spreading from the adjacent fire-prone jack pine plains. The suppression of wildfires during the past sixty years may also account for the development of an overstory canopy. Tire tracks and deer trails were observed within the wetland complex.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across this wetland). If no wildfires occur within the site, prescribed fire should be evaluated as a management tool to express the seed bank. Maintaining a natural community buffer surrounding the intermittent wetland will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. Monitoring for invasive species should be implemented. Finally, control of off-road vehicle traffic is warranted and roads passing through the wetland should be closed. If these roads remain open, culverts should be established under the roads.

Photo by Bradford S. Slaughter.

66. Lake Sixteen (Dead Man's Marsh)

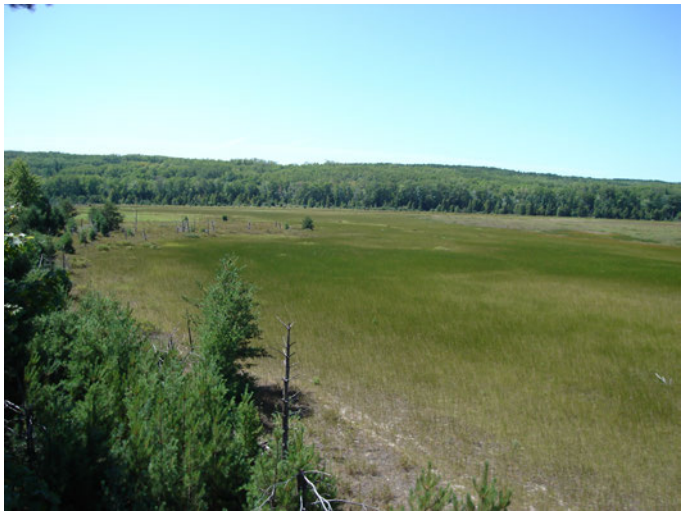
Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Atlanta Forest Management Unit, Compartment 156, and Private Lands
Element Occurrence Identification Number: 11227

Site Description: This intermittent wetland occurs on a shallow depression in relatively level lakeplain with shallow (0-40 cm) slighty acidic (pH 5.5-6.0), sapric peat over moist, acidic (pH 4.5-5.0) sands. In August 2006, the site was dry with saturated to moist open mud flats in the center of the wetland indicating spring saturation and fluctuating water levels. The wetland is bordered by managed pine, maple, oak, and northern hardwood forest with several seasonal homes along the northeastern edge. The site is characterized by several ecological zones patterned by the fluctuating water levels, including a low shrub zone, northern wet meadow, and mud flats.

The wetland is ringed by a low shrub zone dominated by leatherleaf (*Chamaedaphne calyculata*), black chokeberry (*Aronia prunifolia*), and meadowsweet (*Spiraea alba*) with a scattered canopy of white pine (*Pinus strobus*), red pine (*P. resinosa*), and jack pine (*P. banksiana*). Large blocks of this zone occur in the northern and southern portion of the wetland with several shrub peninsulas reaching into the northern wet meadow zone. The northern wet meadow zone is dominated by bayonet rush (*Juncus militaris*, state threatened), grass-leaved goldenrod (*Euthamia graminifolia*), bluejoint grass (*Calamagrostis canadensis*), Virginia marsh St. John's-wort (*Triadenum virginicum*), and lance-leaved violet (*Viola lanceolata*). The wet meadow zone is broad and intermixed with open level mud flats with scattered round-leaved sundew (*Drosera rotundifolia*), panic grass (*Panicum spretum*), brown-fruited rush (*Juncus pelocarpus*), and Dudley's rush (*J. dudleyi*). The site is significant for its well-established population of bayonet rush and as one of the first known locations of the panic grass *Panicum spretum*. Over 45 vascular plant species were identified during the 2006 survey.

Threats: Off-road vehicle traffic occurs throughout the wetland but is concentrated along the southern edge of the wetland in proximity to Twin Lakes Road. Numerous ruts occur with some areas of severe peat compaction. According to a local resident, several man-made ponds occur north of the site and could be altering the site's hydrology.

Management Recommendations: Maintaining a forested buffer surrounding the intermittent wetland will help maintain the wetland's hydrologic regime and limit the possibility for invasive species encroachment. Control of off-road vehicle traffic is warranted. Portions of the wetland and surrounding uplands that occur on private lands could be protected through acquisition or the establishment of conservation easements.




This intermittent wetland was completely dry during August 2006 surveys and is characterized by an extensive northern wet meadow zone dominated by graminoids such as ticklegrass (*Agrostis hyemale*) (right photo). Photos by Joshua G. Cohen.

68. Michaud Lake

Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Location: Shingleton Forest Management Unit, Compartments 86 and 87
Element Occurrence Identification Number: 4653

Site Description: This intermittent wetland rings a softwater seepage lake in a shallow depression on lacustrine sand and gravel deposits. The soils are characterized by organics mixed with sand over moist, slightly acidic (pH 6.5) sands. Sand is exposed at the soil surface around the drawn-down margin of the former lake with saturated organics occurring along the current lake margin. The water table was observed at approximately 45 cm in August 2006. The site is characterized by concentric ecological zonation indicative of fluctuating water levels. A high-quality bog occurs south of US 2, which was formerly mapped as part of the intermittent wetland complex

Open water zones are dominated by submergent marsh with sweet-scented water-lily (*Nymphaea odorata*), yellow pond-lily (*Nuphar variegata*), and pondweeds (*Potamogeton* spp.). A partially saturated, graminoid-dominated zone occurs along the lake edge and is dominated by spike-rushes (*Eleocharis* spp.), three-way sedge (*Dulichium arundinaceum*), and softstem bulrush (*Schoenoplectus tabernaemontani*). Areas of exposed sand are dominated by spike-rushes, larger Canada St. John's-wort (*Hypericum majus*), autumn sedge (*Fimbristylis autumnalis*), and short-fruited rush (*Juncus brachycarpus*). The uppermost portion of the wetland is a shrub zone that is dominated by leatherleaf (*Chamaedaphne calyculata*) and meadowsweet (*Spiraea alba*) with scattered willow (*Salix* spp.) and winterberry (*Ilex verticillata*). Uplands surrounding the wetland are dominated by red pine (*Pinus resinosa*), oaks (*Quercus* spp.), and red maple (*Acer rubrum*). Forty vascular plant species were recorded during the 2006 survey.

Threats: Proximity of the wetland to US 2 and the railroad may affect the local hydrology of the northwestern and southwestern corners of the wetland and facilitate the invasion of non-native species. A burgeoning population of reed canary grass (*Phalaris arundinacea*) threatens to invade the wetland. In addition, there is evidence of off-road vehicle trails in the western portion of the wetland and deer trampling was noted along the western edge.

Management Recommendations: Maintaining a forested buffer surrounding the intermittent wetland will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. Efforts to control populations of invasive reed canary grass should be considered and monitoring for invasive species should be implemented, especially since the site is close to US 2. Finally, control of off-road vehicle traffic is warranted.

Photo by Bradford S. Slaughter.

[12] Tighe Lake bog

69. Mud Lake

Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Atlanta Forest Management Unit, Compartments 168 and 169
Element Occurrence Identification Number: 7652

Site Description: The Mud Lake site is a large depressional wetland that is located in a poorly drained portion of sandy lakeplain. The soils are characterized by thin organics over coarse-textured sands. The wetland is characterized by fluctuating water levels and several vegetation zones ranging from a small open water lake with patches of open mud flats to concentric zones of emergent marsh/northern wet meadow, and a shrub-dominated margin.

Areas of emergent marsh/northern wet meadow are dominated by softstem bulrush (*Schoenoplectus tabernaemontani*), bayonet rush (*Juncus militaris*, state threatened), wiregrass sedge (*Carex lasiocarpa*), and bluejoint grass (*Calamagrostis canadensis*) with water smartweed (*Polygonum amphibium*) and hardstem bulrush (*Schoenoplectus acutus*). Willows (*Salix* spp.) are prevalent near the upland edge. The surrounding uplands and several upland islands within the wetland are dominated by red pine (*Pinus resinosa*) and jack pine (*P. banksiana*).

Threats: Off-road vehicle traffic, especially during the late season and dry years, could degrade the site quality dramatically by causing rutting and altering the hydrology. Reed canary grass (*Phalaris arundinacea*) could potentially negatively impact the wetland's species composition and structure.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across this wetland). If no wildfires occur within the site, prescribed fire should be evaluated as a management tool to express the seed bank. Maintaining a forested buffer surrounding the intermittent wetland will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. Efforts to control populations of invasive reed canary grass should be considered and monitoring for invasive species should be implemented. Finally, control of off-road vehicle traffic is warranted.

Photo by Michael A. Kost.

70. Nine Mile Lake

Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: AB
Location: Shingleton Forest Management Unit, Compartment 84
Element Occurrence Identification Number: 10643

Site Description: This intermittent wetland surrounds a softwater seepage lake and occurs on lacustrine sand and gravel. The wetland is characterized by shallow (0-20 cm) acidic (pH 5.0-5.5) sapric peat over slighty acid (pH 6.5), moist, medium-textured sands. The water table was approximately 30 cm deep during August 2006 surveys. Fluctuating water levels generate distinct ecological zones associated with small-scale hydrologic gradients. The wetland is characterized by three primary ecological zones: a grounded bog mat, a northern wet meadow/poor fen, and open mud flats. The site is surrounded by upland forest of jack pine (*Pinus banksiana*), white pine (*P. strobus*), and quaking aspen (*Populus tremuloides*).

The grounded bog mat constitutes a thin outer ring dominated by leatherleaf (*Chamaedaphne calyculata*) with scattered jack pine trees. This zone transitions to a broad expanse of northern wet meadow/poor fen dominated by few-seed sedge (*Carex oligosperma*) with patches of wiregrass sedge (*C. lasiocarpa*), beaked sedge (*C. utriculata*), and bluejoint grass (*Calamagrostis canadensis*). Additional species include grass-leaved goldenrod (*Euthamia graminifolia*), muhly grass (*Muhlenbergia uniflora*), northern manna grass (*Glyceria borealis*), wild blue flag (*Iris versicolor*), swamp candles (*Lysimachia terrestris*), beak-rush (*Rhynchospora capitellata),* and golden-seeded spike-rush (*Eleocharis elliptica*). This zone grades into open mud flats with patchy rushes (*Juncus* spp.), panic grasses (*Panicum* spp.), softstem bulrush (*Schoenoplectus tabernaemontani*), spike-rushes (*Eleocharis* spp.), and pipewort (*Eriocaulon septangulare*). Scattered within the mudflats are small, shallow pockets of standing water. Thirty-three vascular plant species were noted during the survey.

Threats: Proximity of the wetland to US 2 may facilitate the invasion of non-native species. The natural fire regime may be altered due to fire suppression and fragmentation in the surrounding uplands.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across this wetland). If no wildfires occur within the site, prescribed fire should be evaluated as a management tool to express the seed bank. Maintaining a forested buffer surrounding the intermittent wetland will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. Monitoring for invasive species should be implemented, especially since the site is close to US 2.

Photo by Bradford S. Slaughter.

71. Prison Camp Intermittent Wetland

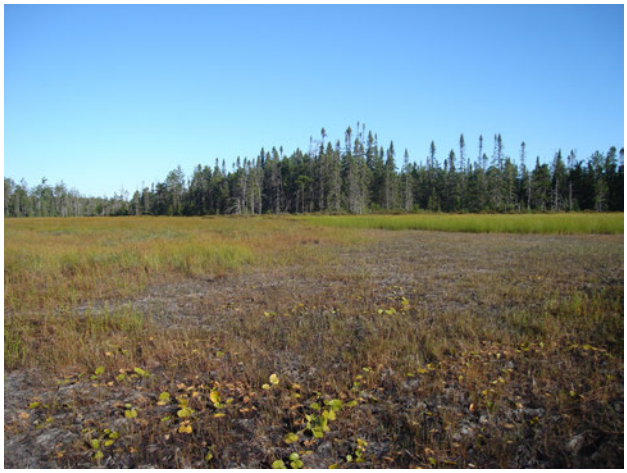
Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: A
Location: Newberry Forest Management Unit, Compartment 58
Element Occurrence Identification Number: 323

Site Description: This large intermittent wetland occurs on a flat, poorly drained lakeplain surrounded by dry sandy dune ridges. The wetland is situated between the forks of two small creeks which drain north and become the South Branch of the Betsy River. An extensive high-quality muskeg occurs to the northwest of the site[13]. Soils of the intermittent wetland are thin, acidic organics that are saturated to inundated and include fibric peats and sapric mucks. Fibric peats are prevalent along the shrub margins and in bog zones where water level fluctuation has stabilized. Mucks or sapric peats are prevalent where water level fluctuates seasonally (northern wet meadow/ emergent marsh zone) and in areas where water levels are more persistent (submergent marsh zone). Poor conifer swamp with black spruce (*Picea mariana*) and dry northern forest with red pine (*Pinus resinosa*) and jack pine (*P. banksiana*) occur as forest fingers extending into the wetland along low-lying, sand dune ridges. The northern wet meadow/emergent marsh zone occurs where water is 10 to 30 cm deep and the submergent marsh zone occurs where water is 30 to 50 cm deep. Moose (*Alces alces*, state special concern) sign is evident throughout the eastern portion of the wetland complex.

The wetland is ringed by a shrub-dominated margin that is 10 to 20 m wide with leatherleaf (*Chamaedaphne calyculata*), few-seed sedge (*Carex oligosperma*), and sphagnum mosses. Ericaceous shrubs, few-seed sedge, and large cranberry (*Vaccinium macrocarpon*) are also prevalent in wetland fingers where the hydrology has stabilized. Scattered tall shrubs and stunted trees occur along the shrub margin and in bog areas and include mountain holly (*Nemopanthus mucronata*), black spruce, jack pine, and white pine (*Pinus strobus*). Areas of seasonal inundation are dominated by the northern wet meadow/emergent marsh zone with few-seed sedge, twig-rush (*Cladium mariscoides*), three-way sedge (*Dulichium arundinaceum*), golden-seeded spike-rush (*Eleocharis elliptica*), and northern manna grass (*Glyceria borealis*) as local dominants. Ponds and pools of deeper water (30-50 cm) are dominated by yellow pond-lily (*Nuphar variegata*).

Threats: There is a limited threat from off-road vehicles and invasive plant species since the trail to the east has been closed to vehicular traffic. Keeping this road closed will help minimize potential threats to this site.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across this wetland). Moose tracks were noted throughout the wetlands. An interesting research question is to examine the impacts of moose browsing on species composition and vegetative structure.



Intermittent wetlands are characterized by water level fluctuations. Prison Camp intermittent wetland was inundated in June (left) and completely dry by early August (right). Photos by Joshua G. Cohen.

[13] Prison Camp Muskeg

Peats have stabilized along the margins of the Prison Camp intermittent wetland and are dominated by low ericaceous shrubs, a continuous carpet of sphagnum mosses, and scattered and stunted conifers. Photos by Joshua G. Cohen.

72. Swamp Lakes (Intermittent Wetland)

Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: A
Location: Newberry Forest Management Unit, Compartment 42, and Private Lands
Element Occurrence Identification Number: 4977

Site Description: This site is characterized by seven intermittent wetlands of variable stages of drawdown occurring on poorly drained lakeplain that is surrounded by Post-Algonquin dune ridges supporting high-quality dry-mesic northern forest[14]. The topography is flat, however, the wetlands contain mild rises that occur as islands, peninsulas, and terraces of old lakebeds. Six of the seven wetlands were completely dry during the 2007 growing season, with the third largest wetland having several shallow pools (10-20 cm deep) in June. By August 15, this wetland was completely drawn down as well. The soils are characterized by a thin layer of acidic muck over wet acidic sands with sandy clay and sandy clay loam occurring sporadically beneath the muck.

The upland margins of the wetlands and the low, sand dune ridge fingers and islands occurring within the wetlands are dominated by leatherleaf (*Chamaedaphne calyculata*) with scattered, stunted jack pine (*Pinus banksiana*), black spruce (*Picea mariana*), and white pine (*Pinus strobus*). These leatherleaf zones are typically flanked by a band of bluejoint grass (*Calamagrostis canadensis*) and few-seed sedge (*Carex oligosperma*). Lower areas exhibit local dominance by golden-seeded spike-rush (*Eleocharis elliptica*), three-way sedge (*Dulichium arundinaceum*), and sedge species (*Carex* spp.). Northern manna grass (*Glyceria borealis*) and yellow pond-lily (*Nuphar variegata*) occur in the limited areas of pooling water. Areas of exposed sand are dominated by panic grass (*Panicum implicatum*), along with tickle grass (*Agrostis hyemalis*), northern St. John's-wort (*Hypericum boreale*), coastal flat-topped goldenrod (*Euthamia remota*), and bog aster (*Aster nemoralis*). The driest wetlands are characterized by barren, crusted muck and areas where wetland obligates are stunted or dead, suggesting that spring drawdown was very rapid and drought conditions prevailed in 2007. A large colony of northern prostrate clubmoss (*Lycopodiella margueriteae*, state threatened) occurs in the north-central portion of the complex.

Threats: The road that accesses the site could lead to future off-road vehicle damage to those wetlands that occur adjacent to the road.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across these wetlands). In addition, portions of the wetland occurring on private lands could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

[14]Swamp Lakes Dry-mesic Northern Forest

LIMESTONE BEDROCK GLADE (ALVAR GLADE)

Overview: Limestone bedrock glade consists of an herb- and graminoid-dominated plant community with scattered clumps of stunted trees and shrubs growing on thin soil over limestone or dolomite. Tree cover is typically 10 to 25%, but occasionally as high as 60%. Shrub and herb cover is variable and there are typically areas of exposed bedrock. Mosses, lichens, and algae can be abundant on the exposed limestone bedrock or thin organic soils. Seasonal flooding and summer drought maintain the open conditions. In Michigan, limestone bedrock glade occurs in the Upper Peninsula near the shorelines of Lakes Huron and Michigan, concentrated in a band from Drummond Island to Cedarville and from Gould City to the Garden Peninsula. In the northern Lower Peninsula, limestone bedrock glade occurs along the Lake Huron shoreline near Rogers City, Alpena, and Thompson's Harbor. This community is also referred to as alvar glade (Kost et al. 2007).

73. Garden Glade Southeast

Natural Community Type: Limestone Bedrock Glade (Alvar Glade) (re-classified from Alvar)
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: AB
Location: Shingleton Forest Management Unit, Compartment 99, and Private Lands
Element Occurrence Identification Number: 9612

Site Description: This extensive limestone bedrock glade occurs over limestone pavement paralleling the shoreline on a gentle eastern slope a quarter of a mile from Lake Michigan. Closed-canopy boreal forest of quaking aspen (*Populus tremuloides*), white spruce (*Picea glauca*), and balsam fir (*Abies balsamea*) surround the glade. The site is characterized by thin (0-15 cm) alkaline (pH 8.0) organic and loam soils over limestone pavement. Exposed limestone slabs occur occasionally.

This alvar glade exhibits structural complexity, grading from sparse vegetation zones to grassland to glade to woodland. In addition, the glade has several seasonally wet pockets. During July surveys, the glade was dry and droughty but pockets of wetland plants indicated spring saturation. In areas of exposed bedrock, vegetation is sparse except for in cracks in the limestone where sufficient soil has developed to support plant growth. In other areas, several centimeters of loam or organic soils support a tree canopy of scattered northern white-cedar (*Thuja occidentalis*). Additional canopy associates include white spruce, aspens (*Populus* spp.), and white pine (*Pinus strobus*). Distribution of northern white-cedars is very clumpy, and a distinct browse line is visible on the trees and shrubs. Scattered clumps of common juniper (*Juniperus communis*) occur in the low shrub layer and the ground layer is dominated by poverty oats (*Danthonia spicata*) in drier areas and dwarf lake iris (*Iris lacustris*, federal/state threatened) is prevalent in moister areas. In addition to the rare dwarf lake iris, Richardson's sedge (*Carex richardsonii*, state special concern) and beauty sedge (*Carex concinna*, state special concern) are known from the alvar glade. Following 2006 surveys, this site, which was formerly classified as alvar, was re-classified as limestone bedrock glade.

Threats: Numerous roads cross the site and may affect the local hydrology (especially in the spring), act as pathways for invasive species, and provide off-road vehicle access. Off-road vehicle use, widespread in the occurrence and in the surrounding area, is highly detrimental to soils and vegetation, and can cause substantial damage in places of such thin soils. Off-road vehicles also introduce and spread non-native invasive species which have become well established within this site. Invasive species are numerous along the trails and some species (particularly hawkweeds) are becoming well-established in places. Numerous deer trails exist within the site, and deer browse is extremely high.

Management Recommendations: The main management recommendations for this site include enforcing off-road vehicle restrictions, blocking trails leading into alvar glade to limit off-road vehicle access, controlling and monitoring for invasive species, and reducing deer densities throughout the larger landscape by increasing deer harvest levels and/or limiting aspen clearcuts and extending the timber rotation of managed forests. Portions of this alvar glade and the surrounding area occur on private lands, so pursuit of acquisition and the establishment of conservation easements are warranted.

This limestone bedrock glade is characterized by an herb- and graminoid-dominated ground cover with scattered clumps of stunted trees and shrubs growing on thin soil over limestone bedrock. Photos by Adrienne L. Bozic.

74. Grand Lake Glade

Natural Community Type: Limestone Bedrock Glade (Alvar Glade) (re-classified from Alvar)
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: BC
Location: Atlanta Forest Management Unit, Compartments 140 and 141
Element Occurrence Identification Number: 6511

Site Description: This limestone bedrock glade occurs in a complex with other natural communities found on limestone bedrock including rich conifer swamp, northern wet meadow, northern shrub thicket, and boreal forest dominated by northern white-cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), and balsam fir (*Abies balsamea*). The alvar glade occurs on a gentle northeast facing slope with thin (4-10 cm) loamy, alkaline (pH 7.5-8.0) soils mixed with dolomite cobble. The bedrock is broken with the north-facing slope having been mostly formed by buried talus.

The glade is characterized by a scattered canopy and subcanopy with northern white cedar (20-37 cm DBH) dominating the canopy (30-60% cover) and cedar, balsam fir, and white spruce (12-17 cm DBH) dominating the subcanopy with associates including paper birch (*Betula papyrifera*), quaking aspen (*Populus tremuloides*), jack pine (*Pinus banksiana*), and sugar maple (*Acer saccharum*). The open shrub layer includes soapberry (*Shepherdia canadensis*), alder-leaved buckthorn (*Rhamnus alnifolia*), red-osier dogwood (*Cornus stolonifera*), round-leaved dogwood (*C. rugosa*), serviceberry (*Amelanchier* sp.), downy arrow-wood (*Viburnum rafinesquianum*), and common juniper (*Juniperus communis*). The ground layer is dense with ebony sedge (*Carex eburnea*), poverty grass (*Danthonia spicata*), dwarf lake iris (*Iris lacustris*, federal/state threatened), bearberry (*Arctostaphylos uva-ursi*), old-field goldenrod (*Solidago nemoralis*), large-leaved aster (*Aster macrophyllus*), arrow-leaved aster (*Aster sagittifolius*), Canada mayflower (*Maianthemum canadense*), and wild rose (*Rosa blanda*). Following 2006 surveys, this site, which was formerly classified as alvar, was re-classified as limestone bedrock glade.

Threats: Invasive species are prevalent in the surrounding landscape and threaten the floristic composition and structure of the glade. A burgeoning population of common barberry (*Berberis vulgaris*) occurs along the road to the southeast of the alvar glade.

Management Recommendations: The primary management need is to control populations of non-native species, especially the nearby population of common barberry. Efforts to control invasive species should be monitored.

Photo by Rebecca K. Schillo.

75. Kregg Bay Glade

Natural Community Type: Limestone Bedrock Glade (Alvar Glade) (re-classified from Alvar)
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: B
Location: Shingleton Forest Management Unit, Compartment 98, and Private Lands
Element Occurrence Identification Number: 5952

Site Description: Kregg Bay Glade is a sinuous limestone bedrock glade located less than half a mile from the shoreline surrounded by second-growth boreal forest of white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), and northern white-cedar (*Thuja occidentalis*), and aspen clearcuts. The soils are thin (0-14 cm) loamy alkaline sands and organics over limestone bedrock with local exposures of bedrock.

The alvar glade is characterized by a scattered to clumped canopy (20-50% cover) of white spruce (10-30 cm DBH) and northern white-cedar (20-40 cm DBH) with sparse balsam fir, white pine (*Pinus strobus*), red pine (*P. resinosa*), and quaking aspen (*Populus tremuloides*). The open subcanopy and tall shrub layer (10-40% cover) is dominated by white spruce with occasional choke cherry (*Prunus virginiana*). Scattered low shrubs include soapberry (*Shepherdia canadensis*), ground juniper (*Juniperus communis*), and alder-leaved buckthorn (*Rhamnus alnifolia*). White spruce also occurs in the low shrub layer. The ground layer is characterized by ebony sedge (*Carex eburnea*), poverty grass (*Danthonia spicata*), dwarf lake iris (*Iris lacustris*, federal/state threatened), and Richardson's sedge (*Carex richardsonii*, state special concern). Fifty-seven vascular plant species were documented during the survey.

Following 2006 surveys, this site, which was formerly classified as alvar, was re-classified as limestone bedrock glade.

Threats: The primary threat to this site is posed by invasive plant species. The invasive plants Canada bluegrass (*Poa compressa*), spotted knapweed (*Centaurea maculosa*), ox-eye daisy (*Chrysanthemum leucanthemum*), and lawn prunella (*Prunella vulgaris*) are beginning to infiltrate the site by spreading along the roads that pass through portions of the occurrence. These invasives could be further spread by off-road vehicle activity. In addition, severe deer browse was noted throughout the site.

Management Recommendations: The main management recommendations for this site are to control and monitor invasives (especially spotted knapweed) and to reduce deer densities throughout the larger landscape by limiting aspen clearcuts and extending timber rotations of adjacent managed forests. Cutting immediately adjacent to the glade to promote winter deer yarding should be evaluated, since increased deer densities may jeopardize the regeneration capacity of cedar and other species within alvar glades. Portions of this alvar glade and the surrounding lands occur on private land, so pursuit of acquisition and the establishment of conservation easements are warranted.

Photo by Bradford S. Slaughter.

76. Seaman's Point (Drummond Island)

Natural Community Type: Limestone Bedrock Glade (Alvar Glade) (re-classified from Alvar)
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: AB
Location: Sault Sainte Marie Forest Management Unit, Compartment 14
Element Occurrence Identification Number: 4734

Site Description: Site Description: This site is characterized by droughty exposures of bedrock with many areas of broken and uneven limestone pavement. The glade supports a floristic community dominated by scattered conifers and low shrubs with patchy ground cover. The vegetation is concentrated where cracks in the bedrock broaden to provide moisture and some soil development. Where soils occur they are thin (0-5 cm deep) and alkaline (pH 8.0). Moisture availability is the controlling factor determining vegetative patterning. Northern white-cedar (*Thuja occidentalis*) dominates the limestone bedrock glade and the boreal forest that surrounds the glade. The alvar glade abuts limestone bedrock lakeshore[15] to the south and second growth boreal forest on all other sides.

The glade is characterized by a scattered canopy and shrub layer with stunted northern white-cedar, white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), common juniper (*Juniperus communis*), and shrubby cinquefoil (*Potentilla fruticosa*). The open areas of alvar glade are dominated by grasses and herbs with calciphiles prevalent. In addition, many areas of open, exposed bedrock characterize much of the glade. Prevalent species in the ground layer include poverty grass (*Danthonia spicata*), low calamint (*Calamintha arkansana*), ebony sedge (*Carex eburnea*), panic grass (*Panicum lindheimeri*), Indian paintbrush (*Castilleja coccinea*), Alaska orchid (*Piperia unalascensis*, state special concern), and Hill's thistle (*Cirsium hillii*, state special concern). Following 2006 surveys, this site, which was formerly classified as alvar, was re-classified as limestone bedrock glade.

Threats: The main threat to this site is posed by future home development on private lands to the west and associated increases in off-road vehicle use.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered (i.e., let wildfires burn) and to maintain a forested buffer surrounding the limestone bedrock glade to prevent the increase of a weedy seed source. A significant portion of the adjacent lands are in private ownership and could be acquired or protected through conservation easements.

Photo by Dennis A. Albert.

[15] Seaman's Point Limestone Bedrock Glade

77. Sucker Lake

Natural Community Type: Limestone Bedrock Glade (Alvar Glade) (re-classified from Alvar)
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: AB
Location: Shingleton Forest Management Unit, Compartments 98 and 99, and Private Lands
Element Occurrence Identification Number: 142

Site Description: This limestone bedrock glade is located a half mile from the shoreline on the Garden Peninsula and is surrounded by aspen forest and rich conifer swamp. The alvar glade is characterized by thin (2-10 cm) calcareous (pH 8.0) sandy to clay loam soils over limestone bedrock with almost no areas of bedrock exposure.

The limestone bedrock glade is dominated by a scattered canopy of white spruce (*Picea glauca*), northern white-cedar (*Thuja occidentalis*), paper birch (*Betula papyrifera*), and quaking aspen (*Populus tremuloides*). These tree species are also found in the surrounding boreal forest with occasional white pine (*Pinus strobus*) (20-40 cm DBH). The scattered shrub layer of the limestone bedrock glade is characterized by common juniper (*Juniperus communis*) and soapberry (*Shepherdia canadensis*), and the ground layer is dominated by ebony sedge (*Carex eburnea*), poverty grass (*Danthonia spicata*), dwarf lake iris (*Iris lacustris*, federal/state threatened), and Richardson's sedge (*Carex richardsonii*, state special concern). Over 70 vascular plant species were documented during the survey. Following 2006 surveys, this site, which was formerly classified as alvar, was re-classified as limestone bedrock glade.

Threats: Multiple logging roads bisect the community and the surrounding landscape providing pathways for invasives and possibly affecting micro-level hydrology due to the thin soils overlying the bedrock. Heavy deer browse was noted throughout the site: most northern white-cedar seedlings were stunted and there is a distinct browse line on the mature trees. A lone glossy buckthorn (*Rhamnus frangula*) shrub was located during the survey. Additional invasive species include Canada bluegrass (*Poa compressa*), common St. John's-wort (*Hypericum perforatum*), spotted knapweed (*Centaurea maculosa*), ox-eye daisy (*Chrysanthemum leucanthemum*), and lawn prunella (*Prunella vulgaris*). These invasives could be further spread by off-road vehicle activity.

Management Recommendations: The main management recommendations for this site are to control and monitor invasives (especially glossy buckthorn and spotted knapweed) and to reduce deer densities throughout the larger landscape by limiting aspen clearcuts and extending timber rotations of adjacent managed forests. Cutting immediately adjacent to the glades to promote winter deer yarding should be evaluated, since increased deer densities may jeopardize the regeneration capacity of cedar and other species within the alvar glades. Portions of these alvar glades and the surrounding lands occur on private land so pursuit of acquisition and the establishment of conservation easements are warranted.

Photo by Michael A. Kost.

78. The Rock – Drummond Island (Limestone Bedrock Glade)

Natural Community Type: Limestone Bedrock Glade (Alvar Glade) (re-classified from Alvar)
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: B
Location: Sault Sainte Marie Forest Management Unit, Compartment 8, and Private Lands
Element Occurrence Identification Number: 8641

Site Description: This limestone bedrock glade is located on Drummond Island and is surrounded by boreal forest with white spruce (*Picea glauca*) and quaking aspen (*Populus tremuloides*). The alvar glade is characterized by thin calcareous (pH 8.0) silty soils over dolomite bedrock, which tilts slightly to the south. Areas of exposed pavement, boulders, and grykes occur throughout the site.

This site is characterized by two areas of limestone bedrock glade dominated by a scattered, open canopy and subcanopy of northern white-cedar (*Thuja occidentalis*), white spruce, white pine (*Pinus strobus*), and balsam fir (*Abies balsamea*). These conifers are also prevalent in the understory. Canopy associates include quaking aspen and paper birch (*Betula papyrifera*). The shrub layer is dominated by common juniper (*Juniperus communis*) with bearberry (*Arctostaphylos uva-ursi*) locally common. Dominant ground layer species include ebony sedge (*C. eburnea*) and Richardson's sedge (*Carex richardsonii*, state special concern). Additional rare plants noted within this site include Hill's thistle (*Cirsium hillii*, state special concern) and Alaska orchid (*Piperia unalascensis*, state special concern). Floristic diversity for this site is low to moderate relative to other occurrences of limestone bedrock glade, possibly due to the droughty nature of the substrate. Large portions of the glade consist of bare bedrock exposures. Following 2007 surveys, this site, which was formerly classified as alvar, was re-classified as limestone bedrock glade.

Threats: Deer herbivory is impacting species composition and structure. Logging roads through the site locally compact soils and provide a conduit for non-native species and off-road vehicles, which have caused localized damage. Logging in the surrounding boreal forest could increase the seed source for weedy species, which could be windblown or bird-dispersed onto the glades. Invasive species found within the site include common St. John's-wort (*Hypericum perforatum*), ox-eye daisy (*Chrysanthemum leucanthemum*), lawn prunella (*Prunella vulgaris*), and hawkweeds (*Hieracium* spp.). These invasives could be further spread by off-road vehicle activity.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered (i.e., let wildfires burn), control populations of non-native species (especially St. John's-wort), and maintain a forested buffer surrounding the glades to prevent the increase of a weedy seed source. Monitoring should be implemented for non-native plant populations and to gauge the impact of deer herbivory. Increasing the amount of late-successional habitat in the adjacent landscape will help reduce deer browse pressure. Reducing deer densities in the general landscape is recommended.

Photo by Bradford S. Slaughter.

LIMESTONE BEDROCK LAKESHORE

Overview: Limestone bedrock lakeshore is a sparsely-vegetated community dominated by herbaceous vegetation, mosses, and lichens, with stunted trees and shrubs often concentrated above the strong influence of waves and ice scour, and on cobble ridges. This community, which is also referred to as alvar pavement and limestone pavement lakeshore, occurs along the shorelines of northern Lake Michigan and Lake Huron on broad, flat, horizontally-bedded expanses of limestone or dolomite bedrock. The soil is mostly organic and the pH is slightly acid to neutral. Three structural or dominance zones are typically present: splash zone of the lowest wave and ice-swept portion; lichen-herb zone in the middle portion, splashed by spray during storms, dominated by crustose lichens with patches of herbs and occasional shrubs; and a heath zone of the upper portion, swept by winds, subject to rime (ice) accumulation, and dominated by stunted conifer trees or low evergreen shrubs. Bedrock lakeshore is characterized by stressed and unstable environment because of winter ice, storms, and wind. On the Lake Michigan shoreline, limestone bedrock lakeshore is concentrated along the Garden Peninsula and the southern part of Schoolcraft County. Along Lake Huron, it is located on Drummond Island, east of the Les Cheneaux Islands, and on Thunder Bay Island (Kost et al. 2007).

79. Bass Cove (Drummond Island)

Natural Community Type: Limestone Bedrock Lakeshore
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: A
Location: Sault Sainte Marie Forest Management Unit, Compartment 15, and Private Lands
Element Occurrence Identification Number: 8109

Site Description: This site is characterized by six distinct stretches of exposed limestone bedrock lakeshore that occur for over three miles along the southern shoreline of Drummond Island along Lake Huron. The limestone bedrock lakeshore is broken by stretches of high-quality limestone cobble shore and sand and gravel beach. Limestone bedrock glade extends upland from the pavement and grades into boreal forest and rich conifer swamp dominated by northern white-cedar (*Thuja occidentalis*).

Most of the pavement lakeshore is very open with vegetation concentrated in the grykes (cracks) or in solution depressions, where moisture and some soil may be present. The site is characterized by distinct zonation with splash and scrub zones in addition to scattered shallow pools. Characteristic vegetation includes northern white-cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), shrubby cinquefoil (*Potentilla fruticosa*), low calamint (*Calamintha arkansana*), dwarf Canadian primrose (*Primula mistassinica*), ninebark (*Physocarpus opulifolius*), panic grass (*Panicum lindheimeri*), bulrush sedge (*Carex scirpoidea*, state threatened), Richardson's sedge (*C. richardsonii*, state special concern), and flattened spike-rush (*Eleocharis compressa*, state threatened).

Threats: Primary threats to this site include future residential development, off-road vehicle traffic, and invasive species. Five invasive species were noted during 2006 surveys but none of those species posed a serious threat. Purple loosestrife (*Lythrum salicaria*) was one of those species but it was very localized and pulled during the 2006 surveys.

Management Recommendations: The main management needs are to control populations of non-native species (i.e., purple loosestrife), monitor control efforts, pursue land acquisition or establish conservation easements for private shoreline and adjacent inlands, and control illegal off-road vehicle use along the shoreline. Invasive species encroachment and illegal off-road vehicle use could be limited by maintaining an unmanaged forest buffer adjacent to the shoreline.

Photo by Dennis A. Albert.

80. Grand Marais Lake (Drummond Island)

Natural Community Type: Limestone Bedrock Lakeshore
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: A
Location: Sault Sainte Marie Forest Management Unit, Compartment 2, and Private Lands
Element Occurrence Identification Number: 3190

Site Description: This limestone bedrock lakeshore is characterized by a series of low bedrock steps that create a series of narrow lakeshore and alvar openings between higher areas of limestone bedrock glade or boreal forest. The site occurs on Drummond Island adjacent to Lake Huron. The bedrock throughout this site consists of limestone with no large solution cracks. A thin layer of carbonates coat the plants and rock along the shores of Grand Marais Lake, which is shallow and occupies a large depression in the bedrock. The ecological gradient includes dry, exposed limestone pavement, narrow zones of northern fen and wet meadow, and low beach ridges with wave-deposited cobbles. Ants are common under the loose cobble and black bears are commonly encountered.

Characteristic species along the limestone bedrock lakeshore include algae, low calamint (*Calamintha arkansana*), bulrush sedge (*Carex scirpoidea*, state threatened), and flattened spike-rush (*Eleocharis compressa*, state threatened). Typical species of the limestone bedrock glade include northern white-cedar (*Thuja occidentalis*), ebony sedge (*Carex eburnea*), and Crawe's sedge (*Carex crawei*). Prairie dropseed (*Sporobolus heterolepis*, state special concern) and Hill's thistle (*Cirsium hillii*, state special concern) are common in areas of alvar grassland. Common species throughout the site include low calamint, shrubby cinquefoil (*Potentilla fruticosa*), bluejoint grass (*Calamagrostis canadensis*), Richardson's sedge (*Carex richardsonii*, state special concern), Indian paintbrush (*Castilleja coccinea*), Kalm's lobelia (*Lobelia kalmii*), small-fringed gentian (*Gentianopsis procera*), and tall flat-top white aster (*Aster umbellatus*).

Threats: Primary threats to this site include future residential development, off-road vehicle traffic, and invasive species. Non-native species noted during the 2006 surveys included common mullein (*Verbascum thapsus*), Canada bluegrass (*Poa compressa*), common St. John's-wort (*Hypericum perforatum*), common plantain (*Plantago major*), common dandelion (*Taraxacum officinale*), and ox-eye daisy (*Chrysanthemum leucanthemum*)

Management Recommendations: The main management needs are to control populations of non-native species (i.e., common mullein and St. John's-wort), monitor control efforts, pursue land acquisition or establish conservation easements for private shoreline and adjacent inlands, and control illegal off-road vehicle use along the shoreline. Invasive species encroachment and illegal off-road vehicle use could be limited by maintaining an unmanaged forest buffer adjacent to the shoreline.

Photo by Dennis A. Albert.

81. Huron Bay (Drummond Island)

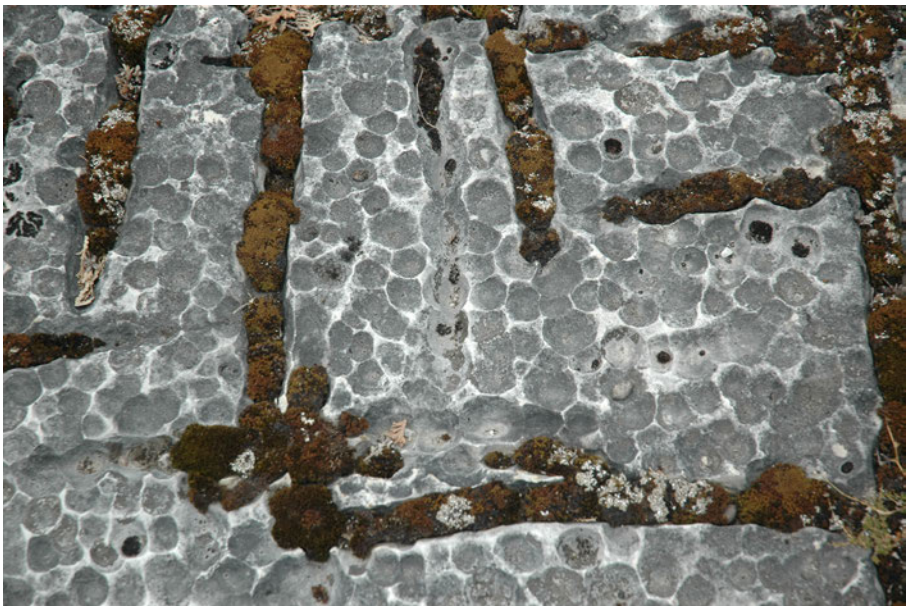
Natural Community Type: Limestone Bedrock Lakeshore
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: A
Location: Sault Sainte Marie Forest Management Unit, Compartment 14, and Private Lands
Element Occurrence Identification Number: 7753

Site Description: This limestone bedrock lakeshore is characterized by gently sloping (3%) limestone bedrock that forms a broad open pavement along the entire shoreline and is broken by small areas of limestone cobble shore, and low ledges. This site occurs along the Lake Huron shoreline on Drummond Island. Small shallow pools that occur in the rock typically lack vegetation but support algae and some bryophytes.

The vegetation cover is generally less than 5% and consists of low herbs with scattered shrubs that are concentrated in the cracks and rock depressions where thin soils have accumulated. Bryophytes, primarily mosses, also occur in the rock depressions and cracks. Characteristic herbaceous species include silverweed (*Potentilla anserina*), common water horehound (*Lycopus americanus*), harebell (*Campanula rotundifolia*), low calamint (*Calamintha arkansana*), hair grass (*Deschampsia cespitosa*), smooth aster (*Aster laevis*), balsam ragwort (*Senecio pauperculus*), Indian paintbrush (*Castilleja coccinea*), sedges (*Carex* spp.), and Baltic rush (*Juncus balticus*). Stunted trees and shrubs are restricted to the cracks and include shrubby cinquefoil (*Potentilla fruticosa*), Kalm's St. John's-wort (*Hypericum kalmianum*), ninebark (*Physocarpus opulifolius*), balsam poplar (*Populus balsamifera*), northern white-cedar (*Thuja occidentalis*), and white spruce (*Picea glauca*).

Threats: Primary threats to this site include future residential development, off-road vehicle traffic, and invasive species. The non-native common mullein (*Verbascum thapsus*) was noted throughout this site.

Management Recommendations: The main management needs are to control populations of non-native species (i.e., common mullein), monitor control efforts, pursue land acquisition or establish conservation easements for private shoreline and adjacent inlands, and control illegal off-road vehicle use along the shoreline. Invasive species encroachment and illegal off-road vehicle use could be limited by maintaining an unmanaged forest buffer adjacent to the shoreline.



Photos by Dennis A. Albert.

82. Kregg Bay Northeast

Natural Community Type: Limestone Bedrock Lakeshore
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: B
Location: Shingleton Forest Management Unit, Compartment 97, and Private Lands
Element Occurrence Identification Number: 1924

Site Description: Limestone bedrock lakeshore extends for just under a mile along the shoreline of northern Lake Michigan. Three distinct stretches of bedrock lakeshore occur and are separated by limestone cobble shore and backed by a high cobble ridge. The exposed, flat to gently sloping limestone bedrock pavement has sparse calcareous soils. Soil development is concentrated in grykes and holes in the bedrock and soils are approximately 1 to 5 cm deep and are alkaline (pH 8.0) sands with a high organic content. Wave action and ice scrape limit vegetation development near the shoreline; vegetation development and maturity increase with distance from the lake. Patches of dense vegetation are interspersed with flat open bedrock and occasional one to two meter limestone shelves and open water pools. The upland adjacent to the limestone bedrock lakeshore is boreal forest of dense white spruce (*Picea glauca*), northern white-cedar (*Thuja occidentalis*), balsam fir (*Abies balsamea*), and aspens (*Populus* spp.).

Vegetation is confined primarily to cracks in the flat bedrock pavement. Dominant vegetation includes silverweed (*Potentilla anserina*), common water horehound (*Lycopus americanus*), harebell (*Campanula rotundifolia*), low calamint (*Calamintha arkansana*), hair grass (*Deschampsia cespitosa*), dwarf lake iris (*Iris lacustris*, federal/state threatened), smooth aster (*Aster laevis*), balsam ragwort (*Senecio pauperculus*), and small, shrub-sized balsam poplar (*Populus balsamifera*). Sporadic dense patches of vegetation with Baltic rush (*Juncus balticus*), silverweed, sedges (*Carex* spp.), and blue wild rye (*Elymus glaucus*) are confined to areas where soil development has occurred farther from the lakeshore.

Threats: In localized areas along the shoreline, piles of zebra mussel (*Dreissena polymorpha*) shells have limited vegetation establishment and are impacting soil accumulation, nutrient cycling, and depositional and erosional processes. Numerous weedy non-native species occur scattered throughout the site including Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), and ox-eye daisy (*Chrysanthemum leucanthemum*). The ease of access to the shoreline at this site presents the potential threat of off-road vehicle damage.

Management Recommendations: The main management needs are to control populations of non-native species, monitor control efforts, pursue land acquisition or establish conservation easements for private shoreline and adjacent inlands, and control illegal off-road vehicle use along the shoreline. Researching the impact of zebra mussel shells on nutrient cycling and soil development is warranted. Invasive species encroachment and illegal off-road vehicle use could be limited by maintaining an unmanaged forest buffer adjacent to the shoreline.

Vegetation is concentrated in the cracks in the exposed limestone bedrock, which is flat to gently sloping. Photos by Rebecca K. Schillo.

83. Point Detour

Natural Community Type: Limestone Bedrock Lakeshore
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: A
Location: Shingleton Forest Management Unit, Compartment 100, and Private Lands
Element Occurrence Identification Number: 10606

Site Description: The site is characterized by a mile-long stretch of limestone bedrock lakeshore along the northern coast of Lake Michigan. This bedrock community varies in width from 16 to 100 m. The shoreline, which is primarily limestone bedrock lakeshore, includes stretches of limestone cobble shore, low limestone ledges, and small pools of open water. The limestone bedrock lakeshore is backed by a one to five meter high limestone cobble ridge and dense boreal forest. The limestone bedrock lakeshore is sparsely vegetated with patchy vegetation concentrated in the cracks within the bedrock. Soils are absent or thin (3-10 cm) and alkaline (pH 8.0) with high organic content and are mainly confined to grykes (cracks) and holes in the limestone pavement.

Characteristic species along the limestone bedrock lakeshore include balsam poplar (*Populus balsamifera*) seedlings, shrubby cinquefoil (*Potentilla fruticosa*), silverweed (*P. anserina*), grass-leaved goldenrod (*Euthamia graminifolia*), Kalm's St. John's-wort (*Hypericum kalmianum*), beak-rush (*Rhynchospora capitellata),* golden-seeded spike-rush (*Eleocharis elliptica*), Baltic rush (*Juncus balticus*), Ohio goldenrod (*Solidago ohioensis*), common water horehound (*Lycopus americanus*), harebell (*Campanula rotundifolia*), low calamint (*Calamintha arkansana*), and sedges (*Carex* spp.). A small limestone bedrock glade occurs at the southern and inland edge of the site with white spruce (*Picea glauca*), northern white-cedar (*Thuja occidentalis*), and dwarf lake iris (*Iris lacustris,* federal/state threatened).

Threats: In localized areas along the shoreline, piles of zebra mussel (*Dreissena polymorpha*) shells have limited vegetation establishment and are impacting soil accumulation, nutrient cycling, and depositional and erosional processes. Numerous weedy non-native species occur scattered throughout the site including Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), Canada bluegrass (*Poa compressa*), and ox-eye daisy (*Chrysanthemum leucanthemum*).

Management Recommendations: The main management needs are to control populations of non-native species, monitor control efforts, and pursue land acquisition or establish conservation easements for the small, private tracts at the tip of the point and along the eastern side. Researching the impact of zebra mussel shells on nutrient cycling and soil development is warranted. Invasive species encroachment could be limited by maintaining an unmanaged forest buffer adjacent to the shoreline.

Point Detour supports over a mile of limestone bedrock lakeshore along the northern Lake Michigan shoreline. Photos by Michael A. Kost.

84. Seaman's Point (Drummond Island)

Natural Community Type: Limestone Bedrock Lakeshore
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: A
Location: Sault Sainte Marie Forest Management Unit, Compartment 14, and Private Lands
Element Occurrence Identification Number: 5883

Site Description: This site is characterized by five distinct stretches of limestone bedrock lakeshore that are 30 to 50 m wide. The exposed limestone/dolomite lakeshore occurs along the south side of Drummond Island along Lake Huron and is interspersed by limestone cobble shore along the shoreline with boreal forest and high-quality limestone bedrock glade[16] adjacent inland.

This site is characterized by high floristic diversity and numerous ecological zones including pools, a scrape zone, and a shrub zone. Characteristic plants include shrubby cinquefoil (*Potentilla fruticosa*), northern white-cedar (*Thuja occidentalis*) seedlings, low calamint (*Calamintha arkansana*), hair grass (*Deschampsia cespitosa*), ebony sedge (*Carex eburnea*), dwarf Canadian primrose (*Primula mistassinica*), Houghton's goldenrod (*Solidago houghtonii*, federal/state threatened), bulrush sedge (*Carex scirpoidea*, state threatened), Richardson's sedge (*C. richardsonii*, state special concern), and white camas (*Zigadenus glaucus*).

Threats: Primary threats to this site include future residential development, off-road vehicle traffic, and invasive species. The non-native common mullein (*Verbascum thapsus*) was noted throughout this site.

Management Recommendations: The main management needs are to control populations of non-native species (i.e., common mullein), monitor control efforts, pursue land acquisition or establish conservation easements for private shoreline and adjacent inlands, and control illegal off-road vehicle use along the shoreline. Invasive species encroachment and illegal off-road vehicle use could be limited by maintaining an unmanaged forest buffer adjacent to the shoreline.

Photo by Dennis A. Albert.

[16] Seaman's Point Limestone Bedrock Glade

85. Summer Island (Limestone Bedrock Lakeshore)

Natural Community Type: Limestone Bedrock Lakeshore
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: AB
Location: Shingleton Forest Management Unit, Compartment 200, and Private Land
Element Occurrence Identification Number: 2258

Site Description: The site is characterized by a 2.5 mile-long stretch of limestone bedrock lakeshore varying from 10 to 100 m wide with most areas 30 to 60 m wide. The shoreline is primarily limestone bedrock lakeshore with stretches of limestone cobble shore, limestone lakeshore cliff, and Great Lakes marsh interspersed. The limestone bedrock lakeshore is characterized by well-developed ecological zonation with three primary zones: a wave-swept/ice-scoured zone or splash/scrape zone, a wide, sparsely-vegetated flat zone, and a shrub-dominated upland margin. Soils and vegetation are concentrated on flat areas above the wave influence in cracks and solution depressions. Thin (1-2 cm deep), alkaline (pH 8.0) organic soils are accumulating in cracks (grykes), solution depressions, and flat areas protected from wave action. Along stretches of shore that run north-south, wave action is most pronounced resulting in a very wide zone of bare/unvegetated pavement.

The wave-swept/ice-scoured zone is characterized by sparse herbaceous vegetation limited to cracks, solution depressions, and flat areas above the wave influence where soils have accumulated. Prevalent species include low calamint (*Calamintha arkansana*), hair grass (*Deschampsia cespitosa*), Baltic rush (*Juncus balticus*), silverweed (*Potentilla anserina*), and ticklegrass (*Agrostis hyemale*). These same species occur in greater abundance and coverage in areas above the wave influence but within the spray zone. Wide flat areas of pavement are characterized by patches of Great Lakes marsh with Baltic rush, Canada wild rye (*Elymus canadensis*), and sedges (*Carex aquatilis* and *C. hystericina*). The shrub zone is dominated by shrubby cinquefoil (*Potentilla fruticosa*) along with Kalm's St. John's-wort (*Hypericum kalmianum*) and conifer seedlings, especially northern white-cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), and balsam fir (*Abies balsamea*). Low calamint, silverweed, Baltic rush, and hair grass are prevalent within this zone. Along the upland margin there are scattered and stunted conifers (2-10 cm DBH and 1-4 m tall). Species characteristic throughout include white camas (*Zigadenus glaucus*), false asphodel (*Tofieldia glutinosa*), Ohio goldenrod (*Solidago ohioensis*), common water horehound (*Lycopus americanus*), harebell (*Campanula rotundifolia*), black-eyed Susan (*Rudbeckia hirta*), ox-eye daisy (*Chrysanthemum leucanthemum*), panic grasses (*Panicum* spp.), hawkeeds (*Hieracium* spp.), and dwarf lake iris (*Iris lacustris*, federal/state threatened), which is confined to the upland margin. Patches of lichens and mosses occur throughout the site on the exposed bedrock. In addition, algal scum accumulates in pools of shallow, warm water along the shoreline.

Threats: In localized areas along the shoreline, piles of zebra mussel (*Dreissena polymorpha*) shells have limited vegetation establishment and are impacting soil accumulation and depositional and erosional processes. Numerous weedy non-native species occur scattered throughout the site with mossy stonecrop (*Sedum acre*) posing the greatest threat to species composition. Mossy stonecrop is concentrated in the southern portion of the occurrence.

Management Recommendations: The primary management need is to control populations of non-native species, especially mossy stonecrop. Efforts to control invasive species should be monitored. Maintaining low densities of deer on Summer Island will help minimize browse damage. Researching the impact of zebra mussel shells on nutrient cycling and soil development is warranted. Portions of this limestone bedrock lakeshore occur on private lands, so pursuit of acquisition and/or the establishment of conservation easements are warranted.

The limestone bedrock lakeshore along Summer Island is characterized by sparse vegetation concentrated in flat areas and cracks in the bedrock. Photos by Joshua G. Cohen.

LIMESTONE CLIFF

Overview: Limestone cliff consists of vertical or near-vertical exposures of bedrock, which typically support less than 25% vascular plant coverage, although some rock surfaces can be densely covered with lichens, mosses, and liverworts. The community occurs predominantly in the Upper Peninsula, most typically within a few kilometers of the Lake Michigan and Lake Huron shorelines, on the Niagaran Escarpment and Cuestra, but with isolated occurrences of much older Precambrian-aged limestones and dolomites in the western Upper Peninsula. Limestone cliffs also occur associated with sinkholes within Devonian Limestone in the northern Lower Peninsula. Like most of Michigan's cliffs, vegetation cover is sparse, but abundant cracks and crevices combined with calcareous conditions result in greater plant diversity and coverage than on most other cliff types (Kost et al. 2007).

86. El Cajon Bay

Natural Community Type: Limestone Cliff
Rank: G4G5 S2, apparently secure globally and imperiled within the state
Element Occurrence Rank: B
Location: Atlanta Forest Management Unit, Compartment 107
Element Occurrence Identification Number: 9208

Site Description: This is a natural exposure of the Genshaw formation of the Traverse group of limestone that is found within a quarter mile of El Cajon Bay. The limestone cliffs are twelve to fifteen feet high forming a three to four foot wide crevice with one to two feet of overhang. The crevice runs northeast to southwest with small upland interruptions. Numerous large boulders and broken slabs have fallen into the crevice indicating that limestone dissolution and erosional forces have been shaping this natural feature for thousands of years. Thin alkaline (pH 8.0) mineral soils have developed in crevices and on ledges. The site is characterized by an abundance of coarse woody debris, which is mostly northern white-cedar (*Thuja occidentalis*) from the surrounding boreal forest.

The ridges surrounding the cliffs are dominated by canopy northern white-cedar with occasional paper birch (*Betula papyrifera*) and dense pockets of understory balsam fir (*Abies balsamea*). The cliffs are covered by mosses in places and are bare in others. Pockets at the base of the cliff (in the crevice) that have greater soil development support a partial subcanopy of balsam fir and northern white-cedar and a moderate shrub layer of round-leaved dogwood (*Cornus rugosa*), mountain maple (*Acer spicatum*), red elderberry (*Sambucus racemosa*), choke cherry (*Prunus virginiana*), American fly honeysuckle (*Lonicera canadensis*), white spruce (*Picea glauca*), and thimbleberry (*Rubus parviflorus*). Within the crevice and on the ledges there is sparse ground cover of boreal forest species, such as gay wings (*Polygala paucifolia*), Canada mayflower (*Maianthemum canadense*), wild columbine (*Aquilegia canadensis*), starry false Solomon's seal (*Smilacina stellata*), ebony sedge (*Carex eburnea*), bedstraw (*Galium* sp.), and large-leaved aster (*Aster macrophyllus*). A turkey vulture (*Cathartes aura*) chick was observed during the 2006 survey and a strong smell was noted where it was found, suggesting the presence of a nesting territory within the site.

Threats: Some erosion has occurred from foot traffic.

Management Recommendations: The main management recommendations are to maintain a forested buffer adjacent to the cliffs to minimize the threat of invasion by non-native species and to allow natural processes (i.e., fire and windthrow) to operate unhindered.

Photo by Joshua G. Cohen.

87. Marblehead

Natural Community Type: Limestone Cliff
Rank: G4G5 S2, apparently secure globally and imperiled within the state
Element Occurrence Rank: A
Location: Sault Sainte Marie Forest Management Unit, Compartment 19
Element Occurrence Identification Number: 5671

Site Description: These limestone/dolomite cliffs are an extensive series of vertical, east-facing cliffs and outcrops that extend from Pilot Cove and ring the Marblehead peninsula. The site, which occurs in the northeastern portion of Drummond Island along the shore of Lake Huron, is comprised of a set of cliffs in various steps backing the shoreline. A thin band of limestone cobble shore separates the cliffs from the lake. The cliffs typically rise sharply from the lakeshore. The cliffs occur as a stepped series, extending inland for approximately a quarter of a mile in some areas. In places, the cliff faces are separated by boulder fields and ledges that support generalist species. The cliff faces themselves are vertical in places, some with overhangs, and support a sparse vegetative cover. Above the cliffs, the surrounding uplands are dominated by aspen stands and old fields/pastures. Given the proximity of the lakeshore, windthrow is prevalent. The cliffs themselves are primarily affected by breaking, cracking, and tumbling of weathered dolomite, which creates boulder fields, various slope angles, and opportunities for varied plant colonization.

Three broad vegetative zones characterize the cliffs: areas along moderate slopes, ledges between the cliff faces, and the cliff faces themselves. The slopes and ledges support sparse vegetation with scattered tree and shrub cover. Characteristic trees include northern white-cedar (*Thuja occidentalis*), quaking aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), and balsam fir (*Abies balsamea*), which are most common along the lower slopes. Prevalent shrubs include round-leaved dogwood (*Cornus rugosa*), soapberry (*Shepherdia canadensis*), bearberry (*Arctostaphylos uva-ursi*), and bush honeysuckle (*Diervilla lonicera*). Poison ivy (*Toxicodendron radicans*) is abundant to locally dominant in several areas along the cliff face. Common herbaceous species include poverty grass (*Danthonia spicata*), large-leaved aster (*Aster macrophyllus*), and harebell (*Campanula rotundifolia*). The vertical cliff faces are sparsely vegetated in crevices and on ledges by ferns including limestone oak fern (*Gymnocarpium robertianum*, state threatened), fragile fern (*Cystopteris fragilis*), common polypody (*Polypodium virginianum*), smooth cliff brake (*Pellaea glabella*), and wall-rue (*Asplenium ruta-muraria*, state endangered). This is the only known site in the state for wall-rue.

Threats: No major threats were identified during the surveys. Logging of surrounding boreal forest on private and state land could potentially increase the seed source for weedy species that might invade portions of the site. Non-native species observed during the surveys in areas of blowdown and disturbed areas at the top of the escarpment include Canada bluegrass (*Poa compressa*), common St. John's-wort (*Hypericum perforatum*), ox-eye daisy (*Chrysanthemum leucanthemum*), spotted knapweed (*Centaurea maculosa*), and hawkweeds (*Hieracium* spp.). Off-road vehicle damage, noted by DNR personnel in areas of low cliffs in the vicinity of the site, is causing localized erosion to the limestone and devegetation.

Management Recommendations: The main management recommendations are to maintain the forested buffer surrounding the cliffs to minimize the threat of invasion by non-native species, to allow natural processes (i.e., windthrow) to operate unhindered, and to prohibit off-road activity near or on the cliffs.

Marblehead is characterized by a series of limestone cliffs on Drummond Island. Photos by Bradford S. Slaughter.

88. Summer Island (Limestone Cliff)

Natural Community Type: Limestone Cliff
Rank: G4G5 S2, apparently secure globally and imperiled within the state
Element Occurrence Rank: A
Location: Shingleton Forest Management Unit, Compartment 200, and Private Lands
Element Occurrence Identification Number: 15586

Site Description: The site is characterized by west- and northwest-facing cliffs of limestone/dolomite on Summer Island where thin glacial tills occur over limestone bedrock. The cliffs extend for 0.75 miles and range in height from 2 to 30 ft, with most areas of exposure being 10 to 20 ft high. Cliffs are two-tiered in some locations and completely disappear sporadically. Large boulders and coarse woody debris have accumulated at the base of the cliffs and provide localized areas for soil development. Coarse woody debris consists of both northern white-cedar (*Thuja occidentalis*) and early-successional species, such as paper birch (*Betula papyrifera*). Mature boreal forest occurs along the top of the escarpment as well as along the base of the cliff. Canopy cedars within the boreal forest are over 100 years old. Thin (< 2 cm) organic, alkaline (pH 8.0) soils accumulate in cracks, ledges, at the base of the cliffs, and at the top of the escarpment. Alkaline (pH 8.0) silt loams occur over the underlying bedrock on low slopes. On the top of the cliff escarpment, the organic soils are slightly acidic (pH 6.5) due to conifer needle influence. Proximity to the Great Lakes results in a moderated climate that supports the surrounding boreal forest and provides moisture conditions on the cliff face suitable for lichens and mosses.

The cliff face supports sparse vegetation that is confined to ledges and cracks with numerous lichens and mosses covering moist portions of the exposed limestone. Ferns are the prevalent vascular species with common polypody (*Polypodium virginianum*), fragile fern (*Cystopteris fragilis*), evergreen woodfern (*Dryopteris intermedia*), and *Cryptogramma stelleri* (slender rock brake, state special concern) being most common. Additional ground cover species restricted to cracks and ledges include sedges (*Carex eburnea* and *C. deweyana*) and Canada mayflower (*Maianthemum canadense*). The scattered low shrub layer is dominated by Canada yew (*Taxus canadensis*), bush honeysuckle (*Diervilla lonicera*), American fly honeysuckle (*Lonicera canadensis*), and wild red raspberry (*Rubus strigosus*) with shrubs concentrated at the base of cliffs, along the escarpment, on ledges, and in cracks or fissures.

Mountain maple (*Acer spicatum*) and balsam fir (*Abies balsamea*) occur within the sparse subcanopy and understory layers with red elderberry (*Sambucus racemosa*) also common in the understory. Canopy dominants include northern white-cedar and paper birch. Canopy trees are scattered and stunted and typically confined to the escarpment, ledges, and at the base of the outcropping. Boreal forest occurs at the base of the cliff and along the top of the cliff face and is dominated by northern white-cedar, paper birch, balsam fir, mountain maple, Canada mayflower, starflower (*Trientalis borealis*), and stiff clubmoss (*Lycopodium annotinum*). Canopy gaps generated by windthrow at the base of the cliffs often have weedy species such as stinging nettle (*Urtica dioica*) and beggars lice (*Hackelia virginiana*), and the non-natives common mullein (*Verbascum thapsus*) and chickweed (*Cerastium glomeratum*).

Threats: No major threats were identified during the surveys. Logging of surrounding boreal forest on private and state land could potentially increase the local seed source for weedy species that might invade portions of the site.

Management Recommendations: The main management recommendations are to maintain the forested buffer surrounding the cliffs to minimize the threat of invasion by non-native species and to allow natural processes (i.e., fire and windthrow) to operate unhindered. Pursuing acquisition of private parcels or establishing conservation easements would allow for the establishment of forested buffers. Maintaining low densities of deer on Summer Island would minimize browse damage.

The limestone cliffs on Summer Island have a climate moderated by nearby Lake Michigan that provides moisture conditions on the cliff face suitable for ferns, lichens, and mosses. Photos by Joshua G. Cohen.

LIMESTONE COBBLE SHORE

Overview: Limestone cobble shore occurs along gently sloping shorelines of Lake Michigan and Lake Huron. The community is studded with cobbles and boulders and is easily inundated by storms and periods of high water. Limestone cobble shore is typically sparsely vegetated, because cobbles cover most of the surface and storm waves prevent the development of a diverse, persistent plant community. Soils are neutral to slightly alkaline mucks and sands that accumulate between cobbles and boulders (Kost et al. 2007).

89. Bois Blanc Island

Natural Community Type: Limestone Cobble Shore
Rank: G2G3 S3, critically imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: B
Location: Gaylord Forest Management Unit, Compartment 221, and Private Lands
Element Occurrence Identification Number: 4632

Site Description: This limestone cobble shore occurs on level lakeplain with dolomite boulders and cobble with alkaline (pH 8.0-8.5) sands and muck mixed within and between the cobble. Areas of 10 to 20 cm of wet sand over cobble support interdunal wetlands.

This limestone cobble shore is characterized by low cover of herbs and shrubs that are primarily growing between the cobbles. Prevalent species include shrubby cinquefoil (*Potentilla fruticosa*), silverweed (*P. anserina*), Ohio goldenrod (*Solidago ohioensis*), and sedge (*Carex viridula*). Areas of interdunal wetland are more densely vegetated and are dominated by Baltic rush (*Juncus balticus*). Species composition and structure along the shore is patterned by wave and wind action. Eastern massasauga (*Sistrurus c. catenatus*, federal candidate species and state special concern) are known to occur within this site.

Threats: The primary threat to this site is off-road vehicle damage, which could lead to the introduction of invasive species and the erosion of wetland soils and vegetation. An off-road vehicle trail out to Snake Island and along the shoreline has resulted in soil compaction and limited vegetation establishment along the tracks.

Management Recommendations: The primary management need is to eliminate off-road vehicle activity along the shoreline. Monitoring should be implemented to evaluate invasive species impacts. Additional high-quality limestone cobble shore on private lands could be protected through acquisition or the establishment of conservation easements.

Photo by Joshua G. Cohen.

90. Seiner's Point (Limestone Cobble Shore)

Natural Community Type: Limestone Cobble Shore
Rank: G2G3 S3, critically imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Sault Sainte Marie Forest Management Unit, Compartment 200
Element Occurrence Identification Number: 3957

Site Description: This large limestone cobble shore occurs along the northern shore of Lake Michigan and is characterized by diverse ecological zonation with sand flats, sparsely vegetated cobble beach, and Great Lakes marsh. Wave and ice abrasion and fluctuating water levels generate a dynamic shoreline. Cobbles are of variable size with pebbles/gravel 1 to 3 cm in diameter and cobbles 10 to 40 cm in diameter. Boulders (0.5-1.5 m in diameter) are scattered throughout the shore. The soils, which accumulate between the cobbles, are thin (1-5 cm) alkaline (pH 8.0) sandy mucks over sandy, gravelly cobble. Areas of sand flats have 5-10 cm of sandy muck (pH 8.0) over cobble. Areas of Great Lakes marsh are characterized by deeper sandy mucks (20-30 cm) over cobble. Shallow pools occur scattered throughout the shoreline with water 5 to 20 cm deep, and a small stream passes through the site. High-quality wooded dune and swale complex occurs adjacent to the cobble shore.[17]

Areas of sparsely vegetated cobble beach are typically typically 50 to 100 meters wide. The sparse vegetation is found growing between cobbles in thin alkaline muck. Prevalent species include Baltic rush (*Juncus balticus*), silverweed (*Potentilla anserina*), common boneset (*Eupatorium perfoliatum*), grass-leaved goldenrod (*Euthamia graminifolia*), shrubby cinquefoil (*Potentilla fruticosa*), and seedlings of northern white-cedar (*Thuja occidentalis*). The sand flats adjacent to the lake are characterized by deeper alkaline muck and heavier cover of rushes (*Juncus* spp.). Areas of deeper organic soil accumulation support Great Lakes marsh dominated by rushes, spike-rushes (*Eleocharis* spp.), twig-rush (*Cladium mariscoides*), and sedges (including *Carex stricta*). Shallow pools are ringed by rushes, livid sedge (*C. livida*), and softstem bulrush (*Schoenoplectus tabernaemontani*). Scattered patches of willows (*Salix* spp.) occur on sand rises. Peninsulas jutting into the lake are dominated by silverweed with willows, balsam poplar (*Populus balsamifera*), and grass-leaved goldenrod. A narrow band of boreal forest with northern white-cedar occurs as a finger between the cobble shore and the westernmost portion of Great Lakes marsh.

Threats: The primary threat to this site is off-road vehicle damage, which could lead to the introduction of invasive species. Zebra mussel (*Dreissena polymorpha*) shells have accumulated along portions of the shoreline and may threaten successional, depositional, and erosional processes.

Management Recommendations: The primary management need is to eliminate off-road vehicle activity along the shoreline. Monitoring should be implemented to evaluate invasive species impacts. Researching the impacts of zebra mussels on limestone cobble shore is needed to ascertain how shell accumulation influences vegetative composition and erosional and depositional processes.

Photo by Joshua G. Cohen.

[17] Seiner's Point Wooded Dune and Swale Complex

91. Warner's Cove (Drummond Island)

Natural Community Type: Limestone Cobble Shore
Rank: G2G3 S3, critically imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Sault Sainte Marie Forest Management Unit, Compartment 14, and Private Land
Element Occurrence Identification Number: 372

Site Description: This limestone cobble shore is a relatively narrow cobble beach that is backed by boreal forest. The site occurs on Drummond Island. In addition to limestone cobble shore, this stretch of shoreline has inclusions of sand and gravel beach, limestone bedrock lakeshore, and large boulders.

This limestone cobble shore is characterized by low cover of herbs and shrubs that are primarily growing in the cracks between the cobbles. The dominant species are rushes (*Juncus* spp.) and spike-rushes (*Eleocharis* spp.).

Threats: The primary threat to this site is off-road vehicle damage, which could lead to the introduction of invasive species and the erosion of wetland soils and vegetation.

Management Recommendations: The primary management need is to eliminate off-road vehicle activity along the shoreline. Monitoring should be implemented to evaluate invasive species impacts. Portions of the high-quality limestone cobble shore occurring on private lands could be protected through acquisition or the establishment of conservation easements.

Photo by Dennis A. Albert.

LIMESTONE LAKESHORE CLIFF

Overview: Limestone lakeshore cliff consists of vertical or near-vertical exposures of bedrock, which typically support less than 25% vascular plant coverage, although some rock surfaces can be densely covered with lichens, mosses, and liverworts. The community occurs in the Upper Peninsula along the shorelines of Lake Michigan and Lake Huron. Like all of Michigan's lakeshore cliffs, vegetation cover is sparse but abundant cracks and crevices combined with calcareous conditions result in greater plant diversity and coverage than on most other cliff types. Limestone lakeshore cliffs are characterized by high site moisture and a stressed and unstable environment because of severe waves, wind, and winter ice due to the proximity to the Great Lakes (Kost et al. 2007).

92. Burnt Bluff

Natural Community Type: Limestone Lakeshore Cliff
Rank: G4G5 S2, apparently secure globally and imperiled within the state
Element Occurrence Rank: AB
Location: Shingleton Forest Management Unit
Element Occurrence Identification Number: 9467

Site Description: The site is characterized by west- and southwest-facing limestone/dolomite cliffs. These cliffs are part of the Niagaran Escarpment and occur on the Garden Peninsula where thin glacial till occurs over limestone bedrock. The cliffs extend for 2.25 miles along the Lake Michigan shoreline and range in height from 5 to 130 ft, with most areas of exposure being 70 to 100 ft high. The cliffs are two-tiered in some locations with a boreal forest band between the cliff faces dominated by northern white-cedar (*Thuja occidentalis*) (10-40 cm DBH). A narrow band of mature boreal forest also occurs along the top of the escarpment. Canopy cedars within the boreal forest are over 100 years old with numerous scattered old-growth trees in protected areas (a cored 18.8 cm cedar was 103 years old and a 34.4 cm cedar was 280 years old). Thin organic, circumneutral to alkaline soils accumulate in cracks, ledges, at the base of the cliffs, and at the top of the escarpment. Large boulders, slabs, and blowdown have accumulated at the base of the cliffs. Coarse woody debris and boulders at the base of the cliffs provide localized areas for soil accumulation. Coarse woody debris consists of both northern white-cedar and early-successional species, such as paper birch (*Betula papyrifera*). Proximity to the Great Lakes results in the frequent occurrence of windthrow and a moderated climate that supports the surrounding boreal forest and provides moisture conditions along the cliff face suitable for lichens and mosses.

The cliff face supports sparse vegetation that is confined to ledges and cracks with numerous lichens and mosses covering portions of the exposed limestone. Ferns are prevalent and include common polypody (*Polypodium virginianum*), fragile fern (*Cystopteris fragilis*), and smooth cliff brake (*Pellaea glabella*). Additional ground cover species restricted to cracks, ledges, the escarpment, and lower slopes include Canada mayflower (*Maianthemum canadense*), rock whitlow-grass (*Draba arabisans*, state special concern), yarrow (*Achillea millefolium*), wild columbine (*Aquilegia canadensis*), sedge (*Carex pedunculata)*, and large-leaved aster (*Aster macrophyllus*). The low shrub layer is scattered with bush honeysuckle (*Diervilla lonicera*) and thimbleberry (*Rubus parviflorus*). Shrubs are concentrated at the base of cliffs, along the escarpment, on ledges, and in cracks/fissures. Mountain maple (*Acer spicatum*) and balsam fir (*Abies balsamea*) occur within the sparse subcanopy and understory layers with red elderberry (*Sambucus racemosa*), choke cherry (*Prunus virginiana*), and round-leaved dogwood (*Cornus rugosa*) also common in the understory. Canopy trees are scattered and stunted and typically confined to the escarpment, ledges, and at the base of the outcropping. Canopy dominants include northern white-cedar, paper birch, and balsam fir. Dense boreal forest occurs between the cliff tiers and along the top of the cliff face and is dominated by northern white-cedar, balsam fir, and paper birch with mountain maple in the understory and Canada mayflower and wild sarsaparilla (*Aralia nudicaulis*) in the ground layer. Non-native weeds are scattered throughout the site and include common dandelion (*Taraxacum officinale*), Canada bluegrass (*Poa compressa*), common mullein (*Verbascum thapsus*), and bittersweet nightshade (*Solanum dulcamara*).

Threats: No major threats were identified during the surveys. Logging of the surrounding forest on private and state land could potentially increase the seed source for weedy species that might invade portions of the site.

Management Recommendations: The main management recommendations are to maintain the forested buffer surrounding the cliffs to minimize the threat of invasion by non-native species and to allow natural processes (i.e., wildfire and windthrow) to operate unhindered. Pursuing acquisition of private parcels or establishing conservation easements would allow for the establishment of forested buffers. Maintaining low densities of deer in the greater landscape would minimize browse damage. Based on aerial photographic interpretation, surveys for additional high-quality limestone lakeshore cliff to the north are merited.

These limestone cliffs occur on the Garden Peninsula along the shoreline of northern Lake Michigan. Photos by Joshua G. Cohen.

MESIC NORTHERN FOREST

Overview: Mesic northern forest is a forest type of moist to dry-mesic sites lying mostly north of the climatic tension zone, characterized by the dominance of northern hardwoods, particularly sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*). Conifers such as hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*) are frequently important canopy associates. This community type breaks into two broad classes: northern hardwood forest and hemlock-hardwood forest. It is primarily found on coarse-textured ground and end moraines, and soils are typically loamy sand to sandy loam. The natural disturbance regime is characterized by gap-phase dynamics; frequent, small windthrow gaps allow for the regeneration of the shade-tolerant canopy species. Catastrophic windthrow occurred infrequently with several generations of trees passing between large-scale, severe disturbance events. Historically, mesic northern forest occurred as a matrix system, dominating vast areas of mesic uplands in the Great Lakes region. These forests were multi-generational, with old-growth conditions lasting many centuries (Kost et al. 2007).

93. Barfield Lakes (Mesic Northern Forest)

Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Newberry Forest Management Unit, Compartment 3
Element Occurrence Identification Number: 10486

Site Description: Three variants of old-growth mesic forest characterize this site. Areas of well-drained, low ground moraine support mesic forest dominated by sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), and yellow birch (*Betula alleghaniensis*). Level, moderately drained lakeplain is dominated by mixed hardwood-conifer forest with hemlock (*Tsuga canadensis*) being prevalent. The site also includes an east-west running, steep-sloped dune ridge that is hemlock-dominated. The soils are primarily sandy loams of variable moisture retaining capacity depending on the landform. The moraine has well-drained soils, the lakeplain has moderately well-drained soils, and the dune ridge has very well-drained soils. Gap-phase dynamics have generated an uneven-aged forest with numerous canopy gaps and high volume of coarse woody debris and snags of varying species composition, diameter range, and decay classes. Well-developed pit and mound topography is found throughout indicating multiple generations of old-growth conditions. These pockets of mesic northern forest are embedded within a high-quality rich conifer swamp.[18]

Four to five vegetative layers characterize this forest: supercanopy with hemlock and white pine (*Pinus strobus*), canopy, subcanopy, shrub layer, and ground layer. Canopy closure ranges from 80-90%. Sugar maple, yellow birch, and beech are prevalent canopy trees on low ground moraine. Hemlock and white pine dominate the dune ridge with white pine stumps occurring sporadically along the ridge. Low level areas of lakeplain of moderate drainage are dominated by hemlock with a diverse array of canopy associates including yellow birch, northern white-cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), sugar maple, and white pine. Some areas of lakeplain forest grade into rich conifer swamp. Diameters of canopy dominants range from 50 to 80 cm with some trees between 80 to 110 cm. Canopy dominants are 80 to 100 feet tall. Shade-tolerant species dominate the canopy, subcanopy, and understory. The low shrub layer throughout the site is dominated by American fly honeysuckle (*Lonicera canadensis*). Characteristic species of the ground cover include starflower (*Trientalis borealis*), wild sarsaparilla (*Aralia nudicaulis*), bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), downy Solomon's seal (*Polygonatum pubescens*), stiff clubmoss (*Lycopodium annotinum*), and sugar maple seedlings.

Threats: Continued and more intensive logging on surrounding private lands could fragment the landscape and the associated rise in road densities could increase the potential for invasive species encroachment. Recent logging on private lands significantly reduced the acreage of old-growth forest within this site.

[18] Barfield Lakes Rich Conifer Swamp

Management Recommendations: The primary management recommendation is to allow natural processes (i.e., fire and windthrow) to operate unhindered (e.g., prohibit salvage logging). Private lands surrounding the site could be acquired or protected through conservation easements. Closing roads within and around this forest would help limit invasive species establishment.

Photo by Joshua G. Cohen.

94. Bois Blanc Island (Mesic Northern Forest)

Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Gaylord Forest Management Unit, Compartment 217
Element Occurrence Identification Number: 9668

Site Description: This site is a large tract of old-growth mesic northern forest that occurs on a level lakeplain. The forest is found on a peninsula on Bois Blanc Island, which is surrounded by Lake Huron. The shallow humus soils occur over a mix of pebbles and large cobble-sized St. Ignace dolomite and mineral soil. The organic soils range from acidic to circumneutral (pH 5.0-7.5) with acidity increasing with conifer canopy composition. The mesic northern forest is edged by high-quality boreal forest[19] and limestone cobble shore along the lakeshore. This old-growth forest is lake-moderated with excellent growing conditions, a diversity of vegetation zones, and a prevalence of windthrow and associated coarse woody debris and structural complexity.

The central portion of the forest is characterized by old-growth sugar maple (*Acer saccharum*) and hemlock (*Tsuga canadensis*). The southwestern portion of the forest is dominated by old-growth white pine (*Pinus strobus*) and red pine (*P. resinosa*) (a cored red pine was estimated to be 294 years old). Areas of blowdown are dominated by paper birch (*Betula papyrifera*), especially near the point. American beech (*Fagus grandifolia*) is notably absent from the canopy. The tall shrub layer is dominated by sugar maple and striped maple (*Acer pensylvanicum*). Hemlock seedlings are common on highly decomposed, large-diameter nurse logs. Characteristic ground cover species include goldthread (*Coptis trifolia*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), bunchberry (*Cornus canadensis*), sugar maple seedlings, wild sarsaparilla (*Aralia nudicaulis*), spinulose woodfern (*Dryopteris carthusiana*), and hairy sweet cicely (*Osmorhiza claytonii*).

Threats: Deer herbivory may be limiting conifer recruitment. Some non-native species and weedy native plants were noted to be concentrated along the roads.

Management Recommendations: The primary management recommendation is to allow natural processes (i.e., fire and windthrow) to operate unhindered. Monitoring should be implemented to gauge the spread of invasive species and deer browse pressures. Establishment of deer exclosures would allow for the assessment of how herbivory impacts species composition and structure (i.e., hemlock regeneration). Reducing deer densities on the island could be accomplished through culling and/or increasing late-successional habitat. Closure of the road out to the point to vehicular traffic would help limit the spread of weedy invasive and native plants.

Photo by Joshua G. Cohen.

[19] Lime Kiln Point Boreal Forest

95. Craig Lake

Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Craig Lake State Park (formerly part of Gwinn Forest Management Unit)
Element Occurrence Identification Number: 7496

Site Description: This large block of old-growth and second-growth mesic northern forest occurs on a ground moraine with rolling to severe topography and variable slope and aspect. The site's rugged terrain is accentuated by numerous large scattered granitic boulders and several outcroppings of granite cliffs. Well-developed pit and mound topography, which characterizes the site, has been generated by centuries of gap-phase dynamics. The soils are acidic loamy sands of medium to fine texture. The mesic northern forest is bordered by Claire Lake to the north and Craig Lake to the east and south. Numerous intermittent streams intersect the forest and a permanent stream occurs in the northeastern portion of the site, connecting the two lakes. Intermittent streams and depressions support areas of hardwood-conifer swamp with muck soils overlying glacial till.

Gap-phase dynamics drive species composition, stand structure, and succession within this large block of mesic northern forest. The canopy is dominated by sugar maple (*Acer saccharum*) and hemlock (*Tsuga canadensis*). Areas dominated by sugar maple are characterized by maple dominance in all strata. These sugar maple areas are uneven-aged, second-growth forest. Hemlock dominates the conifer-hardwood forest, which is old-growth. Canopy associates include yellow birch (*Betula alleghaniensis*), sugar maple, and northern white-cedar (*Thuja occidentalis*). Occasional canopy species include white spruce (*Picea glauca*), white pine (*Pinus strobus*), red oak (*Quercus rubra*), and red maple (*Acer rubrum*). Canopy dominants range in DBH from 50 to 80 cm. The subcanopy is dominated by sugar maple and hemlock with red maple, white spruce, northern white-cedar, and balsam fir (*Abies balsamea*) as common associates. These species are also prevalent in the tall shrub layer along with mountain maple (*Acer spicatum*). Abundant hemlock, northern white-cedar, and yellow birch regeneration are found on tip-up mounds, nurse logs, and moss-covered boulders. In addition to sugar maple, American fly honeysuckle (*Lonicera canadensis*) is prevalent in the low shrub layer. Sugar maple is dominant in the ground cover along with spinulose woodfern (*Dryopteris carthusiana*), shining clubmoss (*Huperzia selago*), starflower (*Trientalis borealis*), and Canada mayflower (*Maianthemum canadense*). A diverse array of lichens and mosses are found growing on the boles of large-diameter trees (especially deciduous species).

Threats: If deer densities increase due to a string of mild winters, deer browse could eliminate significant amounts of shade-tolerant advanced regeneration.

Management Recommendations: The primary management recommendation is to allow natural processes (i.e., fire and windthrow) to operate unhindered by prohibiting salvage logging of windthrow and allowing lightning strike fires to burn. In addition, deer herbivory of hemlock and northern white-cedar regeneration should be monitored and deer densities should be reduced if deemed necessary. Several granite cliffs occur within the mesic northern forest and should be surveyed for rare plant populations.

Photo by Joshua G. Cohen.

96. Cut River Gorge

Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Sault Sainte Marie Forest Management Unit, Compartment 120, and Private Lands
Element Occurrence Identification Number: 10987

Site Description: This mesic northern forest occurs in a north- and south-facing ravine with steep topography carved by the Cut River through an old sand dune. The soils are acidic sandy loam over fine-textured sand. A thicker organic layer and greater soil development occurs on terraces and shallow organic matter and a less developed soil profile is found on the steep slopes. Groundwater seepage areas are characterized by thick organics and mucky soils. Gap-phase dynamics are prevalent, as indicated by the abundance of snags and coarse woody debris of diverse species composition, diameter distribution (10 -70 cm), and decay classes with numerous nurse logs present. High levels of coarse woody debris occur in the Cut River.

This uneven-aged, selectively harvested old-growth forest has four structural layers: canopy, subcanopy, tall shrub, and ground layer. Canopy dominants include sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*), and hemlock (*Tsuga canadensis*). Four primary vegetative zones characterize the site. South-facing slopes are dominated by hemlock, yellow birch, and American beech and are characterized by a rich ground layer. North-facing slopes are dominated by hemlock and have more acidic soils and a less diverse herbaceous layer. The terrace (level area) on the south side of the ravine is characterized by thick organic matter accumulation, groundwater seepage influence, and diverse canopy composition with hemlock, American beech, yellow birch, sugar maple, and white spruce (*Picea glauca*). Groundwater seepage areas are located immediately adjacent to the Cut River and are dominated by northern white-cedar (*Thuja occidentalis*) with yellow birch and hemlock. The following are diameter ranges for canopy dominants: hemlock (50-80 cm), yellow birch (40-80 cm), sugar maple (50-60 cm), American beech (45-60 cm), northern white-cedar (40-60 cm), and white pine (*Pinus strobus*) (50-80 cm). Characteristic ground cover species include starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), goldthread (*Coptis trifolia*), bunchberry (*Cornus canadensis*), sugar maple seedlings, wild sarsaparilla (*Aralia nudicaulis*), downy Solomon's seal (*Polygonatum pubescens*), bluebead lily (*Clintonia borealis*), and Solomon's seal (*Smilacina racemosa*).

Threats: Garlic mustard (*Alliaria petiolata*) threatens to drastically alter the species composition of this forest and could travel along the trails that pass through the site. Two logging trails pass through the ravine, one on each side of the Cut River and two pipeline clearings occur towards the northern end of the property.

Management Recommendations: The primary stewardship need is to control the population of garlic mustard by manually removing it or by careful herbicide application. Monitoring of the control efforts should be implemented. Closure of trails that parallel the river may help limit the spread of garlic mustard. Maintaining an unmanaged forest buffer surrounding the ravine may help limit the spread of garlic mustard and other invasive species. Portions of the mesic northern forest occurring on private land could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

97. Harlow Lake

Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Gwinn Forest Management Unit, Compartment 204
Element Occurrence Identification Number: 3138

Site Description: Harlow Lake is an uneven-aged mesic northern forest with well-developed pit and mound topography and large-diameter canopy and super canopy trees occurring on ground moraine of moderate to rugged topography. The forest is beginning to display the full suite of structural attributes characteristic of an old-growth ecosystem (i.e., canopy gaps and large-diameter coarse woody debris of variable diameter, species composition, and decay classes). Granitic boulders and exposed bedrock occur throughout the site, which includes a granite bedrock glade in the southwestern portion. The soils are acidic sands of medium texture. Numerous intermittent streams occur throughout the site. Depressions and draws are characterized by mucky and loamy soils. The site is adjacent to Lake Superior which moderates the local climate. Windthrow and fire are the primary ecological processes driving species composition and structure although deer herbivory within the past several decades has had a major influence on species composition and structure, including the virtual elimination of hemlock regeneration.

The closed canopy is dominated by hemlock (*Tsuga canadensis*) with scattered supercanopy white pine (*Pinus strobus*) and a mixture of hardwoods including yellow birch (*Betula alleghaniensis*), sugar maple (*Acer saccharum*), and red maple (*A. rubrum*). The subcanopy is dominated by hemlock as well. The tall shrub and sapling layer is sparse having been intensively browsed by wintering deer. Red maple and striped maple (*Acer pensylvanicum*) are prevalent in this layer and hemlock and white pine are noticeably absent or sparse. Thimbleberry (*Rubus parviflorus*) is the overwhelming dominant of the low shrub layer while sugar maple, large-leaved aster (*Aster macrophyllus*), and bracken fern (*Pteridium aquilinum*) dominate in the sparse ground cover. Wetter areas with loamy sand have denser vegetation. Areas of bedrock glade are characterized by an open and stunted canopy with white pine, red pine (*Pinus resinosa*), and red oak (*Quercus rubra*) and heavy lichen cover over the bedrock.

Threats: The primary threat to the site is deer herbivory, which is limiting tree recruitment, especially hemlock, and altering the site's species composition and structure. One of the few understory hemlock saplings (16.5 cm) was 66 years old, suggesting that 70 to 80 years ago, deer densities were low enough to allow for hemlock recruitment. Most hemlock regeneration is below the snow line. High densities of deer winter within this hemlock-dominated forest. In addition to browsing hemlock, deer have been heavily browsing striped maple and even balsam fir (often referred to as "starvation food" for deer). Continued high levels of wintering deer within this forest will limit hemlock's capacity to regenerate and jeopardize its future capacity to serve as thermal cover. Spotted knapweed (*Centaurea maculosa*) occurs along County Road 550 and could invade the site if additional road development and soil disturbance occur.

Management Recommendations: Management recommendations for this site include allowing natural processes (i.e., windthrow and wildfire) to operate unhindered (no salvage logging and allow lightning strike fires to burn), and reducing deer densities and early-successional habitat in the surrounding landscape to reduce deer browse pressure. In addition, establishment of deer exclosures within the site will foster immediate conifer seedling and sapling regeneration. Placement of exclosures should be located around concentrations of large-diameter coarse woody debris or nurse logs since these microsites provide important establishment sites for hemlock, as well as white pine and yellow birch. The impacts of deer herbivory should be monitored, especially if exclosures are erected.

The Harlow Lake mesic northern forest is acruing late-successional attributes, such as coarse woody debris (above). However, intensive deer herbivory (below) has resulted in the virtual absence of a sapling layer. Photos by Joshua G. Cohen.

98. Jean Worth Tract

Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Escanaba Forest Management Unit, Compartments 45 and 55
Element Occurrence Identification Number: 14559

Site Description: This small block of old-growth mesic northern forest occurs on the second bottom of the floodplain of the Cedar River within a lakeplain. The site is characterized by low volumes of coarse woody debris possibly resulting from past logging episodes. The soils are silty clay loams.

The canopy is dominated by large-diameter (> 60 cm), old-growth (200+ years) hemlock (*Tsuga canadensis*). Canopy associates include northern white-cedar (*Thuja occidentalis*), sugar maple (*Acer saccharum*), and yellow birch (*Betula alleghaniensis*) with occasional supercanopy white pine (*Pinus strobus*) (> 100 cm DBH). The forest is characterized by uneven-aged structure with sugar maple, hemlock, beech, yellow birch, and northern white-cedar in the subcanopy. The low shrub layer is sparse to absent. Characteristic species of the ground cover include starflower (*Trientalis borealis*), wild sarsaparilla (*Aralia nudicaulis*), downy Solomon's seal (*Polygonatum pubescens*), ferns, and hemlock regeneration.

Threats: Evidence of turn-of-the-century logging occurs throughout the site. The site is characterized by high levels of human traffic, which is facilitated by the numerous roads and trails passing through this forest. Deer herbivory is likely limiting hemlock and northern white-cedar regeneration.

Management Recommendations: The primary management recommendation is to allow natural processes (i.e., fire and windthrow) to operate unhindered (e.g., prohibit salvage logging, even of dead and dying beech). Closing roads and trails throughout the forest will help reduce anthropogenic impacts. In addition, deer herbivory of hemlock and northern white-cedar regeneration should be monitored and deer densities should be reduced if deemed necessary.

Photo by Christopher R. Weber.

99. Lime Kiln Point

Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Gaylord Forest Management Unit, Compartment 219, and Private Lands
Element Occurrence Identification Number: 7658

Site Description: This is a small pocket of old-growth forest occurring on poorly-drained level lakeplain with moist acidic (pH 5.0) sands and clay loams and a perched water table.

The closed-canopy (75-95%) is dominated by hemlock (*Tsuga canadensis*), which ranges in DBH from 50 to 87 cm. Canopy associates include occasional American beech (*Fagus americana*) and paper birch (*Betula papyrifera*). The sparse shrub layer is dominated by striped maple (*Acer pensylvanicum*) and the moderately vegetated ground layer is characterized by starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), spinulose woodfern (*Dryopteris carthusiana*), Indian cucumber root (*Medeola virginiana*), stiff clubmoss (*Lycopodium annotinum*), and great bladder sedge (*Carex intumescens*).

Threats: A main road passes through the center of the occurrence. Continued and more intensive logging on surrounding private lands could fragment the landscape and increase deer browse pressure and the threat of invasive species encroachment. High deer densities could be limiting hemlock regeneration.

Management Recommendations: The primary management recommendation is to allow natural processes (i.e., fire and windthrow) to operate unhindered (e.g., prohibit salvage logging). Private lands surrounding the site could be acquired or protected through conservation easements. The old-growth forest could be buffered by unmanaged forest. If the surrounding forest is managed, extending the rotation and maintaining late-successional features of the forest are recommended. Monitoring should be implemented to gauge the spread of invasive species and deer browse pressures. Establishment of deer exclosures would allow for the assessment of how herbivory impacts species composition and structure (i.e., hemlock regeneration). Reducing deer densities on the island could be accomplished through culling and/or increasing late-successional habitat.


Photos by Joshua G. Cohen.

100. Little Two-Hearted Lakes

Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Newberry Forest Management Unit, Compartment 42
Element Occurrence Identification Number: 8524

Site Description: This large block of uneven-aged old-growth (278+ years) mesic northern forest occurs on flat to gently sloping lakeplain on acidic sandy loams with deep organic accumulation. The site occurs immediately north of Little Two-Hearted Lakes and south of a high-quality muskeg. The organic soil depth and acidity decrease with increasing hardwood canopy composition. The forest is characterized by large-diameter (50-130 cm) canopy and supercanopy trees (120-130 ft tall), a high volume of coarse woody debris of diverse species composition (including conifers), decay classes (numerous nurse logs), and diameter classes (including 50-100 cm class), well developed-pit and mound topography, excellent shade-tolerant regeneration, and complex ecological zonation. Gap-phase dynamics have driven species composition, structure, and succession for centuries.

Areas of hardwood dominance are characterized by a scattered canopy of American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), and yellow birch (*Betula alleghaniensis*) with occasional hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*). Numerous beech snags generate large canopy gaps and areas of high density beech and sugar maple understory and ground cover. Hemlock-dominated portions of the site are characterized by a scattered supercanopy with hemlock and white pine (both live and dead trees). Canopy associates include yellow birch, red maple (*Acer rubrum*), and northern white-cedar (*Thuja occidentalis*). Shade-tolerant species are prevalent in the subcanopy and tall shrub layer with hemlock thriving on old and new nurse logs and tip-up mounds. Tall bilberry (*Vaccinium ovalifolium*) is prevalent in the low shrub layer along with shade-tolerant seedlings, which also occur in the ground cover. Additional characteristic ground cover species include stiff clubmoss (*Lycopodium annotinum*), shining clubmoss (*Huperzia selago*), goldthread (*Coptis trifolia*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), wintergreen (*Gaultheria procumbens*), and Indian cucumber root (*Medeola virginiana*). Proximity to the lake is correlated with increased importance of white pine, northern white-cedar, and balsam fir (*Abies balsamea*) and increased density in all strata.

Threats: Beech bark disease will likely cause significant mortality of canopy and subcanopy beech. If deer densities increase due to a string of mild winters, deer browse could eliminate significant amounts of conifer advanced regeneration.

Management Recommendations: The primary management recommendation is to allow natural processes (i.e., fire and windthrow) to operate unhindered (e.g., prohibit salvage logging, even of dead and dying beech). Private lands to the east of the site could be acquired or protected through conservation easements. Aerial photographic interpretation and brief ground surveys indicate that high-quality muskeg occurs to the north and dry-mesic northern forest occurs to the south of the mesic northern forest. These areas should be surveyed and considered for inclusion within the ecological reference area.

Photo by Joshua G. Cohen.

101. Martin's Bluff (Beaver Island)

Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Gaylord Forest Management Unit, Compartments 65 and 66, and Private Lands
Element Occurrence Identification Number: 626

Site Description: Several small islands of old-growth mesic northern forest occur on rolling ground moraine with fine- to medium-textured loamy sands that range from acidic to alkaline. The site is characterized by well-developed pit and mound topography but only moderate levels of coarse woody debris and snags were observed. The forest is surrounded by beaver-influenced wetlands, conifer swamp, and 100+ year old paper birch (*Betula papyrifera*) and aspen (*Populus* spp.) forest that likely established following turn-of-the-century logging.

The canopy is dominated by large-diameter (> 60 cm), old-growth (250+ years old) sugar maple (*Acer saccharum*), hemlock (*Tsuga canadensis*), American beech (*Fagus grandifolia*), and yellow birch (*Betula alleghaniensis*). The forest is characterized by uneven-aged structure with sugar maple, hemlock, yellow birch, and red maple (*Acer rubrum*) in the subcanopy. Canopy associates include pockets of mid-tolerant species, such as green ash (*Fraxinus pennsylvanica*) and shade-intolerant species, such as paper birch and quaking aspen (*Populus tremuloides*), which occur along the edges of the forest and in larger light gaps. Numerous canopy gaps of diverse age, size, and shape are found throughout the site. The tall shrub layer is dominated by sugar maple with balsam fir (*Abies balsamea*) as a local dominant and striped maple (*Acer pensylvanicum*) and beaked hazelnut (*Corylus cornuta*) characteristic. American fly honeysuckle (*Lonicera canadensis*) is prevalent in the low shrub layer. The ground cover is dominated by sugar maple seedlings with characteristic species including starflower (*Trientalis borealis*), wild sarsaparilla (*Aralia nudicaulis*), violets (*Viola* spp.), spinulose woodfern (*Dryopteris carthusiana*), Indian cucumber root (*Medeola virginiana*), and stiff clubmoss (*Lycopodium annotinum*). Areas along the ecotonal edge of the mesic northern forest and the adjacent wetland are dominated by hemlock with yellow birch, red maple, and occasional northern white-cedar (*Thuja occidentalis*).

Threats: Deer herbivory is likely impacting the site's species composition and structure (i.e., eliminating hemlock regeneration). Browsed sugar maple saplings and jewelweed (*Impatiens capensis*) were noted during the survey. In the northern block of the forest there is a hunting blind with a wood stove. Hunters are cutting coarse woody debris for firewood and clearing trails with a chainsaw. One non-native earthworm was observed while digging a soil pit. Earthworms could potentially alter the soil decomposition rates and nutrient dynamics. Finally, the private portion of the old-growth forest could be logged.

Management Recommendations: The primary management recommendation is to allow natural processes (i.e., fire and windthrow) to operate unhindered (e.g., prohibit salvage logging). Private lands within and surrounding the site could be acquired or protected through conservation easements. The old-growth forest could be buffered by unmanaged forest and swamp. If the surrounding forest is managed, extending the rotation and maintaining late-successional features of the forest are recommended. Monitoring should be implemented to gauge the spread of invasive species and deer browse pressures. Reducing deer densities on the island could be accomplished through culling and/or increasing late-successional habitat by allowing early-successional stands to senesce and succeed to more mature, shade-tolerant systems.

Photo by Joshua G. Cohen.

102. Parcell Lakes

Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Newberry Forest Management Unit, Compartment 52, and Private Lands
Element Occurrence Identification Number: 2836

Site Description: This small block of old-growth mesic northern forest occurs on wet-mesic to mesic, flat, sandy glacial lakeplain with occasional low, sandy beach ridges. The site is characterized by well-developed pit and mound topography and high volumes of coarse woody debris in all size and decay classes. The soils are fine-textured, acidic loamy sands. The mesic northern forest occurs just north of an extensive, high-quality muskeg.[20]

The canopy is dominated by large-diameter (> 60 cm), old-growth trees. Canopy dominance varies with areas dominated by conifers supporting hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), and northern white-cedar (*Thuja occidentalis*), and areas dominated by hardwoods supporting sugar maple (*Acer saccharum*), red maple (*A. rubrum*), American beech (*Fagus grandifolia*), and yellow birch (*Betula alleghaniensis*). The forest is characterized by uneven-aged structure with sugar maple, red maple, hemlock, beech, yellow birch, and balsam fir (*Abies balsamea*) in the subcanopy. The low shrub layer is dominated by tall bilberry (*Vaccinium ovalifolium*) with American fly honeysuckle (*Lonicera canadensis*) occasional. Characteristic species of the ground cover include starflower (*Trientalis borealis*), wild sarsaparilla (*Aralia nudicaulis*), bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), bluebead lily (*Clintonia borealis*), spinulose woodfern (*Dryopteris carthusiana*), trailing arbutus (*Epigaea repens*), and northern wood sorrel (*Oxalis acetosella*).

Threats: Beech bark disease will likely cause significant mortality of canopy and subcanopy beech. If deer densities increase due to a string of mild winters, deer browse could eliminate significant amounts of conifer advanced regeneration.

Management Recommendations: The primary management recommendation is to allow natural processes (i.e., fire and windthrow) to operate unhindered (e.g., prohibit salvage logging, even of dead and dying beech). Private lands within and adjacent to the site could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

[20] Prison Camp Muskeg

103. Scotty Bay North

Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Location: Sault Sainte Marie Forest Management Unit, Compartments 24, and Private Lands
Element Occurrence Identification Number: 13253

Site Description: This mesic northern forest occurs on a coarse-textured ground moraine of sandy clay loam and lakeplain of sandy loam. Sugar maple (*Acer saccharum*) dominates the forest, which has been selectively harvested with local areas more intensively managed. Areas of moraine are gently sloping with a northwest aspect while the lakeplain is flat with moderate pit and mound topography. The soils are underlain by limestone bedrock and numerous large limestone boulders are scattered throughout the site.

Sugar maple is the overwhelming dominant of all vegetative layers. Scattered yellow birch (*Betula alleghaniensis*) occur in the canopy. Early-successional forest dominated by paper birch (*Betula papyrifera*) and big-toothed aspen (*Populus grandidentata*) occur on sandy clay loam of ground moraine. Several areas of boreal forest occur closer to the lake in areas of lower slope with shallower soils over bedrock. Canopy closure ranges from 60 to 75% in places and 75 to 90% in more mesic areas. Diameters of canopy trees were typically between 30 and 50 cm with scattered old-growth sugar maple ranging between 50 and 70 cm. Canopy height ranged from 60 to 80 feet. Due to the history of timber management, this site lacks diversity and volume of coarse woody debris and snags. The coarse woody debris load is primarily from early-successional species and self-thinning of subcanopy hardwoods. A lone gray wolf (*Canis lupus*, state threatened) was encountered on foot during the 2006 survey.

Threats: The primary threat to this site has been forest management that has eliminated the late-successional characteristics of this forest. Opening the canopy near large boulders could drastically alter the micro-environments of the boulders. Invasive and weedy species were documented but remain confined to road margins.

Management Recommendations: Maintaining late-successional features (i.e., large-diameter trees, coarse woody debris, and snags) can be accomplished by extending the timber rotation or refraining from further logging. Micro-environments characteristic of boulders can be protected by maintaining canopy closure around large moss-covered boulders and avoiding felling timber on these boulders. Private lands within and surrounding the site could be acquired or protected through conservation easements.

Photo by Christopher R. Weber.

104. Walloon Lake State Forest

Natural Community Type: Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Gaylord Forest Management Unit, Compartment 38, and Private Land
Element Occurrence Identification Number: 15791

Site Description: This site is characterized by a small band of old-growth mesic northern forest occurring on slopes of rolling moraine adjacent to Walloon Lake. The forest contains structural attributes of uneven-aged, old-growth forest driven by gap-phase dynamics, namely, numerous canopy gaps, a high volume of large-diameter snags and coarse wood of varying species and states of decomposition, and pit and mound microtopography.

The canopy is dominated by large-diameter hemlock (*Tsuga canadensis*), sugar maple (*Acer saccharum*), and American beech (*Fagus grandifolia*). Based on increment core readings, canopy dominants are likely at least 200 years old. The canopy composition is diverse with numerous associates, including yellow birch (*Betula alleghaniensis*), northern white-cedar (*Thuja occidentalis*), basswood (*Tilia americana*), big-toothed aspen (*Populus grandidentata*), paper birch (*Betula papyrifera*), and white ash (*Fraxinus americana*). Yellow birch and northern white-cedar are concentrated along the lakeshore (often growing over the water) and mid-tolerant species are scattered along the upper slopes. The understory is dominated by shade-tolerant saplings of American beech, sugar maple, and some hemlock. Striped maple (*Acer pensylvanicum*) is also prevalent in the understory and ironwood (*Ostrya virginiana*) is common along the upper slopes. Prevalent ground cover species include jewelweed (*Impatiens capensis*), Canada mayflower (*Maianthemum canadense*), wild sarsaparilla (*Aralia nudicaulis*), spinulose woodfern (*Dryopteris carthusiana*), hairy sweet cicely (*Osmorhiza claytonii*), stiff clubmoss (*Lycopodium annotinum*), Solomon's seal (*Smilacina racemosa*), downy Solomon's seal (*Polygonatum pubescens*), white bear sedge (*Carex albursina*), doll's eye (*Actaea pachypoda*), maidenhair fern (*Adiantum pedatum*), wild leek (*Allium tricoccum*), round-lobed hepatica (*Hepatica americana*), and sugar maple and beech seedlings.

Threats: A boat launch has been proposed within this site. The boat launch would require the opening and expansion of the closed road to the lake. The old-growth forest in the immediate vicinity of the launch would be negatively impacted by this activity and the forest along the lakeshore would be negatively impacted by the increased level of anthropogenic disturbance.

Management Recommendations: The primary management objective for this high-quality mesic northern forest is to allow ecological processes to operate unhindered. Management should be restricted to ecological stewardship. Stewardship activities within this site should focus on the removal of the small incursions of non-native plants that occur along the old road and near the informal camping areas. Maintaining the closure of the road will allow closed-canopy forest to form over the road over the course of several decades. Gradual canopy closure along the old road will result in the eventual decrease of many of the non-native and native weeds that are limited to this area. Efforts should be made to prevent illicit camping and to prohibit collection of firewood, especially the cutting of conifer regeneration, which can take decades to establish. In addition, landowners adjacent to the forest should be encouraged to refrain from dumping brush and yard waste within the forest. The total acreage of the high-quality forest could be increased over many decades by eliminating active management within the surrounding northern hardwoods and allowing these stands to naturally succeed to more mature conditions and eventually to old-growth forest (which can take several hundred years). Increasing the amount of late-successional habitat surrounding the forest would also help reduce deer browse pressure within the mesic northern forest (Cohen 2006).

Consideration of this mesic northern forest as an Ecological Reference Area should preclude the creation of a public boat launch within the site. Creation of a boat launch would most likely result in the decrease of the site's element occurrence rank from a B to a C due to the loss of acreage of old-growth forest and the reduction of the site's condition. The creation of the proposed boat launch would negatively impact this old-growth forest in the following ways. The proposed launch would require the opening and expansion of the closed road to the lake. This

expansion of the road and creation of the boat launch would likely result in the reduction of the area of old-growth forest and the reduction of the amount of coarse woody debris along the lakeshore. The area surrounding the old road is characterized by a concentration of non-native plants and weedy natives. Expansion of this road would likely lead to the subsequent expansion of these invasive species and native weeds. The old-growth forest in the immediate vicinity of the launch area would likely be negatively impacted by this activity and the forest along the lakeshore would be negatively impacted by the increased level of anthropogenic disturbance. Currently, anthropogenic disturbance is associated with two dispersed camping areas, the old road leading to the lake, and the residential areas to the north and south. In the area surrounding the camping area to north, people have been harvesting wood for campfires including cedar and hemlock saplings and coarse woody debris. Higher levels of human traffic with the boat launch would increase this kind of human disturbance throughout the forest.

This small band of old-growth mesic northern forest occurs on slopes of rolling moraine adjacent to Walloon Lake. Photos by Joshua G. Cohen.

MUSKEG

Overview: Muskeg is a nutrient-poor peatland characterized by acidic, saturated peat, and scattered or clumped, stunted conifer trees set in a matrix of sphagnum mosses and ericaceous shrubs. Black spruce (*Picea mariana*) and tamarack (*Larix laricina*) are typically the most prevalent tree species. The community primarily occurs in large depressions on glacial outwash and sandy glacial lakeplains. Fire occurs naturally during periods of drought and can alter the hydrology, mat surface, and floristic composition of muskegs. Windthrow, beaver flooding, and insect defoliation are also important disturbance factors that influence species composition and structure (Kost et al. 2007).

105. Beavertown Lakes (Muskeg)

Natural Community Type: Muskeg
Rank: G4G5 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: A
Location: Newberry Forest Management Unit, Compartments 9, 10, and 16, and Private Lands
Element Occurrence Identification Number: 7430

Site Description: This extensive black spruce (*Picea mariana*) and tamarack (*Larix laricina*) muskeg occurs on deep, saturated peats on a vast expanse of poorly drained sand lakeplain with sandy dune ridges dominated by pine forest. Deep (80 - > 100 cm), saturated, acidic (pH 4.5-5.0), sphagnum peats with well-developed fibric, hemic, and sapric structure overlay wet sands. Well-developed sphagnum hummock and hollow microtopography occurs throughout the site. Peats tend to be shallower (30-50 cm) in areas near dune margins and slightly more acidic on hummocks. There are also localized areas with minerotrophic influence that are slightly acidic (pH 6.0). Seasonally wet pockets of muskeg occur throughout the complex. The complex is bordered to the north by the North Branch of the Two-Hearted River and to the south by the West Branch of the Two-Hearted River, which also passes through the south-central portion of the complex. Both rivers impart a minerotrophic influence to surrounding communities. Laduce Lake and Beavertown Lakes occur within the site and high-quality dry-mesic northern forest occurs on the adjacent dune ridges and high-quality rich conifer swamp lies to the west.[21]

Lake-filling and paludification have resulted in the development of an extensive muskeg complex on this poorly drained sand lakeplain with deep saturated sphagnum peats. Well-developed sphagnum hummock and hollow microtopography generates microsite heterogeneity due to fine-scale gradients of soil moisture and soil chemistry. In addition, the site is characterized by diverse patterning of natural communities due to different stages of lake-filling with more recent areas of peatland development supporting intermittent wetland or bog. In addition, localized areas of minerotrophic influence support northern shrub thicket, rich conifer swamp, and patterned fen. The North Branch of the Two-Hearted River and The West Branch of the Two-Hearted River impart a minerotrophic influence to the surrounding communities and are associated with beaver influence, which is also evident throughout Beavertown Lakes. Surrounding uplands burned approximately 110 years ago and portions of the muskeg and the surrounding wetlands were likely also burned by this wildfire.

Four primary vegetative strata occur in this muskeg: a conifer tree canopy, an understory layer, a low shrub layer, and a ground layer. The canopy is dominated by scattered and stunted black spruce and tamarack (3-20 cm DBH, 5-20 ft tall, and canopy closure typically ranging from 2-25%). White pine (*Pinus strobus*) and red pine (*P. resinosa*) (10-30 cm DBH and 6-40 ft tall) are common associates and are most prevalent along dune margins where the density and diversity of species in all strata tends to be greatest. Trees and woody plants also tend to be concentrated or clumped on sphagnum hummocks. Black spruce, white pine, and tamarack are prevalent in the tall shrub layer. The tall shrub zone is most developed along edges of muskeg and at the base of dune ridges in areas of slight minerotrophic influence. Wild-raisin (*Viburnum cassinoides*), mountain holly (*Nemopanthus mucronata*), and black chokeberry (*Aronia prunifolia*) are typical tall shrubs. The low shrub layer (75-95% closure) is overwhelmingly dominated by leatherleaf (*Chamaedaphne calyculata*) with other ericaceous shrub associates including bog laurel (*Kalmia polifolia*), bog rosemary (*Andromeda glaucophylla*), low sweet blueberry (*Vaccinium angustifolium*), and Labrador tea (*Ledum groenlandicum*), with the Labrador tea most prevalent along the margins of the dune ridges. Conifer seedlings are also prevalent in the low shrub layer and sweet gale

[21] Beavertown Lakes Dry-mesic Northern Forest and Beavertown Lakes Muskeg

(*Myrica gale*) is common in areas with minerotrophic influence. Graminoids, especially few-seed sedge (*Carex oligosperma*) and few-flower sedge (*C. pauciflora*), and sphagnum species dominate the ground cover. Characteristic ground cover species include small cranberry (*Vaccinium oxycoccos*), pitcher-plant (*Sarracenia purpurea*), and cotton-grasses (*Eriophorum* spp.). Species that are common on hummocks include wintergreen (*Gaultheria procumbens*), goldthread (*Coptis trifolia*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), and cow-wheat (*Melampyrum lineare*). These species along with false mayflower (*Smilacina trifolia*) and royal fern (*Osmunda regalis*) are also common in areas of muskeg near the dune ridges. The diverse array of sphagnum species are stratified along soil moisture and chemical gradients that characterize the hummock and hollow microtopography.

Bog-dominated areas, which occur along many of the lake margins, are dominated by graminoids, such as few-seed sedge, white beak-rush (*Rhynchospora alba*), and dioecious sedge (*Carex sterilis*), and ericaceous shrubs (i.e., leatherleaf and bog rosemary) with other characteristic species including pitcher-plant, bog buckbean (*Menyanthes trifoliata*), yellow-eyed grass (*Xyris montana*), round-leaved sundew (*Drosera rotundifolia*), large cranberry (*Vaccinium macrocarpon*), and cotton-grasses. Bogs occurring as floating mats around lake margins are often ringed by areas of muskeg where the mat has grounded. Areas of poor conifer swamp, which occur in narrow peatland pockets and areas where the peats are shallower over the sands, are characterized by a denser canopy with larger diameter trees. Canopy dominants in areas of poor conifer swamp include black spruce, tamarack, and white pine. In addition, the understory is denser and more diverse than areas of muskeg with conifer saplings, mountain holly, wild-raisin, and black chokeberry prevalent. Several minerotrophic wetlands are mapped within the muskeg complex and include northern shrub thicket, rich conifer swamp, and patterned fen. Areas of northern shrub thicket are dominated by tag alder (*Alnus rugosa*) with bog birch (*Betula pumila*), sweet gale, royal fern, tussock sedge (*Carex stricta*), winterberry, and northern white-cedar (*Thuja occidentalis*) as common species. The same species are prevalent in rich conifer swamps dominated by a northern white-cedar canopy. The southwestern portion of the complex includes an area with vegetation that is typical of patterned fens and areas of peatland where there is a minerortophic surface flow influence. This area is dominated by graminoids such as tufted bulrush (*Trichophorum cespitosum*), livid sedge (*Carex livida*), along with bog aster (*Aster nemoralis*), bog birch, and scattered northern white-cedar.

Threats: Logging on private parcels is a potential threat. Fire suppression in the overall landscape may reduce the fire frequency within the muskeg.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the muskeg as well as the surrounding uplands. In the event of a wildfire, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. Vehicular traffic should be avoided through this peatland. Forested inclusions (dry-mesic northern forest on dune ridges, rich conifer swamp, and poor conifer swamp) adjacent to and intersecting the muskeg should be left uncut. Private lands within and adjacent to the site could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

106. Jackson Tindle Road Muskeg

Natural Community Type: Muskeg
Rank: G4G5 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Sault Sainte Marie Forest Management Unit, Compartment 107
Element Occurrence Identification Number: 2367

Site Description: This muskeg occurs on a broad expanse of poorly drained sand lakeplain. The organic soils are saturated, acidic, sphagnum peats. The peat profile includes fibric, hemic and deep sapric peat (at least 1.5 meters deep). The water table ranges in depth from 40 to 50 cm. Well-developed sphagnum hummock and hollow microtopography occurs throughout the site and provides fine-scale gradients in soil moisture and chemistry.

The muskeg is characterized by four vegetative strata: canopy, tall shrub layer, low shrub layer, and ground cover. The canopy is dominated by scattered and stunted conifers (5-30 cm DBH, 15-30 ft tall, with canopy closure ranging from 2-10%). Denser canopy occurs in areas where the sand is approximately 20 cm below the sphagnum peat. Dominant conifers include black spruce (*Picea mariana*), tamarack (*Larix laricina*), and white pine (*Pinus strobus*), which are all prevalent in the tall shrub layer. The tall shrub layer is most developed along the edges of the muskeg in areas of minerotrophic influence where tag alder (*Alnus rugosa*), bog birch (*Betula pumila*), and mountain holly (*Nemopanthus mucronata*) are typical. The low shrub layer is dense (75-95% closure) and is overwhelmingly dominated by leatherleaf (*Chamaedaphne calyculata*) with other ericaceous shrub associates including low sweet blueberry (*Vaccinium angustifolium*), bog laurel (*Kalmia polifolia*), bog rosemary (*Andromeda glaucophylla*), and Labrador tea (*Ledum groenlandicum*). The ground cover is dominated by sphagnum species and graminoids, especially few-seed sedge (*Carex oligosperma*) and sheathed cotton-grass (*Eriophorum spissum*). Sphagnum species are stratified along soil moisture and chemical gradients that characterize the hummock and hollow microtopography.

Threats: Fire suppression in the overall landscape may reduce the fire frequency within the muskeg.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the muskeg as well as the surrounding uplands and wetlands. Vehicular traffic should be avoided through this peatland. Forested inclusions and adjacent forest (dry-mesic northern forest on dune ridges, and poor conifer swamp) should be left uncut. Maintaining a forested buffer surrounding the muskeg will help ensure the stability of the muskeg's hydrologic regime.

Photo by Joshua G. Cohen.

107. Prison Camp Muskeg

Natural Community Type: Muskeg
Rank: G4G5 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: A
Location: Tahquamenon Falls State Park and Newberry Forest Management Unit, Compartments 45, 47, 57, and 58
Element Occurrence Identification Number: 10471

Site Description: This is the state's largest expanse of muskeg, covering over 35 square miles. This muskeg occurs in a large peatland complex that consists of muskeg, bog, patterned fen, and poor conifer swamp. This complex of wetlands is located on poorly drained, sandy lakeplain. The deep sphagnum mat is continuous and dominated by graminoids and forbs, with patchy shrub cover. Diversity of the site is enhanced by the presence of open pools of water fringed by quaking saturated sphagnum mats. The sphagnum peats are strongly acidic (pH 4.0-4.5). The extensive peatland contains projections of dry, sandy pine ridges, and several large and small lakes. The ridges connect to surrounding uplands of pine-dominated dry northern forest and dry-mesic northern forest. High-quality mesic northern forest and intermittent wetland occur adjacent to the muskeg.[22]

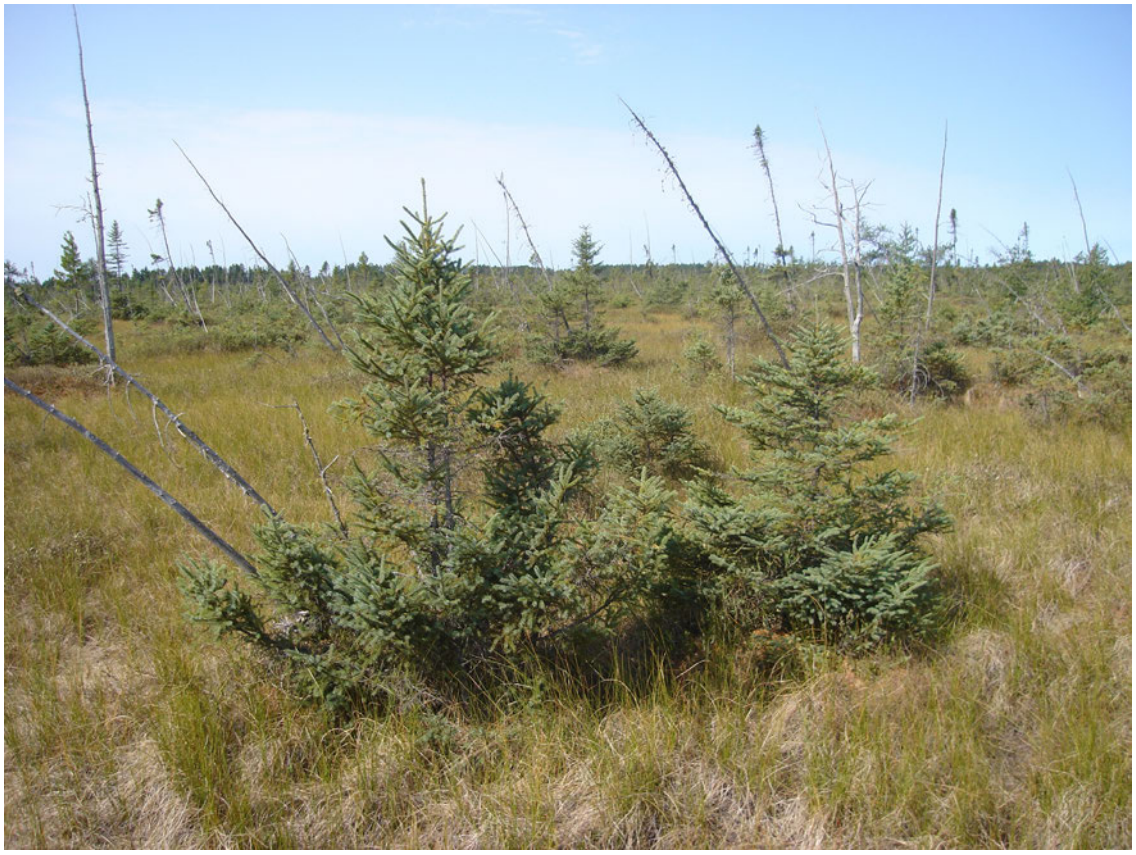
The canopy of the muskeg is characterized by well-spaced, mostly stunted tamarack (*Larix laricina*), black spruce (*Picea mariana*), and jack pine (*Pinus banksiana*). The scattered and stunted trees are typically 3 to 10 cm in DBH, 15 to 30 ft tall and the canopy coverage ranges from 20 to 50%. The site is characterized by an open understory with conifer tree saplings and mountain holly (*Nemopanthus mucronata*), which is uncommon. The low shrub layer is dominated by patchy, ericaceous shrubs including leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), bog laurel (*Kalmia polifolia*), and Labrador tea (*Ledum groenlandicum*). Graminoids, especially few-seed sedge (*Carex oligosperma*), and sphagnum species dominate the ground cover. Additional species include small cranberry (*Vaccinium oxycoccos*), pitcher-plant (*Sarracenia purpurea*), bog aster (*Aster nemoralis*), and cotton-grasses (*Eriophorum* spp.). Quaking mats associated with open pools are dominated by white beak-rush (*Rhynchospora alba*), yellow-eyed grass (*Xyris montana*), sundews (*Drosera* spp.), large cranberry (*Vaccinium macrocarpon*), and arrow-grass (*Scheuchzeria palustris*). Narrow upland ridges are dominated by relatively large red pine (*Pinus resinosa*) (36-55 cm DBH), with red pine, jack pine, and black spruce (*Picea mariana*) in the understory, and a shrub-dominated ground cover. There are local areas of patterning with linear strings and flarks, the former supporting rows of small conifers, the latter being open and sedge-dominated, creating the appearance of tree-lined alleys. Over 40 vascular plant species were documented during the survey.

Threats: Fire suppression in the overall landscape may reduce the fire frequency within the muskeg. The roads that pass through the peatland create microhabitats colonized by sometimes dense stands of tag alder (*Alnus rugosa*), with herbaceous species such as soft-stemmed rush (*Juncus effusus*) and rattlesnake grass (*Glyceria canadensis*). The roads are also likely associated with increased nutrient input, locally altering the muskeg structure and composition in their immediate vicinity.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the muskeg as well as the surrounding uplands. If wildfires occur within this peatland, no plow lines should be established within the peatland. Instead, existing fire lines in the surrounding uplands should be relied upon. Vehicular traffic should be avoided through this peatland. Forested inclusions and adjacent forest (dry-mesic northern forest and dry northern forest on dune ridges, and poor conifer swamp) should be left uncut. Maintaining a forested buffer surrounding the muskeg will help ensure the stability of the muskeg's hydrologic regime.

[22] Parcell Lakes mesic northern forest and Prison Camp Intermittent Wetland

Prison Camp Muskeg, the state's largest expanse of muskeg, is characterized by deep sphagnum peats, low ericaceous shrubs, and scattered, stunted conifers. Photos by Joshua G. Cohen.



NORTHERN FEN

Overview: Northern fen is a sedge- and rush-dominated wetland occurring on neutral to moderately alkaline saturated peat and/or marl influenced by groundwater rich in calcium and magnesium carbonates. The community occurs north of the climatic tension zone and is found primarily where calcareous bedrock underlies a thin mantle of glacial drift on flat areas or shallow depressions of glacial outwash and glacial lakeplains and also in kettle depressions on pitted outwash and moraines (Kost et al. 2007).

108. Barker Creek Fen

Natural Community Type: Northern Fen
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Grayling Forest Management Unit, Compartment 279
Element Occurrence Identification Number: 4661

Site Description: This northern fen occurs within a shallow basin in a poorly drained portion of a large outwash plain. Early-successional aspen (*Populus* spp.) and jack pine (*Pinus banksiana*) occur in the surrounding uplands. The soils of the fen are deep (> 120 cm), circumneutral (pH 7.0) peats over coarse-textured gleyed sand. Water depths range from 20 cm to a meter deep, especially near the west and northwest edge of the wetland where Barker Creek enters and spills into wetland. Water temperature is warmer in the interior of the fen and cooler towards the edges.

Wiregrass sedge (*Carex lasiocarpa*) dominates the wetland with small islands of sphagnum hummocks supporting leatherleaf (*Chamaedaphne calyculata*) and meadowsweet (*Spiraea alba*). The open wetland is ringed by a shrub-dominated zone with bog birch (*Betula pumila*), slender willow (*Salix petiolaris*), shrubby cinquefoil (*Potentilla fruticosa*), and tamarack (*Larix laricina*), many of which appear to be flood-killed. Other typical species include pitcher-plant (*Sarracenia purpurea*), bog buckbean (*Menyanthes trifoliata*), tussock sedge (*Carex stricta*), tufted bulrush (*Trichophorum cespitosum*), marsh St. John's-wort (*Triadenum fraseri*), Kalm's St. John's-wort (*Hypericum kalmianum*), and scattered jack pine and white pine (*Pinus strobus*).

Threats: Potential threats include off-road vehicle damage and alteration of the hydrologic and nutrient regime from logging of the adjacent uplands.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered (i.e., wildfires should be allowed to burn the wetlands and the surrounding uplands). Prescribed fire should be considered as a management tool to reduce the thickness of the leaf litter and stimulate seed bank expression. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. Maintaining a forested buffer surrounding the northern fen will help ensure the stability of the fen's hydrologic regime. In addition, maintaining a forested buffer around the site and closing roads and trails within the surrounding forest would help reduce the potential for illegal off-road vehicle traffic.

Barker Creek Fen occurs in a poorly drained outwash plain. Groundwater seepage generates minerotrophic conditions correlated with high floristic diversity. Photos by Joshua G. Cohen.

109. Big Bay de Noc

Natural Community Type: Northern Fen
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: A
Location: Hiawatha National Forest, Shingleton Forest Management Unit, Compartment 88, and Private Lands
Element Occurrence Identification Number: 16603

Site Description: This site is a large northern fen that occurs on interdunal swales within a large dune and swale complex[23] along a sandy lakeplain. The fen occupies shallow to deep circumneutral peat deposits in swales of varying width. These fen-dominated swales range from open, flat, and sedge-dominated to shrubby, hummocky swales with scattered or clumped, stunted conifers. The fen-dominated swales in the southeastern portion of the wooded dune and swale complex contain a small lake (Cousineau Lake) and two small ponds. The organic peat deposits are slightly acidic to circumneutral (pH 6.0-7.0) and range from 20 to 100 cm in depth over saturated sands. Organic deposits are generally deeper in the swales farthest from the bay.

This northern fen is characterized by high floristic diversity. Sedges (*Carex* spp.) dominate the low saturated flats and hollows with shrubs concentrated on sphagnum covered hummocks. Characteristic shrubs include bog birch (*Betula pumila*), bog rosemary (*Andromeda glaucophylla*), shrubby cinquefoil (*Potentilla fruticosa*), sweet gale (*Myrica gale*), leatherleaf (*Chamaedaphne calyculata*), and bog willow (*Salix pedicellaris*), with small cranberry (*Vaccinium oxycoccos*) carpeting hummocks. The dominant sedge is wiregrass sedge (*Carex lasiocarpa*), with mud sedge (*C. limosa*), dioecious sedge (*C. sterilis*), and livid sedge (*C. livida*) locally important, the latter species primarily in low, wet flats, associated with white beak-rush (*Rhynchospora alba*). Common forbs include pitcher-plant (*Sarracenia purpurea*), bog goldenrod (*Solidago uliginosa*), and round-leaved pyrola (*Pyrola rotundifolia*). Scattered or clumped stunted trees occur in some of the swales and include tamarack (*Larix laricina*), northern white-cedar (*Thuja occidentalis*), and black spruce (*Picea mariana*). Tall shrubs are common along the ecotone with the dune ridges and include tag alder (*Alnus rugosa*), winterberry (*Ilex verticillata*), and willows (*Salix* spp.). The native form of reed (*Phragmites australis*) is present in the southeastern swales.

Threats: Potential threats include off-road vehicle damage and alteration of the hydrologic and nutrient regime from logging of the adjacent uplands. A railroad crosses this wetland complex and has locally altered the hydrology.


Photo by Bradford S. Slaughter.

Management Recommendations: The main management recommendation is to allow natural processes (i.e., wildfire) to operate unhindered. Maintaining a forested buffer surrounding the northern fen will help ensure the stability of the fen's hydrologic regime. In addition, maintaining a forested buffer around the site and closing roads through the wooded dune and swale complex would help reduce the potential for illegal off-road vehicle traffic. Portions of the northern fen and surrounding wooded dune and swale complex occurring on private lands could be acquired or protected through conservation easements.

[23] Big Bay de Noc Wooded Dune and Swale Complex

110. Root Lake

Natural Community Type: Northern Fen
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Traverse City Forest Management Unit, Compartment 40
Element Occurrence Identification Number: 9558

Site Description: This site constitutes two blocks of northern fen that occur in large, flat wetlands formed by kettle depressions within pitted outwash. The soils are alkaline (pH 8.0) marl of variable depth (30 cm - > 100 cm) overlying wet alkaline to circumneutral sands. The depth of the marl increases from the upland edge to the center of the wetlands as depth to the water table decreases. Calcium precipitation has resulted in extensive marl flats and groundwater influence contributes to the alkaline conditions. Fluctuation of water levels results in complex patterning of ecological zones and dynamic shifting of these zones.

Three primary vegetative zones characterize the site: a floating sedge peat mat, submergent marsh, and marl flats. Floating mat, which is extensive in the eastern kettle depression, is dominated by twig-rush (*Cladium mariscoides*) with wiregrass sedge (*Carex lasiocarpa*) and hardstem bulrush (*Schoenoplectus acutus*). Submergent marsh is prevalent in the western depression, which has a higher portion of open water. Prevalent vegetation in the submergent marsh zone includes sweet-scented water-lily (*Nymphaea odorata*), stoneworts (*Chara* spp.), and pondweeds (*Potamogeton* spp.). The marl flats are dominated by silverweed (*Potentilla anserina*), sedge (*Carex viridula*), Kalm's St. John's-wort (*Hypericum kalmianum*), and goldenrods (*Solidago* spp.). The low shrub layer, which is patchy and limited to drier marl flats, is dominated by Kalm's St. John's-wort with some patches of shrubby cinquefoil (*Potentilla fruticosa*). Bluejoint grass (*Calamagrostis canadensis*) is prevalent in areas of northern wet meadow.

Threats: Off-road vehicle tracks occur throughout the western wetland and have resulted in marl compaction, unvegetated areas, and the spread of spotted knapweed (*Centaurea maculosa*) along the tracks and the margin of the wetland. Off-road vehicle damage has likely caused alteration of local hydrology especially in the northern portion where rutting is ubiquitous.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered (i.e., wildfires should be allowed to burn the wetlands and the surrounding uplands). In the event of a wildfire or if prescribed fire is implemented in the surrounding dry-mesic northern forest, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. The adjacent dry-mesic northern forest should be left uncut. Maintaining a forested buffer surrounding the northern fen will help ensure the stability of the fen's hydrologic regime. In addition, maintaining a forested buffer around the site and closing roads and trails within the surrounding forest would help reduce the illegal off-road vehicle traffic. The population of spotted knapweed should be eradicated and efforts to control this invasive species should be monitored.

Photo by Joshua G. Cohen.

111. Sand Lakes (Northern Fen)

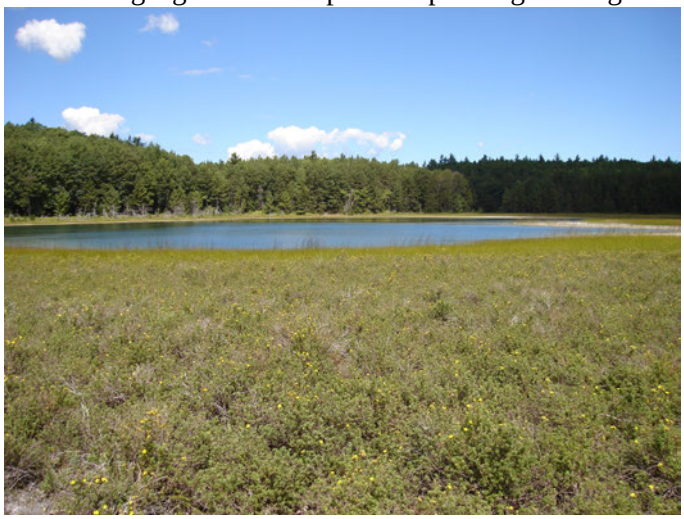
Natural Community Type: Northern Fen
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Traverse City Forest Management Unit, Compartment 45 (Sand Lakes Quiet Area)
Element Occurrence Identification Number: 13159

Site Description: This site contains numerous northern fens that occur along the margins of seven alkaline kettle lakes within a pitted outwash plain dominated by high-quality dry-mesic northern forest.[24] The soils are alkaline marl of variable depth (> 1 meter in areas) overlying circumneutral to alkaline sands. The depth of the marl increases from the upland to the lake margin. Calcium precipitation results in formation of extensive marl flats and groundwater influence also contributes to minerotrophic conditions. Fluctuation of water levels results in complex patterning of ecological zones, high native species diversity (> 60 species noted during the 2006 survey), and dynamic shifting of these zones.

Areas of marl beach immediately adjacent to the open water are dominated by twig-rush (*Cladium mariscoides*), wiregrass sedge (*Carex lasiocarpa*), sedge (*C. viridula*), and hardstem bulrush (*Schoenoplectus acutus*). In drier areas of deep marl (> 1 m), the vegetation is dominated by silverweed (*Potentilla anserina*), rushes (*Juncus* spp.), Kalm's St. John's-wort (*Hypericum kalmianum*), common water horehound (*Lycopus americanus*), and goldenrods (*Solidago* spp.). Areas of shallower marl (approximately 30 cm) with greater depth to the water table are characterized by dense cover of shrubby cinquefoil (*Potentilla fruticosa*) and balsam ragwort (*Senecio pauperculus*). Submergent marsh occurs near the margins of the lakes and supports aquatic species such as sweet-scented water-lily (*Nymphaea odorata*), yellow pond-lily (*Nuphar variegata*), slender naiad (*Najas flexilis*), and pondweeds (*Potamogeton* spp.).

Threats: Primary threats to the fen are off-road vehicle damage and continued human degradation of the marl shoreline in the northwestern wetland.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered (i.e., wildfires should be allowed to burn the wetlands and the surrounding uplands). In the event of a wildfire or if prescribed fire is implemented in the surrounding dry-mesic northern forest, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. The adjacent dry-mesic northern forest should be left uncut. Maintaining a forested buffer surrounding the northern fen will help ensure the stability of the fen's hydrologic regime. In addition, maintaining closure of roads within the surrounding forest and quiet area will help reduce the potential for illegal off-road vehicle traffic. Erosion of marl shore in the northwestern wetland could be reduced by establishing signs near campsites explaining the fragile nature of these wetlands.



Photos by Joshua G. Cohen.

[24] Sand Lakes Dry-mesic Northern Forest

The Sand Lakes northern fens occur along the margins of kettle lakes within a pitted outwash plain. The soils are alkaline marl overlaying sands. Photos by Joshua G. Cohen.

112. Stevenson's Fen

Natural Community Type: Northern Fen
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Atlanta Forest Management Unit, Compartment 133
Element Occurrence Identification Number: 15803

Site Description: This site occurs in an area of lakeplain with poorly drained organic soils overlying limestone or dolomite pavement. The neutral to slightly alkaline saturated peat and marl soils are 20 to 40 cm deep and overlay sandy lacustrine deposits that are underlain by limestone bedrock. Depth to the water table ranges from 5 to 20 cm. Minerotrophic conditions are generated by groundwater influence. Vast areas of marl occur throughout the site and areas of sphagnum peat are concentrated in the western portion of the wetland. Rainbow Creek drains the fen to Lake Huron. The surrounding uplands are boreal forests of balsam fir (*Abies balsamea*), paper birch (*Betula papyrifera*), and aspens (*Populus* spp.) that occur on thin soils over the bedrock.

This fen is dominated by sedges (*Carex* spp.) and rushes (*Juncus* spp.) with scattered and stunted northern white-cedar (*Thuja occidentalis*), tamarack (*Larix laricina*), and black spruce (*Picea mariana*), and shrubby cinquefoil (*Potentilla fruticosa*) in the low shrub layer. Additional low shrubs include Labrador tea (*Ledum groenlandicum*), bog rosemary (*Andromeda glaucophylla*), bearberry (*Arctostaphylos uva-ursi*), alder-leaved buckthorn (*Rhamnus alnifolia*), leatherleaf (*Chamaedaphne calyculata*), and northern white-cedar and tamarack seedlings. Characteristic species of the ground cover include tufted bulrush (*Trichophorum cespitosum*), dwarf Canadian primrose (*Primula mistassinica*), small-fringed gentian (*Gentianopsis procera*), ebony sedge (*Carex eburnea*), sedges (*C. castanea* and *C. capillaris*), grass-of-Parnassus (*Parnassia glauca*), Ohio goldenrod (*Solidago ohioensis*), pitcher-plant (*Sarracenia purpurea*), and false asphodel (*Tofieldia glutinosa*). Rushes and sedges are most prevalent in wetter areas of fen while shrubby zones with sphagnum hummocks occur in less inundated areas. Clumps of trees are found in even less inundated areas and along the margin of the fen. Over 70 native species were recorded during 2002 and 2006 surveys.

Threats: An off-road vehicle trail passes through the fen and disrupts the local hydrology. Ruts create unnatural areas of pooling. In addition, the railroad grade to the east has also likely disrupted the natural hydrology. A small population of reed canary grass (*Phalaris arundinacea*) was noted during the surveys.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Adjacent forest and swamp should be left uncut. Maintaining a forested buffer surrounding the northern fen will help ensure the stability of the fen's hydrologic regime. In addition, maintaining a forested buffer around the site and closing roads and trails within the surrounding forest would help reduce the illegal off-road vehicle traffic. The population of reed canary grass should be monitored and controlled if necessary.

Stevenson's Fen is a graminoid-dominated wetland that is characterized by diverse herbaceous and shrub layers and scattered, stunted conifers. Photos by Joshua G. Cohen.

113. Wiregrass Lake

Natural Community Type: Northern Fen
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Escanaba Forest Management Unit, Compartments 4 and 5, and Private Lands
Element Occurrence Identification Number: 14562

Site Description: This minerotrophic peatland complex occurs in a large, poorly drained glacial drainageway in an area of drumlinized ground moraine north of Wiregrass Lake. The northern fen is surrounded by closed-canopy rich conifer swamp in the lowlands and the surrounding uplands support northern hardwoods and early-successional forest. The fen occurs on slightly saturated, alkaline sedge and woody peats.

North of County Road 374 the northern fen is dominated by wiregrass sedge (*Carex lasiocarpa*) with shrubby cinquefoil (*Potentilla fruticosa*) and bog birch (*Betula pumila*) prevalent. Mud sedge (*Carex limosa*), bog buckbean (*Menyanthes trifoliata*), and golden-seeded spike-rush (*Eleocharis elliptica*) are prevalent in slightly wetter areas including along deer trails. This portion of the fen gradually grades into a tamarack (*Larix laricina*) savanna with a fen understory under the open tamarack canopy. This area does not represent a recent invasion (many of the small-diameter tamaracks were aged to be 120+ years old). The tamarack savanna grades into a more typical rich conifer swamp where shade-intolerant species are sparse and the canopy is dominated by northern white-cedar (*Thuja occidentalis*), tamarack, and black spruce (*Picea mariana*).

South of the road, open fen occurs on saturated sedge peat of slightly higher pH than the fen north of the road. This area is characterized by a greater concentration of calciphiles and orchids. Characteristic species in the fen south of the road include dioecious sedge (*Carex sterilis*), tufted bulrush (*Trichophorum cespitosum*), Kalm's lobelia (*Lobelia kalmii*), and grass-of-Parnassus (*Parnassia glauca*). Areas of open fen adjacent to Wiregrass Lake occur on a floating sedge mat. Beaver flooding surrounding Wiregrass Lake has significantly altered the local species composition and structure, killing canopy tamarack and northern white-cedar and generating conditions favorable for the non-natives reed canary grass (*Phalaris arundinacea*) and European marsh thistle (*Cirsium palustre*). In addition, just south of the road where the water table has been lowered, closed-canopy swamp forest has locally developed. Numerous orchids (over twenty species) have been documented within the northern fen and also in the vicinity including round-leaved orchis (*Amerorchis rotundifolia*, state endangered) and ram's head lady's-slipper (*Cypripedium arietinum*, state special concern).

Threats: The road passing through the northern fen has locally altered the site's hydrology. Just south of the road where the water table has been lowered, closed-canopy swamp forest has locally developed. Beaver flooding surrounding Wiregrass Lake has significantly altered the local species composition and structure, killing canopy tamarack and northern white-cedar and generating conditions favorable for the non-natives reed canary grass and European marsh thistle. Potential threats include off-road vehicle damage and alteration of the hydrologic and nutrient regime from logging of the adjacent uplands. In addition, deer browse is locally heavy, and northern white-cedar regeneration is rare.

Management Recommendations: The main management recommendation is to allow natural processes (i.e., groundwater seepage and wildfire) to operate unhindered. Maintaining a forested buffer surrounding the northern fen will help ensure the stability of the fen's hydrologic regime. In addition, maintaining a forested buffer around the site and closing roads and trails within the surrounding forest would help reduce the potential for illegal off-road vehicle traffic. The population of reed canary grass should be monitored and controlled if necessary. Monitoring deer herbivory can help resource managers assess whether species composition and structure is being negatively impacted by deer browse. To reduce deer browse pressure, the surrounding forests could be managed for late-successional habitat and the regional deer population could be reduced through culling. As noted above, beaver flooding surrounding Wiregrass Lake has significantly altered the floristic composition of the fen. Trapping of beaver should be investigated as a management option to prevent the further loss of northern fen habitat. Portions of the northern fen and surrounding area occurring on private land could be acquired or protected through conservation easements.

This northern fen is part of a minerotrophic peatland complex that occurs in a large, poorly drained glacial drainageway in an area of drumlinized ground moraine north of Wiregrass Lake. Photo by Bradford S. Slaughter.

NORTHERN HARDWOOD SWAMP

Overview: Northern hardwood swamp is a seasonally inundated, deciduous swamp forest community dominated by black ash (*Fraxinus nigra*) that occurs on neutral to slightly acidic, hydric mineral soils and shallow muck over mineral soils. Located north of the climatic tension zone, northern hardwood swamp is found primarily in depressions on level to hummocky glacial lakeplains, fine- and medium-textured glacial tills, and broad flat outwash plains. Fundamental disturbance factors affecting northern hardwood swamp development include seasonal flooding and windthrow (Kost et al. 2007).

114. Selma Swamp

Natural Community Type: Northern Hardwood Swamp (Re-classified from Southern Hardwood Swamp)
Rank: G4 S3?, secure globally and apparently vulnerable within state
Element Occurrence Rank: C
Location: Traverse City Forest Management Unit, Compartment 39, and Private Lands
Element Occurrence Identification Number: 7693

Site Description: This small block of seasonally inundated deciduous swamp forest occurs on a flat, poorly drained lakeplain with a high water table (approximately 30 cm deep). Soils are characterized by weakly acidic (pH 6.5-6.8), sandy, clay loam overlying circumneutral (pH 7.0) clay lenses and circumneutral (pH 7.0) wet sand.

The overwhelming canopy dominant is silver maple (*Acer saccharinum*) (30-80 cm DBH) and canopy associates include green ash (*Fraxinus pennsylvanica*) and black ash (*F. nigra*) with yellow birch (*Betula alleghaniensis*) and northern white-cedar (*Thuja occidentalis*) restricted to the margins and primarily confined to the subcanopy. The subcanopy also contains silver maple, ash species, and American elm (*Ulmus americana*). The tall shrub layer is sparse with ashes, elm, and musclewood (*Carpinus caroliniana*). The low shrub layer is scattered with winterberry (*Ilex verticillata*), spicebush (*Lindera benzoin*), and raspberries (*Rubus* spp.). Ground cover ranges from closed to patchy (due to seasonal inundation) and is dominated by false nettle (*Boehmeria cylindrica*), northern bugleweed (*Lycopus uniflorus*), spinulose woodfern (*Drypoteris carthusiana*), and silver maple seedlings. Common ground cover species include fragrant bedstraw (*Galium triflorum*), mad-dog skullcap (*Scutellaria lateriflora*), and fowl manna grass (*Glyceria striata*). This site is characterized by high native species diversity (over 80 species were recorded during the 2006 survey). Following 2006 surveys, this site, which was formerly classified as a southern hardwood swamp, was re-classified as northern hardwood swamp.

Threats: Logging and fire have dramatically altered the species composition, structure, and hydrology of this site. This site was historically logged and burned. The conifer canopy component was likely removed and fire likely altered the site's hydrology and soil properties by possibly burning off the organic layer. Approximately nine acres of the site on private land in the north central portion were recently logged. Regeneration failure of conifers may occur due to limited seed source and high deer densities. Non-native earthworms were observed throughout site. Earthworms are potentially negatively impacting soil nutrient and accumulation properties.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered, to maintain canopy closure of the surrounding uplands to minimize surface water flow into the swamp and to maintain groundwater seepage, to reduce deer densities in the surrounding landscape to dampen deer browse pressure, and to monitor for invasive plant populations.

OAK-PINE BARRENS

Overview: Oak-pine barrens is a fire-dependent, savanna community dominated by oaks and pines, having between 5 and 60% canopy cover, with or without a shrub layer. The predominantly graminoid ground layer contains plant species associated with both prairie and forest. The community occurs on a variety of landforms on droughty, infertile sand or loamy sands occasionally within southern Lower Michigan but mostly north of the climatic tension zone in the northern Lower and Upper Peninsulas. Typically oak-pine barrens occurs on nearly level to slightly undulating ground in well-drained sandy glacial outwash, sandy glacial lakeplains, and less often on sandy areas in coarse-textured moraines (Kost et al. 2007).

115. Carpenter Creek North and South

Natural Community Type: Oak-Pine Barrens
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: B
Location: Traverse City Forest Management Unit, Compartments 47, 52, and 53
Element Occurrence Identification Number: 12308

Site Description: This site is an extensive oak-pine barrens of variable physiognomy that occurs on level to gently rolling pitted outwash. The soils are characterized as moderately to slightly acidic Rubicon sands of medium to coarse texture, contain scattered gravel, and have low moisture-retaining capacity.

The scattered canopy is dominated by white oak (*Quercus alba*) with white pine (*Pinus strobus*) and black cherry (*Prunus serotina*) as canopy associates and more dense patches dominated by jack pine (*Pinus banksiana*) and quaking aspen (*Populus tremuloides*). The tall shrub layer is scattered with clumps of black cherry and hawthorn (*Crataegus* sp.) and scattered serviceberry (*Amelanchier* sp.) and witch hazel (*Hamamelis virginiana*) in areas of denser canopy. Red maple (*Acer rubrum*) is also common in the understory. Recently burned areas have significant black cherry dieback. The low shrub layer is dominated by sweetfern (*Comptonia peregrina*) and low sweet blueberry (*Vaccinium angustifolium*).

Poverty grass (*Danthonia spicata*), little bluestem (*Andropogon scoparius*), and Pennsylvania sedge (*Carex pensylvanica*) are dominant in the herbaceous layer with scattered blazing star (*Liatris* sp.) and rough-leaved rice grass (*Oryzopsis asperifolia*). Weedy and non-native species are confined to roads and trails. The northern portion of the site was prescribe-burned in the spring of 2006, while the southern portion has yet to be burned and is characterized by greater prevalence of jack pine, which occurs in dense patches. Hill's thistle (*Cirsium hillii*, state special concern) and the non-native invasive leafy spurge (*Euphorbia esula*) were documented in the southern portion.

Threats: The invasive plant leafy spurge is common along the road through the southern portion in proximity to the population of Hill's thistle. Autumn olive (*Elaeagnus umbellata*) was also observed within the site. Invasive species could spread along the newly established fire breaks. In addition, the potential for off-road vehicle damage has likely increased now that fire has helped open up the site.

Management Recommendations: The continued use of prescribed fire will help set back the black cherry and red maple. In the event of a wildfire or if additional prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. Autumn olive and leafy spurge should be controlled now while they are confined to small portions of the occurrence and control efforts should be monitored. In addition, monitoring should be implemented to assess the impacts of prescribed fire on vegetative structure and composition.

The continued use of prescribed fire will maintain the open canopy conditions of this oak-pine barrens. Photos by Joshua G. Cohen.

116. Shakey Lakes

Natural Community Type: Oak-Pine Barrens
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: BC
Location: Escanaba Forest Management Unit, Compartments 24 and 109, and Private Lands
Element Occurrence Identification Number: 11124

Site Description: This large site is a mosaic of aspen stands, closed-canopy dry northern forests, and remnant (or restored) open to partial canopy oak-pine barrens on a sandy outwash plain. The topography ranges from level to rolling and the soils are acidic to slightly acidic sands and loamy sands. The site also includes several pockets of seasonal wet depressions, emergent marsh around Muskrat Lake, and areas of northern wet meadow. Native Americans likely contributed to the open character of the barrens complex by intentionally and accidentally starting fires. Pines and oaks were initially cut from the site during the early 1900s.

Dominant overstory species in the oak-pine barrens and in the closed-canopy forest include northern pin oak (*Quercus ellipsoidalis*), red oak (*Q. rubra*), and jack pine (*Pinus banksiana*). Additional canopy associates include quaking aspen (*Populus tremuloides*), big-toothed aspen (*P. grandidentata*), and red pine (*Pinus resinosa*). Canopy oaks are typically stump sprouts and aspens generally occur in closed-canopy clonal groves. Scattered shrubs and clumps of shrubs include American hazelnut (*Corylus americana*), prairie willow (*Salix humilis*), pin cherry (*Prunus pensylvanica*), and choke cherry (*P. virginiana*). Characteristic low shrubs include low sweet blueberry (*Vaccinium angustifolium*), huckleberry (*Gaylussacia baccata*), and sweet fern (*Comptonia peregrina*) with Canada blueberry (*Vaccinium myrtilloides*) and snowberry (*Symphoricarpos albus*) less frequent. Pennsylvania sedge (*Carex pensylvanica*) dominates the ground cover along with big bluestem (*Andropogon gerardii*), little bluestem (*A. scoparius*), poverty grass (*Danthonia spicata*), and hair grass (*Deschampsia flexuosa*). Additional grasses include quack grass (*Agropyron repens*) and rice grass (*Oryzopsis pungens*). Dwarf milkweed (*Asclepias ovalifolia*, state endangered) was documented within the oak-pine barrens.

Threats: Decades of fire suppression have caused the closure of the canopy in many areas of the oak-pine barrens. The current management practice of clearcutting to simulate fire needs to be evaluated. The use of clearcutting threatens the site by reducing light resource heterogeneity, altering competitive interactions, lowering species richness and equitability, disturbing and compacting soils, exposing species favoring partial light niches to high light levels, causing chlorosis and plant death, leaving large slash piles on the soil surface that prevent plants from establishing or reaching light, introducing seed of invasive species on truck tires to this sensitive ecosystem, and facilitating the access of off-road vehicles. In addition, deer browse is severe, and high deer densities threaten forb diversity and populations of rare plant species (e.g., dwarf milkweed was commonly browsed). Invasive species are mostly localized along roads, and include common St. John's-wort (*Hypericum perforatum*), leafy spurge (*Euphorbia esula*), spotted knapweed (*Centaurea maculosa*), and white sweet-clover (*Melilotus alba*). In clearcuts, non-native species sometimes occur in dense patches.

Management Recommendations: Prescribed fire should be used as the primary mechanism to maintain open canopy conditions. Use of clearcutting should be re-assessed (see above). In the event of a wildfire or if additional prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. Efforts to control populations of invasive plants (especially leafy spurge and spotted knapweed) should be enacted and monitoring for invasive species should be implemented. Monitoring deer densities and deer herbivory will allow assessment of the impacts of deer browse to species composition and structure. If necessary, deer densities could be reduced through direct measures. Finally, control of off-road vehicle traffic is warranted. Portions of the oak-pine barrens occurring on private lands should be acquired or protected through conservation easements.

Photo by Bradford S. Slaughter.

OPEN DUNES

Overview: Open dunes is a grass- and shrub-dominated multi-seral community located on wind-deposited sand formations near the shorelines of the Great Lakes. Dune formation and the patterning of vegetation are strongly affected by lake-driven winds. The greatest concentration of open dunes occurs along the eastern and northern shorelines of Lake Michigan, with the largest dunes along the eastern shoreline due to the prevailing southwest winds (Kost et al. 2007).

117. McFadden Point (Beaver Island)

Natural Community Type: Open Dunes
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Location: Gaylord Forest Management Unit, Compartments 68 and 69, and Private Lands
Element Occurrence Identification Number: 10808

Site Description: This site is characterized by high parabolic dunes and a low foredune that occur along the western shore of Beaver Island. The soils are fine-textured wind-blown and wave-worked alkaline sands. The high parabolic dunes are found in the northern portion of the site with a steep foredune adjacent to the sand and gravel beach. An area with low foredunes forms a long tail to the south and is adjacent to limestone cobble shore. Houses are scattered throughout the forested dunes just behind the low foredunes.

Marram grass (*Ammophila breviligulata*), sand reed grass (*Calamovilfa longifolia*), and little bluestem (*Andropogon scoparius*) are prevalent on the dunes. Characteristic herbaceous species include beach pea (*Lathyrus japonicus*), Pitcher's thistle (*Cirsium pitcheri*, federal/state threatened), and wormwood (*Artemisia campestris*). Lake Huron tansy (*Tanacetum huronense*, state threatened) is uncommon. Dune fields and back dunes support scattered patches of bearberry (*Arctostaphylos uva-ursi*) and common juniper (*Juniperus communis*) with a scattered, stunted conifer canopy of northern white-cedar (*Thuja occidentalis*), white pine (*Pinus strobus*), white spruce (*Picea glauca*), and balsam poplar (*Populus balsamifera*). Bare sand increases in areas near residences due to devegetation and erosion.

Threats: The primary threat to these dunes is posed by continued residential development and ensuing correlated anthropogenic impacts, especially dune erosion and devegetation caused by foot traffic and off-road vehicle impacts. Spotted knapweed (*Centaurea maculosa*) was noted along portions of the low dunes but is currently uncommon and has not yet impacted species composition and structure.

Photo by Joshua G. Cohen.

Management Recommendations: It is imperative to eliminate off-road vehicle traffic along the beach and limit human traffic in the parabolic dunes. Portions of the complex occurring on private lands, especially the areas of parabolic dunes in the northern end of the site could be acquired or protected through conservation easements. Spotted knapweed should be removed now while it is confined to small portions of the occurrence and control efforts should be monitored.

118. Inland Harbor (Open Dunes)

Natural Community Type: Open Dunes
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Sault Sainte Marie Forest Management Unit, Compartment 200, and Private Lands
Element Occurrence Identification Number: 1910

Site Description: This mile-long stretch of open dunes has three to four successive dune ridges that are separated by long, parallel-running, high-quality interdunal wetlands.[25] The dune ridges have a north/south aspect and reach just under 100 ft tall. The complex is approximately 0.1 mi wide. Great Lakes barrens occurs as a narrow strip along the forested margins. Aeolian sands are circumneutral (pH 7.5-8.0), white to light brown, fine-textured, and dry at the surface but increase in moisture with increasing depth. A small creek passes perpendicular to the orientation of the dune ridges and feeds into Lake Michigan.

The foredune is dominated by marram grass (*Ammophila breviligulata*) and sand reed grass (*Calamovilfa longifolia*), along with willow (*Salix* spp.), balsam poplar (*Populus balsamifera*), and Lake Huron tansy (*Tanacetum huronense*, state threatened). Lake Huron tansy is locally dominant on the foredune and Pitcher's thistle (*Cirsium pitcheri*, federal/state threatened) occurs scattered throughout the high dunes. Harebell (*Campanula rotundifolia*), hair grass (*Deschampsia flexuosa*), and tickseed (*Coreopsis lanceolata*) are also common along the dunes. White pine (*Pinus strobus*) and white spruce (*Picea glauca*) occur in the scattered, stunted canopy (10-30 cm DBH and 6-15 ft tall) in the Great Lakes barrens zone along with bearberry (*Arctostaphylos uva-ursi*) and common juniper (*Juniperus communis*) in the low shrub layer. Dwarf lake iris (*Iris lacustris*, federal/state threatened) is found along the forest edge in the western extent of the occurrence. Conifers are also prevalent along the margins of the interdunal wetlands. Interdunal wetland swales are dominated by Baltic rush (*Juncus balticus*), Canadian rush (*J. canadensis*), twig-rush (*Cladium mariscoides*), silverweed (*Potentilla anserina*), and shrubby cinquefoil (*P. fruticosa*).

Piping plover (*Charadrius melodus*, federal/state endangered) have been recorded nesting in the interdunal wetlands adjacent to these open dunes.

Threats: The primary threat to the site is off-road vehicle damage, which can cause dune erosion, devegetation, and allow for the introduction of invasive species

Management Recommendations: The primary stewardship need is to eliminate off-road vehicle activity along the shoreline. Portions of the dunes occurring on private lands could be acquired or protected through conservation easements. Monitoring should be implemented for rare plant populations, piping plover nesting success, illegal off-road vehicle activity, and invasive species.

Photo by Joshua G. Cohen.

[25] Inland Harbor Interdunal Wetland

PATTERNED FEN

Overview: Patterned fen is a minerotrophic shrub- and herb-dominated peatland mosaic characterized by a series of peat ridges (strings) and hollows (flarks) oriented parallel to the slope of the landform and perpendicular to the flow of groundwater. The strings vary in height, width, and spacing, but are generally less than one meter tall, resulting in a faint wave-like pattern that may be discernable only from aerial photographs. The flarks are saturated to inundated open lawns of sphagnum mosses, sedges, and rushes, while the strings are dominated by sedges, shrubs, and scattered, stunted trees. Patterned fens occur exclusively on sandy glacial lakebeds and broad outwash channels immediately adjacent to glacial lakebeds in the eastern Upper Peninsula, with the highest concentration found in Schoolcraft County. Patterned fens are also referred to as patterned bogs, patterned peatlands, strangmoor, aapamires, and string bogs (Kost et al. 2007).

119. Creighton Marsh

Natural Community Type: Patterned Fen
Rank: GU S2, unranked globally and imperiled within the state
Element Occurrence Rank: A
Location: Shingleton Forest Management Unit, Compartments 147, 153, 154, 155, 161, 162, 163, 164, and 165, and Private Lands
Element Occurrence Identification Number: 32

Site Description: This peatland, which occurs on a poorly drained sand lakeplain, is an extensive, open minerotrophic wetland characterized by a V-shape. Strong string and flark or ribbed patterning is concentrated in the eastern lobe on generally deep (>1 m) sapric, slightly acidic to circumneutral peats (pH 6.0-7.0) over saturated sands. The peatland is surrounded by mesic northern forest (second-growth) and rich conifer swamp and occurs in an unfragmented landscape. Water flow is directed north to south over subtly sloping topography that creates the east-west string and flark patterning. Shrub-dominated strings alternate with sedge-dominated flarks in wide north-south water tracks that are separated by linear bands of shrubs and conifers on “teardrop” islands. This patterned peatland is a landscape-scale occurrence that supports significant ecological diversity and high native species richness. The site is shaped by natural processes and is buffered by extensive wetlands and unfragmented forests. In addition to the patterned fen, the peatland complex encompasses several natural community types including northern wet meadow, northern shrub thicket, rich conifer swamp, dry-mesic northern forest, and dry northern forest. Scattered throughout the wetland are small upland ridges dominated by pines and paper birch (*Betula papyrifera*) on acidic, fine-textured sands. The northeastern portion of the eastern lobe of the peatland was burned by the 1976 Seney Fire, which burned into the peat in areas. Drought impacts are especially apparent in this area.

The patterned peatland supports numerous vegetative zones. The ribbed fen zone, which occurs in the eastern lobe of the occurrence, is characterized by string and flark patterning. The strings are shrub-dominated with shrubs sparse to locally dense, including bog birch (*Betula pumila*), shrubby cinquefoil (*Potentilla fruticosa*), bog rosemary (*Andromeda glaucophylla*), sweet gale (*Myrica gale*), leatherleaf (*Chamaedaphne calyculata*), alder-leaved buckthorn (*Rhamnus alnifolia*), black chokeberry (*Aronia prunifolia*), swamp rose (*Rosa palustris*), and Kalm’s St. John’s-wort (*Hypericum kalmianum*). Graminoids and forbs common on the strings include wiregrass sedge (*Carex lasiocarpa*), dioecious sedge (*C. sterilis*), hair grass (*Deschampsia cespitosa*), bog aster (*Aster nemoralis*), tall flat-top white aster (*Aster umbellatus*), bog goldenrod (*Solidago uliginosa*), pitcher-plant (*Sarracenia purpurea*), marsh wild timothy (*Muhlenbergia glomerata*), and wild blue flag (*Iris versicolor*). Scattered, stunted tamarack (*Larix laricina*) and northern white-cedar (*Thuja occidentalis*) occupy some of the strings. Flarks are characterized by livid sedge (*Carex livida*), wiregrass sedge, mud sedge (*C. limosa*), white beak-rush (*Rhynchospora alba*), twig-rush (*Cladium mariscoides*), bluejoint grass (*Calamagrostis canadensis*), Canadian rush (*Juncus canadensis*), three-way sedge (*Dulichium arundinaceum*), large cranberry (*Vaccinium macrocarpon*), bog buckbean (*Menyanthes trifoliata*), spoon-leaf sundew (*Drosera intermedia*), bladderworts (*Utricularia* spp.), and arrow-grass (*Scheuchzeria palustris*). Species typical of flarks often grow on strings in lower densities. Several low diversity open northern wet meadows are present within the peatland complex and are often associated with beaver activity. These areas of northern wet meadow are characterized by few-seed sedge

(*Carex oligosperma*), three-way sedge, marsh cinquefoil (*Potentilla palustris*), Canadian rush, and northern St. John's-wort (*Hypericum boreale*). Several teardrop island "tails" occur within the wetland and are characterized by northern shrub thicket and rich conifer swamp. Areas of rich conifer swamp are dominated by northern white-cedar, tamarack, and red maple (*Acer rubrum*) with understory tag alder (*Alnus rugosa*), winterberry (*Ilex verticillata*), red-osier dogwood (*Cornus stolonifera*), and wild-raisin (*Viburnum cassinoides*). These tall shrubs are also prevalent in the areas of northern shrub thicket. Common ground cover species in both the rich conifer swamp and northern shrub thicket islands include tussock sedge (*Carex stricta*), lake sedge (*C. lacustris*), royal fern (*Osmunda regalis*), tall flat-top white aster, swamp dewberry (*Rubus hispidus*), and rough goldenrod (*Solidago rugosa*). Scattered throughout the peatland are small upland islands on acidic sands, occupied by dry-mesic northern forest of white pine (*Pinus strobus*), red maple (*Acer rubrum*), and paper birch (*Betula papyrifera*). In the northeastern portion of the wetland, peat fires have resulted in a depauperate flora. Two rare plants were documented within this peatland complex. Dwarf raspberry (*Rubus acaulis*, state endangered) occurs in areas with sparse conifer cover and well-developed sphagnum hummock and hollow microtopography at the base of sphagnum hummocks. English sundew (*Drosera anglica*, state special concern) was found in a floating bog mat surrounding a small conifer island.

Threats: Logging of the surrounding uplands could alter the hydrology of the site. Anthropogenic disturbances are limited to off-road vehicle damage, which was noted along the periphery of the peatland associated with a private hunting camp on the eastern edge of the complex. One non-native plant species, European marsh thistle (*Cirsium palustre*) was noted within one of the conifer swamp islands.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., wildfire and sheet flow) to operate unhindered and to retain an intact buffer of natural communities surrounding the peatland. If wildfires occur within this peatland, no plow lines should be established within the peatland. Instead, existing fire lines (i.e., roads and wetlands) should be relied upon. Off-road vehicle traffic should be controlled. Portions of the peatland and surrounding uplands occurring on private lands could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

120. Marsh Creek

Natural Community Type: Patterned Fen
Rank: GU S2, unranked globally and imperiled within the state
Element Occurrence Rank: A
Location: Shingleton Forest Management Unit, Compartments 21, 22, and 31, the Seney National Wildlife Refuge, and Private Lands
Element Occurrence Identification Number: 6951

Site Description: This extensive peatland complex that covers over 30,000 acres occurs on a broad, flat expanse of poorly drained sandy lakeplain with deep peats that are saturated or inundated. The patterned portion occurs in the central block of peatland and is characterized by strong patterning of strings and flarks oriented east-west, perpendicular to the north-south sheet flow. North-south bands of east-west oriented strings and flarks are separated by linear islands of northern shrub thicket and rich conifer swamp. The organic soils within the peatland vary from moderate (30-50 cm) to deep (>100 cm), well-decomposed sapric to hemic peat over saturated sands. The peats tend to be circumneutral throughout the wetland, with measured pH values generally between 6.5 and 7.0 and becoming slightly more acidic (pH 6.0-6.5) under thin sphagnum layers on hummocks in the open peatland. Within the areas of patterning, the strings were slightly acidic and the flarks and low areas were more influenced by minerotrophic conditions. Organic deposits were shallow (30-40 cm) in areas of northern shrub thicket relative to adjacent northern wet meadows (50 cm) on the western edge of the peatland and compared to the patterned areas where peats were very deep (>100 cm). On the upland ridges a shallow needle duff overlays fine-textured, acidic (pH 4.5-5.0) sands. This patterned peatland is a landscape-scale occurrence that supports significant ecological diversity and high native species richness. The site is shaped by natural processes and is buffered by extensive wetlands and unfragmented forests. The peatland complex encompasses several natural community types in addition to patterned fen including northern wet meadow, northern shrub thicket, poor fen, northern fen, rich conifer swamp, dry-mesic northern forest, and dry northern forest. Scattered throughout the wetland are small upland ridges dominated by pines and paper birch (*Betula papyrifera*) on acidic, fine-textured sands.

The central portion of the peatland is characterized by patterned fen that exhibits distinct development of low, wet, sedge-dominated flarks and shrub-dominated strings. Characteristic species of the flarks include white beak-rush (*Rhynchospora alba*), large cranberry (*Vaccinium macrocarpon*), bog buckbean (*Menyanthes trifoliata*), rushes (*Juncus* spp.), livid sedge (*Carex livida*), and arrow-grass (*Scheuchzeria palustris*). Strings are raised one to two feet and are characterized by bog birch (*Betula pumila*), shrubby cinquefoil (*Potentilla fruticosa*), bog rosemary (*Andromeda glaucophylla*), wiregrass sedge (*Carex lasiocarpa*), dioecious sedge (*C. sterilis*), and royal fern (*Osmunda regalis*) on sphagnum-covered hummocks.

The western portion of the wetland contains broad bands of northern wet meadow dominated by lake sedge (*Carex lacustris*) with bluejoint grass (*Calamagrostis canadensis*) and tussock sedge (*Carex stricta*) locally common. Common forbs include marsh pea (*Lathyrus palustris*), tufted loosestrife (*Lysimachia thyrsiflora*), marsh bellflower (*Campanula aparinoides*), common skullcap (*Scutellaria galericulata*), and, locally, sweet coltsfoot (*Petasites sagittatus*, state threatened). The northern wet meadow occupies shallow (20-50 cm) circumneutral sapric peat over slightly acid, medium-textured saturated sand. The wettest bands of northern wet meadow occur closest to the edge of the adjacent upland forest. Bands of northern shrub thicket dominated by tag alder (*Alnus rugosa*) occur adjacent to the northern wet meadow. Areas of northern shrub thickets tend to occur on slightly shallower mucks than the sedge-dominated community.

The sedge-dominated wet meadow zone is separated from the patterned fen by a dense band of northern shrub thicket characterized by tag alder, bog birch, wild-raisin (*Viburnum cassinoides*), black chokeberry (*Aronia prunifolia*), leatherleaf (*Chamaedaphne calyculata*), bog rosemary, bluejoint grass, and marsh fern (*Thelypteris palustris*). Scattered stunted tamarack (*Larix laricina*) and northern white-cedar (*Thuja occidentalis*) occupy this zone. This shrub-dominated zone repeats with some variation as north-south bands separating the bands of

patterned fen. Between the patterned fen zone and Marsh Ditch occur bands of northern shrub thicket and rich conifer swamp of increasing thickness to the east. In places, northern white-cedar (*Thuja occidentalis*) dominates, with a sparse understory of tag alder and Labrador tea (*Ledum groenlandicum*) and an open, species-poor ground layer, including three-seeded sedge (*Carex trisperma*) and royal fern.

Distributed throughout the wet meadow are seasonal pools best characterized as intermittent wetlands; these pools exhibit significant seasonal fluctuation of water levels, and are dominated by spike-rush (*Eleocharis palustris*, also known as *E. smallii*), Canadian rush (*Juncus canadensis*), three-way sedge (*Dulichium arundinaceum*), and bur-reeds (*Sparganium* spp.). Many of these pools exhibit a semicircle or crescent shape, creating an unusually patterned signature on aerial photos. At the eastern portion of the northern wet meadow zone, coarse sedges are replaced by wiregrass sedge (*Carex lasiocarpa*), forming open, wet sedge flats with scattered cover of alder and willows (*Salix* spp.). Bog birch increases in importance in this zone, as do other species characteristic of poor fen communities, including small cranberry (*Vaccinium oxycoccos*), marsh cinquefoil (*Potentilla palustris*), mud sedge (*Carex limosa*), leatherleaf, and bog rosemary. Peat depth also increases in these poor fen areas, becoming greater than a meter deep in this zone. Draw-down pools within the wiregrass sedge flats are dominated by white beak-rush, beak-rush (*Rhynchospora fusca*), mud sedge, arrow-grass (*Scheuchzeria palustris*), spoon-leaf sundew (*Drosera intermedia*), large cranberry, and three-way sedge.

Scattered throughout the peatland are small upland islands on acidic sands, occupied by dry-mesic northern forest of white pine (*Pinus strobus*), red maple (*Acer rubrum*), and paper birch or dry northern forest with red pine (*Pinus resinosa*) and scattered white pine. Common ground layer species include huckleberry (*Gaylussacia baccata*), Canada blueberry (*Vaccinium myrtilloides*), bracken fern (*Pteridium aquilinum*), wintergreen (*Gaultheria procumbens*), Pennsylvania sedge (*Carex pensylvanica*), starflower (*Trientalis borealis*), bunchberry (*Cornus canadensis*), and rough-leaved rice grass (*Oryzopsis asperifolia*). Several ridges contain large, old-growth trees and snags.

Surveyors noted white-tailed deer (*Odocoileus virginianus*), tracks of moose (*Alces alces*, state threatened), American bittern (*Botaurus lentiginosus*, state special concern), nesting merlin (*Falco columbarius*, state threatened), northern harrier (*Circus cyaneus*, state special concern), sandhill cranes (*Grus canadensis*), and black bear (*Ursus americanus*).

Threats: Logging of the surrounding uplands could alter the hydrology of the site. Anthropogenic disturbances are limited to ditches created in attempts to convert the wetlands for agricultural use in the early 1900s, and occasional cut pines on the upland ridges. Portions of the complex just west of Marsh Drain are drought-impacted northern wet meadow characterized by wool-grass (*Scirpus cyperinus*) and scattered tamarack, willows (*Salix* spp.), and bog birch. Weedy native and non-native species occur in this zone and the hydrology of this area is likely impacted by Marsh Drain.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., wildfire and sheet flow) to operate unhindered and to retain an intact buffer of natural communities surrounding the peatland. If wildfires occur within this peatland, no plow lines should be established within the peatland. Instead, existing fire lines in the surrounding uplands, roads, and wetlands should be relied upon.

The extensive Marsh Creek patterned fen is characterized by strong patterning of strings and flarks oriented east-west, perpendicular to the north-south sheet flow. Photos by Joshua G. Cohen.

121. McMahon Lake

Natural Community Type: Patterned Fen
Rank: GU S2, unranked globally and imperiled within the state
Element Occurrence Rank: A
Location: Newberry Forest Management Unit, Compartments 28, Private Lands
Element Occurrence Identification Number: 9938

Site Description: This extensive peatland complex occurs on a broad, flat expanse of sandy lakeplain with deep peats that are saturated or inundated. The patterned portion occurs in the center of the peatland and is characterized by string and flark patterning with strings being moderately acidic and flarks being influenced by more minerotrophic conditions. Groundwater flow and sheet flow influence patterning of the peatland.

Within the patterned portions of the peatland, strings are dominated by graminoids and scattered low shrub clumps with occasional stunted conifers, especially tamarack (*Larix laricina*). Characteristic species include few-seed sedge (*Carex oligosperma*), coastal sedge (*Carex exilis*), livid sedge (*C. livida*), twig-rush (*Cladium mariscoides*), and bog aster (*Aster nemoralis*). Prevalent low shrubs on the strings include leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), bog laurel (*Kalmia polifolia*), and black chokeberry (*Aronia prunifolia*). Flarks are characterized by emergent graminoids with areas of shallow pools. Typical species include twig-rush, Canadian rush (*Juncus canadensis*), and submergent bulrush (*Schoenoplectus subterminalis*) with pools of shallow water supporting sweet-scented water-lily (*Nymphaea odorata*). The peatland complex contains numerous non-patterned peatland types including muskeg and poor fen. Muskeg occurs on areas of grounded peat mat that are more acidic with scattered stunted conifers, namely tamarack and black spruce (*Picea mariana*). Few-seed sedge is dominant in these areas and sphagnum mosses and ericaceous shrubs, especially leatherleaf, bog laurel, and Labrador tea (*Ledum groenlandicum*) are prevalent. Areas influenced by minerotrophic conditions but not supporting patterning support dense bog birch (*Betula pumila*), tag alder (*Alnus rugosa*), and shrubby cinquefoil (*Potentilla fruticosa*). Livid sedge and bog aster are also common in these areas. Several sand dune ridges are included within the occurrence and support dry-mesic northern forest with large-diameter red pine (*Pinus resinosa*). Areas immediately adjacent to the Two-Hearted River are characterized by inundated conditions and dense thickets of bog birch and tag alder with tussock sedge (*Carex stricta*).

MNFI ecologists visited McMahon Lake in 2008 to assess the ecological impacts of the Sleeper Lake Fire on the peatland. Within the patterned fen, the fire burned evenly through the flarks (the low areas) and burned patchily within the strings (the hummocks). This likely occurred because the flarks tend to be composed of more sapric and decomposed peats, which likely dried out more completely during the drought that preceded the fire. The strings or hummocks are composed of fibric peats and dominated by sphagnums, which likely retained moisture even during the drought. Interestingly, where there were coniferous trees and ericaceous shrubs on the strings, the fire consumed the shrubs and trees, often burning the woody stems and incinerating the hummocks. The shrubs and trees provided fuel for the fire and also absorbed the moisture in localized areas. The fire likely spread to these trees and shrubs through two mechanisms; wind blown flames that ignited the tops of the woody stems and/or sub-surface peat fires that ignited the root mass. A preliminary examination of the plant species lists from 2006 and 2008 suggests that the suite of native species found within these sites is comparable with some species being more prevalent following the fire but no noticeable losses of native species diversity. All ericaceous species and peatland shrubs are resprouting and graminoids (e.g., sedges, beak-rushes, and cotton-grasses) throughout the peatlands are growing vigorously.

Within the pine-dominated ridges that occur in the peatland and in the surrounding area, the fire behavior was variable, likely depending on slope, dune height, and the overstory species composition. Mortality ranged from 100% on low dune ridges dominated by jack pine (*Pinus banksiana*) to 0% on steeper ridges with a hardwood component. It appeared as if the fire crowned in areas dominated by jack pine but in other areas with red pine and jack pine, surface fires or patchy crown fires passed across the ridges, typically causing 50-60% mortality. Most trees were scorched on their boles and were subsequently blown over. However, some trees were completely incinerated with nothing but a nub left or in places, a root footprint.

Within areas of burned muskeg, the fire killed most coniferous trees and shrubs, locally simplifying the vertical structure of these systems. However, there were numerous patches that were unburned. The same processes observed within hummocks in the patterned fen occurred within the muskeg with the fire burning most severely within the hummocks with woody stems due to the availability of fuels and the drier local conditions.

Threats: During the Sleeper Lake Fire, plow lines were established along the dune ridges west of the fen and also within the wetlands to the south. Vehicular access to the peatland could be facilitated by the new roads and lines that were established to fight the fire.

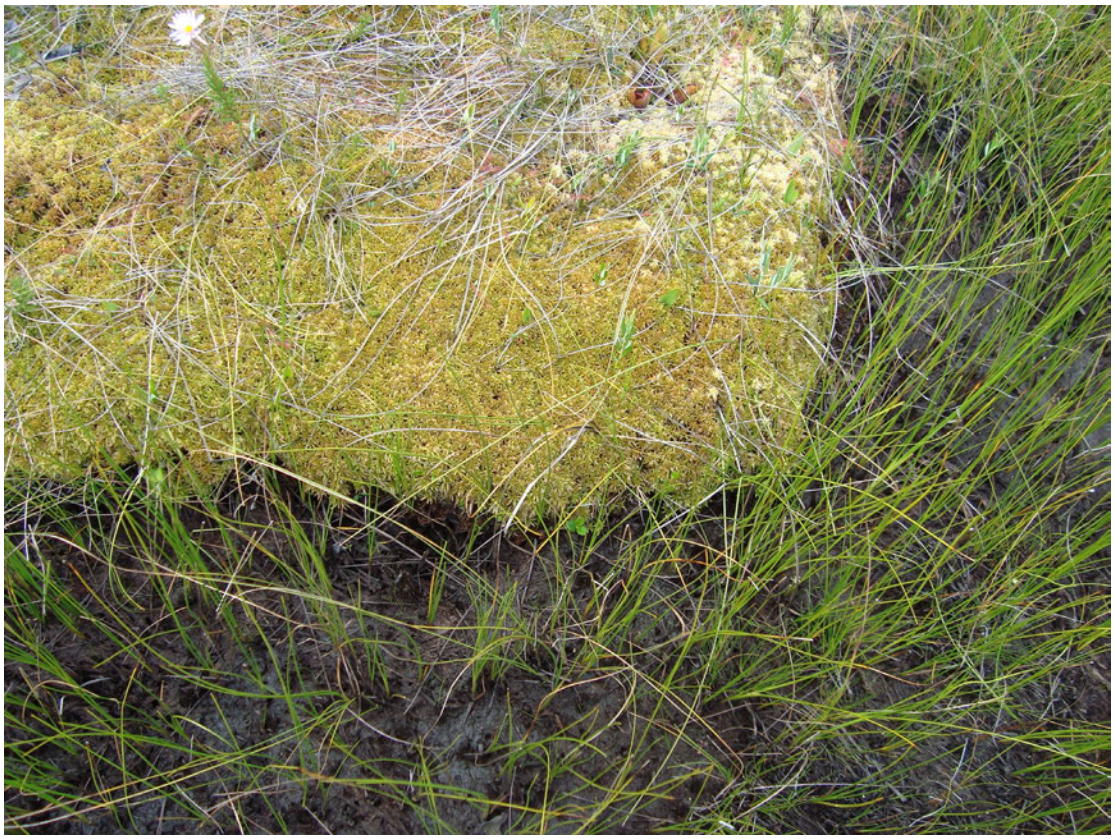
Management Recommendations: The main management recommendation is to allow natural processes (i.e., wildfire and sheet flow) to operate unhindered. The Sleeper Lake Fire offers a unique opportunity to research the impact of fire on a peatland ecosystem. The impacts of the nearby plow lines on peatland hydrology and invasive species populations should be carefully monitored. In the future, if wildfires occur within this peatland, no new plow lines should be established within the peatland. Instead, existing fire lines in the surrounding uplands should be relied upon and the peatland should be allowed to burn. Closing trails along the adjacent dune ridges to vehicular traffic will help prevent off-road vehicle traffic within open peatland. In addition, portions of the peatland occurring on private lands could be acquired or protected through conservation easements.

A year after the fire, burned muskeg (above) and patterned fen within the McMahon Lake peatland are characterized by vibrant re-growth of graminoids and resprouting of ericaceous shrubs like leatherleaf (below). Photos by Joshua G. Cohen

Incinerated conifer and former hummock. Photo by Joshua G. Cohen.

Within the patterned portion of the peatland, strings are dominated by graminoids, low shrubs, and scattered conifers, and the flarks are characterized by emergent graminoids with areas of shallow pools supporting submergent vegetation. 2006 Photos by Joshua G. Cohen.

Within the patterned fen, the fire burned evenly through the drought-dried flarks (the low areas) and burned patchily within the moister strings (the hummocks). 2008 Photos by Joshua G. Cohen.



122. Negro Creek

Natural Community Type: Patterned Fen
Rank: GU S2, unranked globally and imperiled within the state
Element Occurrence Rank: AB
Location: Shingleton Forest Management Unit, Compartments 147 and 163, and Private Lands
Element Occurrence Identification Number: 4963

Site Description: This large peatland complex occurs on a poorly drained lakeplain with saturated, acidic peats overlying wet, acidic sands. The peatland is characterized by complex ecological zonation with areas of muskeg, bog, and northern shrub thicket dominated by bog birch (*Betula pumila*), in addition to patterned fen. Subtle string and flark patterning occurs perpendicular to the surface flow, which is primarily northwest to southeast and west to east in the eastern portion of the complex. Peats range in depth from 30 to > 100 cm and are typically acidic (pH 5.0-5.5) with more minerotrophic (pH 5.5-6.0) areas along the flarks and peatland margin. Fire burned this peatland 32 years ago during the Seney Fire, killing most of the scattered conifer canopy and possibly diminishing the contrast between strings and flarks by reducing the peat depth and dampening the sphagnum hummock and hollow microtopography. Fire may have also imparted a competitive advantage to sprouting ericaceous shrubs. Deer trails, which criss-cross the complex, are visible from 1998 imagery and provide wet microsites within the peatland matrix.

The peatland is dominated by graminoids, sphagnum mosses, and ericaceous shrubs with a scattered and stunted canopy dominated by small (5-10 cm DBH) jack pine (*Pinus banksiana*), tamarack (*Larix laricina*), and black spruce (*Picea mariana*) of low stature (10-20 ft tall). Areas of muskeg within the peatland are dominated by scattered black spruce, tamarack, and white pine (*Pinus strobus*) and a prevalent tall shrub layer with mountain holly (*Nemopanthus mucronata*), black chokeberry (*Aronia prunifolia*), bog birch, and wild-raisin (*Viburnum cassinoides*). The low shrub layer within the muskeg is dominated by ericaceous species, namely leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), and bog laurel (*Kalmia polifolia*), and the ground cover is dominated by few-seed sedge (*Carex oligosperma*) and small cranberry (*Vaccinium oxycoccos*). Bog birch dominates the tall shrub layer in shrub-dominated portions along the southern margin of the peatland and along the ecotone between the muskeg and the open peatland. Areas of bog or ericaceous flats are characterized by a dense low shrub layer dominated by leatherleaf with bog laurel, bog rosemary, and black chokeberry with local dominance by bog laurel (possibly favored by fire), a ground cover dominated by few-seed sedge and coastal sedge (*Carex exilis*), and a scattered tall shrub layer with jack pine, black spruce, and mountain holly. Within the patterned fen, flarks are graminoid-dominated with few-seed sedge, livid sedge (*Carex livida*), bluejoint grass (*Calamagrostis canadensis*), bog aster (*Aster nemoralis*), tufted bulrush (*Trichophorum cespitosum*), marsh St. John's-wort (*Triadenum fraseri*), and marsh cinquefoil (*Potentilla palustris*). The strings are characterized by patches of low shrubs including bog birch, leatherleaf, bog rosemary, bog laurel, and bog willow (*Salix pedicellaris*) with few-seed sedge and coastal sedge as the prevalent herbaceous cover.

Threats: Continued off-road vehicle damage is a potential threat and could create rutting and alter the hydrology in localized areas of the fen. Deer herbivory is a potential threat but deer densities appear to be low currently.

Management Recommendations: The main management recommendations are to eliminate off-road vehicle activity, allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site and the surrounding uplands), and to maintain a forested buffer surrounding the wetland to protect the site's hydrology. In addition, portions of the peatland occurring on private lands could be acquired or protected through conservation easements. Finally, deer herbivory should be monitored and deer densities should be reduced if deemed necessary.

Photo by Joshua G. Cohen.

123. Sleeper Lake

Natural Community Type: Patterned Fen
Rank: GU S2, unranked globally and imperiled within the state
Element Occurrence Rank: A
Location: Newberry Forest Management Unit, Compartments 28, 84, and 85, and Private Lands
Element Occurrence Identification Number: 8139

Site Description: This extensive peatland complex occurs on a broad, flat expanse of sandy lakeplain with deep peats that are saturated or inundated. The patterned portion occurs in the central block of peatland and is characterized by faint (almost indiscernible) strings and flarks with the strings being moderately acidic (pH 5.0-5.5) and the flarks and low areas being more influenced by minerotrophic conditions (pH 5.5-6.0). Sand dune ridges rising one to three feet above the peatland are concentrated in the northwestern and southern portions of the wetland. The peatland drains into several bog lakes in the north-central portion of the site. Sheet flow is most prevalent in the central portion of the peatland draining into the bog lakes. Organic soils are characterized by saturated to inundated deep fibric sphagnum peat overlying sands. Along the peatland edge and near dune ridges, sand is 30 to 100 cm below the peats. In the heart of the peatland, sapric peat is > 1.5 meters deep.

Throughout the peatland, few-seed sedge (*Carex oligosperma*) is the overwhelming dominant along with sphagnum mosses. The low shrub layer is dominated by clumps of ericaceous shrubs, including leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), and bog laurel (*Kalmia polifolia*) with more minerotrophic areas supporting bog birch (*Betula pumila*), black chokeberry (*Aronia prunifolia*), and mountain holly (*Nemopanthus mucronata*). The overstory and understory layers are characterized by scattered and stunted conifer trees (2-15 cm DBH and 6-25 ft tall) including tamarack (*Larix laricina*), black spruce (*Picea mariana*), jack pine (*Pinus banksiana*), and white pine (*P. strobus*). Many areas of the peatland are virtually treeless. Low areas and flarks with more minerotrophic conditions are characterized by few-seed sedge along with coastal sedge (*Carex exilis*), twig-rush (*Cladium mariscoides*), bog aster (*Aster nemoralis*), and bluejoint grass (*Calamagrostis canadensis*). Areas of shallow pools with 40 to 80 cm of standing water are dominated by sweet-scented water-lily (*Nymphaea odorata*) and yellow pond-lily (*Nuphar variegata*). The numerous dune ridges that intersect the peatland are dominated by jack pine, black spruce, and white pine.

This patterned peatland was surveyed in the summer of 2006 prior to the Sleeper Lake Fire of 2007. MNFI ecologists revisited Sleeper Lake in 2008 to assess the ecological impacts of the fire on the peatland. Within the patterned fen, the fire burned evenly through the flarks (the low areas) and burned patchily within the strings (the hummocks). This likely occurred because the flarks tend to be composed of more sapric and decomposed peats, which likely dried out more completely during the drought that preceded the fire. The strings or hummocks are composed of fibric peats and dominated by sphagnums, which likely retained moisture even during the drought. Interestingly, where there were coniferous trees and ericaceous shrubs on the strings, the fire consumed the shrubs and trees, often burning the woody stems and incinerating the hummocks. The shrubs and trees provided fuel for the fire and also absorbed the moisture in localized areas. The fire likely spread to these trees and shrubs through two mechanisms; wind blown flames that ignited the tops of the woody stems and/or sub-surface peat fires that ignited the root mass. A preliminary examination of the plant species lists from 2006 and 2008 suggests that the suite of native species found within these sites is comparable with some species being more prevalent following the fire but no noticeable losses of native species diversity. All ericaceous species and peatland shrubs are resprouting and graminoids (e.g., sedges, beak-rushes, and cotton-grasses) throughout the peatlands are growing vigorously.

Within areas of burned muskeg, the fire killed most coniferous trees and shrubs, locally simplifying the vertical structure of these systems. However, there were numerous patches that were unburned. The same processes observed within hummocks in the patterned fen occurred within the muskeg with the fire burning most severely within the hummocks with woody stems due to the availability of fuels and the drier local conditions.

Within the pine-dominated ridges that occur in the peatland and in the surrounding area, the fire behavior was variable, likely depending on slope, dune height, and the overstory species composition. Mortality ranged from 100% on low dune ridges dominated by jack pine to 0% on steeper ridges with a hardwood component. It appeared as if the fire crowned in areas dominated by jack pine but in other areas with red pine and jack pine, surface fires or patchy crown fires passed across the ridges, typically causing 50-60% mortality. The majority of dune ridges within

the Sleeper Lake peatland are low and dominated by jack pine. These areas experienced intense crown fires. Most trees were scorched on their boles and were subsequently blown over. However, some trees were completely incinerated with nothing but a nub left or in places, a root footprint.

Threats: During the Sleeper Lake Fire, plow lines were established within the wetland on dune ridges and within the peatland as well. In addition, numerous plow lines were established on dune ridges and peatland to the south and north and on dune ridges to the northwest. In 2008, MNFI ecologist surveyed along the fire lines within the open peatland and dune ridges in sections 10, 11, 27, and 34. None of the fire lines observed passed through patterned fen (areas with very active subsurface flow) and the lines appear to occur northeast, east, and southeast of the minerotrophic areas of the Sleeper Lake peatland complex. The majority of the fire lines observed passed through areas of ombrotrophic peatland. Ombrotrophic peatlands receive hydrologic inputs from precipitation. These are acidic systems where the peat is raised above the water table. Locally the ditches are causing areas of pooling, but theoretically a ditch passing through an ombrotrophic wetland should not influence the system's overall hydrology since the wetland is raised above the water table. In addition, ombrotrophic systems are typically resistant to encroachment by invasive species. A competitive suite of native species is well-adapted to these acidic conditions, and non-natives are typically absent from these systems. Currently the suite of species establishing along the rolled up peat of the plow lines are native peatland species. Black chokeberry is dominating many stretches of rolled up peat along with few-seed sedge. No non-native plants were found along these fire lines a year after their creation and no non-natives were observed within the entire peatland during the 2006 and 2008 surveys. However, there is the possibility that invasives could encroach into the peatlands along the fire lines. An additional concern is that vehicular access to the peatland may facilitated by the plow lines and the roads along the dune ridge to the north and south. Some off-road vehicle incursions were noted in 2006 along the northern edge of the peatland and numerous off-road vehicle ruts in the peat were noted in the northwest portion of the site in 2008. In the western portions of the Sleeper Lake peatland, the DNR has done an excellent job in blocking vehicular access.

Management Recommendations: The main management recommendation is to allow natural processes (i.e., wildfire and sheet flow) to operate unhindered. The Sleeper Lake Fire offers a unique opportunity to research the impact of fire on a peatland ecosystem. The long term impacts of the plow lines on the peatland hydrology and on invasive species populations should be carefully monitored. It will be imperative to monitor for invasive plants along the plow lines, especially in areas near major roads to the south of the Sleeper Lake patterned fen. Monitoring for illegal off-road vehicle access and controlling illegal activity are also critical stewardship needs. Closing trails along the adjacent dune ridges within several miles of the peatland to vehicular traffic will help prevent off-road vehicle traffic within the open peatland.

Mechanized rehabilitation efforts to push the rolled up peat of the plow line back into the ditches should be avoided since they would likely further degrade the organic soils, especially during high water levels. If any rehabilitation efforts are taken, hand crews should be utilized to roll the peat back into the ditch.

All fire lines surveyed within the peatland were ineffective at stopping the fire. Along every stretch of fire line, the fire had burned on both sides of the line, either blowing over the top of the line via wind-blown flames or creeping under the line via a deep peat burn. In addition, fire lines through the low dune ridges within the peatland were equally ineffective since the fire burned through the peatland around the discontinuous ridges and/or blew over the line. In the future, if wildfires occur within this peatland, no new plow lines should be established. Instead, existing fire lines in the surrounding uplands should be relied upon and the peatland should be allowed to burn.

Ineffective fire line through burned, ombrotrophic portion of Sleeper Lake peatland. 2008 Photo by Joshua G. Cohen.

This extensive peatland complex occurs on a vast expanse of poorly drained lakeplain with deep sphagnum peats. 2006 Photos by Joshua G. Cohen.

The 2007 Sleeper Lake fire burned extensive areas of the Sleeper Lake peatland complex, including open peatland (above) and low dune ridges within the peatland (below). 2008 Photos by Joshua G. Cohen.

PINE BARRENS

Overview: Pine barrens is a coniferous, fire-dependent savanna of scattered and clumped trees located north of the climatic tension zone in the northern Lower and Upper Peninsulas. The community occurs on level sandy outwash plains and sandy glacial lakeplains. The droughty sand soils are very strongly to strongly acid, with very poor water-retaining capacity. The community is dominated by jack pine (*Pinus banksiana*), with northern pin oak (*Quercus ellipsoidalis*) as a frequent canopy associate. Frequent fires, drought, and growing-season frosts maintain the open canopy conditions (Kost et al. 2007).

124. Danaher Plains

Natural Community Type: Pine Barrens
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: NA
Location: NewberryForest Management Unit, Compartment 93, 94, and 96
Element Occurrence Identification Number: NA (formerly 12420)

Site Description: This site was incorrectly identified as a pine barrens. Circa 1800 maps indicate that the area was historically composed of white pine (*Pinus strobus*)-red pine (*P. resinosa*) forest and white pine-mixed hardwood forest. It was logged at the turn-of-the-century and subsequently burned. The soils likely burned so hot that the organic topsoil was removed. Portions of this site have been part of a sharp-tailed grouse (*Tympanuchus phasianellus*, state special concern) management unit. In addition, the site was roller chopped in 1991 and burned in June of 1996. The current open condition of this site is the result of this anthropogenic management history. Closely spaced stumps throughout are evidence of this. MNFI's natural community grading and ranking criteria for pine barrens state that a pine barrens occurrence "must be located in a former region of pine barrens—not in disturbed formerly forested land" (MNFI 1988). Therefore, this site was removed from MNFI's database as a high-quality example of pine barrens.

Photo by Adrienne L. Bozic.

125. Frog Lake Barrens

Natural Community Type: Frog Lake Barrens
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: AB
Location: Grayling Forest Management Unit, Compartment 253 (Part of the Pine Barrens Management Opportunity Areas at Camp Grayling)
Element Occurrence Identification Number: 16049

Site Description: These pine barrens are situated on a gently rolling, sandy outwash plain with occasional ice block depressions containing pockets of high-quality intermittent wetland.[26] The site is characterized by loamy sands and sands of medium acidity (pH 5.5).

The short, scrubby jack pine (*Pinus banksiana*) canopy ranges from 20 to 70% with most trees between 30 and 45 years old. A tall shrub layer is mostly absent. The dense ground layer of low shrubs and herbaceous vegetation is dominated by low sweet blueberry (*Vaccinium angustifolium*), sweet-fern (*Comptonia peregrina*), sand cherry (*Prunus pumila*), bearberry (*Arctostaphylos uva-ursi*), poverty grass (*Danthonia spicata*), little bluestem (*Andropogon scoparius*), big bluestem (*A. gerardii*), hair grass (*Deschampsia flexuosa*), rough fescue (*Festuca scabrella*, state threatened), fringed brome (*Bromus ciliatus*), and rice grass (*Oryzopsis pungens*). Prevalent forbs include old-field goldenrod (*Solidago nemoralis*), northern blazing star (*Liatris scariosa*), smooth aster (*Aster laevis*), and harebell (*Campanula rotundifolia*). In addition, Hill's thistle (*Cirsium hillii*, state special concern) occurs scattered throughout these barrens.

Threats: The main threats to this site are fire suppression and non-native species spread. Currently, common St. John's-wort (*Hypericum perforatum*) is the only non-native species found away from trails and roads and it is an occasional component of the ground cover. Off-road vehicle use, including military vehicles, could exacerbate the existing invasive species problems by facilitating spread.

Management Recommendations: Prescribed fire is an imperative management tool for maintaining an open canopy, promoting high levels of grass and forb diversity, deterring the encroachment of woody vegetation and invasive plants, and limiting the success of overstory dominants. Implementation of prescribed fire should be followed by monitoring to assess the impacts of prescribed fire on vegetative structure and composition. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment.

Common St. John's-wort should be removed now while it is confined to a small portion of the occurrence and control efforts should be monitored. Off-road vehicle activity, including military vehicles, should be restricted from this area, and this could be facilitated by closing roads and trails within the occurrence.

Photo by Bradford S. Slaughter.

[26] Frog Lakes Complex intermittent wetland

126. Little Bear Lake Barrens
Natural Community Type: Pine Barrens
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: BC
Location: Gaylord Forest Management Unit, Compartment 3
Element Occurrence Identification Number: 10013

Site Description: This pine barrens occurs on pitted outwash with acidic sandy soils. The topography is rolling with numerous depressions and variable aspect. This site was recently managed to restore pine barrens.

The scattered canopy and subcanopy is dominated by jack pine (*Pinus banksiana*) and red pine (*P. resinosa*) with northern pin oak (*Quercus ellipsoidalis*) as an associate. The tall shrub layer is patchy and dominated by black cherry (*Prunus serotina*), serviceberry (*Amelanchier* sp.), quaking aspen (*Populus tremuloides*), jack pine, and willow (*Salix* sp.). Low sweet blueberry (*Vaccinium angustifolium*), sweet-fern (*Comptonia peregrina*), and bearberry (*Arctostaphylos uva-ursi*) are prevalent in the low shrub layer. The ground layer is dominated by graminoids, especially poverty grass (*Danthonia spicata*), little bluestem (*Andropogon scoparius*), big bluestem (*A. gerardii*), Pennsylvania sedge (*Carex pensylvanica*), and hair grass (*Deschampsia flexuosa*). Rough fescue (*Festuca scabrella*, state threatened) is a local dominant throughout the site. Depressions or frost pockets within the pitted outwash are typically devoid of a tree and shrub layer and often support dense populations of pale agoseris (*Agoseris glauca*, state threatened). Several quaking aspen (*Populus tremuloides*) clones occur throughout the site. Red pine is most common along the northern edge of the site. Invasives are prevalent along and adjacent to roads and include spotted knapweed (*Centaurea maculosa*) and common St. John's-wort (*Hypericum perforatum*).

Threats: The main threats to this site are fire suppression and spread of non-native species (i.e., spotted knapweed and St. John's-wort). The site was recently logged in order to restore the pine barrens physiognomy of this fire suppressed site. The site was fire-suppressed for decades (60-80 years). While logging has opened up the canopy, the slash from the logging threatens to stifle the ground cover. In addition, there are still many areas of heavy shrub dominance due to fire suppression. Off-road vehicle damage could occur now that harvest has opened up the site. Off-road vehicle use could exacerbate the existing invasive species problems by facilitating spread.

Management Recommendations: Prescribed fire is an imperative management tool for reducing the logging slash and canopy density, promoting high levels of grass and forb diversity, deterring the encroachment of woody vegetation and invasive plants, and limiting the success of overstory dominants. Implementation of prescribed fire should be followed by monitoring to assess the impacts of prescribed fire on vegetative structure and composition and rare plant populations. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. Invasive species should be controlled and control efforts should be monitored.


A crtitical management need is to follow the mechanical treatment with prescribed fire to remove the logging slash and stimulate the ground cover. Photos by Joshua G. Cohen.

127. Shupac Lake Barrens

Natural Community Type: Shupac Lake Barrens
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: BC
Location: Grayling Forest Management Unit, Compartments 271 and 272
Element Occurrence Identification Number: 15942

Site Description: These open pine barrens occur on sandy outwash plain. The soils are characterized as acidic (pH 4.5-6.0) medium-textured loamy sand over coarser sands with abundant pebbles.

Jack pine (*Pinus banksiana*) occurs as scattered trees and in scattered clumps. Low shrubs found throughout the site include low sweet blueberry (*Vaccinium angustifolium*), sand cherry (*Prunus pumila*), and bearberry (*Arctostaphylos uva-ursi*). The low herbaceous vegetation is dominated by grasses including poverty grass (*Danthonia spicata*), little bluestem (*Andropogon scoparius*), big bluestem (*Andropogon gerardii*), hair grass (*Deschampsia flexuosa*), rough fescue (*Festuca scabrella*, state threatened), and Pennsylvania sedge (*Carex pensylvanica*). Prevalent forbs include rough blazing star (*Liatris aspera*), old-field goldenrod (*Solidago nemoralis*), northern blazing star (*Liatris scariosa*), smooth aster (*Aster laevis*), harebell (*Campanula rotundifolia*), Hill's thistle (*Cirsium hillii*, state special concern), and pale agoseris (*Agoseris glauca*, state threatened).

Threats: The main threats to this site are fire suppression and non-native species spread. Currently, the non-native invasive plants St. John's-wort (*Hypericum perforatum*) and spotted knapweed (*Centaurea maculosa*) are mostly restricted to roadsides but are occasionally common twenty feet from road edges. Off-road vehicle use could exacerbate the existing invasive species problems by facilitating spread.

Management Recommendations: Prescribed fire is an imperative management tool for reducing the canopy density of jack pine, promoting high levels of grass and forb diversity, deterring the encroachment of woody vegetation and invasive plants, and limiting the success of overstory dominants. Implementation of prescribed fire should be followed by monitoring to assess the impacts of prescribed fire on vegetative structure and composition. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. Common St. John's-wort and spotted knapweed should be controlled now while they are confined to a small portion of the occurrence and control efforts should be monitored.

Photo by Bradford S. Slaughter.

128. Walton

Natural Community Type: Pine Barrens
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: C
Location: Cadillac Forest Management Unit, Compartment 126, and Private Lands
Element Occurrence Identification Number: 5074

Site Description: This is a fire-suppressed pine barrens remnant that occurs on relatively level outwash plain with excessively drained acidic sands. The site contains several small patches of pine barrens within two distinct areas that are separated by 0.5 miles of closed-canopy forest. The pine barrens remnants are of low to moderate species diversity and are decreasing in size due to fire suppression, and have been degraded by the numerous roads which have facilitated non-native species invasion. The site occurs in a primarily forested landscape that is managed and contains numerous roads and trails.

The canopy coverage ranges from open to closed. The overstory is dominated by jack pine (*Pinus banksiana*), which is associated with white oak (*Quercus alba*), northern pin oak (*Q. ellipsoidalis*), black cherry (*Prunus serotina*), and occasional white pine (*Pinus strobus*). Scattered patches of tall shrubs include black cherry (*Prunus serotina*), hawthorn (*Crataegus* sp.), and serviceberry (*Amelanchier* sp.). Fire suppression for approximately 60 years has resulted in canopy closure in portions of the occurrence and the prevalence of black cherry in the overstory and understory. The low shrub layer is dominated by blueberry (*Vaccinium angustifolium*) and sweet-fern (*Comptonia peregrina*) with local concentrations of common blackberry (*Rubus alleghaniensis*). The herbaceous layer is dominated by graminoids, especially poverty grass (*Danthonia spicata*), little bluestem (*Andropogon scoparius*), and Pennsylvania sedge (*Carex pensylvanica*). Invasives are prevalent along and adjacent to roads and include spotted knapweed (*Centaurea maculosa*) and common St. John's-wort (*Hypericum perforatum*).

Threats: The main threats to this site are fire suppression and non-native species invasion (i.e., spotted knapweed and St. John's-wort). Off-road vehicle use could exacerbate the existing invasive species problems by facilitating spread.

Management Recommendations: Prescribed fire is an imperative management tool for reducing canopy density, promoting high levels of grass and forb diversity, deterring the encroachment of woody vegetation and invasive plants, and limiting the success of overstory dominants. Implementation of prescribed fire should be followed by monitoring to assess the impacts of prescribed fire on vegetative structure and composition. In the event of a wildfire or if prescribed fire is utilized, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. Invasive species (i.e., spotted knapweed and St. John's-wort) should be controlled and control efforts should be monitored. In addition, the pine barrens includes areas of private lands that could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

129. Walton Marsh

Natural Community Type: Pine Barrens
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: BC
Location: Cadillac Forest Management Unit, Compartments 126 and 127, and Private Lands
Element Occurrence Identification Number: 6486

Site Description: Three small patches of pine barrens occur on broad flat outwash plain with excessively drained acidic sands of medium texture. These small patches of pine barrens of moderate species diversity are decreasing in size due to fire suppression and have been degraded by numerous roads which have facilitated non-native species invasion. The site occurs in a primarily forested landscape that is managed and contains numerous roads and trails.

Small-diameter jack pines (*Pinus banksiana*) occur as scattered trees and in patchy clumps. Canopy associates include northern pin oak (*Quercus ellipsoidalis*) and black cherry (*Prunus serotina*) with black cherry increasing in importance in the canopy and subcanopy due to fire suppression. The low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*) and sweet-fern (*Comptonia peregrina*), and the ground layer is dominated by graminoids, especially poverty grass (*Danthonia spicata*), little bluestem (*Andropogon scoparius*), Pennsylvania sedge (*Carex pensylvanica*), and numerous blazing stars (*Liatris* spp.). Lichen (*Cladonia* spp.) is common and areas of open sand are also prevalent. Invasives are prevalent along and adjacent to roads and include spotted knapweed (*Centaurea maculosa*) and common St. John's-wort (*Hypericum perforatum*).

Threats: The main threats to this site are fire suppression and non-native species invasion (i.e., spotted knapweed and St. John's-wort). Off-road vehicle use could exacerbate the existing invasive species problems by facilitating spread.

Management Recommendations: Prescribed fire is an imperative management tool for reducing canopy density, promoting high levels of grass and forb diversity, deterring the encroachment of woody vegetation and invasive plants, and limiting the success of overstory dominants. Implementation of prescribed fire should be followed by monitoring to assess the impacts of prescribed fire on vegetative structure and composition. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment.

Invasive species (i.e., spotted knapweed and St. John's-wort) should be controlled and control efforts should be monitored. The total acreage of this pine barrens could be increased by prescribing manual cutting followed by prescribed fire in the southeast portion of section 5. In addition, the pine barrens includes areas of private lands that could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

POOR FEN

Overview: Poor fen is a sedge-dominated wetland found on very strongly to strongly acid, saturated peat that is moderately influenced by groundwater. The community occurs north of the climatic tension zone in kettle depressions and in flat areas or mild depressions on glacial outwash and glacial lakeplain (Kost et al. 2007).

130. Egg Lake

Natural Community Type: Poor Fen (re-classified from Bog)
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Gaylord Forest Management Unit, Compartment 66, and Private Lands
Element Occurrence Identification Number: 2988

Site Description: This open peatland system occurs on a poorly drained flat lakeplain with saturated and inundated sphagnum and sedge peats that range from weakly minerotrophic to ombrotrophic. Groundwater influence creates weakly minerotrophic conditions along the peatland margin. Fine-scale gradients in soil moisture and chemistry are also generated by sphagnum hummock and hollow development. These gradients in soil and water chemistry generate high floristic diversity (over 60 species were noted during the 2006 survey) and complex ecological zonation.

The southeastern portion of the wetland is dominated by graminoids, especially twig-rush (*Cladium mariscoides*), sedges (*Carex* spp.), white beak-rush (*Rhynchospora alba*), and golden-seeded spike-rush (*Eleocharis elliptica*), and is characterized by clumps of the ericaceous shrubs leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), Labrador tea (*Ledum groenlandicum*), and bog rosemary (*Andromeda glaucophylla*), and stunted, scattered conifers, including tamarack (*Larix laricina*), black spruce (*Picea mariana*), and northern white-cedar (*Thuja occidentalis*). Other characteristic species include wiregrass sedge (*Carex lasiocarpa*), mud sedge (*C. limosa*), bluejoint grass (*Calamagrostis canadensis*), three-way sedge (*Dulichium arundinaceum*), pitcher-plant (*Sarracenia purpurea*), round-leaved sundew (*Drosera rotundifolia*), tawny cotton-grass (*Eriophorum virginicum*), and yellow-eyed grass (*Xyris torta*).

Areas of partial canopy occur along the margin of the lake and along the edges of the open fen. These areas of denser canopy coverage are characterized by a partial canopy of northern white-cedar, black spruce, tamarack, and red maple (*Acer rubrum*), a dense tall shrub layer of winterberry (*Ilex verticillata*) and mountain holly (*Nemopanthus mucronata*), a low shrub layer with sweet gale (*Myrica gale*) and leatherleaf, and ground cover dominated by bog buckbean (*Menyanthes trifoliata*), marsh fern (*Thelypteris palustris*), and tussock sedge (*Carex stricta*). Areas of concentrated groundwater influence support rich conifer swamp inclusions dominated by northern white-cedar with red maple, tamarack, and black ash (*Fraxinus nigra*) over muck soils.

Following the 2006 survey, this site, which was originally classified as a bog, was re-classified as a poor fen.

Threats: A small population of reed (*Phragmites australis*) is restricted to the southern portion of the wetland and reed canary grass (*Phalaris arundinacea*) was scattered along the lake margin. These species are currently not altering the hydrology or reducing species diversity but could potentially alter the species composition, vegetative structure, and hydrologic regime. The site contains several private inholdings that could be developed in the future.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Adjacent forest and swamp should be left uncut. Maintaining a forested buffer surrounding the poor fen will help ensure the stability of the fen's hydrologic regime. The populations of reed canary grass and reed should be monitored and controlled if necessary. Portions of the wetland complex occurring on private lands could be acquired or protected through conservation easements.

This poor fen occurs on a poorly drained lakeplain on Beaver Island along the margins of Egg Lake. Photos by Joshua G. Cohen.

130. Jackson Trail (Poor Fen)

Natural Community Type: Poor Fen
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Sault Sainte Marie Forest Management Unit, Compartment 116
Element Occurrence Identification Number: 9790

Site Description: This poor fen occurs on poorly drained, flat, sandy lakeplain with moderately acidic (pH 5.0-6.0), fibric peat and sapric peat overlying acidic sand (pH 5.0-5.5). Areas of groundwater influence along the wetland margins are characterized by more minerotrophic conditions. Numerous shallow pools and old beaver channels occur in the eastern and northeastern portions of the wetland complex.

Areas of the poor fen are characterized by a scattered and stunted canopy of conifers (5-20 cm DBH, 6-35 years old) with white pine (*Pinus strobus*), tamarack (*Larix laricina*), black spruce (*Picea mariana*), and northern white-cedar (*Thuja occidentalis*). These species, along with tag alder (*Alnus rugosa*) and mountain holly (*Nemopanthus mucronata*), occur in the tall shrub layer. Patches of low ericaceous shrubs include leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), Labrador tea (*Ledum groenlandicum*), and bog rosemary (*Andromeda glaucophylla*) with black chokeberry (*Aronia prunifolia*) and bog willow (*Salix pedicellaris*). Few-seed sedge (*Carex oligosperma*) and sphagnum mosses are the ground cover dominants with mud sedge (*Carex limosa*) and wild blue flag (*Iris versicolor*) common. Open graminoid portions of the wetland that are acidic are dominated by few-seed sedge. Lower areas on more minerotrophic sapric sedge peat support twig-rush (*Dulichium arundinaceum*), wiregrass sedge (*Carex lasiocarpa*), bluejoint grass (*Calamagrostis canadensis*), and spike-rush (*Eleocharis smallii*). Shallow pools and beaver channels with 40 to 80 cm of water are dominated by yellow pond-lily (*Nuphar variegata*).

Threats: Fire suppression in the overall landscape could prolong the fire return time for the wetland. High deer densities could impact the species composition, structure, and successional pathways of the site.

Management Recommendations: The main management recommendation is to allow natural processes (i.e., fire and beaver flooding) to operate unhindered. Wildfires should be allowed to burn the poor fen as well as the surrounding uplands. Monitoring deer herbivory can help resource managers assess whether species composition and structure is being negatively impacted by deer browse. To reduce deer browse pressure, the surrounding forests could be managed for late-successional habitat.

Photo by Joshua G. Cohen.

131. Lovell's Fen

Natural Community Type: Poor Fen
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Grayling Forest Management Unit, Compartments 263 and 264
Element Occurrence Identification Number: 10005

Site Description: This poor fen is situated in an ice-block depression on a sandy outwash plain. The organic soils are slightly acidic (pH 6.5), fibric, sedge peat with the water table 5 cm below the surface. The wetland is characterized by complex and patchy zonation representing a variety of open wetland types in addition to poor fen, including bog, northern wet meadow, and northern fen. Dry-mesic northern forest and red pine (*Pinus resinosa*) plantations occur on all sides. A fire recently burned across the wetland and up the slopes, killing many of the pines in the adjacent uplands. The site is characterized by high floristic diversity (over 60 species were noted during the 2006 survey) and complex ecological zonation due to gradients in soil and water chemistry.
The vegetative zones include sedge-dominated areas on saturated peat; hummucky, shrub-dominated bog; sparsely vegetated marl flats; sedge-grass tussock meadow; and submerged and aquatic vegetation.

Characteristic species include wiregrass sedge (*Carex lasiocarpa*), mud sedge (*C. limosa*), bluejoint grass (*Calamagrostis canadensis*), three-way sedge (*Dulichium arundinaceum*), pitcher-plant (*Sarracenia purpurea*), round-leaved sundew (*Drosera rotundifolia*), tawny cotton-grass (*Eriophorum virginicum*), and yellow-eyed grass (*Xyris torta*). Areas of open water support submergent vegetation with sweet-scented water-lily (*Nymphaea odorata*) dominant. Sedge-dominated zones are dominated by wiregrass sedge and twig-rush with scattered shrubby cinquefoil (*Potentilla fruticosa*). Areas in the northern end of the complex with sphagnum hummocks are dominated by few-seed sedge (*Carex oligosperma*) and leatherleaf (*Chamaedaphne calyculata*).

Threats: The non-natives reed canary grass (*Phalaris arundinacea*) and European marsh thistle (*Cirsium palustre*) were found throughout this site and threaten to alter the species composition and vegetative structure.

Management Recommendations: The main management recommendation is to allow natural processes to operate unhindered. Wildfires should be allowed to burn the wetland as well as the surrounding uplands. The populations of reed canary grass and European marsh thistle should be eliminated and efforts to control these invasive should be monitored.

Photo by Bradford S. Slaughter.

132. Munuscong River

Natural Community Type: Poor Fen (re-classified from Bog)
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Sault Sainte Marie Forest Management Unit, Compartment 55
Element Occurrence Identification Number: 13552

Site Description: This large poor fen occurs within a poorly drained sand and clay lakeplain northeast of Munuscong River and northwest and west of Munuscong Bay. The site grades to an extensive high-quality Great Lakes marsh, which occurs to the southwest, south, and southeast.[27] The poor fen is characterized by two primary ecological zones with shrub fen along the margins and twig-rush (*Cladium mariscoides*) flats in the center of the peatland. Groundwater seepage generates weakly minerotrophic conditions, especially along the peatland margin, while the underlying clay pan maintains the high water table and resulting inundated to saturated peats. Sapric mucks range in depth from 50 to 80 cm and are slightly acidic (pH 6.5) to circumneutral (pH 7.0). Species diversity is increased by fine-scale gradients of soil moisture and soil chemistry generated by sphagnum hummock and hollow microtopography along the peatland margins and along the margins of tree and ericaceous shrub mounds or islands (hummocks being slightly more acidic than hollows). Clay and sandy clay underlie the organic soils, with sandy clay being more prevalent closer to the Great Lakes marsh in the southern portion of the fen.

Stunted and scattered canopy trees range in age from 30 to 73 years and are 2 to 10 cm in DBH and 5 to 15 ft tall. The canopy is dominated by tamarack (*Larix laricina*) with black spruce (*Picea mariana*) and northern white-cedar (*Thuja occidentalis*), with the latter concentrated along the margins in more minerotrophic areas. Tamarack and northern white-cedar are also prevalent in the tall shrub layer and in the low shrub layer, especially along the peatland margins. The shrub and conifer islands and margins of the peatlands support a dense low shrub layer with sweet gale (*Myrica gale*), leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), and black chokeberry (*Aronia prunifolia*). Treeless areas or twig-rush flats are dominated by twig-rush, wiregrass sedge (*Carex lasiocarpa*), and beak-rushes (*Rhynchospora* spp.) with marsh St. John's-wort (*Triadenum fraseri*), marsh wild timothy (*Muhlenbergia glomerata*), rush aster (*Aster borealis*), long-leaved aster (*A. longifolius*), small cranberry (*Vaccinium oxycoccos*), bog buckbean (*Menyanthes trifoliata*), pitcher-plant (*Sarracenia purpurea*), livid sedge (*Carex livida*), and bog goldenrod (*Solidago uliginosa*). Ground cover in shrub-dominated areas includes wiregrass sedge, bluejoint grass (*Calamagrostis canadensis*), long-leaved aster, marsh St. John's-wort, water horsetail (*Equisetum fluviatile*), marsh fern (*Thelypteris palustris*), bog aster (*Aster nemoralis*), and wild blue flag (*Iris versicolor*). The southern portion of the wetland grades to a northern wet meadow zone of Great Lakes marsh. In addition, the occurrence contains inclusions of some poor conifer swamp islands and northern shrub thicket. Scattered tall shrubs include tag alder (*Alnus rugosa*), winterberry (*Ilex verticillata*), sweet gale, and black chokeberry.

Following the 2007 survey, this site, which was previously classified as a bog, was re-classified as a poor fen.

Threats: The site is accessible only by foot which limits potential anthropogenic disturbance. Deer herbivory may limit northern white-cedar regeneration and alter species composition and structure.

Management Recommendations: To reduce deer browse pressure, the surrounding northern shrub thicket, conifer swamp, and hardwood swamp can be allowed to mature to limit adjacent early-successional habitat. Monitoring deer herbivory can help resource managers assess whether species composition and structure is being negatively impacted by deer browse.

[27] Munuscong and Little Munuscong Rivers and Pickford Point Great Lakes marsh

This poor fen occurs on a large expanse of poorly drained lakeplain (above). Peat mounds (below) provide microhabitat heterogeneity that increases the species richness of this poor fen. These microsites are characterized by sphagnum mosses, ericaceous shrubs, and scattered and stunted conifer trees. Photos by Joshua G. Cohen.

RICH CONIFER SWAMP

Overview: Rich conifer swamp is a groundwater-influenced, minerotrophic, forested wetland dominated by northern white-cedar (*Thuja occidentalis*) that occurs on organic soils (i.e., peat) primarily north of the climatic tension zone in the northern Lower and Upper Peninsulas. Rich conifer swamp occurs in outwash channels, outwash plains, glacial lakeplains, and in depressions on coarse- to medium-textured ground moraines. It is common in outwash channels of drumlin fields and where groundwater seeps occur at the bases of moraines. Rich conifer swamp typically occurs in association with lakes and cold, groundwater-fed streams. It also occurs along the Great Lakes shoreline in old abandoned embayments and in swales between former beach ridges where it may be part of a wooded dune and swale complex. Windthrow is common, especially on broad, poorly drained sites. Fire was historically infrequent. Rich conifer swamp is characterized by diverse microtopography and ground cover. The community is also referred to as cedar swamp (Kost et al. 2007).

133. Barfield Lakes (Rich Conifer Swamp)

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: A
Location: Newberry Forest Management Unit, Compartment 3, and Private Lands
Element Occurrence Identification Number: 5676

Site Description: This extensive rich conifer swamp occurs on a poorly drained sand lakeplain. The soils are characterized by over a meter of circumneutral (pH 6.5-7.0), sapric to fibric peats over sands. Along the base of the beach ridges (on the glacial lakebed) and in narrow drainages on the ground moraine, are some of the largest northern white-cedar (*Thuja occidentalis*) in the state (70-100 cm DBH). More poorly drained areas of lakeplain are dominated by much smaller cedar due to frequent windthrow. Pockets of high-quality mesic northern forest are embedded within this rich conifer swamp.[28]

The canopy is dominated by northern white-cedar (40-100 cm DBH) with black spruce (*Picea mariana*) and occasional white pine (*Pinus strobus*). The relatively open subcanopy and tall shrub layers include northern white-cedar, black spruce, mountain maple (*Acer spicatum*), striped maple (*Acer pensylvanicum*), and balsam fir (*Abies balsamea*). The diverse ground cover is dense and characterized by sphagnum mosses, clubmosses (*Lycopodium* spp.), sedges (*Carex* spp.), naked miterwort (*Mitella nuda*), violets (*Viola* spp.), sensitive fern (*Onoclea sensibilis*), northern wood sorrel (*Oxalis acetosella*), and rattlesnake plantains (*Goodyera* spp.). Areas of intense blowdown are characterized by a dense shrub layer of balsam fir (*Abies balsamea*) and northern white-cedar regeneration with occasional canopy black ash (*Fraxinus nigra*), black spruce, and yellow birch (*Betula alleghaniensis*). Coarse woody debris of various sizes and decay classes was noted. Over 80 native species were documented during the 2006 surveys.

Threats: The network of logging roads in the surrounding landscape may provide pathways for invasive species encroachment. The potential exists for deer herbivory to limit northern white-cedar recruitment.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered and to reduce deer densities in the surrounding landscape to dampen deer browse pressure. Deer densities could be reduced through direct measures and also by reducing early-successional habitat in the surrounding landscape. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure. Portions of the swamp occurring on private lands could be acquired or protected through conservation easements.

[28] Barfield Lakes Mesic Northern Forest

Barfield Lakes rich conifer swamp is dominated by large-diameter cedar. Photos by Bradford S. Slaughter.

135. Bear River Swamp

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Gaylord Forest Management Unit, Compartment 113
Element Occurrence Identification Number: 15953

Site Description: This large rich conifer swamp occurs within a narrow outwash channel on circumneutral organic soils. Organic soils are saturated peats of variable depth (typically > 1 meter) and are typically circumneutral (pH 6.0-7.5) due to groundwater influence. Sphagnum hummocks tend to be acidic (pH 4.5-5.5). Groundwater seepage from the surrounding uplands provides minerotrophic conditions. The site is characterized by several different vegetative zones and high species diversity due to broad gradients in groundwater influence and fine-scale gradients of soil moisture and soil chemistry. Sphagnum hummock and hollow microtopography increases microhabitat and contributes to species diversity (over 85 species were noted during a single site visit). Natural processes influencing the site include flooding, fire, and windthrow. Flooding mortality (probably from beaver flooding) is concentrated along the Bear River where sedges and grasses are more prevalent and the canopy is more open. Evidence of past fires was found along the upper slopes of the swamp where there are numerous charred stumps and where mineral soil is more prevalent than peat. Areas of heavy blowdown occur throughout the swamp.

Small-diameter northern white-cedars (*Thuja occidentalis*) (15-30 cm) dominate the closed canopy (90-95%). Canopy associates include scattered tamarack (*Larix laricina*), black spruce (*Picea mariana*), paper birch (*Betula papyrifera*), and balsam poplar (*Populus balsamifera*) with occasional white pine (*Pinus strobus*). The understory is typically sparse (< 5%) with seedling and sapling balsam fir (*Abies balsamea*), balsam poplar (sprouts), black ash (*Fraxinus nigra*), and red maple (*Acer rubrum*). The short shrub layer is prevalent with alder-leaved buckthorn (*Rhamnus alnifolia*), dwarf raspberry (*Rubus pubescens*), wild red raspberry (*R. strigosus*), American fly honeysuckle (*Lonicera canadensis*), wild black currant (*Ribes americanum*), and prickly gooseberry (*R. cynosbati*) as dominants. A diverse array of ferns, bryophytes, herbs, sedges, and grasses are found in the ground cover. Characteristic species include sphagnum mosses (*Sphagnum* spp.), sensitive fern (*Onoclea sensibilis*), starflower (*Trientalis borealis*), goldthread (*Coptis trifolia*), bunchberry (*Cornus canadensis*), dwarf scouring rush (*Equisetum scirpoides*), rattlesnake grass (*Glyceria canadensis*), Canada mayflower (*Maianthemum canadense*), ebony sedge (*Carex eburnea*), sedge (*C. pedunculata*), bluejoint grass (*Calamagrostis canadensis*), bluebead lily (*Clintonia borealis*), creeping snowberry (*Gaultheria hispidula*), naked miterwort (*Mitella nuda*), twinflower (*Linnaea borealis*), fragrant bedstraw (*Galium triflorum*), bulblet fern (*Cystopteris bulbifera*), partridge berry (*Mitchella repens*), gay wings (*Polygala paucifolia*), lady fern (*Athyrium filix-femina*), and northern bugleweed (*Lycopus uniflorus*). Bear River occurs in the western and eastern portion of the swamp complex. Sedge and grass ground cover increase in importance closer to the drainages where the canopy is more open. Sphagnum cover is more prevalent in the center of the swamp. It is possible that fires eliminated the organic peats along the swamp edges.

Threats: The primary threat is posed by deer herbivory, which could limit northern white-cedar regeneration and alter the swamp's structure and species composition.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered, to maintain canopy closure of the surrounding uplands to minimize surface water flow into the swamp and to maintain groundwater seepage, to reduce deer densities in the surrounding landscape to dampen deer browse pressure, and to monitor for invasive plant populations. In addition, monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure.

Bear River Swamp is dominated by small-diameter northern white-cedar (above) and is characterized by numerous patches of blowdown (below). Photos by Joshua G. Cohen.

136. Beavertown Lakes

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and very rare and local throughout state
Element Occurrence Rank: AB
Location: Newberry Forest Management Unit, Compartment 9, and Private Lands
Element Occurrence Identification Number: 10789

Site Description: This extensive rich conifer swamp occurs on flat, poorly drained lakeplain between the North Branch of the Two-Hearted River and the West Branch of the Two-Hearted River in a predominantly unfragmented landscape with no roads in the immediate vicinity and low road densities in the overall landscape. High-quality dry-mesic northern forest divides the two polygons of rich conifer swamp and also occurs to the east and west of the swamp. Also to east is a high-quality muskeg.[29] Well-developed ecological zonation is patterned by windthrow, flooding and groundwater influence, which determine species composition, structure, and succession. The site is characterized by high native species diversity (over 80 species were noted during a single survey) that is driven by large-scale ecological zonation (influenced by windthrow, flooding, and groundwater influence) and microscale variability controlled by sphagnum hummock and hollow microtopography. Deep, saturated organic soils (>1 meter) are characterized by peats with fibric peat overlying hemic and sapric peats. The entire soil profile is typically circumneutral with very slight acidity (pH 6.8) near the surface. The primary canopy cohort is over 80 years old and likely regenerated following catastrophic fire 90 to 110 years ago (no stumps were noted within the site). Windthrow gaps and flooded areas result in numerous patches of younger age classes.

The site exhibits variable canopy dominance with areas close to the ridge dominated by northern white-cedar (*Thuja occidentalis*) with tamarack (*Larix laricina*) and white pine (*Pinus strobus*) as canopy associates. Tamarack is prevalent north of the ridge. The majority of the swamp is conifer dominated (northern white-cedar and/or tamarack with white pine) with prevalent canopy hardwoods including black ash (*Fraxinus nigra*) and red maple (*Acer rubrum*), especially in the subcanopy. The understory is dominated by tag alder (*Alnus rugosa*) with dogwoods (*Cornus* spp.), wild-raisin (*Viburnum cassinoides*), red maple, and northern white-cedar. Areas with windthrow or flood-kill have open canopies with 80-100% shrub cover. Excellent northern white-cedar regeneration occurs in all size classes throughout the site but is especially dense in the southern portion of the system and in areas of blowdown. The low shrub layer is less dense than the tall shrub layer with many of the same species being prevalent in addition to Labrador tea (*Ledum groenlandicum*) and American fly honeysuckle (*Lonicera canadensis*). Species dominant in the ground cover include royal fern (*Osmunda regalis*), lake sedge (*Carex lacustris*), tussock sedge (*C. stricta*), dwarf raspberry (*Rubus pubescens*), and jewelweed (*Impatiens capensis*). Additional species include starflower (*Trientalis borealis*), goldthread (*Coptis trifolia*), bunchberry (*Cornus canadensis*), creeping snowberry (*Gaultheria hispidula*), naked miterwort (*Mitella nuda*), marsh marigold (*Caltha palustris*), joe-pye-weed (*Eupatorium maculatum*), purple avens (*Geum rivale*), and Canada mayflower (*Maianthemum canadense*). Areas with flooding influence tend to have a more open canopy (20-40% compared to 65-85%) and have a more significant graminoid component in the ground cover with sedges, bluejoint grass (*Calamagrostis canadensis*), and fowl manna grass (*Glyceria striata*). Areas not influenced by flooding exhibit well-developed sphagnum hummock and hollow microtopography.

Threats: The primary threat is logging of the private parcels. Beaver flooding could result in additional tree mortality. In addition, high winter deer densities could negatively impact regeneration of northern white-cedar and alter species composition and structure. Currently cedar regeneration is abundant.

Management Recommendations: The main management recommendation is to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure. The site is surrounded by swamp systems that need to be surveyed in order to determine if they should be incorporated in the Ecological Reference Area boundaries. Finally, portions of the swamp occurring on private lands could be acquired or protected through conservation easements.

[29] Beavertown Lakes Dry-mesic Northern Forest and Beavertown Lakes Muskeg

Beavertown Lakes rich conifer swamp is dominated by dense, small-diameter northern white-cedar and tamarack. Photos by Joshua G. Cohen.

137. Cedar Island

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Shingleton Forest Management Unit, Compartments 23 and 24, and Private Lands
Element Occurrence Identification Number: 13062

Site Description: This large block of northern white-cedar (*Thuja occidentalis*)–dominated rich conifer swamp occurs on a flat, poorly-drained lakeplain west of Hickey Creek, with the West Branch of Hickey Creek passing through the northern portion of the site. This uneven-aged system is characterized by diverse ecological zonation and numerous successional stages patterned by windthrow, beaver flooding, and fire. High species diversity (over 100 native species were noted during a single visit) is driven at the site scale by ecological zonation and at the microscale by sphagnum hummock and hollow microtopography. The predominant canopy cohort is 130+ years old with numerous younger patches occurring where flooding and/or windthrow have killed canopy trees. Well-developed sphagnum hummock and hollow microtopography occurs where the hydrology has stabilized. The circumneutral (pH 7.0) peats are of variable depth (50 - >100 cm) overlying wet sands. Fibric peats on sphagnum hummocks are slightly acidic and sands along low dune ridges are also acidic (pH 5.0). Sedge peats are prevalent in areas of standing water, where flooding has prevented the establishment of sphagnum peat.

The canopy is dominated by northern white-cedar (20-40 cm DBH) with canopy associates including tamarack (*Larix laricina*), black spruce (*Picea mariana*), black ash (*Fraxinus nigra*), red maple (*Acer rubrum*), and scattered white pine (*Pinus strobus*). Dune ridges extending into the swamp are dominated by white pine along with red pine (*Pinus resinosa*), northern white-cedar, big-toothed aspen (*Populus grandidentata*), and paper birch (*Betula papyrifera*). Areas of younger swamp along the margins where flooding is more pervasive are characterized by an open canopy and are dominated by tamarack and black ash with a dense understory of tag alder (*Alnus rugosa*) and winterberry (*Ilex verticillata*). Tag alder and winterberry also occur in the understory of the cedar-dominated areas along with black ash, northern white-cedar, and balsam fir (*Abies balsamea*). The low shrub layer is scattered with seedlings of canopy species, alder-leaved buckthorn (*Rhamnus alnifolia*), American fly honeysuckle (*Lonicera canadensis*), raspberries (*Rubus* spp.), blueberries (*Vaccinium* spp.), and gooseberries (*Ribes* spp.). Areas with stable hydrology are sphagnum-dominated with three-seeded sedge (*Carex trisperma*), royal fern (*Osmunda regalis*), starflower (*Trientalis borealis*), goldthread (*Coptis trifolia*), bunchberry (*Cornus canadensis*), sensitive fern (*Onoclea sensibilis*), fowl manna grass (*Glyceria striata*), and marsh marigold (*Caltha palustris*) as prevalent ground cover species. Areas along the swamp margins and in the northern portion of the site that have standing water or have been recently flooded are characterized by an open canopy, a dense understory, and graminoid dominance in the ground cover with tussock sedge (*Carex stricta*) and lake sedge (*C. lacustris*) as dominants. Prevalent ground cover species in these flooded areas include common skullcap (*Scutellaria galericulata*), joe-pye-weed (*Eupatorium maculatum*), swamp candles (*Lysimachia terrestris*), swamp milkweed (*Asclepias incarnata*), marsh marigold, bluejoint grass (*Calamagrostis canadensis*), and royal fern.

Threats: The primary threat is logging of the private parcels. In addition, high winter deer densities could negatively impact regeneration of northern white-cedar and alter species composition and structure.

Management Recommendations: The main management recommendation is to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure. The site is surrounded by high-quality northern wet meadow and northern shrub thicket, which could be managed as part of the Ecological Reference Area to buffer the rich conifer swamp. These wetlands should be protected since they contain a large population of sweet coltsfoot (*Petasites sagittatus*, state threatened). Finally, portions of the swamp occurring on private lands could be acquired or protected through conservation easements.

This uneven-aged rich conifer swamp is characterized by diverse ecological zonation and numerous successional stages patterned by windthrow, beaver flooding, and fire. Photos by Joshua G. Cohen.

138. Central Cedar Swamp

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Gaylord Forest Management Unit, Compartments 217 and 218, and Private Lands
Element Occurrence Identification Number: 317

Site Description: This large rich conifer swamp occurs on Bois Blanc Island on level lakeplain with circumneutral, saturated organic soils with well developed hummock and hollow microtopography. The organic soils range from fibric to sapric peats. Organic matter on the tops of sphagnum mounds is slighty acidic with circumneutral peats occurring in the hollows. The water table is typically 10 cm deep but there is standing water in the central portions of the swamp. The swamp is characterized by distinct gradients in water levels with highest water levels at the center of the swamp and decreasing towards the upland margin. The site is bordered by mesic northern forest.

The canopy is dominated by northern white-cedar (*Thuja occidentalis*) with trees ranging in DBH from 20 to 40 cm and oldest trees being over 200 years old. Canopy associates include black spruce (*Picea mariana*), black ash (*Fraxinus nigra*), balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), tamarack (*Larix laricina*), white pine (*Pinus strobus*), and balsam fir (*Abies balsamea*). The shrub layer is locally dense and dominated by tag alder (*Alnus rugosa*) and winterberry (*Ilex verticillata*). The diverse ground cover includes false mayflower (*Smilacina trifolia*), sphagnum species, starflower (*Trientalis borealis*), alder-leaved buckthorn (*Rhamnus alnifolia*), Canada mayflower (*Maianthemum canadense*), royal fern (*Osmunda regalis*), and dwarf raspberry (*Rubus pubescens*). Areas in the center of the swamp with standing water have a sparse canopy of black ash, tamarack, and red maple (*Acer rubrum*) with a dense shrub layer of winterberry and tag alder and ground cover dominated by royal fern.

Threats: The primary threat is posed by deer herbivory, which could limit northern white-cedar regeneration and alter the swamp's structure and species composition.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered and to reduce deer densities in the surrounding landscape to dampen deer browse pressure. Deer densities could be reduced through direct measures and also by reducing early-successional habitat on the island. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure. Portions of the swamp occurring on private lands could be acquired or protected through conservation easements.

139. El Cajon Bay

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Atlanta Forest Management Unit, Compartment 107
Element Occurrence Identification Number: 5676

Site Description: This rich conifer swamp occurs on lacustrine sand and cobble along El Cajon and Misery Bays of Lake Huron. The soils are circumneutral (pH 7.0.) peats over sand or sand mixed with cobbles. Boreal forest inclusions occur on slight rises of loamy sand over cobble or cobble mixed with sand.

The canopy is dominated by second-growth northern white-cedar (*Thuja occidentalis*) that was estimated to be 100 to 110 years old. Canopy trees range in DBH from 20 to 40 cm and canopy coverage ranges from 80 to 95%. Canopy associates include black spruce (*Picea mariana*), paper birch (*Betula papyrifera*), black ash (*Fraxinus nigra*), and balsam fir (*Abies balsamea*). The subcanopy and tall shrub layer is characterized by northern white-cedar, balsam fir, and round-leaved dogwood (*Cornus rugosa*). The low shrub layer is sparse with alder-leaved buckthorn (*Rhamnus alnifolia*) and American fly honeysuckle (*Lonicera canadensis*). The ground cover is sparse to absent in the northern section near El Cajon Bay but a dense carpet of ebony sedge (*Carex eburnea*), dwarf lake iris (*Iris lacustris*, federal/state threatened), starflower (*Trientalis borealis*), large-leaved aster (*Aster macrophyllus*), twinflower (*Linnaea borealis*), and sweet coltsfoot (*Petasites palmatus*) occurs along Misery Bay. Dwarf lake iris is most prevalent along the swamp's lakeward margin where the canopy is more open. Boreal forest inclusions occurring on slight rises are dominated by white spruce (*Picea glauca*), balsam fir, and quaking aspen (*Populus tremuloides*), with dense balsam fir in the subcanopy and tall shrub layer.

Threats: The primary threat is posed by deer herbivory, which could limit northern white-cedar regeneration and alter the swamp's structure and species composition. Deer sign is prevalent in the northern section near El Cajon Bay and likely limiting cedar regeneration and altering forest structure. Near Misery Bay, cedar regeneration is common, perhaps as a result of the abundance of wind-snapped snags that provide protection for cedar seedlings. Some off-road vehicle activity was noted.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow and fire) to operate unhindered and to reduce deer densities in the surrounding landscape to dampen deer browse pressure. Deer densities could be reduced through direct measures and also by reducing early-successional habitat in the surrounding landscape. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure. Portions of the swamp occurring on private lands could be acquired or protected through conservation easements. Finally, illegal off-road vehicle activity should be restricted.

Photo by Joshua G. Cohen.

140. Green Swamp

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Atlanta Forest Management Unit, Compartments 20, 33, 34, 35, 36, 37, 38, 41, and 42, Pigeon River Forest Management Unit, Compartment 52, and Private Lands
Element Occurrence Identification Number: 12248

Site Description: The Green Swamp or Rattlesnake Swamp is an extensive rich conifer swamp that occupies a branched outwash channel associated with several streams. The swamp is surrounded by glacial moraines and kames that rise dramatically from the wetland basin. The swamp slopes down gently from the uplands towards the streams, and is situated on deep circumneutral to alkaline peat that is typically greater than a meter in depth. The entire area appears to have been cut circa 1920s. The swamp is characterized by high ground cover diversity associated with the heterogeneous microtopography of the moss-covered hummocks and hollows. In addition to fine-scale gradients in soil moisture and soil chemistry, there are also large-scale gradients in these factors depending on proximity to streams and upland margins. Coarse woody debris of all decomposition classes is abundant. Portions of the wetland complex include pockets of northern shrub thicket, northern wet meadow, and northern fen.

The overstory dominant within this rich conifer swamp is primarily northern white-cedar (*Thuja occidentalis*) (15-30 cm DBH). Canopy associates include tamarack (*Larix laricina*), black spruce (*Picea mariana*), balsam fir (*Abies balsamea*), and paper birch (*Betula papyrifera*) with white pine (*Pinus strobus*) occasional. The understory is relatively open with characteristic shrubs including tag alder (*Alnus rugosa*), Labrador tea (*Ledum groenlandicum*), red-osier dogwood (*Cornus stolonifera*), and swamp fly honeysuckle (*Lonicera oblongifolia*). The ground layer is covered by a thick carpet of sphagnum mosses with a diversity of graminoids and forbs, including false mayflower (*Smilacina trifolia*), creeping winterberry (*Gaultheria hispidula*), dwarf raspberry (*Rubus pubescens*), wild sarsaparilla (*Aralia nudicaulis*), twinflower (*Linnaea borealis*), naked miterwort (*Mitella nuda*), three-seeded sedge (*Carex trisperma*), sedge (*C. disperma*), bristly-stalked sedge (*C. leptalea*), goldthread (*Coptis trifolia*), starflower (*Trientalis borealis*), and Canada mayflower (*Maianthemum canadense*). Two rare plants have been documented within the rich conifer swamp: ram's head lady's-slipper (*Cypripedium arietinum*, state special concern) and limestone oak fern (*Gymnocarpium robertianum*, state threatened). In addition, eastern massasaugas (*Sistrurus c. catenatus*, federal candidate species and state special concern) occur throughout this swamp complex.

Threats: The majority of the swamp was clearcut circa 1920s, and numerous railroad grades and spurs locally disrupt the hydrology. The main threats to the site include deer herbivory, development on private lands adjacent to the swamp, and timber harvesting on private inholdings. Heavy deer browse was noted during the survey. Several invasive species were noted during the surveys but are typically concentrated along the roads and grades and pose little threat to the swamp. The non-native lawn prunella (*Prunella vulgaris*) was documented within the swamp. This swamp complex is also threatened by oil and gas well development, which could significantly reduce the acreage of high-quality rich conifer swamp.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered, to maintain canopy closure of surrounding upland stands to minimize surface flow into the swamp and to maintain the ground water seepage, and to reduce deer densities in the surrounding landscape to dampen deer browse pressure. Deer densities could be reduced through direct measures and also by reducing early-successional habitat in the surrounding landscape. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure. Non-native plant populations should be monitored and controlled if necessary. Portions of the swamp and surrounding uplands occurring on private lands could be acquired or protected through conservation easements.

The Green Swamp is characterized by high ground cover diversity associated with the heterogeneous microtopography of the moss-covered hummocks and hollows and tip-up mounds. Photos by Bradford S. Slaughter.

141. Jackson Tindle Road (Rich Conifer Swamp)

Natural Community Type: Rich Conifer Swamp (re-classified from Hardwood-Conifer Swamp)
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Sault Sainte Marie Forest Management Unit, Compartments 106 and 107
Element Occurrence Identification Number: 8824

Site Description: This small rich conifer swamp occurs within a poorly drained depression in a broad lakeplain. Sandy dune ridges occur throughout the lakeplain. The soils are characterized by shallow (18-75 cm), slightly acidic to circumneutral (pH 6.5-7.0) peats overlying sandy clay. The small stand of old-growth northern white-cedar (*Thuja occidentalis*) occurs in a matrix of younger, more heavily disturbed conifer- and shrub-dominated wetlands.

The overstory of the rich conifer swamp is overwhelmingly dominated by northern white-cedar. Canopy associates include black spruce (*Picea mariana*), tamarack (*Larix laricina*), paper birch (*Betula papyrifera*), and balsam fir (*Abies balsamea*). Younger portions of the surrounding swamp are dominated by tamarack and black spruce. Upland rises or dune ridges within the swamp on lacustrine sands support tamarack, black spruce, and paper birch and formerly contained white pine (*Pinus strobus*) as indicated by the numerous cut and burnt white pine stumps. Prevalent tall shrubs within the rich conifer swamp include tag alder (*Alnus rugosa*), red-osier dogwood (*Cornus stolonifera*), and wild-raisin (*Viburnum cassinoides*). Typical low shrubs include Labrador tea (*Ledum groenlandicum*) and dwarf raspberry (*Rubus pubescens*). Characteristic ground cover species are royal fern (*Osmunda regalis*), sedges (*Carex* spp.), creeping snowberry (*Gaultheria hispidula*), and false mayflower (*Smilacina trifolia*).

Threats: High winter deer densities could negatively impact regeneration of northern white-cedar and alter species composition and structure. Non-native species are rare within this swamp, although a localized colonization of lawn prunella (*Prunella vulgaris*) was observed.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered, to maintain canopy closure of the surrounding uplands to minimize surface water flow into the swamp and to maintain groundwater seepage, to reduce deer densities in the surrounding landscape to dampen deer browse pressure, and to monitor for invasive plant populations. In addition, monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure.

Photo by Bradford S. Slaughter.

142. Kate's Lake

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Gwinn Forest Management Unit, Compartment 262, and Private Lands
Element Occurrence Identification Number: 9448

Site Description: This small block of old-growth rich conifer swamp occupies a narrow outwash channel along Bryan Creek, northeast of Kate's Lake. Areas along the creek are characterized by acidic (pH 5.0-6.0) mineral soils with silts overlying clay. Peats characterize the remainder of the swamp and increase in depth with distance from the creek. The peats are slightly acidic to circumneutral (pH 6.5-7.0), saturated, and overlay clays, sandy clays, and sands. Small dune ridges within the swamp support dry-mesic northern forest with large-diameter white pine (*Pinus strobus*) and red pine (*P. resinosa*). Windthrow occurs throughout the swamp.

This very small occurrence includes two subtypes: cedar swamp occurring on mineral soils or shallow organics and cedar swamp occurring over deep peats. Immediately adjacent to Bryan Creek is a wet-mesic, northern white-cedar (*Thuja occidentalis*)–dominated forest that occurs on shallow peats and poorly drained mineral soils and is influenced by the flood dynamics of the creek. This portion of the site is characterized by an overstory of very large, clumped cedars and ground cover dominated by grasses, sedges and ferns. The portion of the swamp that is isolated from the creek's flood dynamics is characterized by deep peats with well-developed sphagnum hummock-hollow microtopography and more evenly spaced trees, which do not reach the size of those on the immediate floodplain. The canopy throughout the swamp is dominated by northern white-cedar with canopy associates including white pine, black spruce (*Picea mariana*), white spruce (*P. glauca*), and paper birch (*Betula papyrifera*). Where it occurs, the subcanopy supports balsam fir (*Abies balsamea*), red maple (*Acer rubrum*), and mountain maple (*A. spicatum*). The tall shrub layer is sparse on deep organic soils and dense adjacent to the creek. Characteristic tall shrubs include tag alder (*Alnus rugosa*) and winterberry (*Ilex verticillata*) and common low shrubs are alder-leaved buckthorn (*Rhamnus alnifolia*), American fly honeysuckle (*Lonicera canadensis*), Canada blueberry (*Vaccinium myrtilloides*), and Labrador tea (*Ledum groenlandicum*). Common species in the ground cover adjacent to Bryan Creek include bladder sedge (*Carex intumescens*), fowl manna grass (*Glyceria striata*), New York fern (*Thelypteris noveboracensis*), bearded shorthusk (*Brachyelytrum erectum*), wild red raspberry (*Rubus strigosus*), and virgin's bower (*Clematis virginiana*). Ground cover plants in areas of swamp occurring over deeper peats include three-seeded sedge (*Carex trisperma*), goldthread (*Coptis trifolia*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), wood sorrel (*Oxalis acetosella*), glandular woodfern (*Dryopteris intermedia*), sedge (*Carex pedunculata*), and cinnamon fern (*Osmunda cinnamomea*).

Threats: The primary threat is posed by deer herbivory, which could limit northern white-cedar regeneration and alter the swamp's structure and species composition. Deer herbivory was noted on both shrub and tree species. Some logging of large-diameter, old-growth pines has occurred on the adjacent upland ridges. Several non-native plant species were noted at low densities including European marsh thistle (*Cirsium palustre*), lawn prunella (*Prunella vulgaris*), common plantain (*Plantago major*), and common dandelion (*Taraxacum officinale*).

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered, to maintain canopy closure of surrounding upland stands to minimize surface flow into the swamp and to maintain ground water seepage, and to reduce deer densities in the surrounding landscape to dampen deer browse pressure. Deer densities could be reduced through direct measures and also by reducing early-successional habitat in the surrounding landscape. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer

herbivory threatens northern white-cedar regeneration and impacts species composition and structure. Portions of the swamp occurring on private lands could be acquired or protected through conservation easements.

Photo by Bradford S. Slaughter.

143. Little West Branch

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Gwinn Forest Management Unit, Compartment 67
Element Occurrence Identification Number: 14555

Site Description: This site is a small and shrinking band of rich conifer swamp occurring in a flat, poorly drained outwash channel on saturated sphagnum peat overlying circumneutral sand. Groundwater influence generates circumneutral conditions and beaver flooding associated with the Little West Branch of the Escanaba River and Lone Pine Creek has resulted in flood-killing and expansion of northern shrub thicket into cedar swamp. The site is characterized by microsite diversity, which is driven by pit and mound topography from windthrows and from sphagnum hummock and hollow microtopography. Flood-killing along the northern portion of the swamp and pervasive windthrow generate site-level diversity.

The closed to partial canopy is overwhelmingly dominated by northern white-cedar (*Thuja occidentalis*) with scattered associates including paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), black spruce (*Picea mariana*), and white pine (*Pinus strobus*). Deciduous species are most prevalent closer to the upland margin. The tall shrub layer is dominated by balsam fir (*Abies balsamea*) and tag alder (*Alnus rugosa*) with balsam fir most prevalent in areas of windthrow and tag alder dominant in areas of recent beaver flood-kill. The low shrub layer is scattered with alder-leaved buckthorn (*Rhamnus alnifolia*) and American fly honeysuckle (*Lonicera canadensis*). Scattered northern white-cedars occur as seedlings especially along the edge of the swamp and in areas of shrub thicket. Cedar is noticeably missing from the sapling layer due to deer herbivory. The ground cover is diverse with a continuous sphagnum carpet and numerous orchids and ferns and high diversity patterned by hummock and hollow microtopography. Typical ground cover species include bluebead lily (*Clintonia borealis*), common horsetail (*Equisetum arvense*), false mayflower (*Smilacina trifolia*), oak fern (*Gymnocarpium dryopteris*), goldthread (*Coptis trifolia*), and starflower (*Trientalis borealis*).

Threats: Continued beaver flooding would threaten the remaining rich conifer swamp. In addition, continued high levels of deer herbivory could limit cedar's regeneration capacity and alter the swamp's species composition and structure.

Management Recommendations: The main management recommendations are to allow natual processes (i.e., windthrow and fire) to operate unhindered and to reduce deer densities in the surrounding landscape to dampen deer browse pressure. Deer densities could be reduced through direct measures and also by reducing early-successional habitat in the surrounding landscape. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure. As noted above, beaver flooding has significantly altered the floristic composition and structure of the rich conifer swamp. Trapping of beaver should be investigated as a management option to prevent the loss of rich conifer swamp habitat.

Photo by Joshua G. Cohen..

144. Minnehaha Creek

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Gaylord Forest Management Unit, Compartment 125, and Private Lands
Element Occurrence Identification Number: 8154

Site Description: This extensive minerotrophic swamp complex is dominated by rich conifer swamp with inclusions of hardwood-conifer swamp, northern shrub thicket, northern wet meadow associated with streams and beaver flooding, and two patches of northern fen. This wetland occurs on poorly drained lakeplain with alkaline to circumneutral, inundated mucks and saturated peats of variable depth overlying sands and less frequently clay. The site is characterized by high native species diversity (over 145 species were noted during the 2007 survey) driven by complex ecological zonation (patterned by windthrow, beaver floodings associated with Mud Creek, and groundwater seepage) and microsite heterogeneity (i.e., tip-up mounds and sphagnum hummock and hollow microtopography). The swamp is bordered to the north by Crooked Lake and to the east by Pickerel Lake, and several creeks pass through the site. The large cedar swamp generates a microclimate with cooler temperatures in the summer, warmer temperatures in the winter, and less temperature extremes throughout the year compared to the surrounding uplands.

The majority of the site is dominated by mature northern white-cedar (*Thuja occidentalis*) swamp (60+ years old) with recently disturbed areas occurring in areas of windthrow gaps and older trees scattered throughout (one cored cedar was 130+ years old). The canopy is dominated by northern white-cedar with tamarack (*Larix laricina*) and scattered black spruce (*Picea mariana*), white spruce (*P. glauca*), and white pine (*Pinus strobus*). Areas of hardwood-conifer swamp are dominated by northern white-cedar with green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), balsam poplar (*Populus balsamifera*), and black ash (*Fraxinus nigra*). These areas have dense understories with tag alder (*Alnus rugosa*), winterberry (*Ilex verticillata*), and balsam fir (*Abies balsamea*). The low shrub layer of the cedar swamp contains swamp fly honeysuckle (*Lonicera oblongifolia*), American fly honeysuckle (*L. canadensis*), alder-leaved buckthorn (*Rhamnus alnifolia*), northern white-cedar seedlings, tamarack seedlings, and balsam fir seedlings. The diverse ground cover is characterized by thick carpets of sphagnum mosses with well-developed sphagnum hummock and hollow microtopography in more mature areas and where hydrology has been stable. Characteristic species include sedges (*Carex deweyana, C. eburnea,* and *C. trisperma*), fowl manna grass (*Glyceria striata*), dwarf raspberry (*Rubus pubescens*), dwarf scouring rush (*Equisetum scirpoides*), grass-of-Parnassus (*Parnassia glauca*), false mayflower (*Smilacina trifolia*), and a diverse array of ferns, including oak fern (*Gymnocarpium dryopteris*), cinnamon fern (*Osmunda cinnomomea*), royal fern (*O. regalis*), and sensitive fern (*Onoclea sensibilis*). Areas impacted by beaver flooding have an open canopy (10-50% canopy cover) with flood-killed northern white-cedar, tamarack, and green ash. These areas are characterized by dense graminoid growth with lake sedge (*Carex lacustris*), tussock sedge (*C. stricta*), bluejoint grass (*Calamagrostis canadensis*), cut grass (*Leersia oryzoides*), reed canary grass (*Phalaris arundinacea*), and broad-leaved cat-tail (*Typha latifolia*). Prevalent herbs include jewelweed (*Impatiens capensis*), common skullcap (*Scutellaria galericulata*), wild blue flag (*Iris versicolor*), common water horehound (*Lycopus americanus*), and joe-pye-weed (*Eupatorium maculatum*). The two pockets of northern fen have a scattered and stunted canopy of northern white-cedar and tamarack, which are also prevalent in the understory and low shrub layers. The low shrub layer is dense and diverse with additional species including shrubby cinquefoil (*Potentilla fruticosa*), sweet gale (*Myrica gale*), leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), and creeping juniper (*Juniperus horizontalis*). The diverse ground cover is characterized by clumps of tufted bulrush (*Trichophorum cespitosum*) and patches of white beak-rush (*Rhynchospora alba*) and sedge (*Carex flava*). Additional species include marsh fern (*Thelypteris palustris*), small cranberry (*Vaccinium oxycoccos*), bog buckbean (*Menyanthes trifoliata*), pitcher-plant (*Sarracenia purpurea*), false asphodel (*Tofieldia glutinosa*), round-leaved sundew (*Drosera rotundifolia*), grass-of-Parnassus, Indian tobacco (*Lobelia inflata*), and marsh wild timothy (*Muhlenbergia glomerata*). Northern shrub thicket and northern wet meadow occur along stretches of the creeks, which also support submergent vegetation.

Threats: The primary threat is logging of the private parcels and continued encroachment by non-native species, especially purple loosestrife. In addition, deer herbivory could limit northern white-cedar regeneration.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered, to control non-native invasive species, and to reduce deer densities in the surrounding landscape to dampen deer browse pressure. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure. Non-native invasive plants documented within the swamp include reed canary grass (*Phalaris arundinacea*) and watercress (*Nasturtium officinale*). In addition, purple loosestrife (*Lythrum salicaria*) was observed along Pickerel Lake Road just south of the swamp within a drainage ditch. Eliminating this population should be a stewardship priority and efforts to control non-native plant populations should be monitored. Finally, portions of the swamp occurring on private lands could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

145. Noble Lake

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Shingleton Forest Management Unit, Compartments 176 and 177
Element Occurrence Identification Number: 964

Site Description: This rich conifer swamp occurs on an ice contact depression among end moraine of medium-textured till. Soils are saturated, acidic to circumneutral (pH 5.0-6.8), sapric to fibric peats over deep sands with a subsurface flow of mineral-rich, cold groundwater. Plant species diversity is high and is correlated with the diversity of microhabitats that results from windthrow mounds, hummock formation, vernal pool depressions, and frequent light gaps. The swamp is surrounded on all sides by managed upland forest.

Northern white-cedar (*Thuja occidentalis*) is the predominant species in all vegetative layers, and appears to be reproducing well though deer browse is evident. Canopy cedar range in DBH from 30 to 60 cm. Portions of the occurrence consist of old-growth cedar, though logging in the northern portions has removed many large trees. Canopy associates include black spruce (*Picea mariana*), tamarack (*Larix laricina*), black ash (*Fraxinus nigra*), and yellow birch (*Betula alleghaniensis*). The tall shrub layer is characterized by northern white-cedar, mountain maple (*Acer spicatum*), balsam fir (*Abies balsamea*), tag alder (*Alnus rugosa*), and elderberry (*Sambucus canadensis*). Labrador tea (*Ledum groenlandicum*) and swamp dewberry (*Rubus hispidus*) are prevalent in the low shrub layer. The ground cover is diverse with species such as false mayflower (*Smilacina trifolia*), bluebead lily (*Clintonia borealis*), goldthread (*Coptis trifolia*), wild sarsaparilla (*Aralia nudicaulis*), naked miterwort (*Mitella nuda*), small cranberry (*Vaccinium oxycoccos*), and wintergreen (*Gaultheria procumbens*).

Threats: Some logging has taken place in the northern half of the swamp, and more recently in the northern quarter. Old logging roads exist through the northern half. Hydrology in the area has likely been, and is currently, affected by compaction of the soil and the construction of roads associated with past and present logging activity. Overabundance of deer results in browse on northern white-cedar, reduction in cedar regeneration, and stress to native plant populations through eating and trampling.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow, fire, and flooding) to operate unhindered and to reduce deer densities in the surrounding landscape to dampen deer browse pressure. Deer densities could be reduced through direct measures and also by reducing early-successional habitat in the surrounding landscape. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure. Finally, illegal off-road vehicle activity should be restricted.

146. Pine River Swamp North Branch

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Cadillac Forest Management Unit, Compartment 142, and Private Lands
Element Occurrence Identification Number: 4139

Site Description: This rich conifer swamp occurs in the drainageway of the North Branch of the Pine River in a poorly drained outwash plain. Uplands adjacent to the rich conifer swamp are early-successional forest dominated by aspens (*Populus* spp.). The soils of the rich conifer swamp are circumneutral (pH 7.0-7.5) peats of variable depth. Windthrow is prevalent throughout the swamp.

The closed canopy is dominated by northern white-cedar (*Thuja occidentalis*) (10-30 cm DBH) with canopy associates including tamarack (*Larix laricina*), black spruce (*Picea mariana*), and balsam fir (*Abies balsamea*), which occurs primarily in the subcanopy. The shrub layer is sparse and dominated by balsam fir with tag alder (*Alnus rugosa*) prevalent in the windthrow gaps. Typical low shrubs include alder-leaved buckthorn (*Rhamnus alnifolia*) and Canada blueberry (*Vaccinium myrtilloides*). The ground cover ranges from sparse to dense with characteristic species including goldthread (*Coptis trifolia*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), creeping winterberry (*Gaultheria hispidula*), and sedges (*Carex* spp.).

Threats: The primary threat is posed by deer herbivory, which could limit northern white-cedar regeneration and alter the swamp's structure and species composition. Deer herbivory was noted on both shrub and tree species. Some selective logging of cedar occurred in this swamp around the turn-of-the century. The non-native reed canary grass (*Phalaris arundinacea*) is locally common along the stream and in a few openings.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered, to maintain canopy closure of surrounding upland stands to minimize surface flow into the swamp and to maintain the ground water seepage, and to reduce deer densities in the surrounding landscape to dampen deer browse pressure. Deer densities could be reduced through direct measures and also by reducing early-successional habitat in the surrounding landscape. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure. The population of reed canary grass should be controlled and monitored. Portions of the swamp occurring on private lands could be acquired or protected through conservation easements.

Photo by Bradford S. Slaughter.

147. Sage Lake Cedar Swamp

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Location: Atlanta Forest Management Unit, Compartment 12, and Private Lands
Element Occurrence Identification Number: 15952

Site Description: This rich conifer swamp is dominated by 100+ year old northern white-cedar (*Thuja occidentalis*) occurring on poorly drained outwash plain on mucky alkaline soils with sphagnum peat overlying sapric peat. The water table varies from 0 to 30 cm. The site is characterized by hummock and hollow microtopography, and groundwater seepage creates minerotrophic conditions. Flooding has killed trees along the lake margin. Many different vegetative zones and high species diversity characterize the site due to the proximity to the lake, the rapid transition from wetland to upland, and the hummock and hollow microtopography.

The closed canopy (70-90%) is dominated by northern white-cedar (20-40 cm DBH) with canopy associates including tamarack (*Larix laricina*) and black spruce (*Picea mariana*) with occasional supercanopy white pine (*Pinus strobus*). Flooding mortality close to the lake results in dominance in the ground layer by sedges and grasses, namely tussock sedge (*Carex stricta*), bluejoint grass (*Calamagrostis canadensis*), and fowl manna grass (*Glyceria striata*). With the exception of some areas with heavy balsam fir (*Abies balsamea*) or tag alder (*Alnus rugosa*), the understory is sparse to scattered with dogwoods (*Cornus* spp.) and alder. A low shrub layer is prevalent with gooseberries (*Ribes* spp.), dwarf raspberry (*Rubus pubescens*), American fly honeysuckle (*Lonicera canadensis*), and alder-leaved buckthorn (*Rhamnus alnifolia*). The ground cover is dominated by sphagnum species along with large-leaved aster (*Aster macrophyllus*), goldthread (*Coptis trifolia*), and horsetails (*Equisetum* spp.). As noted, the pit and mound microtopography increases microhabitats and also contributes to the high species diversity (over 80 species were noted during the 2006 surveys).

Threats: The main threats to the site include off-road vehicle damage and high levels of deer herbivory. Off-road vehicle damage in the northwestern corner of the complex has resulted in deep rutting of the organic soils. Deer herbivory is limiting cedar recruitment throughout the swamp.

Management Recommendations: Management recommendations for this site include allowing natural processes (i.e., windthrow, flooding, and fire) to operate unhindered, eliminating illegal off-road vehicle activity, reducing deer densities within the general landscape, and maintaining canopy closure of surrounding upland stands to minimize surface flow into the swamp and to maintain the groundwater seepage. Deer densities could be reduced through direct measures and also by reducing early-successional habitat in the general landscape. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure. Portions of the swamp occurring on private lands could be acquired or protected through conservation easements.

A main threat to this rich conifer swamp is posed by off-road vehicles. Photos by Joshua G. Cohen

146. Trout Unlimited

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Location: Private Lands
Element Occurrence Identification Number: 8303

This rich conifer swamp occurs on private lands and was therefore not surveyed.

149. Watson Swamp

Natural Community Type: Rich Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: AB
Location: Traverse City Forest Management Unit, Compartments 124, 125, and 126, and Private Lands
Element Occurrence Identification Number: 6020

Site Description: This rich conifer swamp occurs on a poorly drained outwash channel associated with the North Branch of the Manistee River. The swamp is surrounded by early-successional forest and pine plantations occurring on the adjacent sandy moraine. The rich conifer swamp slopes gently from the upland margin on the east side towards the river to the west where the swamp is bordered by dense northern shrub thicket dominated by tag alder (*Alnus rugosa*). The rich conifer swamp occurs on deep peats of variable composition and depth. The saturated peats are slightly acidic to circumneutral (pH 5.5-7.5). Windthrow occurs throughout the swamp but is concentrated along the stream. The site is characterized by high species diversity due to broad gradients in groundwater influence and fine-scale gradients of soil moisture, soil chemistry, and canopy closure. Sphagnum hummock and hollow microtopography increases microhabitat and contributes to species diversity (121 native plant species were identified during the survey).

The closed canopy is dominated by northern white-cedar (*Thuja occidentalis*) (20-60 cm DBH). Canopy associates include black spruce (*Picea mariana*) and balsam fir (*Abies balsamea*), with the latter also prevalent in the understory. Tamarack (*Larix laricina*) is found in areas of open canopy and hemlock (*Tsuga canadensis*) occurs where peats are shallow. Paper birch (*Betula papyrifera*) is an occasional canopy associate. Portions of the swamp near the river on unstable, wet, muck soils exhibit a greater importance of hardwoods, especially black ash (*Fraxinus nigra*) and red maple (*Acer rubrum*). The understory is dominated by balsam fir, tag alder, and winterberry (*Ilex verticillata*). These species are especially prevalent in windthrow gaps. Additional tall shrubs include mountain holly (*Nemopanthus mucronata*), red-osier dogwood (*Cornus stolonifera*), and wild-raisin (*Viburnum cassinoides*). Low shrubs are sparse with common species including alder-leaved buckthorn (*Rhamnus alnifolia*), American fly honeysuckle (*Lonicera canadensis*), and Canada blueberry (*Vaccinium myrtilloides*) with Labrador tea (*Ledum groenlandicum*) locally common. The ground cover ranges from sparse to dense with characteristic species of hummocks including goldthread (*Coptis trifolia*), bunchberry (*Cornus canadensis*), Canada mayflower (*Maianthemum canadense*), creeping winterberry (*Gaultheria hispidula*), wild sarsaparilla (*Aralia nudicaulis*), sphagnum mosses (*Sphagnum* spp.), twinflower (*Linnaea borealis*), and three-seeded sedge (*Carex trisperma*). Hollows are characterized by fowl manna grass (*Glyceria striata*), sensitive fern (*Onoclea sensibilis*), false mayflower (*Smilacina trifolia*), sphagnum mosses, and sedges (*Carex* spp.)

Threats: The primary threat is posed by deer herbivory, which could limit northern white-cedar regeneration and alter the swamp's structure and species composition. Deer herbivory was noted on both shrub and tree species. Some selective logging of cedar occurred in this swamp around the turn-of-the century. Several non-natives were noted within the rich conifer swamp including lawn prunella (*Prunella vulgaris*), European marsh thistle (*Cirsium palustre*), and bittersweet nightshade (*Solanum dulcamara*),

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow, flooding, and fire) to operate unhindered, to maintain canopy closure of surrounding upland stands to minimize surface flow into the swamp and to maintain the ground water seepage, and to reduce deer densities in the surrounding landscape to dampen deer browse pressure. Deer densities could be reduced through direct measures and also by reducing early-successional habitat in the surrounding landscape. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens northern white-cedar regeneration and impacts species composition and structure. The population of non-native plants should be monitored and controlled if necessary. Portions of the swamp occurring on private lands could be acquired or protected through conservation easements.

Watson Swamp is characterized by high species diversity due to broad gradients in groundwater influence and fine-scale gradients of soil moisture, soil chemistry, and canopy closure. Photos by Bradford S. Slaughter.

SANDSTONE LAKESHORE CLIFF

Overview: Sandstone lakeshore cliff consists of vertical or near-vertical exposures of bedrock with sparse coverage of vascular plants, lichens, mosses, and liverworts. The community occurs primarily in the central and western Upper Peninsula along Lake Superior but also is found along a short stretch of shore along Lake Huron in the thumb region. Sandstone lakeshore cliffs range from 2 to 65 m (6 to 200 ft) high and are characterized by high site moisture and a stressed and unstable environment because of severe waves, wind, and winter ice due to the proximity to the Great Lakes (Kost et al. 2007).

150. Rabbit Bay - Jacobsville

Natural Community Type: Sandstone Lakeshore Cliff
Rank: G3 S2, vulnerable globally and imperiled in the state
Element Occurrence Rank: AB
Location: Baraga Forest Management Unit, Compartment 59, and Private Lands
Element Occurrence Identification Number: 9468

Site Description: These eastern-facing Jacobsville sandstone cliffs extend along the Lake Superior shoreline for 2.5 miles and range in height from 2 to 6 m tall with talus accumulating at the base in localized areas, boreal forest occurring along the escarpment, and sandstone pavement lakeshore, sand and gravel beach, and cobble shore occurring lakeward. Soils, which accumulate at the base of the cliffs and in cracks and on ledges, are thin, strongly acidic (pH 4.5) sands. Wave action, freeze thaw dynamics, and weathering cause erosion of the cliff face and generation of talus and boulders at the cliff base. Windthrow of trees from the boreal forest on top of the cliffs results in an abundance of coarse woody debris and also contributes to accumulation of talus and localized accumulation of soil from root mounds.

Sparse vegetation is restricted to ledges, cracks, and the base of the cliffs in talus and among boulders, cobble, and windthrown trees. Scattered and stunted seedlings and saplings include paper birch (*Betula papyrifera*), quaking aspen (*Populus tremuloides*), balsam fir (*Abies balsamea*), white spruce (*Picea glauca*), and northern white-cedar (*Thuja occidentalis*). Tall shrubs scattered throughout include pin cherry (*Prunus pensylvanica*), serviceberries (*Amelanchier* spp.), mountain alder (*Alnus crispa*), and willows (*Salix* spp.). Characteristic low shrubs are wild red raspberry (*Rubus strigosus*) and bush honeysuckle (*Diervilla lonicera*). Herbaceous cover is sparse with localized patches of hair grass (*Deschampsia cespitosa*), fireweed (*Epilobium angustifolium*), marsh pea (*Lathyrus palustris*), jewelweed (*Impatiens capensis*), and northern bugleweed (*Lycopus uniflorus*). Additional characteristic ground cover species include yarrow (*Achillea millefolium*), red maple (*Acer rubrum*), fleshy stitchwort (*Stellaria crassifolia*, state threatened), cinnamon willowherb (*Epilobium coloratum*), quaking aspen seedlings, paper birch seedlings, grass-leaved goldenrod (*Euthamia graminifolia*), goldenrods (*Solidago* spp.), asters (*Aster* spp.), hairy hawkweed (*Hieracium gronovii*), and the non-native pearlwort (*Sagina procumbens*). Sphagnum mosses and lichens are prevalent on moist rock faces, especially where cliffs overhang the lake and where two streams flow across the sandstone into the lake.

The escarpment along the top of the cliffs is forested to the edge and dominated by boreal forest. The boreal forest occurs on thin (10-20 cm), acidic (pH 4.5) organic soils over sandstone bedrock. The canopy is dominated by northern white-cedar, white spruce, paper birch, and white pine (*Pinus strobus*) with local prevalence of hemlock (*Tsuga canadensis*). Understory species of the boreal forest include balsam fir (*Abies balsamea*), mountain maple (*Acer spicatum*), and occasional mountain ash (*Sorbus decora*). The low shrub layer is dominated by Canada blueberry (*Vaccinium myrtilloides*) with localized prevalence of Canada bilberry (*Vaccinium membranaceum*). Characteristic ground cover species include bluebead lily (*Clintonia borealis*), goldthread (*Coptis trifolia*), bunchberry (*Cornus canadensis*), wild sarsaparilla (*Aralia nudicaulis*), Canada mayflower (*Maianthemum canadense*), starflower (*Trientalis borealis*), and cow-wheat (*Melampyrum lineare*).

Threats: Continued cutting along the cliff edge and within the interior of the boreal forest could decrease the coarse woody debris inputs along the cliff and increase the available seed source for non-native species and weedy native species. Off-road vehicle activity along the shoreline could degrade the portions of sandstone bedrock lakeshore.

Management Recommendations: The main management recommendations are to maintain a forested buffer and eliminate off-road vehicle activity along the shoreline to minimize the threat of invasion by non-native species. Localized patches of the non-native clover *Trifolium depauperatum* should be eliminated and efforts to control other non-native species populations should be monitored. In addition, several private parcels occur within or adjacent to the occurrence (including sandstone lakeshore cliff and interior boreal forest) and could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

SINKHOLE

Overview: Sinkholes are depressions in the landscape caused by the dissolution and collapse of subsurface limestone, dolomite, or gypsum. These karst collapse features are limited in distribution to northeast Lower Michigan and the south-central portion of eastern Upper Michigan. Vegetation is predominantly that of the surrounding forest but a moister and cooler microclimate and vertical limestone walls provides habitat for mosses and ferns (Kost et al. 2007).

151. Rockport Karst

Natural Community Type: Sinkhole
Rank: G3G5 S2, vulnerable to secure globally and imperiled within the state
Element Occurrence Rank: AB
Location: Atlanta Forest Management Unit, Compartment 133
Element Occurrence Identification Number: 8704

Site Description: This site consists of a series of ten sinkholes on the Traverse Group of limestone. The sinkholes vary in depth (20-40 ft) and size. Five of the observed sinkholes contained standing water or small lakes during the August 2006 survey. Soils of the lake margins and within the five dry sinkholes ranged from moist to saturated and were slightly alkaline (pH 7.5) sapric peat over clay or bedrock. All sinkholes had an abundance of coarse woody debris of varying sizes and decay classes blown in from the surrounding uplands.

Vegetation varies significantly by sinkhole but most sinkholes are characterized by an outer ring of upland tree species including northern white-cedar (*Thuja occidentalis*), basswood (*Tilia americana*), quaking aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), American beech (*Fagus grandifolia*), white ash (*Fraxinus americana*), and hemlock (*Tsuga canadensis*). Shrubs prevalent along the margins of the sinkholes include soapberry (*Shepherdia canadensis*), willows (*Salix* spp.), and round-leaved dogwood (*Cornus rugosa*). Herbaceous vegetation is variable from sinkhole to sinkhole and includes northern bugleweed (*Lycopus uniflorus*), common water horehound (*L. americanus*), marsh fern (*Thelypteris palustris*), sensitive fern (*Onoclea sensibilis*), wild mint (*Mentha arvensis*), skullcaps (*Scutellaria* spp.), cardinal flower (*Lobelia cardinalis*), beggar-ticks (*Bidens* spp.), softstem bulrush (*Schoenoplectus tabernaemontani*), and sedges (*Carex* spp.). Additional species include bulblet fern (*Cystopteris bulbifera*), water smartweed (*Polygonum amphibium*), hardstem bulrush (*Schoenoplectus acutus*), and fowl manna grass (*Glyceria striata*). Aquatic plants occurring in the open waters of the sinkholes include pondweeds (*Potamogeton* spp.), bladderwort (*Utricularia vulgaris*), and water-milfoil (*Myriophyllum tenellum*).

Threats: Timber management in the surrounding forests could alter the groundwater hydrology and coarse woody debris inputs to the sinkholes. Introduction of roads in the adjacent forests could increase the probability of non-native species spread to the sinkhole margins. Stocking of fish to the sinkholes could alter the aquatic composition.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow) to operate unhindered and to maintain a forested buffer surrounding the sinkholes to protect the groundwater quality, minimize surface water input and sedimentation, and prevent the increase of a non-native species in the surrounding landscape. Stocking the sinkholes with fish should be avoided.

The sinkholes range from open lakes to log-filled depressions. Photos by Joshua G. Cohen

152. The Rock – Drummond Island (Sinkhole)

Natural Community Type: Sinkhole
Rank: G3G5 S2, vulnerable to secure globally and imperiled within the state
Element Occurrence Rank: AB
Location: Sault Sainte Marie Forest Management Unit, Compartment 8
Element Occurrence Identification Number: 13582

Site Description: This site consists of a series of small, shallow dolomite sinkholes with uneven terrain occurring on Drummond Island. In 2007, several of the sinkholes were dry while one contained shallow water. Shallow soils overlying the dolomite bedrock were moderately alkaline (pH 8.0) sapric peats. The sinkholes are bordered by forest that was heavily logged in recent years. Vegetation varies significantly by sinkhole. Common species include cordgrass (*Spartina pectinata*), bluejoint grass (*Calamagrostis canadensis*), hardstem bulrush (*Schoenoplectus acutus*), water smartweed (*Polygonum amphibium*), sedges (*Carex* spp.), spike-rush (*Eleocharis palustris*, also known as *E. smallii*), swamp milkweed (*Asclepias incarnata*), wild blue flag (*Iris versicolor*), green bulrush (*Scirpus atrovirens*), twig-rush (*Cladium mariscoides*), and Kalm's lobelia (*Lobelia kalmii*). Sedges, twig-rush, spike-rush, and bulrush are most prevalent in the lowest depressions where there is standing water. Alder-leaved buckthorn (*Rhamnus alnifolia*) forms locally dense bands around areas of graminoid dominance. Margins of the sinkholes, particularly in dry areas, support a scattered canopy of black ash (*Fraxinus nigra*), northern white-cedar (*Thuja occidentalis*), quaking aspen (*Populus tremuloides*), balsam poplar (*P. balsamifera*), and paper birch (*Betula papyrifera*).

Threats: Timber management in the surrounding forests could alter the groundwater hydrology and coarse woody debris inputs to sinkholes. Introduction of roads in the adjacent forests could increase the probability of non-native species spread to the sinkhole margins.

Management Recommendations: The main management recommendations are to allow natural processes (i.e., windthrow) to operate unhindered and to maintain a forested buffer surrounding the sinkholes to protect the groundwater quality, minimize surface water input and sedimentation, and prevent the increase of non-native species in the surrounding landscape. Monitoring for invasive species should be implemented and control measures taken if necessary.

Photo by Bradford S. Slaughter.

VOLCANIC BEDROCK GLADE

Overview: Volcanic bedrock glade consists of an open forested or savanna community found where basaltic bedrock and conglomerates are exposed. The sparse vegetation consists of scattered open-grown trees, scattered shrubs or shrub thickets, and a partial turf of herbs, grasses, sedges, mosses, and lichens. The community occurs in the western Upper Peninsula on Isle Royale and the Keweenaw Peninsula, extending southwest into Houghton, Ontonagon, and Gogebic Counties (Kost et al. 2007).

153. Fish Cove

Natural Community Type: Volcanic Bedrock Glade
Rank: GU S2, unknown status globally and critically imperiled within the state
Element Occurrence Rank: A
Location: Baraga Forest Management Unit, Compartment 82
Element Occurrence Identification Number: 6892

Site Description: This volcanic bedrock glade occurs on south-facing exposed basalt and rhyolite bedrock of the Portage Lake Volcanics on the Keweenaw Peninsula along the Lake Superior shoreline and inland along the Montreal River. The glade includes steep bedrock escarpment, stair-stepped slopes or stacks, and exposed bedrock knobs. Some organic soil has developed in pockets and cracks within the volcanic rock, but there are also large areas with no soil where lichens and mosses are the predominant vegetation. Thin soils, cold winter temperatures, steady winds, and summer droughts make vegetation especially prone to desiccation. Blowdowns are prevalent throughout the glade due to the high winds near Lake Superior and the thin rooting zone. Boreal forest, high-quality volcanic bedrock lakeshore[30], and dry-mesic northern forest occur adjacent to this community. A small portion of the glade burned during the summer of 2007.

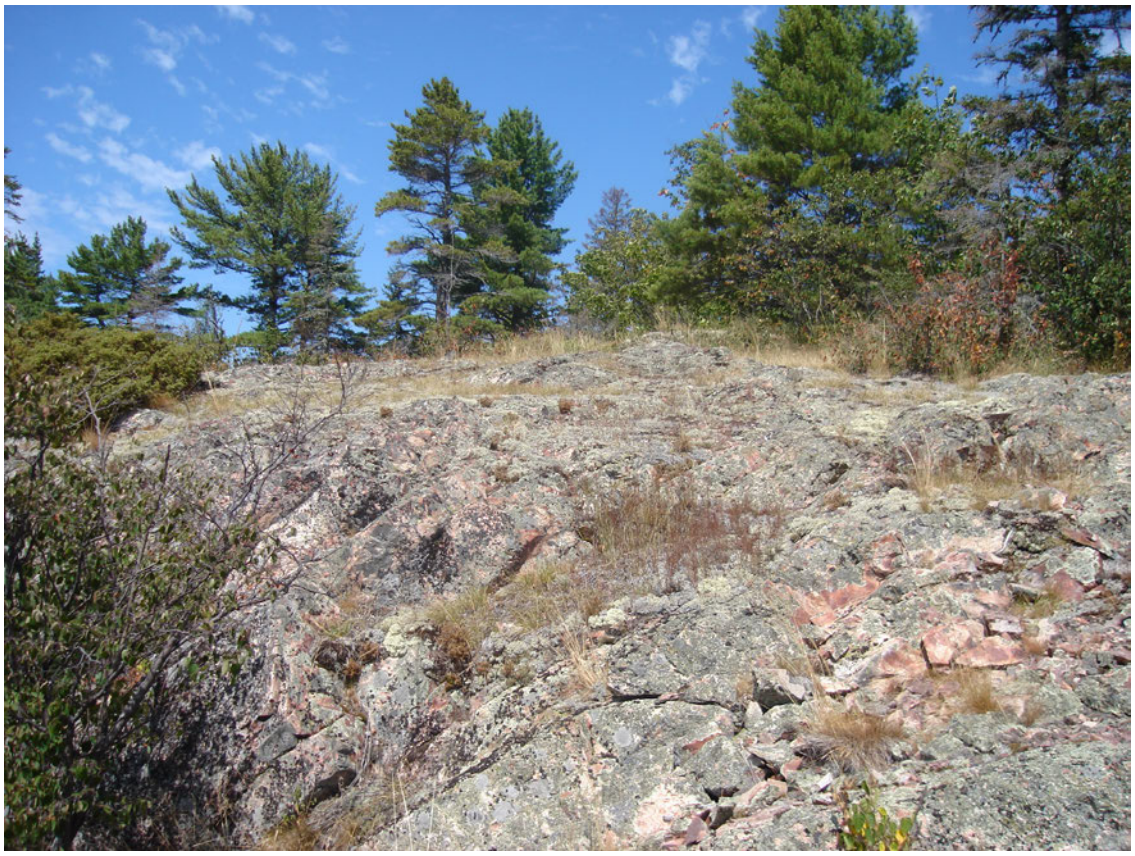
The sparse vegetation consists of scattered open-grown trees, scattered shrubs or shrub thickets, and a partial turf of herbs, grasses, sedges, mosses, and lichens. The scattered overstory is dominated by white pine (*Pinus strobus*), red oak (*Quercus rubra*), and paper birch (*Betula papyrifera*) and canopy associates include white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), and northern white-cedar (*Thuja occidentalis*) as associates. Scattered tall shrubs include mountain maple (*Acer spicatum*), serviceberry (*Amelanchier* sp.), mountain ash (*Sorbus decora*), and mountain alder (*Alnus crispa*). The overstory species, as well as red maple (*Acer rubrum*), also occur scattered in the understory. Common low shrubs include bearberry (*Arctostaphylos uva-ursi*), common juniper (*Juniperus communis*), and blueberries (*Vaccinium* spp.). Characteristic graminoids are poverty grass (*Danthonia spicata*), hair grass (*Deschampsia flexuosa*), and Pennsylvania sedge (*Carex pensylvanica*). Typical forbs include cow-wheat (*Melampyrum lineare*), harebell (*Campanula rotundifolia*), Gillman's goldenrod (*Solidago simplex*), and Canada mayflower (*Maianthemum canadense*). Bracken fern (*Pteridium aquilinum*) is also common. Lichens (e.g., *Cladina* spp. and *Usnea* spp.) and mosses (e.g., *Polytrichum* spp.) are typically abundant to locally dominant. Canada bluegrass (*Poa compressa*), ox-eye daisy (*Chrysanthemum leucanthemum*), and hawkweeds (*Hieracium* spp.) were documented at low densities along the shoreline.

Threats: No major threats were documented during the course of the 2007 survey. The thin soils and lichen cover of this community type are easily destroyed by off-road vehicles or excessive foot traffic. Invasive plants that could potentially threaten the diversity and community structure in volcanic bedrock glades include spotted knapweed (*Centaurea maculosa*), ox-eye daisy, Canada bluegrass, Kentucky bluegrass (*P. pratensis*), sheep sorrel (*Rumex acetosella*), and hawkweeds. Hawkweeds, ox-eye daisy, and Canada bluegrass were documented at low densities within this site. Logging of the surrounding forests could increase the seed source for weedy species, which could be windblown or bird-dispersed onto the glades.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered (i.e., let wildfires burn) and to maintain a forested buffer surrounding the glades to prevent the increase of a weedy seed source. Current invasive species should be removed and monitoring efforts to detect invasive species should be implemented.

[30] Bete Gris-Bear Bluff and Big Bay West volcanic bedrock lakeshore

Fish Cove occurs on south-facing basalt and rhyolite bedrock on the Keweenaw Peninsula along the Lake Superior shoreline. Photos by Joshua G. Cohen.



VOLCANIC BEDROCK LAKESHORE

Overview: Volcanic bedrock lakeshore is a sparsely vegetated community dominated by mosses and lichens, with a scattered coverage of vascular plants. The community is located primarily along the Lake Superior shoreline on the Keweenaw Peninsula and Isle Royale. This Great Lakes coastal plant community includes all types of volcanic bedrock, including basalt, conglomerate composed of volcanic rock, and rhyolite.

154. Bete Gris - Bear Bluff and Big Bay West

Natural Community Type: Volcanic Bedrock Lakeshore
Rank: G4G5 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: A
Location: Baraga Forest Management Unit, Compartment 82, and Private Lands
Element Occurrence Identification Number: 2123

Site Description: This element occurrence represents two formerly separate volcanic bedrock lakeshore sites (Big Bay West and Bete Gris - Bear Bluff) that were combined into one element occurrence. This volcanic bedrock lakeshore occurs along a five mile stretch of the Lake Superior shoreline on the Keweenaw Peninsula and occurs on exposed basalt of the Portage Lake volcanics with occasional stretches of volcanic conglomerates and localized exposures of rhyolite. Almost no soil development takes place on either the massive, fine-grained basalts or the volcanic conglomerates. The only places where plants are able to establish are in cracks, joints, vesicles, and depressions in the bedrock, where small amounts of organic matter accumulate. Near the water's edge, storm waves regularly scour the rock. During the winter, ice scours and abrades the rock even more violently. Freezing rain and mist coat both the rock and vegetation, and in combination with high winds, result in dwarf shrubs and stunted trees along the shore. This volcanic bedrock lakeshore is bordered by boreal forest along its upland margin. Along the shoreline, the volcanic bedrock lakeshore is interspersed with areas of volcanic lakeshore cliff and volcanic cobble shore. This narrow band of exposed basaltic lava along Lake Superior varies from flat to steep and is broken by many embayments of volcanic cobble shore and localized pockets of sand and gravel beach. The Montreal River empties into Lake Superior along this portion of shoreline, with wide stretches of rapids passing over the bedrock and a short band of sand and gravel beach occurring at the mouth of the river. Extensive volcanic bedrock glade occurs inland of the shoreline surrounding the Montreal River.[31]

The volcanic bedrock lakeshore is a sparsely vegetated community dominated by mosses and lichens, with a scattered coverage of vascular plants. Plant diversity is low due to wave and ice action. Mosses and lichens are able to establish and survive close to the lake, while vascular plants are generally above the zone of active storm waves and ice scour. Wave action and ice scour are strongest near the lakeshore, producing a wave-washed zone that is almost devoid of vegetation except for scattered tufts of mosses and lichens. With greater distance above the lake, plant cover increases, with lichens predominating. On the high, dry rocks, a diversity of lichens forms a patchy cover, while mosses, liverworts, herbs, and woody plants are also well represented. Herbs and woody plants are largely restricted to narrow cracks and joints in the rock, where there is limited soil development and greater moisture retention. Characteristic vascular plants include harebell (*Campanula rotundifolia*), wild strawberry (*Fragaria virginiana*), hair grass (*Deschampsia cespitosa*), fescue (*Festuca saximontana*), Gillman's goldenrod (*Solidago simplex*), rock cress (*Arabis holboellii*), poverty grass (*Danthonia spicata*), yarrow (*Achillea millefolium*), and common wood-rush (*Luzula multiflora*). Non-native plants documented during surveys included Canada bluegrass (*Poa compressa*) and ox-eye daisy (*Chrysanthemum leucanthemum*). Scattered and stunted trees and shrubs include northern white-cedar (*Thuja occidentalis*), soapberry (*Shepherdia canadensis*), and mountain alder (*Alnus crispa*). Rare plants documented along this stretch of shoreline include Ross's sedge (*Carex rossii*, state threatened), Douglas's hawthorn (*Crataegus douglasii*, state special concern), pale Indian paintbrush (*Castilleja septentrionalis*, state threatened), and downy oatgrass (*Trisetum spicatum*, state special concern). In addition, a historical record for mountain timothy (*Phleum alpinum*, presumed extirpated from Michigan) was recorded along this portion of lakeshore.

[31] Fish Cove volcanic bedrock glade

Threats: No major threats were documented during the course of the 2007 survey. The thin soils and lichen cover are easily destroyed by off-road vehicles or excessive foot traffic. Invasive plants that could potentially threaten the diversity and community structure of volcanic bedrock lakeshore include spotted knapweed (*Centaurea maculosa*), ox-eye daisy, Canada bluegrass, Kentucky bluegrass (*P. pratensis*), sheep sorrel (*Rumex acetosella*), and hawkweeds (*Hieracium* spp.). Ox-eye daisy and Canada bluegrass have been observed within the site. Logging of the surrounding forests could increase the seed source for weedy species, which could be windblown or bird-dispersed onto the lakeshore.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to maintain a forested buffer surrounding the lakeshore to prevent the increase of a weedy seed source. Monitoring efforts to detect invasive species should be implemented. When found, invasive species should be removed. A significant portion of the shoreline and adjacent uplands occurs on private lands and could be acquired or protected through conservation easements.

Photo by Michael A. Kost.

155. Keweenaw Point, High Rock, Keystone Bay

Natural Community Type: Volcanic Bedrock Lakeshore
Rank: G4G5 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: A
Location: Baraga Forest Management Unit, Compartment 75, and Private Lands
Element Occurrence Identification Number: 10595

Site Description: This volcanic bedrock lakeshore occurs along a several-mile stretch of the Lake Superior shoreline around Keweenaw Point at the tip of the Keweenaw Peninsula and occurs on exposed basalt of the Portage Lake volcanics with occasional stretches of volcanic conglomerates. Almost no soil development takes place on either the massive, fine-grained basalts or on the volcanic conglomerates. The only places where plants are able to establish are in the sporadic cracks, joints, vesicles, and depressions in the bedrock where small amounts of slightly acidic (pH 6.5) organic matter accumulate. Near the water's edge, storm waves regularly scour the rock. During the winter, ice scours and abrades the rock even more violently. Freezing rain and mist coat both the rock and vegetation, and in combination with high winds, result in dwarf shrubs and stunted trees along the shore. This volcanic bedrock lakeshore is bordered by boreal forest along its upland margin. Along the shoreline, the volcanic bedrock lakeshore is interspersed with areas of volcanic lakeshore cliff, volcanic cobble shore, and sand and gravel beach.

This volcanic bedrock lakeshore is a sparsely vegetated community dominated by mosses and lichens, with a scattered coverage of vascular plants. Plant diversity is low due to wave and ice action. Mosses and lichens are able to establish and survive close to the lake, while vascular plants are generally above the zone of active storm waves and ice scour. Wave action and ice scour are strongest near the lakeshore, producing a wave-washed zone that is almost devoid of vegetation except for scattered tufts of mosses and lichens. With greater distance above the lake, plant cover increases, with lichens predominating. On the high, dry rocks, a diversity of lichens forms a patchy cover, while mosses, liverworts, herbs, and woody plants are also well represented. Herbs and woody plants are largely restricted to narrow cracks and joints in the rock, where there is limited soil development and greater moisture retention. Characteristic herbaceous plants include harebell (*Campanula rotundifolia*), hair grass (*Deschampsia cespitosa*), Gillman's goldenrod (*Solidago simplex*), and Kalm's lobelia (*Lobelia kalmii*). Scattered and stunted trees and shrubs include northern white-cedar (*Thuja occidentalis*), paper birch (*Betula papyrifera*), white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), balsam poplar (*Populus balsamifera*), willows (*Salix* spp.), serviceberry (*Amelanchier* sp.), ninebark (*Physocarpus opulifolius*), soapberry (*Shepherdia canadensis*), bush honeysuckle (*Diervilla lonicera*), and wild rose (*Rosa acicularis*).

Threats: No major threats were documented during the course of the 2007 survey. The thin soils and lichen cover of volcanic bedrock lakeshore are easily destroyed by off-road vehicles or excessive foot traffic. Non-native plants documented during surveys included Kentucky bluegrass (*Poa pratensis*), ox-eye daisy (*Chrysanthemum leucanthemum*), hawkweeds (*Hieracium* spp.), common St. John's-wort (*Hypericum perforatum*), and common dandelion (*Taraxacum officinale*). Invasive plants that could potentially threaten the diversity and community structure of volcanic bedrock lakeshore include spotted knapweed (*Centaurea maculosa*), ox-eye daisy, Canada bluegrass (*Poa compressa*), Kentucky bluegrass, sheep sorrel (*Rumex acetosella*), and hawkweeds. Logging of the surrounding forests could increase the seed source for weedy species, which could be windblown or bird-dispersed onto the lakeshore.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to maintain a forested buffer surrounding the lakeshore to prevent the increase of a weedy seed source. Current populations of invasive species should be removed. Monitoring efforts to detect invasive species and evaluate control efforts should be implemented. A significant portion of the shoreline and adjacent uplands occurs on private lands and could be acquired or protected through conservation easements.

This volcanic bedrock lakeshore is bordered by boreal forest. The boreal forest near Keweenaw Point recently burned to the edge of the shoreline (below). Photos by Joshua G. Cohen.

A diversity of lichens and mosses occurs on the volcanic bedrock. Photo by Joshua G. Cohen.

156. Keystone Point

Natural Community Type: Volcanic Bedrock Lakeshore
Rank: G4G5 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: A
Location: Baraga Forest Management Unit, Compartments 75 and 82
Element Occurrence Identification Number: 2311

Site Description: This volcanic bedrock lakeshore occurs along a 1.5 mile-long stretch of the Lake Superior shoreline on the Keweenaw Peninsula and occurs on exposed basalt and rhyolite of the Portage Lake volcanics with some areas of vesicular lava. Portions of the narrow, south-facing lakeshore are steep and broken with stair-stepped slopes or stacks. Almost no soil development takes place on the massive, fine-grained basalts. The only places where plants are able to establish are in the sporadic cracks, joints, vesicles, and depressions in the bedrock, where small amounts of organic matter accumulate. Near the water's edge, storm waves regularly scour the rock. During the winter, ice scours and abrades the rock even more violently. Freezing rain and mist coat both the rock and vegetation, and in combination with high winds, result in dwarf shrubs and stunted trees along the shore. This narrow (6-20 meters wide) volcanic bedrock lakeshore is bordered by mesic northern forest and boreal forest along its upland margin. Along the shoreline, the volcanic bedrock lakeshore is interspersed with areas of volcanic cobble shore and sand and gravel beach.

This volcanic bedrock lakeshore is a sparsely vegetated community dominated by mosses and lichens, with a scattered coverage of vascular plants. Plant diversity is low due to wave and ice action. Mosses and lichens are able to establish and survive close to the lake, while vascular plants are generally above the zone of active storm waves and ice scour. Wave action and ice scour are strongest near the lakeshore, producing a wave-washed zone that is almost devoid of vegetation except for scattered tufts of mosses and lichens. With greater distance above the lake, plant cover increases, with lichens predominating. On the high, dry rocks, a diversity of lichens forms a patchy cover, while mosses, liverworts, herbs, and woody plants are also well represented. Herbs and woody plants are largely restricted to narrow cracks and joints in the rock, where there is limited soil development and greater moisture retention. Characteristic herbaceous plants include harebell (*Campanula rotundifolia*), hair grass (*Deschampsia cespitosa*), Gillman's goldenrod (*Solidago simplex*), Kalm's lobelia (*Lobelia kalmii*), yarrow (*Achillea millefolium*), upland white goldenrod (*S. ptarmicoides*), grass-leaved goldenrod (*Euthamia graminifolia*), balsam ragwort (*Senecio pauperculus*), and sedges (*Carex* spp.). Scattered and stunted trees and shrubs include northern white-cedar (*Thuja occidentalis*), paper birch (*Betula papyrifera*), white spruce (*Picea glauca*), white pine (*Pinus strobus*), balsam fir (*Abies balsamea*), balsam poplar (*Populus balsamifera*), mountain ash (*Sorbus decora*), mountain alder (*Alnus crispa*), willows (*Salix* spp.), serviceberry (*Amelanchier* sp.), ninebark (*Physocarpus opulifolius*), soapberry (*Shepherdia canadensis*), bush honeysuckle (*Diervilla lonicera*), and wild rose (*Rosa acicularis*). Bearberry (*Arctostaphylos uva-ursi*) is also common.

Threats: No major threats were documented during the course of the 2007 surveys. The thin soils and lichen cover of volcanic bedrock lakeshore are easily destroyed by off-road vehicles or excessive foot traffic. Non-native plants documented during surveys included Kentucky bluegrass (*Poa pratensis*), ox-eye daisy (*Chrysanthemum leucanthemum*), hawkweeds (*Hieracium* spp.), common St. John's-wort (*Hypericum perforatum*), and common dandelion (*Taraxacum officinale*). Invasive plants that could potentially threaten the diversity and community structure of volcanic bedrock lakeshore include spotted knapweed (*Centaurea maculosa*), ox-eye daisy, Canada bluegrass (*Poa compressa*), Kentucky bluegrass, sheep sorrel (*Rumex acetosella*), common St. John's-wort, and hawkweeds. Logging of the surrounding forests could increase the seed source for weedy species, which could be windblown or bird-dispersed onto the lakeshore.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to maintain a forested buffer surrounding the lakeshore to prevent the increase of a weedy seed source. Current populations of invasive species should be removed. Monitoring efforts to detect invasive species and evaluate control efforts should be implemented.

Keystone Point volcanic bedrock lakeshore occurs on exposed basalt of the Portage Lake Volcanics. Photos by Michael A. Kost.

157. Manitou Island (Volcanic Bedrock Lakeshore)

Natural Community Type: Volcanic Bedrock Lakeshore
Rank: G4G5 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: A
Location: Baraga Forest Management Unit, Compartment 75, and Private Lands
Element Occurrence Identification Number: 9280

Site Description: This volcanic bedrock lakeshore occurs along a three-mile stretch of the Lake Superior shoreline on Manitou Island and occurs on exposed basalt and rhyolite of the Portage Lake volcanics and volcanic conglomerates of the Copper Harbor Conglomerates. Almost no soil development takes place on either the massive, fine-grained basalts or on the volcanic conglomerates. The only places where plants are able to establish are in the sporadic cracks, joints, vesicles, and depressions in the bedrock, where small amounts of organic matter accumulate. Near the water's edge, storm waves regularly scour the rock. During the winter, ice scours and abrades the rock even more violently. Freezing rain and mist coat both the rock and vegetation, and in combination with high winds, result in dwarf shrubs and stunted trees along the shore. This volcanic bedrock lakeshore is bordered by boreal forest along its upland margin. Along the shoreline, the narrow volcanic bedrock lakeshore is interspersed with areas of volcanic lakeshore cliff and volcanic cobble shore.

The volcanic bedrock lakeshore along Manitou Island is a sparsely vegetated community dominated by mosses and lichens, with a scattered coverage of vascular plants. Plant diversity is low due to wave and ice action. Mosses and lichens are able to establish and survive close to the lake, while vascular plants are generally above the zone of active storm waves and ice scour. Wave action and ice scour are strongest near the lakeshore, producing a wave-washed zone that is almost devoid of vegetation except for scattered tufts of mosses and lichens. With greater distance above the lake, plant cover increases, with lichens predominating. On the high, dry rocks, a diversity of lichens forms a patchy cover, while mosses, liverworts, herbs, and woody plants are also well represented. Herbs and woody plants are largely restricted to narrow cracks and joints in the rock, where there is limited soil development and greater moisture retention. Characteristic herbaceous plants include harebell (*Campanula rotundifolia*), hair grass (*Deschampsia cespitosa*), wild strawberry (*Fragaria virginiana*), and grass-leaved goldenrod (*Euthamia graminifolia*). Scattered and stunted trees and shrubs include northern white-cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), ninebark (*Physocarpus opulifolius*), and soapberry (*Shepherdia canadensis*).

Threats: No major threats were documented during the course of the 2007 surveys. The thin soils and lichen cover of volcanic bedrock lakeshore are easily destroyed by excessive foot traffic. Invasive plants that could potentially threaten the diversity and community structure of volcanic bedrock lakeshore include spotted knapweed (*Centaurea maculosa*), Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*P. pratensis*), ox-eye daisy (*Chrysanthemum leucanthemum*), hawkweeds (*Hieracium* spp.), common St. John's-wort (*Hypericum perforatum*), and sheep sorrel (*Rumex acetosella*). Logging of the surrounding forests could increase the seed source for weedy species, which could be windblown or bird-dispersed onto the lakeshore.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to maintain a forested buffer surrounding the lakeshore to prevent the increase of a weedy seed source. Monitoring efforts to detect invasive species should be implemented and invasives should be removed if found. A significant portion of the shoreline and adjacent uplands occurs on private lands and could be acquired or protected through conservation easements.

The volcanic bedrock lakeshore on Manitou Island includes stretches of volcanic conglomerate (above) and basalt (below). Photos by Michael A. Kost.

VOLCANIC LAKESHORE CLIFF

Overview: Volcanic lakeshore cliffs consist of vertical or near-vertical exposures of bedrock, which support less than 25% vascular plant coverage, although lichens, mosses, and liverworts are abundant on some rock surfaces. The cliffs range in height from 3 to 80 meters (10 to 260 ft) and occur on Lake Superior along the Keweenaw Bay shoreline of the Keweenaw Peninsula and along the northern shoreline of Isle Royale. Volcanic lakeshore cliffs are characterized by high site moisture due to the proximity to Lake Superior and a stressed and unstable environment because of severe waves, wind, and winter ice (Kost et al. 2007).

158. Manitou Island (Volcanic Lakeshore Cliff)

Natural Community Type: Volcanic Lakeshore Cliff
Rank: GU S1, unknown status globally and critically imperiled within the state
Element Occurrence Rank: A
Location: Baraga Forest Management Unit, Compartment 75, and Private Lands
Element Occurrence Identification Number: 12518

Site Description: This two-mile stretch of volcanic lakeshore cliffs consists of vertical or near-vertical exposures of volcanic conglomerate bedrock of the Copper Harbor Conglomerate. The cliffs range in height from 5 to 15 m and occur on the southern side of Manitou Island just off the Keweenaw Peninsula and adjacent to Lake Superior. There is little soil development on the steep rock face of the cliffs. Some organic soil development occurs in crevices in the rock face and on the upper lip of the cliffs. This site is characterized by high site moisture due to the proximity to Lake Superior and a stressed and unstable environment because of severe waves, wind, and winter ice. The cliffs are exposed to almost continual wave action from Lake Superior. During winter, ice adds to the erosive environment along the shore, both for the cliff and the upland forest along the cliff edge. Storm winds off Lake Superior uproot trees and erode soils. Thin soils, winter winds, full exposure, and summer droughts produce a desiccating environment for plants. The regularly occurring fog along the coast serves to somewhat mitigate these desiccating effects during the growing season. These volcanic lakeshore cliffs are bordered by boreal forest inland.

While mosses and lichens are common on the exposed cliff face, vascular plant cover is sparse, being generally restricted to the flat, exposed bedrock at the upper edge of the cliff (the lip), cracks and joints in the cliff face, and along the cliff base. The upper edge of the cliff is typically backed by boreal forest, with abundant windthrown trees resulting from strong lake winds. Vegetation is restricted to the upper portion of the cliff face. Herbaceous species characteristic of the upper flat edge or lip include harebell (*Campanula rotundifolia*), wild strawberry (*Fragaria virginiana*), hair grass (*Deschampsia cespitosa*), and grass-leaved goldenrod (*Euthamia graminifolia*). Shrubs occurring along the upper lip include mountain alder (*Alnus crispa*), soapberry (*Shepherdia canadensis*), serviceberry (*Amelanchier* sp.), and wild rose (*Rosa acicularis*). Dense, shrubby stands of white spruce (*Picea glauca*), northern white-cedar (*Thuja occidentalis*), paper birch (*Betula papyrifera*), mountain ash (*Sorbus decora*), and balsam fir (*Abies balsamea*) form the coastal boreal forest along the edge of the cliff.

Threats: No major threats were documented during the course of the 2007 survey. Threats to lakeshore cliffs include shoreline development, logging of adjacent uplands and associated soil erosion, excessive foot traffic along the upper edge, and invasive plants. The thin soils and unstable environment make soil development and plant reestablishment slow. Some of the invasive plants that may threaten the diversity and structure of volcanic lakeshore cliffs include spotted knapweed (*Centaurea maculosa*), ox-eye daisy (*Chrysanthemum leucanthemum*), Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*P. pratensis*), sheep sorrel (*Rumex acetosella*), and hawkweeds (*Hieracium* spp.).

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to maintain a forested buffer surrounding the lakeshore cliff to prevent the increase of a weedy seed source. Monitoring efforts to detect invasive species should be implemented and invasives should be removed if found. A significant portion of the shoreline and adjacent uplands occurs on private lands and could be acquired or protected through conservation easements.

The volcanic lakeshore cliff on Manitou Island consists of vertical exposures of volcanic conglomerate bedrock of the Copper Harbor Conglomerate. Photo by Michael A. Kost.

WET-MESIC SAND PRAIRIE

Overview: Wet-mesic sand prairie is a native lowland grassland occurring on sandy outwash plains and lakeplains within shallow depressions and as a vegetation zone separating fire-dependent upland and open wetland systems. The community occurs in the southern and northern Lower Peninsula on loamy sand or fine sand, usually with high organic content, and sometimes covered by a thin layer of muck. Sites that support wet-mesic sand prairie experience fluctuating water tables, with high water tables occurring in the spring followed by drought conditions in late summer and fall. Thus, the community contains species from a broad range of moisture classes, but is dominated by species of wetland affinity. Species dominance is shared by several prairie and wetland grasses and sedges. Historically, fire and beaver flooding played integral roles in maintaining the species composition and community structure of wet-mesic sand prairies (Kost et al. 2007).

159. Portage Creek Complex

Natural Community Type: Wet-Mesic Sand Prairie
Rank: G2G3 S2, imperiled to vulnerable globally and imperiled in the state
Element Occurrence Rank: B
Location: Grayling Forest Management Unit, Compartments 180, 181, and 182, and Traverse City Forest Management Unit, Compartment 129
Element Occurrence Identification Number: 2078

Site Description: This site is characterized by a series of small wet-mesic prairie openings in depressions on a flat glacial outwash plain on slightly acidic to neutral (pH 6.5-7.5) sandy substrate, with various dominance patterns associated with landscape position, hydrology, and disturbance history. The soils are loamy sands mixed with organics and exhibit iron mottling, which indicates a fluctuating water table. The prairie openings are likely former interdunal wetlands formed along an old glacial lakebed. The surrounding uplands are dry northern forest dominated by jack pine (*Pinus banksiana*) and red pine (*Pinus resinosa*).

The prairie openings are graminoid-dominated with prevalent native grasses including switch grass (*Panicum virgatum*), and locally, prairie dropseed (*Sporobolus heterolepis*, state special concern) in mesic zones, and bluejoint grass (*Calamagrostis canadensis*) and hair grass (*Deschampsia cespitosa*) in wet-mesic zones. Other common grasses, particularly in drier areas, include big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), poverty grass (*Danthonia spicata*), and Pennsylvania sedge (*Carex pensylvanica*). Additional ground cover species include balsam ragwort (*Senecio pauperculus*), common water horehound (*Lycopus americanus*), rush (*Juncus greenei*), long-leaved aster (*Aster longifolius*), rush aster (*Aster borealis*), bristly-stalked sedge (*Carex leptalea*), crested woodfern (*Dryopteris cristata*), and wild blue flag (*Iris versicolor*). Scattered shrubs and stunted trees occur within the openings and are most prevalent along the margins. Typical species include jack pine, leatherleaf (*Chamaedaphne calyculata*), meadowsweet (*Spiraea alba*), shrubby cinquefoil (*Potentilla fruticosa*), and sand cherry (*Prunus pumila*). Rare species documented within this complex include prairie dropseed, Houghton's goldenrod (*Solidago houghtonii*, federal/state threatened), Vasey's rush (*Juncus vaseyi*, state threatened), and secretive locust (*Appalachia arcane*, state special concern). Over 91 plant species were noted during the survey of this site.

Threats: The main threats to this site are posed by fire suppression, invasive species, and off-road vehicle damage. Fire suppression may allow for the eventual conversion of prairie openings to shrub- or tree-dominated systems. Several non-native plants were documented during the surveys, including leafy spurge (*Euphorbia esula*), Canada bluegrass (*Poa compressa*), and hawkweeds (*Hieracium* spp.).

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across these wetlands). If no wildfires occur within the site within the next fiv to ten years, prescribed fire should be employed as a management tool to express the seed bank and

limit woody encroachment into the prairie openings. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for invasive species encroachment. Efforts to control populations of invasive plants (especially leafy spurge) should be enacted, and monitoring for invasive species should be implemented. Maintaining a buffer of natural communities surrounding the wet-mesic sand prairie will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. Finally, control of off-road vehicle traffic is warranted.

Photo by Bradford S. Slaughter.

WOODED DUNE AND SWALE COMPLEX

Overview: Wooded dune and swale complex is a large complex of parallel wetland swales and upland beach ridges (dunes) found in coastal embayments and on large sand spits along the shorelines of the Great Lakes. Wooded dune and swale complexes have formed over thousands of years as a result of long-term drops in lake level combined with post-glacial uplift of the earth's crust, which caused the primary wind-formed foredunes to rise above the influence of the lakes. New foredunes were created along the shore with a low, wet swale located inland between the two dunes. Over several thousand years, a series of ridges and swales was created. The upland dune ridges are typically forested, while the low swales support a variety of herbaceous or forested wetland types, with open wetlands more common near the shoreline and forested wetlands more prevalent further from the lake. Wooded dune and swale complexes occur primarily in the northern Lower and Upper Peninsulas (Kost et al. 2007).

160. Bethlehem Tract

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Sault Sainte Marie Forest Management Unit, Compartments 199, 202, and 203
Element Occurrence Identification Number: 6496

Site Description: This is a large wooded dune and swale complex occurring adjacent to northern Lake Michigan. Thousands of years of lacustrine processes developed the complex patterning of northeast-southwest trending dune ridges (up to 5 m high but typically 1-3 meters high) and swales of variable depth and width. The site is characterized by complex community structure that includes dry-mesic northern forest, rich conifer swamp, poor conifer swamp, northern fen, mesic northern forest, northern shrub thicket, northern wet meadow, bog, interdunal wetland, and emergent marsh. Great Lakes barrens, open dunes, Great Lakes marsh, limestone cobble shore, and sand and gravel beach occur within near-shore areas. The ridges are characterized by acidic (pH 4.5-5.0), fine-textured sands. The forested swales typically have 20 to > 100 cm of saturated slightly acidic to circumneutral (pH 6.5-7.0) peat over sand. Well-developed sphagnum hummock and hollow microtopography occurs in the forested swales, especially in broader swamps. Open swales have alkaline (pH 7.5) mucks of variable depth (10-50 cm) overlying wet, circumneutral sands (pH 7.0). Standing water in open swales is typically 10 to 50 cm deep but in places is 100 to 200 cm deep. The lake effect influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist). Several creeks (including Catarac River) pass through the complex and several larger swales support permanent ponds.

The wooded dune and swale community is characterized by complex ecological patterning, which results in high species and community diversity in an area with a fair amount of anthropogenic disturbance. Natural ecological processes (i.e., windthrow, beaver flooding, and senescence) are the dominant factors structuring patterning and succession. There are numerous single windthrow gaps as well as multiple treefall gaps with windthrow being most prevalent near the lakeshore. Paper birch (*Betula papyrifera*) and balsam fir (*Abies balsamea*) contribute the greatest volume of coarse woody debris with small-diameter snags and dead and downed logs but there are scattered white pine (*Pinus strobus*) and northern white-cedar (*Thuja occidentalis*) snags and dead and downed wood. Dead and down logs within swales provide important seedling establishment substrate and are moss-covered. Well-developed sphagnum hummock and hollow microtopography is prevalent in the broad forested swales. Evidence of fire occurs throughout the site with charring and fire scars occurring on the boles of trees. Beaver flooding was noted in the southwestern portion of the complex.

Dune ridges are dominated by dry-mesic northern forest with white pine, red pine (*Pinus resinosa*), and paper birch associated with northern white-cedar, balsam fir, red maple (*Acer rubrum*), hemlock (*Tsuga canadensis*), red oak (*Quercus rubra*), and white spruce (*Picea glauca*). Diameters of canopy trees typically range between 30

and 60 cm. Conifers are prevalent closer to the shore and northern white-cedar and balsam fir are also common along low dune ridges. Hemlock occurs in small groves farther inland. White pine occurs as a scattered supercanopy. The subcanopy is characterized by balsam fir and spruces along with red maple and paper birch. The understory is dominated by balsam fir with spruce and white pine regeneration. Subcanopy and understory density increases in areas with more open canopy due to windthrow and/or senescence of paper birch and balsam fir. The low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*), Canada blueberry (*V. myrtilloides*), and huckleberry (*Gaylussacia baccata*) with American fly honeysuckle (*Lonicera canadensis*) common and bearberry (*Arctostaphylos uva-ursi*) and common juniper (*Juniperus communis*) locally dominant, especially near the shore. The ground cover is dominated by bracken fern (*Pteridium aquilinum*) with bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), wild sarsaparilla (*Aralia nudicaulis*), wintergreen (*Gaultheria procumbens*), and lichens (*Cladina rangifera* and *C. mitis*). Dwarf lake iris (*Iris lacustris*, federal/ state threatened) is often dominant along the shoreward margin of the first forested dune ridge.

Forested swales are dominated by dense northern white-cedar (10-40 cm DBH) with black spruce (*Picea mariana*) and tamarack (*Larix laricina*) as canopy associates and black ash (*Fraxinus nigra*), paper birch, white pine, and balsam poplar (*Populus balsamifera*) as occasional associates. The understory of the forested swales is characterized by tag alder (*Alnus rugosa*), winterberry (*Ilex verticillata*), black spruce, balsam fir, and locally, northern white-cedar regeneration (especially in areas of windthrow and younger forest). The low shrub layer contains alder-leaved buckthorn (*Rhamnus alnifolia*), black spruce, northern white-cedar, Labrador tea (*Ledum groenlandicum*), and leatherleaf (*Chamaedaphne calyculata*). Characteristic ground cover species include dwarf raspberry (*Rubus pubescens*), false mayflower (*Smilacina trifolia*), oak fern (*Gymnocarpium dryopteris*), sensitive fern (*Onoclea sensibilis*), creeping snowberry (*Gaultheria hispidula*), three-seeded sedge (*Carex trisperma*), starflower, naked miterwort (*Mitella nuda*), and wild blue flag (*Iris versicolor*). Well-developed sphagnum hummock and hollow microtopography occurs throughout these forested swales and contributes to floristic diversity by providing fine-scale gradients of soil moisture and chemistry. Inland portions of the complex are characterized by a wide rich conifer swamp that has been heavily browsed by wintering deer.

Narrow swales are often shrub-dominated by dense thickets of alder with winterberry, alder-leaved buckthorn (*Rhamnus alnifolia*), and sweet gale (*Myrica gale*). Ground cover in the shrub swales is characterized by dwarf raspberry, sensitive fern, marsh fern (*Thelypteris palustris*), bluejoint grass (*Calamagrostis canadensis*), great bladder sedge (*Carex intumescens*), lake sedge (*C. lacustris*), tussock sedge (*C. stricta*), common skullcap (*Scutellaria galericulata*), marsh marigold (*Caltha palustris*), and wild blue flag. The open swales are dominated by northern wet meadow, northern fen, and freshwater marshes. Open minerotrophic swales are dominated by graminoids such as wiregrass sedge (*Carex lasiocarpa*), mud sedge (*C. limosa*), tussock sedge, bluejoint grass, twig-rush (*Cladium mariscoides*), and three-way sedge (*Dulichium arundinaceum*). Additional species include bog buckbean (*Menyanthes trifoliata*), pitcher-plant (*Sarracenia purpurea*), broad-leaved cat-tail (*Typha latifolia*), marsh St. John's-wort (*Triadenum fraseri*), shrubby cinquefoil (*Potentilla fruticosa*), marsh cinquefoil (*P. palustris*), sweet gale, Labrador tea (*Ledum groenlandicum*), and leatherleaf (*Chamaedaphne calyculata*). Areas of northern fen are also characterized by a stunted, scattered canopy of northern white-cedar, tamarack, and black spruce.

The shoreline adjacent to the wooded dune and swale complex includes stretches of sand and gravel beach, open dunes, interdunal wetland, Great Lakes barrens, Great Lakes marsh, and limestone cobble shore. Areas of open dunes are dominated by dune grasses, especially marram grass (*Ammophila breviligulata*) and sand reed grass (*Calamovilfa longifolia*) with wormwood (*Artemisia campestris*), harebell (*Campanula rotundifolia*), and Lake Huron tansy (*Tanacetum huronense*, state threatened). Great lakes barrens are characterized by a scattered conifer canopy of white pine and white spruce over a dense shrub layer with junipers. Areas of Great Lakes marsh are dominated by Baltic rush (*Juncus balticus*), and interdunal wetlands are dominated by rushes (*Juncus* spp.), bulrushes (*Scirpus* and *Schoenoplectus* spp.), and sedges (*Carex* spp.).

Threats: Roads that pass through the site could introduce invasive species into the wooded dune and swale complex. Deer herbivory is locally limiting northern white-cedar and hemlock regeneration and impacting species composition and structure. Further logging to sustain wintering deer will likely jeopardize cedar's capacity to regenerate.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and allowing wildfires to burn. Critical management needs include the reduction of wintering deer densities and monitoring deer herbivory, especially of cedar and hemlock regeneration. Along the shoreline, it is imperative to eliminate off-road vehicle traffic and monitor for invasive species.

Photo by Joshua G. Cohen.

161. Big Bay de Noc

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Shingleton Forest Management Unit, Compartment 88, Fishdam Park, and Private Lands
Element Occurrence Identification Number: 11401

Site Description: This is an extensive wooded dune and swale complex occurring adjacent to northern Lake Michigan on a silty/clay lakeplain. Thousands of years of lacustrine processes developed the complex patterning of low to high dune ridges and swales of variable depth and width. In the northern two-thirds of the complex, there are extensive wetland areas within the broad swales, which are separated by poorly-defined beach ridges. Closer to Lake Michigan, the beach ridges are higher. The site is characterized by complex community structure that includes dry northern forest, mesic northern forest, poor conifer swamp, rich conifer swamp, northern fen, northern shrub thicket, and northern wet meadow. Ridges are characterized by acidic (pH 5.0), fine-textured sands with a thin layer of needle duff. Forested swales and paludified dune ridges supporting conifer swamp species are characterized by shallow, acidic (pH 4.5-5.0) peats overlying fine-textured, wet sands. Open swales have slightly acidic to circumneutral (pH 6.0-7.0) peats of variable depth (40 - >100 cm) overlying wet, slightly acidic sands (pH 6.0-6.5). The depth of organic soils within the swales is highly variable but tends to increase with distance from the Lake Michigan shoreline. Standing water occurs in some of the open swales. The lake effect influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist).

This wooded dune and swale community is characterized by complex ecological patterning, which results in high species and community diversity in an area with localized anthropogenic disturbance, primarily on the private lands. Natural ecological processes (i.e., windthrow, fire, and senescence) are the dominant factors structuring patterning and succession. Dune ridges within the southwestern portion of the complex on mesic to wet-mesic soils support pockets of old-growth mesic northern forest dominated by hemlock (*Tsuga canadensis*), yellow birch (*Betula alleghaniensis*), and white pine (*Pinus strobus*). Dune ridges with acidic, droughty sands support dry northern forest dominated by jack pine (*Pinus banksiana*) with scattered red pine (*P. resinosa*) and understory black spruce (*Picea mariana*) and white spruce (*P. glauca*). The ground layer is characterized by low sweet blueberry (*Vaccinium angustifolium*), bracken fern (*Pteridium aquilinum*), wintergreen (*Gaultheria procumbens*), cow-wheat (*Melampyrum lineare*), and lichens (*Cladina* spp.). Forested swales and paludified, low beach ridges support poor conifer swamp and rich conifer swamp. Areas of poor conifer swamp are dominated by black spruce and tamarack (*Larix laricina*) with winterberry (*Ilex verticillata*), Labrador tea (*Ledum groenlandicum*), low sweet blueberry, sphagnum species (*Sphagnum* spp.), and three-seeded sedge (*Carex trisperma*). In many of these swales, the subsurface peats are minerotrophic, suggesting that the rooting zone is mostly isolated from this minerotrophic zone by the outer sphagnum layers on the often hummocky surface. Areas of rich conifer swamp are typically dominated by northern white-cedar (*Thuja occidentalis*). Shrub-dominated wetland swales are dominated by tag alder (*Alnus rugosa*), winterberry, and slender willow (*Salix petiolaris*). Areas of northern wet meadow are dominated by tussock sedge (*Carex stricta*), lake sedge (*C. lacustris*), and bluejoint grass (*Calamagrostis canadensis*). Swales dominated by northern fen are characterized by bog birch (*Betula pumila*), shrubby cinquefoil (*Potentilla fruticosa*), wiregrass sedge (*Carex lasiocarpa*), sweet gale (*Myrica gale*), bog rosemary (*Andromeda glaucophylla*), and leatherleaf (*Chamaedaphne calyculata*). Northern fen swales are concentrated in broad bands in the northern portion of the occurrence and also in the southeastern portion of the complex near Cousineau Lake. The largest northern fen swale has been mapped as an A-ranked occurrence of northern fen.[32] Areas with pronounced sphagnum hummocks tend to be more acidic and are dominated by leatherleaf and other acidophiles.

[32] Big Bay de Noc Northern Fen

Threats: Roads and railroad grades that pass through the site locally impact the hydrology and could introduce invasive species into the wooded dune and swale complex. Recent logging activity on private lands, including strip cutting, have caused significant soil disturbance and could also lead to the increase in non-native species. Several non-native species were noted within the forested wetland including European marsh thistle (*Cirsium palustre*). Deer herbivory is impacting species composition and structure. Shoreline housing development could further fragment the wooded dune and swale complex and increase the potential for off-road vehicle damage.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and allowing wildfires to burn. Critical stewardship needs include the reduction of deer densities and monitoring deer herbivory, which can help resource managers assess whether species composition and structure is being negatively impacted by deer browse. To reduce deer browse pressure, the surrounding forests could be managed for late-successional habitat and direct measures could be taken to reduce population densities. Along the shoreline, it is imperative to eliminate off-road vehicle traffic and monitor for invasive species. Portions of the complex occurring on private lands could be acquired or protected through conservation easements.

Photo by Bradford S. Slaughter.

162. Big Knob Campground (Wooded Dune and Swale Complex)

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: AB
Location: Sault Sainte Marie Forest Management Unit, Compartments 175, 176, 201, and 203
Element Occurrence Identification Number: 6497

Site Description: This is a large wooded dune and swale complex occurring adjacent to northern Lake Michigan. Thousands of years of lacustrine processes developed the complex patterning of northeast-southwest trending dune ridges (up to 8 m high but typically 1-4 m high) and swales of variable depth and width. The site is characterized by complex community structure that includes dry-mesic northern forest, bog, rich conifer swamp, poor conifer swamp, northern fen, mesic northern forest, northern shrub thicket, northern wet meadow, and emergent marsh. The shoreline adjacent to the wooded dune and swale complex includes stretches of sand and gravel beach, open dunes, Great Lakes marsh, limestone cobble shore, and high-quality interdunal wetland.[33] The ridges are characterized by acidic (pH 4.5-5.5), fine-textured sands. The inland forested swales typically have saturated acidic sphagnum peat over sand. Swales closer to the lakeshore have shallower peats (ranging from sedge peat to sedge/sphagnum peat) and mucks overlying sands, and these soils are slightly acidic to alkaline (pH 6.5 to 8.0) with a higher water table. The lake effect influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist). The Crow River and McNeil Creek pass through the complex and several large swales support permanent ponds.

This wooded dune and swale community is characterized by complex ecological patterning that results in high species and community diversity in an area with a fair amount of anthropogenic disturbance. Natural ecological processes (i.e., windthrow, beaver flooding, and senescence) are the dominant factors structuring patterning and succession. There are numerous single windthrow gaps as well as multiple treefall gaps with windthrow being most prevalent near the lakeshore. Paper birch (*Betula papyrifera*) and balsam fir (*Abies balsamea*) contribute the greatest volume of coarse woody debris with small-diameter snags and dead and downed logs but there are scattered white pine (*Pinus strobus*) and northern white-cedar (*Thuja occidentalis*) snags and dead and downed wood. Dead and down logs within swales provide important seedling establishment substrate and are moss covered. Well-developed sphagnum hummock and hollow microtopography is prevalent in the broad forested swales. Evidence of fire occurs throughout the site with charring and fire scars occurring on the boles of trees.

Dune ridges are dominated by dry-mesic northern forest with white pine and red pine (*Pinus resinosa*). Canopy associates include jack pine (*Pinus banksiana*), paper birch, big-toothed aspen (*Populus grandidentata*), and red maple (*Acer rubrum*) with northern white-cedar and white spruce (*Picea glauca*) prevalent near the lakeshore and hemlock (*Tsuga canadensis*) localized. Closer to shore, the canopy is dominated by more coniferous species and inland, deciduous species become more prevalent in the canopy. Balsam fir and spruces are common in the subcanopy and understory along with red maple. Pine regeneration (especially white pine) is common throughout the dune ridges. The low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*), Canada blueberry (*V. myrtilloides*), and huckleberry (*Gaylussacia baccata*) with American fly honeysuckle (*Lonicera canadensis*) common and bearberry (*Arctostaphylos uva-ursi*) and common juniper (*Juniperus communis*) locally dominant, especially near the shore. The ground cover is dominated by bracken fern (*Pteridium aquilinum*) with bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), wintergreen (*Gaultheria procumbens*), and lichens (*Cladina rangifera* and *C. mitis*).

Forested swales are dominated by dense northern white-cedar (5-20 cm DBH) with black spruce (*Picea mariana*) and tamarack (*Larix laricina*) as canopy associates and paper birch and white pine as occasional associates. The understory of the forested swales is characterized by tag alder (*Alnus rugosa*), winterberry (*Ilex verticillata*), black spruce, and locally, northern white-cedar regeneration (especially in areas of windthrow, younger swamp forest, and northern fen). The low shrub layer contains alder-leaved buckthorn (*Rhamnus alnifolia*), black spruce, northern white-cedar, Labrador tea (*Ledum groenlandicum*), and leatherleaf

[33] Big Knob Campground Interdunal Wetland

(*Chamaedaphne calyculata*). Characteristic ground cover species include false mayflower (*Smilacina trifolia*), oak fern (*Gymnocarpium dryopteris*), royal fern (*Osmunda regalis*), creeping snowberry (*Gaultheria hispidula*), ebony sedge (*Carex eburnea*), and starflower. Well-developed sphagnum hummock and hollow microtopography occurs throughout these forested swales and contributes to floristic diversity by providing fine-scale gradients of soil moisture and chemistry.

Narrow swales are often shrub-dominated by dense thickets of tag alder with winterberry, alder-leaved buckthorn, and sweet gale (*Myrica gale*). Ground cover in shrub swales is characterized by dwarf raspberry (*Rubus pubescens*), sensitive fern (*Onoclea sensibilis*), wild blue flag (*Iris versicolor*), marsh fern (*Thelypteris palustris*), great bladder sedge (*Carex intumescens*), common skullcap (*Scutellaria galericulata*), and marsh marigold (*Caltha palustris*). The open swales are dominated by northern wet meadow, northern fen, and freshwater marshes and gradually become more bog-like as distance from the shore increases. Bog swales or open acidic swales are characterized by few-seed sedge (*Carex oligosperma*) and leatherleaf with deep sphagnum peats. Additional species include bog rosemary (*Andromeda glaucophylla*), Labrador tea, small cranberry (*Vaccinium oxycoccos*), pitcher-plant (*Sarracenia purpurea*), and round-leaved sundew (*Drosera rotundifolia*). Open minerotrophic swales are dominated by graminoids such as wiregrass sedge (*Carex lasiocarpa*), tussock sedge (*Carex stricta*), twig-rush (*Cladium mariscoides*), three-way sedge (*Dulichium arundinaceum*), and bluejoint grass (*Calamagrostis canadensis*). Additional species include bog buckbean (*Menyanthes trifoliata*), shrubby cinquefoil (*Potentilla fruticosa*), and sweet gale.

Threats: Roads that pass through the complex could introduce invasive species into the complex. Off-road vehicle damage occurs along the shoreline. Deer herbivory is potentially limiting northern white-cedar regeneration and impacting species composition and structure.

Management Recommendations: Allow natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and permitting wildfires to burn. Natural pine regeneration occurs throughout the site. If no fire occurs in 20 to 40 years, then pine regeneration should be assessed, and if lacking, prescribed fire should be considered as a management option. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., roads and wetlands) should be used. New fire breaks could allow for spotted knapweed (*Centaurea maculosa*) encroachment. Along the shoreline, it is imperative to eliminate off-road vehicle traffic and monitor for invasive species. In addition, monitoring deer herbivory can help resource managers assess whether species composition and structure is being negatively impacted by deer browse. To reduce deer browse pressure, the surrounding forests could be managed for late-successional habitat.

Photo by Joshua G. Cohen.

164. Grand Traverse Bay

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnrable throughout range
Element Occurrence Rank: BC
Location: Baraga Forest Management Unit, Compartment 74, and Private Lands
Element Occurrence Identification Number: 3631

Site Description: This large wooded dune and swale complex occurs adjacent to Lake Superior along the shores of Keweenaw Bay near the mouth of the Traverse River in Grand Traverse Bay on a silt/clay lakeplain. Thousands of years of lacustrine processes have developed complex patterning of low and narrow sandy dune ridges (1-2 m high and approximately 5 m wide) and swales of variable depth and width (10 - > 200 m wide). Complex community structure characterizes the site and includes dry northern forest, poor conifer swamp, northern shrub thicket, bog, poor fen, and northern wet meadow. Ridges are characterized by acidic (pH 4.5), fine-textured, well-drained sands with a thin layer of needle duff. Ombrotrophic swales with poor conifer swamp and bog have saturated, acidic (pH 4.5) fibric peat over wet sands and well developed sphagnum hummock and hollow microtopography. The lake effect influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist).

Low sandy dune ridges (1-2 m high) are dominated by black spruce (*Picea mariana*) and tamarack (*Larix laricina*) with canopy associates including white pine (*Pinus strobus*), jack pine (*P. banksiana*), paper birch (*Betula papyrifera*), and red maple (*Acer rubrum*). Common shrubs include Canada blueberry (*Vaccinium myrtilloides*) and Labrador tea (*Ledum groenlandicum*). Bracken fern (*Pteridium aquilinum*) dominates the ground cover. Many swales are dominated by ombrotrophic poor conifer swamp or bog. Forested swales with poor conifer swamp are characterized by a canopy of tamarack and black spruce. Bog-dominated swales are characterized by sphagnum hummocks and ericaceous shrubs including leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), bog laurel (*Kalmia polifolia*), low sweet blueberry (*Vaccinium angustifolium*), and large cranberry (*V. macrocarpon*). Few-seed sedge (*Carex oligosperma*) is also prevalent in the acidic open swales. Additional species include bog willow (*Salix pedicellaris*), wild blue flag (*Iris versicolor*), and pitcher-plant (*Sarracenia purpurea*). Less acidic swales are dominated by northern shrub thicket vegetation with tag alder (*Alnus rugosa*), sweet gale (*Myrica gale*), bog birch (*Betula pumila*), black chokeberry (*Aronia prunifolia*), and mountain holly (*Nemopanthus mucronata*).

Threats: Primary threats include continued residential development, mining deposits, and logging on private land. Roads and off-road vehicle trails that pass through the complex could introduce invasive species into the wooded dune and swale complex. Mine tailings remain in areas of former open dune.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site and prohibit salvage logging in areas of windthrow). Monitoring for populations of non-native plants should be implemented and off-road vehicle activity along the shoreline and along the dune ridges should be eliminated. Efforts should be implemented to re-vegetate the mine tailing along the former open dunes. Portions of the wooded dune and swale complex occurring on private lands could be acquired or protected through conservation easements.

Photo by Michael A. Kost.

165. Gulliver Lake Dunes

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Location: Shingleton Forest Management Unit, Compartment 66, and Private Lands
Element Occurrence Identification Number: 7333

Site Description: This is a large wooded dune and swale complex occurring adjacent to northern Lake Michigan. Thousands of years of lacustrine processes developed the complex patterning of east-west trending dune ridges (typically 1-3 m high) and swales of variable depth and width in addition to irregular parabolic dunes (3-6 m high). The site is characterized by complex community structure that includes dry northern forest, dry-mesic northern forest, rich conifer swamp, poor conifer swamp, northern fen, mesic northern forest, northern shrub thicket, northern wet meadow, bog, intermittent wetland, interdunal wetland, and emergent marsh. Great Lakes barrens, open dunes, and sand and gravel beach occur within near-shore areas. Scattered throughout the site are pockets of old-growth hemlock (*Tsuga canadensis*) (one 65 cm tree was estimated to be 257 years old) and old-growth pines with fire scars. Cored red pine (*Pinus resinosa*) in old-growth pockets ranged from 173-245 years old. Dune ridge are primarily dominated by an even-aged cohort of pines (80+ years old). Forested swales are dominated by northern white-cedar (*Thuja occidentalis*). Ridges are characterized by acidic (pH 5.5), fine-textured sands with a thin layer of needle duff (4 cm deep). Forested swales have 50 to >100 cm of saturated, slightly acidic to circumneutral (pH 6.0-7.0) peat over sand. Well-developed sphagnum hummock and hollow microtopography occurs in the forested swales, especially in the broader swamps. Open swales have slightly acidic to circumneutral (pH 6.0-8.0) mucks of variable depth (10 - >100 cm) overlying wet, slightly acidic (pH 6.0-6.5) sands. Standing water occurs in some of the open swales and ranges from 10 to 50 cm deep. The lake effect influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist).

This wooded dune and swale community is characterized by complex ecological patterning, which results in high species and community diversity in an area with fairly little anthropogenic disturbance on the state lands. Natural ecological processes (i.e., windthrow, fire, and senescence) are the dominant factors structuring patterning and succession. There are numerous single windthrow gaps as well as multiple treefall gaps with windthrow being most prevalent near the lakeshore and in cedar swamps. Paper birch (*Betula papyrifera*) and balsam fir (*Abies balsamea*) contribute the greatest volume of coarse woody debris with small-diameter snags and dead and downed logs but there are scattered white pine, hemlock, and northern white-cedar snags and dead and downed wood. Tip ups and snapped boles are common throughout. Well-developed sphagnum hummock and hollow microtopography is prevalent in the broad forested swales. Evidence of fire occurs throughout the site with many larger canopy pines having fire scars on their boles.

Steep, north-facing parabolic dune ridges near the shore are dominated by large-diameter hemlock (60-90 cm) with canopy associates including yellow birch (*Betula alleghaniensis*) and red maple (*Acer rubrum*). Pines dominate south-facing parabolic dunes near the shore and the inland dunes with local dominance by red pine and jack pine (*Pinus banksiana*) with white pine occurring as a supercanopy associate and additional associates including red oak (*Quercus rubra*), big-toothed aspen (*Populus grandidentata*), paper birch, and red maple. Conifers, such as white spruce (*Picea glauca*), northern white-cedar, and balsam fir are prevalent in the canopy closer to the shore. Balsam fir, white spruce, and black spruce (*Picea mariana*) are prevalent in the subcanopy along with northern white-cedar, red maple, and paper birch. The understory is dominated by balsam fir with spruces and white pine and red pine regeneration. Subcanopy and understory density increases in areas with more open canopy due to windthrow and/or senescence of paper birch and balsam fir. The low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*), Canada blueberry (*V. myrtilloides*), and huckleberry (*Gaylussacia baccata*) with bearberry (*Arctostaphylos uva-ursi*) and common juniper (*Juniperus communis*) locally dominant, especially near the shore, and Labrador tea (*Ledum groenlandicum*) prevalent along the margins of jack pine-dominated dune ridges farther inland. The ground cover is dominated by bracken fern

(*Pteridium aquilinum*) with bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), wild sarsaparilla (*Aralia nudicaulis*), wintergreen (*Gaultheria procumbens*), stiff clubmoss (*Lycopodium annotinum*), and lichens (*Cladina rangifera* and *C. mitis*).

Forested swales are dominated by dense northern white-cedar (10-30 cm DBH range) with black spruce, tamarack (*Larix laricina*), red maple, and scattered white pine and hemlock as canopy associates. The understory of the forested swales contains tag alder (*Alnus rugosa*), winterberry (*Ilex verticillata*), black spruce, balsam fir, and locally, northern white-cedar regeneration (especially in areas of windthrow and younger swamp forest). Prevalent in the low shrub layer are alder-leaved buckthorn (*Rhamnus alnifolia*), black spruce, northern white-cedar, Labrador tea, leatherleaf (*Chamaedaphne calyculata*), American fly honeysuckle (*Lonicera canadensis*), and huckleberry. Characteristic ground cover species include starflower, dwarf raspberry (*Rubus pubescens*), goldthread, false mayflower (*Smilacina trifolia*), oak fern (*Gymnocarpium dryopteris*), sensitive fern (*Onoclea sensibilis*), creeping snowberry (*Gaultheria hispidula*), three-seeded sedge (*Carex trisperma*), starflower, naked miterwort (*Mitella nuda*), and wild blue flag (*Iris versicolor*). The well-developed sphagnum hummock and hollow microtopography in the forested swales increases species diversity by generating fine-scale gradients in soil moisture and chemistry.

Narrow swales are often shrub-dominated with dense thickets of tag alder. Associated shrubs within these swales include winterberry, bog birch (*Betula pumila*), northern white-cedar, tamarack, wild-raisin (*Viburnum cassinoides*), red-osier dogwood (*Cornus stolonifera*), black chokeberry (*Aronia prunifolia*), alder-leaved buckthorn, and sweet gale (*Myrica gale*). Ground cover in shrub swales is characterized by dwarf raspberry, royal fern (*Osmunda regalis*), marsh fern (*Thelypteris palustris*), bluejoint grass (*Calamagrostis canadensis*), tussock sedge (*Carex stricta*), wild blue flag, marsh marigold (*Caltha palustris*), and common skullcap (*Scutellaria galericulata*). The open swales are dominated by northern wet meadows, northern fens, bogs, and freshwater marshes. Open swales are dominated by graminoids with wiregrass sedge (*Carex lasiocarpa*), tussock sedge, few-seed sedge (*C. oligosperma*), bluejoint grass, and three-way sedge (*Dulichium arundinaceum*) being some of the dominants. Additional species include marsh fern, green bulrush (*Scirpus atrovirens*), spike-rush (*Eleocharis palustris*, also known as *E. smallii*), common water horehound (*Lycopus americanus*), broad-leaved cat-tail (*Typha latifolia*), marsh St. John's-wort (*Triadenum fraseri*), Baltic rush (*Juncus balticus*), wild mint (*Mentha arvensis*), swamp candles (*Lysimachia terrestris*), tufted loosestrife (*L. thyrsiflora*), marsh cinquefoil (*Potentilla palustris*), shrubby cinquefoil (*P. fruticosa*), sweet gale, bog rosemary (*Andromeda glaucophylla*), and leatherleaf. Farther inland, scattered throughout the portions of dry northern forest, there are numerous acidic bogs dominated by leatherleaf and few-seed sedge.

The shoreline adjacent to the wooded dune and swale complex includes stretches of sand and gravel beach, extensive open dunes with wide dune fields (over 0.15 miles wide in places), interdunal wetlands, and Great Lakes barrens. Areas of open dune are dominated by the dune grasses, especially marram grass (*Ammophila breviligulata*) and sand reed grass (*Calamovilfa longifolia*) with wormwood (*Artemisia campestris*), harebell (*Campanula rotundifolia*), and Lake Huron tansy (*Tanacetum huronense*, state threatened). Great lakes barrens is characterized by a scattered conifer canopy of white pine and white spruce over a dense shrub layer with junipers (*Juniperus* spp.). Small pockets of interdunal wetland are dominated by rushes (*Juncus* spp.), bulrushes (*Scirpus* and *Schoenoplectus* spp.), and sedges (*Carex* spp.) and are ringed by shrubs such as shrubby cinquefoil and sweet gale.

Threats: Primary threats to the wooded dune and swale complex include continued residential development and logging on private land. Roads and off-road vehicle trails that pass through the complex could introduce invasive species. Off-road vehicle trails passing through the open swales could drastically alter the hydrology through rutting. Deer herbivory is limiting northern white-cedar and hemlock regeneration and impacting species composition and structure.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and allowing wildfires to burn. Critical stewardship needs include the reduction of wintering deer densities and monitoring deer herbivory (especially of cedar and hemlock). Along the shoreline and within open swales, it is imperative to eliminate off-road vehicle traffic and monitor for invasive species. Portions of the complex occurring on private lands could be acquired or protected through conservation easements.

The Gulliver Lake wooded dune and swale complex is characterized by diverse ecological zonation. Photos by Joshua G. Cohen.

165. Iron River

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Location: Gwinn Forest Management Unit, Compartment 201, and Private Lands
Element Occurrence Identification Number: 7311

Site Description: This large wooded dune and swale complex includes two separate areas adjacent to Lake Superior along a sand lakeplain. Thousands of years of lacustrine processes have developed complex patterning of east-west (western area) and northwest-southeast (eastern area) trending low dune ridges and swales of variable depth and width. The dry-mesic dune ridges are characterized by a thin layer of needle duff (1-2 cm) over thin black sands over fine-textured reddish dune sands that are well-drained and strongly acidic (pH 4.5). Many swales are dry with acidic sandy soils. Dry swales result from rapid rises of the dune ridges above Lake Superior. Wetland swales contain saturated and acidic organics of variable depth (5 - >100 cm) overlying wet sands. Iron River winds through the eastern portion of the complex and enters Lake Superior at the northeast end. The lake effect influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist).

This wooded dune and swale community is characterized by complex community structure that includes dry northern forest, dry-mesic northern forest, poor conifer swamp, rich conifer swamp, northern shrub thicket, bog, poor fen, and emergent marsh. High-quality Great Lakes marsh occurs within near-shore areas.[34] The complex ecological patterning results in moderate species and community diversity in an area with localized anthropogenic disturbance. Natural ecological processes (i.e., windthrow, fire, beaver flooding, and senescence) are the dominant factors structuring patterning and succession. Well-developed sphagnum hummock and hollow microtopography is prevalent in the wider ombrotrophic swales. Evidence of fire was prevalent, with old, cut and burnt stumps from turn-of-the-century logging occurring throughout and many of the older canopy trees having fire scars on their boles. The pine-dominated forest ridges are naturally regenerated and uneven-aged with most of canopy cohort establishing following catastrophic fire approximately 110 years ago.

The low sandy dune ridges and dry swales are dominated by red pine (*Pinus resinosa*), white pine (*P. strobus*), and jack pine (*P. banksiana*) (DBH ranges from 20-50 cm) with canopy associates including paper birch (*Betula papyrifera*), red oak (*Quercus rubra*), red maple (*Acer rubrum*), quaking aspen (*Populus tremuloides*), and big-toothed aspen (*P. grandidentata*) with deciduous species more prevalent within the dry swales. Characteristic understory species include serviceberry (*Amelanchier interior*), red oak, choke cherry (*Prunus virginiana*), and pines. The low shrub cover is dominated by low sweet blueberry (*Vaccinium angustifolium*) and Canada blueberry (*V. myrtilloides*) with local dominance by huckleberry (*Gaylussacia baccata*). The herbaceous layer is dominated by bracken fern (*Pteridium aquilinum*) along with wintergreen (*Gaultheria procumbens*), trailing arbutus (*Epigaea repens*), bunchberry (*Cornus canadensis*), cow-wheat (*Melampyrum lineare*), Pennsylvania sedge (*Carex pensylvanica*), and wild sarsaparilla (*Aralia nudicaulis*). Lichens (*Cladina* spp.) are prevalent in areas with open canopy (50-70%).

Open swales are dominated by bog, poor fen, or northern shrub thicket. Bog or poor fen swales are characterized by scattered, stunted conifers, namely black spruce (*Picea mariana*) and tamarack (*Larix laricina*), and dense ericaceous shrub cover with leatherleaf (*Chamaedaphne calyculata*), Labrador tea (*Ledum groenlandicum*), bog willow (*Salix pedicellaris*), bog rosemary (*Andromeda glaucophylla*), and bog laurel (*Kalmia polifolia*). Prevalent ground cover species include few-seed sedge (*Carex oligosperma*), pitcher-plant (*Sarracenia purpurea*), bog buckbean (*Menyanthes trifoliata*), bog goldenrod (*Solidago uliginosa*), marsh cinquefoil (*Potentilla palustris*), and swamp candles (*Lysimachia terrestris*). Less acidic swales are dominated by northern shrub thicket vegetation. Characteristic species in areas of shrub swamp include tag alder (*Alnus*

[34] Independence Lake Great Lakes marsh

rugosa), sweet gale (*Myrica gale*), royal fern (*Osmunda regalis*), bluejoint grass (*Calamagrostis canadensis*), red-osier dogwood (*Cornus stolonifera*), winterberry (*Ilex verticillata*), marsh cinquefoil, marsh St. John's wort (*Triadenum fraseri*), joe-pye-weed (*Eupatorium maculatum*), and broad-leaved cat-tail (*Typha latifolia*).

Threats: Primary threats include continued residential development and logging on private land. Roads and off-road vehicle trails that pass through the complex could introduce invasive species into the wooded dune and swale complex.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site and prohibit salvage logging in areas of windthrow). The site should be monitored to ascertain if pine is recruiting and whether or not surface fires are occurring. If no fire occurs in 10 to 40 years, then pine regeneration should be assessed, and if lacking, prescribed fire should be considered as a management option. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., Lake Superior, Mud Lake Creek, Mud Lake Road, and additional roads) should be used. New fire breaks could allow for spotted knapweed (*Centaurea maculosa*) encroachment. Monitoring for populations of non-native plants should be implemented and off-road vehicle activity along the shoreline and along the dune ridges should be eliminated. Portions of the wooded dune and swale complex occurring on private lands could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

166. Little Presque Isle Point

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Location: Gwinn Forest Management Unit, Compartment 204, and Private Lands
Element Occurrence Identification Number: 3390

Site Description: This well-developed, west-northwest to east-southeast trending wooded dune and swale complex occurs on a 1.5 to 2 mile stretch of Lake Superior on a silty/clay lakeplain that is backed by shallow bedrock. Swales are primarily dry due to the rapid rises of the dune ridges above Lake Superior water levels. Wet swales occur more inland and are of limited extent. Dune ridges exhibit mild topography (1-3 m high) with a north-south aspect typical. Dry swales are typically narrow (2-5 m wide). Harlow Creek passes through the site and also borders the complex to the south/southeast. Northern shrub thicket with sweet gale (*Myrica gale*) and tag alder (*Alnus rugosa*) occur along the creek. Dune ridges and dry swales are characterized by very acidic sands with a shallow needle layer and O horizon overlying fine-textured dune sands. Wet swales are characterized by slightly acidic muck of variable depth over wet acidic sands. Proximity to Lake Superior influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist).

Ridges and dry swales are dominated by uneven-aged red pine (*Pinus resinosa*) forest with white pine (*P. strobus*), paper birch (*Betula papyrifera*), red oak (*Quercus rubra*), and jack pine (*P. banksiana*) as canopy associates. Red maple (*Acer rubrum*), paper birch, balsam fir (*Abies balsamea*), and less frequently white spruce (*Picea glauca*) are prevalent in the subcanopy and tall shrub layer with balsam fir common in areas of blowdown and in more inland portions of the complex. The low shrub layer is dominated by blueberries (*Vaccinium* spp.) and huckleberry (*Gaylussacia baccata*) with serviceberry (*Amelanchier* sp.) also common. The ground cover dominants include bracken fern (*Pteridium aquilinum*), wintergreen (*Gaultheria procumbens*), starflower (*Trientalis borealis*), poverty grass (*Danthonia spicata*), and lichens (*Cladina* spp.). Wet swales are either graminoid-dominated with tussock sedge (*Carex stricta*) and bluejoint grass (*Calamagrostis canadensis*) or are dominated by shrubs, such as tag alder, leatherleaf (*Chamaedaphne calyculata*), and/or winterberry (*Ilex verticillata*).

Threats: Continued intensive foot traffic can devegetate major portions of the complex. Fire suppression could limit future stand dynamics. Spotted knapweed (*Centaurea maculosa*) may invade if additional road development occurs. Deer herbivory may influence species composition and structure.

Management Recommendations: Installing a boardwalk and/or signed trails to the beach may help restore ground cover and understory vegetation to areas associated with the parking lot. The site has burned numerous times. Some of the older red pines (one cored red pine was 233 years old) have multiple (two to three) fire scars on their boles. It is important to allow fires to continue to shape the species composition and structure of the site. Natural pine regeneration occurs throughout the site. If no fire occurs in 10 to 20 years, then a prescribed fire should be considered. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., Lake Superior, Harlow Creek, and County Road 550) should be used. New fire breaks could allow for spotted knapweed encroachment. Monitoring should be implemented for populations of non-native plants, deer herbivory, and pine-drops (*Pterospora andromedea*, state threatened), which was documented at this site in the past. Portions of the wooded dune and swale complex occurring on private lands could be acquired or protected through conservation easements.


Photo by Joshua G. Cohen.

167. Little Traverse Bay

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Location: Baraga Forest Management Unit, Compartment 74, and Private Lands
Element Occurrence Identification Number: 10522

Site Description: This large wooded dune and swale complex occurs adjacent to Lake Superior along a sand lakeplain. Thousands of years of lacustrine processes have developed complex patterning of northeast-southwest trending low dune ridges (typically 0.5-1 m high) and swales of variable depth and width (3-60 m wide). Complex community structure characterizes the site and includes dry northern forest, dry-mesic northern forest, poor conifer swamp, northern shrub thicket, bog, muskeg, and emergent marsh. Sand and gravel beach and open dunes occur within near-shore areas. Ridges are characterized by acidic (pH 4.5-5.0), fine-textured, well-drained sands with a thin (2-6 cm) layer of needle duff. Ombrotrophic swales of poor conifer swamp or bog/muskeg have 20 to 40 cm of saturated, acidic (pH 4.5) peats over wet sands and well-developed sphagnum hummock and hollow microtopography. Shrub swales have slightly acidic (pH 5.0-6.5) peats of variable depth (50 - >100 cm) overlying wet, slightly acidic (pH 6.0-6.5) sands. Mud Lake Creek passes through the first and broadest swale, which is less acidic (pH 6.0-6.5) and wider than all subsequent open swales. The lake effect influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist).

This wooded dune and swale community is characterized by complex ecological patterning, which results in high species and community diversity in an area with fairly little anthropogenic disturbance. Natural ecological processes (i.e., windthrow, fire, beaver flooding, and senescence) are the dominant factors structuring patterning and succession. Scattered windthrow gaps and standing snags occur throughout forested portions of the complex. Well-developed sphagnum hummock and hollow microtopography is prevalent in the ombrotrophic swales. Evidence of fire is found in the site with old, cut and burnt stumps from turn-of-the-century logging occurring throughout.

Low sandy dune ridges (0.5-1 m high) are dominated by red pine (*Pinus resinosa*) and white pine (*P. strobus*) with canopy associates including red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), and black spruce (*Picea mariana*), with the latter occurring along the low dune ridges and along the dune margins. The subcanopy is dominated by black spruce, paper birch, and red maple, and the scattered understory supports serviceberry (*Amelanchier interior*), black spruce, and pines. The low shrub cover is dominated by low sweet blueberry (*Vaccinium angustifolium*) and Canada blueberry (*V. myrtilloides*) with Labrador tea (*Ledum groenlandicum*) and leatherleaf (*Chamaedaphne calyculata*) occurring along the dune margins and along low dune ridges. In addition, bush honeysuckle (*Diervilla lonicera*) is locally common and bearberry (*Arctostaphylos uva-ursi*) is prevalent along the first forested dune near the lakeshore. Bracken fern (*Pteridium aquilinum*) dominates the ground cover along with wintergreen (*Gaultheria procumbens*), trailing arbutus (*Epigaea repens*), starflower (*Trientalis borealis*), bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), cow-wheat (*Melampyrum lineare*), Canada mayflower (*Maianthemum canadense*), creeping snowberry (*Gaultheria hispidula*), wild sarsaparilla (*Aralia nudicaulis*), poverty grass (*Danthonia spicata*), and hair grass (*Deschampsia flexuosa*)

Narrow swales are dominated by ombrotrophic poor conifer swamp, musekg, and bog. Forested swales with poor conifer swamp are characterized by a partial canopy (50-75%) of tamarack (*Larix laricina*) and black spruce (20-40 cm DBH), an understory of black spruce, tamarack, mountain holly (*Nemopanthus mucronata*), winterberry (*Ilex verticillata*), tag alder (*Alnus rugosa*), and black chokeberry (*Aronia prunifolia*), a low shrub layer dominated by Labrador tea, and dominant ground cover species including royal fern (*Osmunda regalis*) and three-seeded sedge (*Carex trisperma*). Bog and muskeg swales are characterized by a more open canopy (5-25%) and are dominated by small-diameter (5-15 cm), scattered, stunted conifers (black spruce and tamarack) and dense ericaceous shrub cover with leatherleaf, Labrador tea, bog rosemary (*Andromeda glaucophylla*), and bog laurel (*Kalmia polifolia*). Prevalent ground cover species include few-seed sedge (*Carex oligosperma*), few-flower sedge (*C. pauciflora*), small cranberry (*Vaccinium oxycoccos*), pitcher-plant (*Sarracenia purpurea*), and

cotton-grasses (*Eriophorum* spp.) Well-developed sphagnum hummock and hollow microtopography occurs within these ombrotrophic swales.

Less acidic swales are dominated by northern shrub thicket vegetation. The first swale which is significantly wider than subsequent inland swales (60 m wide compared to 3-15 m wide), is shrub-dominated with sweet gale (*Myrica gale*), bog birch (*Betula pumila*), leatherleaf, and taller shrubs such as tag alder, winterberry, meadowsweet (*Spiraea alba*), swamp rose (*Rosa palustris*), red-osier dogwood (*Cornus stolonifera*), and willows (*Salix* spp.) along the margins of Mud Lake Creek. Dominant ground cover species include wiregrass sedge (*Carex lasiocarpa*), tussock sedge (*C. stricta*), and grass-leaved goldenrod (*Euthamia graminifolia*). Narrower swales are characterized by tag alder dominance with tall shrub associates including winterberry and black chokeberry. Sweet gale and northern dewberry (*Rubus flagellaris*) dominate the low shrub layer and graminoids such as tussock sedge, wiregrass sedge, and bluejoint grass (*Calamagrostis canadensis*) dominate the ground cover.

Threats: Primary threats include continued residential development and logging on private lands. Roads and off-road vehicle trails that pass through the complex could introduce invasive species into the wooded dune and swale complex.

Management: The primary management recommendation is to allow natural processes to operate unhindered (i.e., permit wildfires to burn through this site and prohibit salvage logging in areas of windthrow). The site should be monitored to ascertain if pine is recruiting and whether or not surface fires are occurring. If no fire occurs in 20 to 40 years, then pine regeneration should be assessed, and if lacking, prescribed fire should be considered as a management option. In the event of a wildfire or if prescribed fire is implemented, establishment of new fire lines should be avoided and existing fire breaks (i.e., Lake Superior, Mud Lake Creek, Mud Lake Road, and additional roads) should be used. New fire breaks could allow for spotted knapweed (*Centaurea maculosa*) encroachment. Monitoring for populations of non-native plants should be implemented and off-road vehicle activity along the shoreline and along the dune ridges should be eliminated. Portions of the wooded dune and swale complex occurring on private lands could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

168. Portage Bay

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: AB
Location: Shingleton Forest Management Unit, Compartments 95 and 96, and Private Lands
Element Occurrence Identification Number: 3085

Site Description: This large wooded dune and swale complex occurs along Portage Bay on the Garden Peninsula on a silt/clay lakeplain with low sandy beach ridges. The Portage Bay site, which occurs along the shore of northern Lake Michigan, is an extensive wooded dune and swale complex with more than seven ecological communities and over 180 native plant species documented. Extensive limestone cobble shore and sand and gravel beach grade to open dunes, which are backed by interdunal wetlands. Farther inland, the dune ridges are dominated by dry northern forest, dry-mesic northern forest, and mesic northern forest while northern wet meadow and rich conifer swamps dominate the swales. The site contains three moderate-sized inland lakes, one with a bog community occurring along the margin.

The beach ridges are dominated by white pine (*Pinus strobus*), red pine (*P. resinosa*), balsam fir (*Abies balsamea*), and paper birch (*Betula papyrifera*) with localized hemlock (*Tsuga canadensis*). Characteristic ground cover of the ridges includes low sweet blueberry (*Vaccinium angustifolium*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), bearberry (*Arctostaphylos uva-ursi*), and trailing arbutus (*Epigaea repens*). Northern white-cedar (*Thuja occidentalis*), balsam fir, black spruce (*Picea mariana*), and white spruce (*P. glauca*) dominate the forested swales. Also common in the swales are false mayflower (*Smilacina trifolia*), goldthread (*Coptis trifolia*), alder-leaved buckthorn (*Rhamnus alnifolia*), tag alder (*Alnus rugosa*), Labrador tea (*Ledum groenlandicum*), and ebony sedge (*Carex eburnea*). Four rare plants associated with near shore dunes were documented during surveys: dwarf lake iris (*Iris lacustris*, federal/state threatened), Lake Huron tansy (*Tanacetum huronense*, state threatened), Pitcher's thistle (*Cirsium pitcheri*, federal/state threatened), and Richardson's sedge (*Carex richardsonii*, state special concern).

Threats: Off-road vehicle damage was noted concentrated along the shoreline. Off-road vehicle damage is prohibiting vegetation establishment, making the dunes more prone to blow out, providing pathways for invasive plants, and damaging populations of rare lakeshore plants. Patches of spotted knapweed (*Centaurea maculosa*) were noted along the open dune area and reed (*Phragmites australis*) was noted along the shore. Selective logging has occurred throughout the complex. Further logging to sustain wintering deer will likely jeopardize cedar's capacity to regenerate.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and allowing wildfires to burn. Control of spotted knapweed patches is a high-priority stewardship need. Control efforts should be monitored. Populations of reed should be monitored. Elimination of off-road vehicle traffic along the shore should help reduce potential negative impacts to rare plant species populations and limit invasive species spread, which is often correlated with soil disturbance associated with vehicular traffic. Throughout the dune and swale complex, deer browse was noted to be high and conifer regeneration, especially northern white-cedar regeneration, was noted to be negatively impacted by the browse. Reducing deer browse pressure within this large complex could be accomplished by reducing management for early-successional forest in the landscape surrounding the wooded dune and swale complex. Cutting immediately adjacent to the complex to promote winter deer yarding should be evaluated, since increased deer densities may jeopardize the regeneration capacity of northern white-cedar and other species within the wooded dune and swale complex. Acquisition of private inholdings that occur within the wooded dune and swale complex or establishment of conservation easements would help protect this community and limit future development and off-road vehicle damage.

Photo by Bradford S. Slaughter.

169. Scott Point

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: AB
Location: Sault Sainte Marie Forest Management Unit, Compartments 198 and 200
Element Occurrence Identification Number: 4993

Site Description: This is a large wooded dune and swale complex occurring adjacent to northern Lake Michigan. Thousands of years of lacustrine processes developed the complex patterning of east-west trending dune ridges (up to 6 m high but typically 1-3 m high) and swales of variable depth and width. The site is characterized by complex community structure that includes dry-mesic northern forest, bog, rich conifer swamp, poor conifer swamp, northern fen, mesic northern forest, northern shrub thicket, northern wet meadow, and emergent marsh. The ridges are characterized by acidic, fine-textured sands (pH 5.0). Inland swales are characterized by deep, acidic (pH 4.0-4.5) sphagnum peat overlying sands, while swales closer to the lake have shallower peats (ranging from sedge peat to sedge/sphagnum peat) and mucks overlying sands and are more minerotrophic (pH 6.5-7.0) with a higher water table. The lake effect influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist). The shoreline adjacent to the wooded dune and swale complex includes stretches of limestone cobble shore, limestone bedrock lakeshore, open dunes, and Great Lakes marsh. Several creeks pass through the complex and several larger swales support permanent ponds.

Dune ridges are dominated by dry-mesic northern forest with balsam fir (*Abies balsamea*), paper birch (*Betula papyrifera*), northern white-cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), and black spruce (*P. mariana*) with scattered white pine (*Pinus strobus*) and hemlock (*Tsuga canadensis*). Conifers are most prevalent along the upland dune ridges near the shoreline. Hemlock, red pine (*Pinus resinosa*), and big-toothed aspen (*Populus grandidenta*) occur in scattered stands. Balsam fir is the overwhelming dominant of the understory layer, forming seemingly impenetrable thickets along upland ridges. Cedar dominates the forested swales along with black spruce, and paper birch occurs scattered in the forested wetlands. Well-developed sphagnum hummock and hollow microtopography characterizes the broad forested swales and increases species diversity by generating fine-scale gradients in soil moisture and chemistry.

The open swales are dominated by northern wet meadow, northern fen, and freshwater marshes, and gradually become more bog-like as distance from the shore increases. Open minerotrophic swales are dominated by graminoids especially tussock sedge (*Carex stricta*), bluejoint grass (*Calamagrostis canadensis*), and three-way sedge (*Dulichium arundinaceum*). Bog swales are characterized by deep sphagnum peats, few-seed sedge (*Carex oligosperma*), and leatherleaf (*Chamaedaphne calyculata*).

Threats: Off-road vehicle damage is the primary threat to this site. Excessive off-road vehicle traffic could lead to rutting, hydrologic alteration, and introduction of invasive species.

Management Recommendations: Management recommendations include eliminating off-road vehicle activity along the shoreline and monitoring for illegal off-road vehicle activity and invasive species.

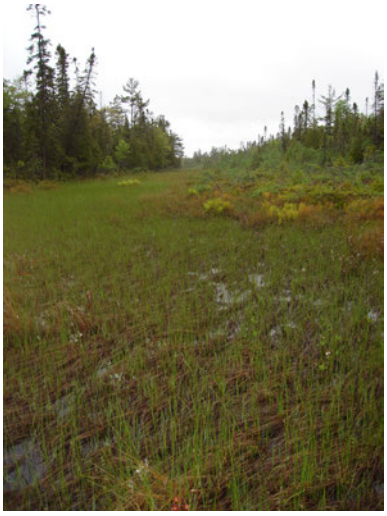


Photo by Joshua G. Cohen.

170. Seiner's Point (Wooded Dune and Swale Complex)

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Sault Sainte Marie Forest Management Unit, Compartments 193, 194, 197, and 200, and Private Lands
Element Occurrence Identification Number: 9523

Site Description: This is a large wooded dune and swale complex occurring adjacent to northern Lake Michigan. Thousands of years of lacustrine processes developed the complex patterning of east-west trending dune ridges (up to 8.5 m high but typically 1-2 m high) and swales of variable depth and width. The site is characterized by complex community structure that includes dry-mesic northern forest, rich conifer swamp, poor conifer swamp, northern fen, mesic northern forest, northern shrub thicket, northern wet meadow, bog, and emergent marsh. Great Lakes barrens, open dunes, Great Lakes marsh, interdunal wetland, high-quality limestone cobble shore[35], and sand and gravel beach occur within near-shore areas. The ridges are characterized by acidic (pH 4.5-5.0), fine-textured sands. The forested swales typically have 10 to > 100 cm of saturated circumneutral (pH 7.0) peat over sand. Well-developed sphagnum hummock and hollow microtopography occurs in the forested swales, especially in broader swamps. Standing water in open swales is typically 10 to 50 cm deep. The lake effect influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist). Several creeks pass through the complex and several larger swales support permanent ponds.

This wooded dune and swale community is characterized by complex ecological patterning that results in high species and community diversity in an area with anthropogenic disturbance concentrated on the private parcels in the southwestern portion of the site. Natural ecological processes (i.e., windthrow, beaver flooding, and senescence) are the dominant factors structuring patterning and succession. There are numerous single windthrow gaps as well as multiple treefall gaps with windthrow being most prevalent near the lakeshore. Paper birch (*Betula papyrifera*) and balsam fir (*Abies balsamea*) contribute the greatest volume of coarse woody debris with small-diameter snags and dead and downed logs but there are scattered white pine (*Pinus strobus*) and northern white-cedar snags and dead and downed wood. Dead and down logs within swales provide important seedling establishment substrate and are moss covered. Well-developed sphagnum hummock and hollow microtopography is prevalent in the broad forested swales. Evidence of fire occurs throughout the site with charring and fire scars occurring on the boles of trees.

Dune ridges are dominated by dry-mesic northern forest with white pine, red pine (*Pinus resinosa*), paper birch, and red maple (*Acer rubrum*) associated with northern white-cedar (*Thuja occidentalis*), balsam fir, hemlock (*Tsuga canadensis*), and white spruce (*Picea glauca*). Conifers are prevalent closer to the shore and northern white-cedar and balsam fir are also common along low dune ridges. Hemlock occurs in small groves farther inland. White pine occurs as a scattered supercanopy. The subcanopy is characterized by balsam fir and spruces along with red maple. The understory is dominated by balsam fir with spruce and white pine regeneration. Subcanopy and understory density increases in areas with more open canopy due to windthrow and/or senescence of paper birch and balsam fir. The low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*) and Canada blueberry (*V. myrtilloides*) with American fly honeysuckle (*Lonicera canadensis*) common and bearberry (*Arctostaphylos uva-ursi*) and common juniper (*Juniperus communis*) locally dominant, especially near the shore. The ground cover is dominated by bracken fern (*Pteridium aquilinum*) with bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), twinflower (*Linnaea borealis*), wild sarsaparilla (*Aralia nudicaulis*), wintergreen (*Gaultheria procumbens*), and lichens (*Cladina rangifera* and *C. mitis*).

Forested swales are dominated by dense northern white-cedar (20-50 cm DBH) with black spruce (*Picea mariana*) and tamarack (*Larix laricina*) as canopy associates and paper birch, white pine, hemlock, yellow birch (*Betula alleghaniensis*), and balsam poplar (*Populus balsamifera*) as occasional associates. The understory of the forested swales is characterized by tag alder (*Alnus rugosa*), winterberry (*Ilex verticillata*), black spruce, balsam

[35] Seiner's Point Limestone Cobble Shore

fir, and locally, northern white-cedar regeneration (especially in areas of windthrow, younger swamp forest, and northern fen). The low shrub layer contains alder-leaved buckthorn (*Rhamnus alnifolia*), black spruce, northern white-cedar, Labrador tea (*Ledum groenlandicum*), and leatherleaf (*Chamaedaphne calyculata*). Characteristic ground cover species include dwarf raspberry (*Rubus pubescens*), false mayflower (*Smilacina trifolia*), oak fern (*Gymnocarpium dryopteris*), sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), creeping snowberry (*Gaultheria hispidula*), three-seeded sedge (*Carex trisperma*), ebony sedge (*C. eburnea*), small enchanter's nightshade (*Circaea alpina*), starflower, naked miterwort (*Mitella nuda*), and wild blue flag (*Iris versicolor*). Well-developed sphagnum hummock and hollow microtopography occurs throughout these forested swales and contributes to floristic diversity by providing fine-scale gradients of soil moisture and chemistry. Inland portions of the complex are characterized by a wide rich conifer swamp that has been heavily browsed by wintering deer.

Narrow swales are often shrub-dominated by dense thickets of alder with winterberry, alder-leaved buckthorn, and sweet gale (*Myrica gale*). Ground cover in shrub swales is characterized by dwarf raspberry, sensitive fern, marsh fern (*Thelypteris palustris*), bluejoint grass (*Calamagrostis canadensis*), great bladder sedge (*Carex intumescens*), lake sedge (*C. lacustris*), tussock sedge (*C. stricta*), common skullcap (*Scutellaria galericulata*), marsh marigold (*Caltha palustris*), and wild blue flag. The open swales are dominated by northern wet meadow, northern fen, and freshwater marshes. Open minerotrophic swales are dominated by graminoids such as wiregrass sedge (*Carex lasiocarpa*), tussock sedge, bluejoint grass, and three-way sedge (*Dulichium arundinaceum*). Additional species include bog buckbean (*Menyanthes trifoliata*), pitcher-plant (*Sarracenia purpurea*), shrubby cinquefoil (*Potentilla fruticosa*), marsh cinquefoil (*P. palustris*), sweet gale, Labrador tea, and leatherleaf. Areas of northern fen are also characterized by a stunted, scattered canopy of northern white-cedar, tamarack, and black spruce. Open swales become more acidic as distance from the shoreline increases.

The shoreline adjacent to the wooded dune and swale complex includes stretches of sand and gravel beach, open dunes, interdunal wetland, Great Lakes barrens, Great Lakes marsh, and limestone cobble shore. Areas of open dune are dominated by dune grasses, especially marram grass (*Ammophila breviligulata*) and sand reed grass (*Calamovilfa longifolia*) with wormwood (*Artemisia campestris*), harebell (*Campanula rotundifolia*), and Lake Huron tansy (*Tanacetum huronense*, state threatened). Great lakes barrens are characterized by a scattered conifer canopy of white pine and white spruce over a dense shrub layer with junipers. Areas of Great Lakes marsh are dominated by Baltic rush (*Juncus balticus*), and interdunal wetlands are dominated by rushes (*Juncus* spp.), bulrushes (*Scirpus* and *Schoenoplectus* spp.), and sedges (*Carex* spp.).

Threats: Roads that pass through the complex could introduce invasive species into the complex. Deer herbivory is locally limiting northern white-cedar and hemlock regeneration and impacting species composition and structure. Further logging to sustain wintering deer will likely jeopardize cedar's capacity to regenerate.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and allowing wildfires to burn. Critical management needs include the reduction of wintering deer densities and monitoring deer herbivory (especially of cedar and hemlock). Along the shoreline, it is imperative to eliminate off-road vehicle traffic and monitor for invasive species. Portions of the complex occurring on private lands could be acquired or protected through conservation easements.

Photo by Joshua G. Cohen.

171. Squaw Bay (Wooded Dune and Swale Complex)

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Location: Atlanta Forest Management Unit, Compartments 89 and 92, and Private Lands
Element Occurrence Identification Number: 403

Site Description: This is a very large wooded dune and swale complex on Squaw Bay bordered by roads to the west, the city of Alpena to the north, degraded wooded dune and swale to the south, and a large, high-quality Great Lakes marsh to the east.[36] This complex is characterized by a long series of low dunes that are largely forested with conifers. Closer to the shore, swales are dominated by a large expanse of fen. Soils of swales are deep (> 1 m) neutral, sapric peats. Soils of ridges are 6 to 9 cm of humus over acidic sands. Soils of forested swales are circumneutral (pH 7.0) peats overlying sand or sand mixed with cobbles. Soils of boreal forest inclusions are 10 cm of loamy sand over cobble or cobble mixed with sand.

From the shore to 100 m inland, northern white-cedar (*Thuja occidentalis*) dominates the swales and very low (< 1 m) ridges. Canopy associates include black spruce (*Picea mariana*) and tamarack (*Larix laricina*) with balsam fir (*Abies balsamea*) in the understory, a shrub layer of tag alder (*Alnus rugosa*) and conifer seedlings, and a moderate ground cover of royal fern (*Osmunda regalis*), goldthread (*Coptis trifolia*), rough goldenrod (*Solidago rugosa*), and naked miterwort (*Mitella nuda*). In the western portion of the complex, swales become narrow and dominated by shrubs with tag alder and winterberry (*Ilex verticillata*) and a ground cover locally dominated by bluejoint grass (*Calamagrostis canadensis*), red manna grass (*Glyceria grandis*), and sensitive fern (*Onoclea sensibilis*). Distinct ridges and dry swales occur 100 to 320 m inland and are dominated by second-growth northern hardwoods and aspen (*Populus* spp.). Series of low upland ridges are mostly dominated by successional species, such as paper birch (*Betula papyrifera*), quaking aspen (*Populus tremuloides*), big-toothed aspen (*P. grandidentata*), red maple (*Acer rubrum*), and balsam fir with occasional red oak (*Quercus rubra*). The ground layer is dominated by Canada blueberry (*Vaccinium myrtilloides*), huckleberry (*Gaylussacia baccata*), and bracken fern (*Pteridium aquilinum*). In the western portion of the complex, dune ridges are dominated by red pine (*Pinus resinosa*).

Threats: Glossy buckthorn (*Rhamnus frangula*) is common throughout the complex (particularly in swales) and threatens to dominate large portions of the wetlands. A two-track parallels the swales and has allowed weedy natives and non-natives to invade the complex. This wooded dune and swale complex has been heavily impacted by logging and road building.

Management Recommendations: Management recommendations include eliminating the illegal off-road vehicle activity and controlling glossy buckthorn before it expands into larger portions of the complex. Control efforts should be monitored. If possible, roads throughout the complex should be closed. Early-successional forest on upland ridges should be allowed to mature. Acquisition of private inholdings that occur within the wooded dune and swale complex or establishment of conservation easements would help protect this community and limit future development and off-road vehicle damage.

Photo by Bradford S. Slaughter.

[36] Squaw Bay Great Lakes Marsh

172. Sturgeon Bay

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: A
Location: Wilderness State Park and Gaylord Forest Management Unit, Compartment 118
Element Occurrence Identification Number: 8136

Site Description: Thousands of years of lacustrine processes have developed a complex patterning of north-south trending dune ridges (up to 6 m high) and swales of variable depth and width. The complex community structure includes dry-mesic northern forest, bog, rich conifer swamp, poor conifer swamp, northern fen, dry northern forest, northern shrub thicket, northern wet meadow, and emergent marsh. Ridges are characterized by acidic sands. Inland swales are characterized by deep acidic sphagnum peat overlying sands, while swales closer to the lake have shallower peats (ranging from sedge peat to sedge/sphagnum peat) overlying sands and are more minerotrophic with a higher water table. This is a very large wooded dune and swale complex surrounded primarily by high-quality natural communities. The site is characterized by complex ecological patterning that results in high species and community diversity in an area with fairly little anthropogenic disturbance. Natural ecological processes (i.e., windthrow and beaver flooding) are the dominant factors structuring patterning and succession.

Red pine (*Pinus resinosa*) and white pine (*P. strobus*) dominate the dune ridges with red oak (*Quercus rubra*) as a common associate. Hemlock (*Tsuga canadensis*) is an occasional canopy associate. Paper birch (*Betula papyrifera*), balsam fir (*Abies balsamea*), big-toothed aspen (*Populus grandidentata*), red maple (*Acer rubrum*), and white spruce (*Picea glauca*) are common in the subcanopy and understory along with red maple. Balsam fir and pine regeneration (especially white pine) is common throughout the dune ridges. The low shrub layer is dominated by low sweet blueberry (*Vaccinium angustifolium*) and huckleberry (*Gaylussacia baccata*). The ground cover is dominated by bracken fern (*Pteridium aquilinum*) with bunchberry (*Cornus canadensis*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), wintergreen (*Gaultheria procumbens*), and lichens (*Cladina rangifera* and *C. mitis*).

Forested swales are dominated by dense northern white-cedar with black spruce (*Picea mariana*) and tamarack (*Larix laricina*) as canopy associates. The understory of the forested swales is characterized by tag alder (*Alnus rugosa*) and winterberry (*Ilex verticillata*). The low shrub layer contains Labrador tea (*Ledum groenlandicum*), leatherleaf (*Chamaedaphne calyculata*), and low sweet blueberry. Characteristic ground cover species include false mayflower (*Smilacina trifolia*) and royal fern (*Osmunda regalis*). Well-developed sphagnum hummock and hollow microtopography occurs throughout these forested swales and contributes to floristic diversity by providing fine-scale gradients of soil moisture and chemistry.

The open swales are dominated by northern wet meadow, northern fen, and freshwater marshes, and gradually become more bog-like as distance from the shore increases. Bog swales are characterized by scattered black spruce over leatherleaf with deep sphagnum peat. Additional ericaceous shrubs in the low shrub layer include Labrador tea, low sweet blueberry, and bog laurel (*Kalmia polifolia*). Typical ground cover species include pitcher-plant (*Sarracenia purpurea*) and small cranberry (*Vaccinium oxycoccos*). Open minerotrophic swales are dominated by graminoids such as tussock sedge (*Carex stricta*), wiregrass sedge (*C. lasiocarpa*), livid sedge (*C. livida*), and twig-rush (*Cladium mariscoides*). Areas of northern fen are characterized by a scattered, stunted canopy of northern white-cedar, tamarack, and black spruce with winterberry, tag alder, and bog birch (*Betula pumila*) in the tall shrub layer. Prevalent low shrubs include shrubby cinquefoil (*Potentilla fruticosa*) and alder-leaved buckthorn (*Rhamnus alnifolia*). In addition, to the aforementioned sedges, bog buckbean (*Menyanthes trifoliata*) is common in the ground cover.

Threats: Roads and trails have likely provided a conduit for the invasion of reed (*Phragmites australis*). Where reed occurs, it is threatening an open fen system with some areas of dense locally dominant growth, which appears to be altering the local hydrology. Other invasives are primarily confined to roadsides and do not appear to pose an imminent threat. Selective logging has occurred in portions of the complex and some salvage logging has occurred in areas of windthrow.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and allowing wildfires to burn. Control of reed patches is a high-priority stewardship need and these control efforts should be monitored.

Photo by Joshua G. Cohen.

173. St. Vital Bay

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Sault Sainte Marie Forest Management Unit, Compartment 20, and Private Lands
Element Occurrence Identification Number: 2834

Site Description: This large wooded dune and swale complex occurs adjacent to Lake Huron along an embayment. Thousands of years of lacustrine processes have developed complex patterning of low dune ridges (1-2 m in height) and swales of variable depth and width (20-100 m). The beach ridges are characterized by a thin layer of needle duff over well-drained and strongly acidic (pH 4.5-5.5) sands. The swales are characterized by slightly acidic to circumneutral (pH 6.5-7.5) peats of variable depth overlying wet sands. Depth of organics within the swales generally increases with distance from the shore. The lake effect influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist).

This wooded dune and swale community is characterized by complex community structure that includes dry-mesic northern forest, rich conifer swamp, northern shrub thicket, northern wet meadow, and submergent marsh. The complex ecological patterning results in high species and community diversity in an area with localized anthropogenic disturbance. Natural ecological processes (i.e., windthrow, fire, and senescence) are the dominant factors structuring patterning and succession. The low sandy dune ridges are dominated by white pine (*Pinus strobus*), paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), and northern white-cedar (*Thuja occidentalis*). Canopy associates include balsam fir (*Abies balsamea*) and red oak (*Quercus rubra*). The shrub and ground layers are patchy along these dune ridges. Typical ground cover species include bluebead lily (*Clintonia borealis*) and goldthread (*Coptis trifolia*). Open swales are dominated by northern wet meadow or northern shrub thicket. Dominant species in areas of shrub swamp include tag alder (*Alnus rugosa*) and sweet gale (*Myrica gale*). Dominant species within the northern wet meadow swales include bluejoint grass (*Calamagrostis canadensis*), tussock sedge (*Carex stricta*), wiregrass sedge (*C. lasiocarpa*), lake sedge (*C. lacustris*), and fowl manna grass (*Glyceria striata*). Forested swales are dominated by rich conifer swamp with northern white-cedar. Characteristic species of the forested swales include scattered tag alder, false mayflower (*Smilacina trifolia*), creeping winterberry (*Gaultheria hispidula*), three-seeded sedge (*Carex trisperma*), and sphagnum mosses. The western portion of the complex supports rich conifer swamp in both swales and on poorly-defined beach ridges. Many of the open swales have over a meter of standing water and support submergent vegetation, including water shield (*Brasenia schreberi*), yellow pond-lily (*Nuphar variegata*), bladderwort (*Utricularia vulgaris*), and mare's tail (*Hippuris vulgaris*). Areas adjacent to the lakeshore support open dunes and sand and gravel beach with rare shoreline species, such as, Pitcher's thistle (*Cirsium pitcheri*, federal/state threatened) and Houghton's goldenrod (*Solidago houghtonii*, federal/state threatened).

Threats: Roads that pass through the site locally impact the hydrology and could introduce invasive species into the wooded dune and swale complex. Several non-native species were noted along the roadsides including lawn prunella (*Prunella vulgaris*) and leafy spurge (*Euphorbia esula*). Deer herbivory is impacting species composition and structure. Shoreline housing development could further fragment the wooded dune and swale complex and increase the potential for off-road vehicle damage.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and allowing wildfires to burn. Critical stewardship needs include the reduction of deer densities and monitoring deer herbivory. Monitoring deer herbivory can help resource managers assess whether species composition and structure is being negatively impacted by deer browse. To reduce deer browse pressure, the surrounding forests could be managed for late-successional habitat. Along the shoreline, it is imperative to eliminate off-road vehicle traffic and monitor for invasive species. Portions of the complex occurring on private lands could be acquired or protected through conservation easements.

St. Vital Bay wooded dune and swale is characterized by complex ecological patterning. Photos by Bradford S. Slaughter.

174. Thompson

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Location: Shingleton Forest Management Unit, Compartment 79, and Private Lands
Element Occurrence Identification Number: 986

Site Description: This extensive wooded dune and swale complex occurs adjacent to Lake Michigan along an embayment on a sandy lakeplain. Thousands of years of lacustrine processes have developed complex patterning of low dune ridges (0.5-2.0 m) and swales of variable depth and width. The soils in this complex range from calcareous dune sand on beach areas to acidic, fine-textured sand mixed with organic material on ridges to acidic to circumneutral sapric or fibric peat deposits over saturated sands in swales. Depth of organics within the swales generally increases with distance from the lakeshore. The lake effect influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist).

This wooded dune and swale complex is characterized by complex community structure that includes dry-mesic northern forest, rich conifer swamp, northern shrub thicket, northern wet meadow, and northern fen. The complex ecological patterning results in high species and community diversity in an area with severe anthropogenic disturbance. The low sandy dune ridges are dominated by white pine (*Pinus strobus*) with canopy associates including red pine (*P. resinosa*), paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), and black spruce (*Picea mariana*). Typical low shrubs include low sweet blueberry (*Vaccinium angustifolium*), huckleberry (*Gaylussacia baccata*), and Labrador tea (*Ledum groenlandicum*). Bracken fern (*Pteridium aquilinum*) is dominant in the ground cover with wintergreen (*Gaultheria procumbens*) common. Some low dune ridges have been paludified and are covered in peat and support rich conifer swamp, which dominates the majority of the swales within the complex. Northern white-cedar (*Thuja occidentalis*) dominates the forested swales with tamarack (*Larix laricina*), balsam fir (*Abies balsamea*), and white pine as a canopy associate. Scattered tall shrubs include tag alder (*Alnus rugosa*) and winterberry (*Ilex verticillata*). Typical species of the ground cover in the forested swales include Labrador tea (*Ledum groenlandicum*), swamp fly honeysuckle (*Lonicera oblongifolia*), alder-leaved buckthorn (*Rhamnus alnifolia*), creeping winterberry (*Gaultheria hispidula*), false mayflower (*Smilacina trifolia*), starflower (*Trientalis borealis*), three-seeded sedge (*Carex trisperma*), goldthread (*Coptis trifolia*), and sphagnum mosses (*Sphagnum* spp.). Narrow swales with a high water table often support northern shrub thickets dominated by tag alder with associates including winterberry, red-osier dogwood (*Cornus stolonifera*), sweet gale (*Myrica gale*), and willows (*Salix* spp.). Bluejoint grass (*Calamagrostis canadensis*), sedges (*Carex* spp.), and saplings of northern white-cedar and tamarack are also characteristic of the shrub-dominated swales. Swales dominated by northern fen are characterized by bog birch (*Betula pumila*), shrubby cinquefoil (*Potentilla fruticosa*), sweet gale, wiregrass sedge (*Carex lasiocarpa*), bog goldenrod (*Solidago uliginosa*), small cranberry (*Vaccinium oxycoccos*), pitcher-plant (*Sarracenia purpurea*), and round-leaved sundew (*Drosera rotundifolia*). Open swales that are more acidic tend to be dominated by leatherleaf (*Chamaedaphne calyculata*) with well-developed sphagnum hummock and hollow microtopography.

Threats: Roads, railroads, and pipelines that pass through the site impact the hydrology locally and could introduce invasive species into the wooded dune and swale complex. Recent logging activity, including strip cutting could also lead to the increase in non-native species. Several non-native species were noted along the roadsides including lawn prunella (*Prunella vulgaris*) and European marsh thistle (*Cirsium palustre*). Deer herbivory is impacting species composition and structure. Shoreline housing development could further fragment the wooded dune and swale complex and increase the potential for off-road vehicle damage.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and allowing wildfires to burn. Critical stewardship needs include the reduction of deer densities and monitoring deer herbivory, which can help resource managers assess whether species composition and structure are being negatively impacted by deer browse. To reduce deer browse pressure, the surrounding forests could be managed for late-successional habitat and direct measures could be taken to reduce population densities. Along the shoreline, it is imperative to eliminate off-road vehicle traffic and monitor for invasive species. Portions of the complex occurring on private lands could be acquired or protected through conservation easements.

Photo by Bradford S. Slaughter.

275. West Epoufette

Natural Community Type: Wooded Dune and Swale Complex
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: B
Location: Sault Sainte Marie Forest Management Unit, Compartment 143, and Private Lands
Element Occurrence Identification Number: 562

Site Description: This small wooded dune and swale complex occurs adjacent to northern Lake Michigan along an embayment. Thousands of years of lacustrine processes have developed complex patterning of low dune ridges and swales of variable depth and width. Over much of the wooded dune and swale complex there are subtle transitions from dunes to swales, which often support the same dominant species due to the lack of significant relief. The soils in this complex range from calcareous dune sand on the beach to acidic sand mixed with organic material on ridges to circumneutral sapric or fibric peat deposits over saturated sands in swales. Depth of organics within the swales generally increases with distance from the shore. The lake influences the local climate with heavy snow loads, moderated temperatures in the winter and summer, and increased precipitation in the summer (fog and mist).

This wooded dune and swale community is characterized by complex community structure that includes beach flats, open dunes, interdunal wetlands, dry-mesic northern forest, and rich conifer swamp. The complex ecological patterning results in high species and community diversity in an area with localized anthropogenic disturbance. Natural ecological processes (i.e., windthrow, fire, and senescence) are the dominant factors structuring patterning and succession. The low sandy dune ridges are dominated by a dense canopy of balsam fir (*Abies balsamea*) due in part to past logging but also due to the high frequency of blowdowns that characterize this nearshore system. Canopy associates on the dune ridges include white pine (*Pinus strobus*), red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), white spruce (*Picea glauca*), and northern white-cedar (*Thuja occidentalis*). Forested swales on shallow organic substrate supporting rich conifer swamp dominate much of the complex, especially in the western portion of the occurrence. Northern white-cedar dominates the forested swales with black spruce (*Picea mariana*) as a canopy associate. Typical species of the ground cover in the forested swales include Labrador tea (*Ledum groenlandicum*), American fly honeysuckle (*Lonicera canadensis*), creeping winterberry (*Gaultheria hispidula*), false mayflower (*Smilacina trifolia*), starflower (*Trientalis borealis*), sedges (*Carex trisperma*, *C. disperma*, and *C. intumescens*), and sphagnum mosses (*Sphagnum* spp.). Ram's head lady's-slipper (*Cypripedium arietinum*, state special concern) was documented within this wooded dune and swale complex along the border of the second dune ridge above the adjacent swale. Beach flats are dominated by three-square (*Schoenoplectus pungens*), Baltic rush (*Juncus balticus*), and silverweed (*Potentilla anserina*). The open dune is characterized by marram grass (*Ammophila breviligulata*), wormwood (*Artemisia campestris*), willows (*Salix* spp.), sand cherry (*Prunus pumila*), Lake Huron tansy (*Tanacetum huronense*, state threatened), and Pitcher's thistle (*Cirsium pitcheri*, federal/state threatened). The interdunal wetlands are dominated by shrubby cinquefoil (*Potentilla fruticosa*) and sweet gale (*Myrica gale*) with scattered northern white-cedar and tamarack (*Larix laricina*) and a sparse ground cover.


Photo by Bradford S. Slaughter.

Threats: Several non-native species were noted during the survey including reed canary grass (*Phalaris arundinacea*) within the interdunal wetlands. Housing development in the vicinity could further fragment the shoreline habitat and increase the potential for off-road vehicle damage.

Management Recommendations: Management recommendations for this site include allowing natural processes to operate unhindered by avoiding salvage logging in areas of windthrow and allowing wildfires to burn. The primary stewardship need is to control populations of invasive species and monitor the control efforts. Portions of the complex occurring on private lands could be acquired or protected through conservation easements.

DISCUSSION

Observed Threats and Noted Management Recommendations

This two-year survey over vast acreage of a variety of high-quality natural communities across the wide spectrum of landscapes in Northern Michigan has provided the unique capacity to assess threats and management opportunities on State Forest lands. An understanding of broad trends in threats can help resource managers and planners prioritize broad-scale threat abatement and evaluate current and potential institutional policies that may foster or mitigate these threats. Table 3 provides a synthesis of the primary on-site threats observed by MNFI scientists, and Table 4 provides a summary of the most commonly noted stewardship needs. The following are some general trends by groups of community types.

Upland forested systems are threatened by high levels of deer herbivory, which has reduced structural and compositional diversity and limits the regeneration capacity of certain species (e.g., hemlock and northern white-cedar). Deer herbivory was noted to be most prevalent in the northern Lower Peninsula and in the Upper Peninsula south of the high snow line. Fire suppression is impacting dry-mesic and dry forested systems, especially in the northern Lower Peninsula. At present, invasive species within upland forests are primarily confined to road and trail margins. These anthropogenic conduits are also associated with firewood harvesting and the reduction of coarse woody debris and tree recruitment (especially conifers). Management recommendations for these upland systems include reducing deer densities and deer browse pressure, implementing prescribed fire in fire-prone systems, and controlling invasive species incursions. Mesic forests tend to be more susceptible than dry-mesic and dry forests to non-native species invasion, so monitoring for invasives should be focused in mesic forests.

The primary threat to prairie and barrens ecosystems is posed by fire suppression. Additional threats observed included invasive species, such as spotted knapweed, leafy spurge, and common St. John's-wort, and off-road vehicle damage, which is often correlated with soil disturbance and invasive species. Management recommendations for fire-dependent prairies and barrens include the sustained use of prescribed fire to maintain structure and species composition, the control of non-native plant populations, and the elimination of off-road vehicle traffic. Prescribed fire management within these systems should utilize existing fire breaks and avoid the creation of new fire lines, unnecessary vehicular activity, and disturbance to the soils.

Within wetland forests the most frequently observed threats were deer herbivory and hydrologic alteration due to roads and dams. Heavy deer browse and associated recruitment failure of northern white-cedar were noted throughout the northern Lower Peninsula and within the Upper Peninsula south of the snow line. Impacts from heavy deer browse are especially concentrated in areas where deer winter near the Great Lakes shoreline. Invasive species found within forested wetlands include glossy buckthorn, reed canary grass, Japanese barberry, and non-native earthworms. Off-road vehicle damage was occasionally noted within the forested wetlands. Management recommendations for forested wetlands include maintaining hydrologic regimes, reducing deer browse pressure, and controlling invasive species and off-road vehicle traffic.

Open wetlands, including marshes and peatlands, are predominantly threatened by hydrologic alteration and off-road vehicle damage. Minerotrophic wetlands (i.e., marshes and fens) tend to be more susceptible than ombrotrophic wetlands (i.e., bogs and muskegs) to non-native species invasion. Peatlands within fire-prone landscapes are often threatened by fire suppression. Management recommendations for these open wetlands include maintaining the natural hydrologic regime, maintaining a buffer of natural communities surrounding the wetlands, implementing prescribed fire where appropriate, controlling invasive species such as glossy buckthorn, purple loosestrife, reed, and reed canary grass, and eliminating off-road vehicle traffic.

Inland bedrock communities are threatened by off-road vehicle damage (most prevalent in the flatter limestone systems, especially on Drummond Island), invasive species, and high levels of deer herbivory. Management recommendations for these communities include eliminating off-road vehicle traffic, controlling invasive species through direct measures and also buffering sites to reduce the weedy seed source in the surrounding landscape, and reducing deer browse pressure.

Shoreline systems, including open dunes and bedrock lakeshore communities, share the same threats of invasive species and off-road vehicle damage. Management recommendations for shoreline systems include eliminating off-road vehicle traffic and controlling invasive species.

	Threat	Threat	Threat	Threat	Threat
Mesic Northern Forest	Deer Herbivory	Roads and Trails	Invasive Plants	Beech Bark Disease	Firewood Harvest
Dry & Dry-Mesic Forest	Fire Suppression	Deer Herbivory	Invasive Plants	Roads and Trails	
Prairies and Barrens	Fire Suppression	Off-Road Vehicles	Invasive Plants		
Wetland Forest	Deer Herbivory	Hydrologic Alteration	Invasive Plants	Off-Road Vehicles	Earth Worms
Marsh	Hydrologic Alteration	Off-Road Vehicles	Invasive Plants		
Peatland	Hydrologic Alteration	Off-Road Vehicles	Invasive Plants	Fire Suppression	
Inland Bedrock	Invasive Plants	Off-Road Vehicles	Deer Herbivory	Fire Suppression	
Bedrock Lakeshore	Invasive Plants	Off-Road Vehicles	Deer Herbivory	Zebra Mussels	
Open Dunes	Invasive Plants	Off-Road Vehicles			

Table 3. A summary of the primary threats observed by surveyors by grouped community types.

	Stewardship Need	Stewardship Need	Stewardship Need	Stewardship Need	Stewardship Need
Mesic Northern Forest	Reduce Deer Browse	Invasive Species Control	Road and Trail Closure		
Dry & Dry-Mesic Forest	Fire	Reduce Deer Browse	Road and Trail Closure	Invasive Species Control	
Prairies and Barrens	Fire	Invasive Species Control	Control ORV Activity		
Wetland Forest	Maintain Hydrology	Reduce Deer Browse	Control ORV Activity	Invasive Species Control	
Marsh	Maintain Hydrology	Invasive Species Control	Control ORV Activity	Maintain Forested Buffer	Fire
Peatland	Maintain Hydrology	Invasive Species Control	Control ORV Activity	Maintain Forested Buffer	Fire
Inland Bedrock	Invasive Species Control	Control ORV Activity	Reduce Deer Browse	Maintain Forested Buffer	Fire
Bedrock Lakeshore	Invasive Species Control	Control ORV Activity	Reduce Deer Browse		
Open Dunes	Invasive Species Control	Control ORV Activity	Reduce Deer Browse		

Table 4. A summary of recommended stewardship needs noted by surveyors by grouped community types.

Next Steps: Setting Stewardship and Inventory Priorities

This report has provided site-based assessments of potential ecological reference areas on state forest lands. Threats, management needs, and restoration opportunities specific to each individual site have been discussed. It is our hope that this report will be a dynamic document, with site summaries and element occurrence records in MNFI's database updated following implementation of biodiversity stewardship, future surveys, and input from resource professionals. The baseline information presented in the current report provides resource managers with an ecological foundation for prescribing site-level biodiversity stewardship, monitoring these management activities, and implementing landscape-level biodiversity planning to prioritize efforts. A much needed future step is the development of a framework for prioritizing stewardship efforts across these sites. This process will involve assessing the conservation significance of each site from both an ecoregional and statewide perspective and evaluating the severity of threats across sites. Understanding how each site relates to other examples of the natural community and how rare that community is within an ecological region will help facilitate difficult decisions regarding the distribution of finite stewardship resources. This analysis should be conducted using an ecological hierarchical framework, such as Albert's (1995) Regional Landscape Ecosystems of Michigan, Minnesota, and Wisconsin.

In addition, this preliminary network of potential ecological reference areas was developed using documented high-quality natural communities that occur on state forest lands. The remaining state forest lands and adjacent private lands have yet to be systematically surveyed for high-quality natural communities. In the course of the 2006 and 2007 surveys, MNFI ecologists encountered numerous additional high-quality natural communities that merit future survey and consideration as potential ecological reference areas. A systematic survey of state forest lands and adjacent private lands would increase the number of high-quality natural communities that could be considered as potential ecological reference areas. In addition, the current criteria for qualifying as an ecological reference area exclude common community types (i.e., G4, G5, S4, or S5 ranked communities). Incorporation of high-quality common natural community types within the network of ecological reference areas will guarantee that examples of all natural community types are represented. A particularly important survey need is the evaluation of areas adjacent to existing potential ecological reference areas for all types of natural communities. Such a survey effort can lead to the expansion of these ecological reference areas or the aggregation of several of them into functional landscape ecosystems.

High-quality muskeg occurs on State Forest land just south of the Sleeper Lake patterned fen (potential ERA). These contiguous natural communities burned in 2007 during the Sleeper Lake Fire. Photo by Joshua G. Cohen.

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Systematic surveys of State Forest lands would identify additional high-quality natural communities for consideration as ecological reference areas. This high-quality patterned fen was documented in 2008 on State Forest land in Chippewa County. Photo by Joshua G. Cohen.

APPENDIX 1

Global and State Element Ranking Criteria

GLOBAL RANKS

G1 = critically imperiled: at very high risk of extinction due to extreme rarity (often 5 or fewer occurrences), very steep declines, or other factors.

G2 = imperiled: at high risk of extinction due to very restricted range, very few occurrences (often 20 or fewer), steep declines, or other factors.

G3 = vulnerable: at moderate risk of extinction due to a restricted range, relatively few occurrences (often 80 or fewer), recent and widespread declines, or other factors.

G4 = apparently secure: uncommon but not rare; some cause for long-term concern due to declines or other factors.

G5 = secure: common; widespread.

GU = currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

GX = eliminated: eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species.

G? = incomplete data.

STATE RANKS

S1 = critically imperiled in the state because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state.

S2 = imperiled in the state because of rarity due to very restricted range, very few occurrences (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the state.

S3 = vulnerable in the state due to a restricted range, relatively few occurrences (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.

S4 = uncommon but not rare; some cause for long-term concern due to declines or other factors.

S5 = common and widespread in the state.

SX = community is presumed to be extirpated from the state. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.

S? = incomplete data.