

Ecological Assessment of Proposed Sand Point Wetland Restoration



Prepared By:

Michael J. Monfils, Joshua G. Cohen, Phyllis J. Higman, Yu Man Lee, David L. Cuthrell, and Peter J. Badra
Michigan Natural Features Inventory
Michigan State University Extension
P.O. Box 13036
Lansing, MI 48901

Prepared For:

Pictured Rocks National Lakeshore
National Park Service

20 August 2020

MNFI Report No 2020-15

Suggested Citation:

Monfils, M.J., J.G. Cohen, P.J. Higman, Y. Lee, D.L. Cuthrell, and P.J. Badra. 2020. Ecological assessment of proposed Sand Point wetland restoration. Michigan Natural Features Inventory, Report Number 2020-15, Lansing, USA.

Copyright 2020 Michigan State University Board of Trustees. MSU Extension programs and materials are open to all without regard to race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, marital status or family status.

Cover: Sand Point Wetland, photograph by M.J. Monfils.

Table of Contents

Executive Summary	iii
Introduction	1
Study Area	1
Methods	4
Past and Current Conditions	4
Expected Conditions	4
Results and Discussion	6
Natural Communities	6
Vegetation	11
Macroinvertebrates	16
Fish.....	24
Herpetofauna	25
Birds	29
Mammals.....	36
Conclusions.....	39
Acknowledgements.....	40
Literature Cited	41
Appendix A: Combined list of plant species detected at Sand Point Wetland across multiple data sources.....	44

List of Tables

Table 1. Rare plant species with potential to occur at Sand Point Wetland targeted during meander surveys conducted by MNFI in fall 2019.	5
Table 2. Rare plant species with potential to occur at Sand Point and the natural communities and microhabitats in which they occur.	14
Table 3. Macroinvertebrate taxa identified during sampling conducted by the Great Lakes Coastal Wetland Monitoring Program during 2019.	17
Table 4. Terrestrial insect species recorded from the Sand Point area by source	19
Table 5. Amphibian and reptile species that have been documented or have potential to occur in the Sand Point Wetland and surrounding vicinity of Pictured Rocks National Lakeshore.	26
Table 6. Bird species documented in and around the Sand Point Wetland, with data source, period of observation (B = breeding or NB = non-breeding), and date of the most recent record provided.	30
Table 7. Mammal species recorded from the Sand Point area, with the general locations and most recent observation dates provided.	38

List of Figures

Figure 1. Location of Sand Point Wetland complex and proposed restoration site within Pictured Rocks National Lakeshore.....	2
Figure 2. View of culvert west of Sand Point Road that serves as the primary connection between Sand Point Wetland and Lake Superior.	3
Figure 3. Average monthly water level for Lake Superior in meters (International Great Lakes Datum 1985) from January 1918 to May 2020.....	3
Figure 4. Poor fen zone of Sand Point Wetland.....	7
Figure 5. Broad-leaved cat-tail in Sand Point Wetland.	7
Figure 6. Northern shrub thicket (foreground) transitioning to rich conifer swamp (background) near wetland perimeter.	8
Figure 7. Dune ridge with open-canopied dry-mesic northern forest.....	9

Executive Summary

The Michigan Natural Features Inventory (MNFI) was contracted by the National Park Service (NPS) to assess the potential effects of the proposed restoration of the Sand Point Wetland (SPW) within the Pictured Rocks National Lakeshore (PRNL). The wetland is hydrologically connected to Lake Superior via a narrow outflow, with water typically flowing from the wetland to Lake Superior. The wetland's hydrology was altered in the 1930s when a road was constructed to access a U.S. Coast Guard station. Culverts placed under the roadbed have been insufficient to facilitate the free flow of water between SPW and the lake and sediment deposition and beaver activity have regularly plugged the culvert that serves as the primary hydrologic connection. The altered hydrology has resulted in water impounding within the wetland complex by approximately 15 cm (0.50 ft). Changes to the hydrology could in turn alter wetland functioning and plant composition. For example, stabilized and increased water levels could make SPW more vulnerable to invasive plant species colonization and spread. Scientists from MNFI evaluated all known information about the natural communities and plant and animal species within the wetland complex and used that information to assess the changes we expect to occur after hydrologic restoration.

The MNFI gathered and synthesized information about the natural communities, plant species, macroinvertebrates, herpetofauna, birds, and mammals of the wetland complex. Information was collected from a variety of sources, including the MNFI Natural Heritage Database, NPS internal data, Great Lakes Coastal Wetland Monitoring Program (CWMP), Michigan Herp Atlas, eBird, and published and gray literature. In addition, MNFI scientists gathered information during a site visit conducted in October 2019. During the site visit, MNFI described the natural communities present, recorded all plant and animal species observed, evaluated the potential for the site to support plant and animal species of conservation concern, and assessed the possible effects of hydrologic restoration to the current natural communities and species assemblages.

Protected by Grand Island and occurring at the base of a steep slope under a sandstone escarpment, SPW is a unique example of the wooded dune and swale complex community type. Protection from Grand Island has allowed the formation of alternating low, narrow dune ridges and broad swales through wave and wind action. The wetland complex is subject to dynamic change due to depositional and erosional forces associated with Lake Superior currents and seasonal and annual water level fluctuations. Sand Point expands during periods of low water levels due to deposition of sand, whereas high water levels result in gradual shrinking due to erosion. Swales within the complex expand and become wetter as lake levels rise and shrink and become less wet as lake levels fall. The swales have variable composition and include four open water areas or ponds, but are primarily characterized as poor fen, with smaller areas of submergent marsh, bog, northern shrub thicket, and rich conifer swamp. Poor fen areas are dominated by a low shrub cover of sweet gale (*Myrica gale*) and leatherleaf (*Chamaedaphne calyculata*) and characteristic graminoids, such as bluejoint grass (*Calamagrostis canadensis*) and wiregrass sedge (*Carex lasiocarpa*). Broad-leaved cat-tail (*Typha latifolia*) is locally dominant, potentially having increased with more stabilized water levels and increased nutrients resulting from partial impoundment. Northern white-cedar (*Thuja occidentalis*), tag alder (*Alnus rugosa*), white pine (*Pinus strobus*), and mountain holly (*Ilex mucronata*) are scattered within poor fen zones, having increased during a prolonged period of low water levels and since dying off due to four consecutive years of high water levels. Submergent marsh areas dominated by yellow pond-lily (*Nuphar variegata*) are present within

the poor fen. Ecotonal northern shrub thicket, largely consisting of tag alder and sweet gale, and rich conifer swamp dominated by northern white-cedar occur at the margins of the poor fen. A small bog area located west of the poor fen swales is characterized by strongly acidic peats overlying acidic sands.

Despite its relatively small size and isolation from other coastal wetlands, a diversity of plant and animal species have been documented within the wetland complex. After combining data from all known sources, we found 133 plant species have been recorded in SPW. Except for potential non-native cat-tails (e.g., *Typha angustifolia* [narrow-leaved cat-tail] and *Typha xglauca* [hybrid cat-tail]), few exotic plant species were observed within the site, with 87% of the recorded species being native. Invertebrate sampling in and around SPW has been limited to work conducted by the CWMP in 2019 and a lepidopteran survey done by NPS staff during 2000-2006. Aquatic sampling done by the CWMP revealed 37 taxa, most of which came from insect orders (Coleoptera, Diptera, Ephemeroptera, Hemiptera, Lepidoptera, Odonata, and Trichoptera). Annelids, crustaceans, bivalves, and gastropods were also collected. Terrestrial insect surveys resulted in 103 insect species being detected in the area, consisting one wasp, 50 butterfly, and 52 moth species. Seven fish species have been captured in SPW, with those associated with wetland habitats being most abundant. Fifteen amphibian and reptile species have been recorded within and/or adjacent to SPW, consisting of six frog and toad species, four salamander species, two turtle species, and three snake species. Only two of these species, mink frog (*Lithobates septentrionalis*; species of greatest conservation need) and boreal chorus frog (*Pseudacris maculata*; state special concern), are of conservation concern. Substantial data exist on bird use of the Sand Point area, with 173 species being documented in or around the wetland complex. Thirteen species listed as endangered, threatened, or special concern have been recorded using the wetland or adjacent uplands during the breeding or non-breeding seasons.

After assessing the potential effects of the proposed restoration of SPW, we believe the project is unlikely to cause detrimental effects to the natural communities or plant and animal species that occur at the site. Improvement of the hydrologic connection between SPW and Lake Superior should result in a more naturally functioning wetland consistent with conditions occurring before road construction. Restoration of natural water level fluctuations may reduce the likelihood for invasive plant species colonization and expansion by reducing the likelihood of water impoundment and trapping of nutrients. Plant diversity could also increase through the creation of microhabitats resulting from greater water level fluctuations and water exchange. Although changes in plant and animal species assemblages can occur during extreme high and low Lake Superior water levels, we expect those changes to be small and temporary, with generally consistent natural community and plant and animal assemblages over the long term. We expect all microhabitats to persist across the range of future water levels, even if the relative size and location of each changes. In addition, the hydrologic changes proposed by the restoration are expected to be small compared to the natural range of variation occurring within the wetland complex when it was connected to Lake Superior. Overall, we think the benefits of restoring the hydrology and associated functioning of SPW outweigh the possible short-term impacts. If NPS implements the proposed restoration activities, we recommend ecological monitoring be conducted to assess restoration success, evaluate the status of invasive species, and inform adaptive management actions.

Introduction

Sand Point Wetland (SPW) is located near Munising, Michigan in Alger County within the Pictured Rocks National Lakeshore (PRNL) and owned by the National Park Service (NPS). The wetland is hydrologically connected to Lake Superior, primarily via a narrow outflow, with water typically flowing from the wetland to the lake. This connection was altered in the 1930s when a road was constructed to access a new U.S. Coast Guard station. The roadbed continues to alter the wetland's hydrology by obstructing the outflow and artificially raising water levels within the wetland. Beaver activity and beach sedimentation regularly plug the culverts passing under the road and connecting the wetland to the lake (Martin 2018). Shoreline erosion caused by high Lake Superior water levels occurring since about 2015 has resulted in damage to the road, which has been a recurring problem during years of above-average water levels.

The NPS has proposed to restore the hydrology of the SPW through improvement of the connection between the wetland and Lake Superior. Natural exchange of water between the wetland and lake will be facilitated by the construction of a new box culvert or similar structure. In assessing decisions about the restoration of the wetland, staff from PRNL would like to better understand the potential effects of the proposed hydrologic reconnection to the wetland ecosystem and plant and animal species of the site.

The NPS requested that the Michigan Natural Features Inventory (MNFI) evaluate the potential effects of the proposed restoration to the biodiversity of SPW. Specifically, we assessed how the proposed hydrologic restoration could influence existing natural communities and plant and animal species at the site. Our goal was to describe the past and current natural community types and species at the SPW using data provided by the NPS and Great Lakes Coastal Wetland Monitoring Program, recorded within the MNFI Natural Heritage Database, available in published and gray literature, and gathered during a visit to the site by MNFI scientists. Based on the changes to the hydrology expected to result from the restoration project, we evaluated the potential effects to the site's current biodiversity. The information compiled in this report will be considered by NPS staff at PRNL as they plan and implement the restoration project.

Study Area

The Sand Point Wetland (SPW) is located within the PRNL about 3.5 miles northeast of Munising, Michigan on the southern shore of Lake Superior (Figure 1). The wetland complex consists of an interspersed mix of aquatic bed, emergent, scrub-shrub, and forested wetland types and is hydrologically connected to Lake Superior primarily through a small outlet draining westward from the site, but also intermittently along the northeast side of the wetland. The landscape surrounding SPW is largely undeveloped forest, beach, and dunes within PRNL. Some low-density development has occurred for PRNL infrastructure (e.g., buildings, parking lots, trails) and residential housing outside of NPS property.

The natural hydrology of the 17-hectare (42-acre) wetland complex was altered when approximately 300 meters of Sand Point Road was constructed at the western margin of the wetland across the outlet to Lake Superior (Figure 1; Martin 2018). Installation of a revetment on the north shore of Sand Point has also altered the natural hydrology of the wetland. During a 2018 hydrologic investigation conducted by NPS Water Resources Division staff, they confirmed

the topography slopes slightly from the wetland down toward Lake Superior, with surface water draining slowly from SPW to the Lake (Wagner et al. 2018). Martin (2018) noted that prior to road construction the natural westward drainage of the wetland likely occurred through a low-gradient main channel and a small number of secondary channels. Under normal conditions, the water table within the wetland would have fluctuated with changes to Lake Superior water levels and was likely also influenced by beaver activity, sand erosion/deposition, and ice/debris jams; however, we do not expect that water impoundment caused by beavers or sand/debris deposition would have been substantial or sustained for long periods.



Figure 1. Location of Sand Point Wetland complex and proposed restoration site within Pictured Rocks National Lakeshore.

Two metal culvert pipes (primary and secondary) were placed under the road to facilitate drainage but the elevation of the primary culvert is too low for current lake levels (Figure 2; Martin 2018). Lake sedimentation from wave action and beaver activity regularly plug the culverts. The culverts have not provided sufficient drainage for the wetland, resulting in the localized impoundment of water within the wetland east of the road. In 2018, Wagner et al. (2018) confirmed the water level within SPW was approximately 15 cm (0.50 feet) higher than the Lake Superior water level, indicating water impoundment likely caused by the roadbed. In addition to increased water depths, water impoundment could result in a more stabilized hydroperiod with a reduction in normal water level fluctuations. Fluctuating water levels are a normal process for wetlands and important to ecosystem functioning. Given the short- and long-

term changes observed in Lake Superior water levels (Figure 3), SPW undoubtedly experienced a range of hydroperiod fluctuations associated with the lake.



Figure 2. View of culvert west of Sand Point Road that serves as the primary connection between Sand Point Wetland and Lake Superior. Photograph by M.J. Monfils.

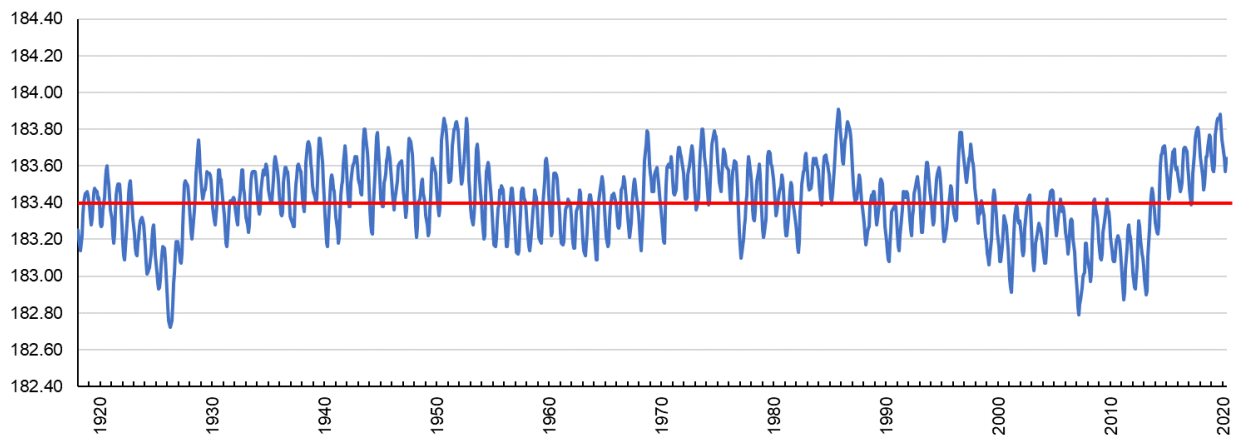


Figure 3. Average monthly water level for Lake Superior in meters (International Great Lakes Datum 1985) from January 1918 to May 2020 (data obtained from NOAA Great Lakes Environmental Research Laboratory, <https://www.glerl.noaa.gov/data/dashboard/data/>, accessed 22 June 2020. Red line indicates the long-term mean water level.

The NPS is proposing to restore SPW by improving the natural hydrological connection between the wetland and Lake Superior. In addition to restoring normal wetland functioning, restoration would also help protect the road infrastructure and reduce maintenance costs. Martin (2018) suggested replacing the existing two culverts with an open-span structure, such as a natural-bottom box culvert, a bridge, or a causeway with additional culverts. These restoration efforts could likely achieve a near natural hydrologic connection (Martin 2018). In conducting our assessment, we assumed that whatever structural option is selected for the restoration, the hydrology will function naturally with short- and long-term water level fluctuations that mimic those of Lake Superior (Figure 3).

Methods

Past and Current Conditions

To assess the potential impacts of the proposed wetland restoration project, MNFI searched for and compiled all available information about the natural communities, vegetation, and animals known from the SPW. In addition to internal data provided by the NPS, we examined information from the MNFI Natural Heritage Database (NHD), Great Lakes Coastal Wetland Monitoring Program (CWMP), Michigan Herp Atlas, eBird, and published and gray literature. Other sources of information, such as the circa 1800 vegetation (Comer et al. 1995) and aerial imagery, were also reviewed. During a site visit conducted in October 2019, MNFI scientists collected information on SPW, such as species observed, hydrologic conditions, soil moisture and texture, potential threats, and landscape context.

Prior to conducting our site visit, we reviewed the NHD information, natural community and rare species abstracts, aerial photographs, and vegetation types from 2010 NPS vegetation mapping to identify potential natural communities and rare species that could occur in the wetland complex. We used this information to identify and prioritize areas for in-field site assessments. During the site visit, MNFI scientists assessed potential habitats for rare animal species and conducted meander surveys for natural communities and rare plant species.

Plant species habitat requirements and currently known distributions for rare species were reviewed to determine those species with the greatest likelihood of occurrence at Sand Point. The list was broad, erring on the side of inclusivity to ensure capturing as many species with some chance of occurring at SPW as possible. Thirty-three rare plant species were identified as potential survey targets according to natural community type, with several natural community types grouped together because of overlap in rare species (Table 1). Meander surveys were conducted throughout the wetland complex within each vegetation type to assess the availability of microhabitats for the target species. Aquatic sampling was not conducted due to time constraints. Species observed during the meander survey were noted and added to a running list of all species previously identified for SPW during past studies. We made special effort to document the occurrence of *pyrola* species to confirm the presence of *Pyrola minor*.

Expected Conditions

After compiling information on the current biodiversity of SPW, MNFI scientists evaluated the potential changes to natural communities and plant and animal species occurrences caused by restoration of the hydrology. We assessed how the restored hydrology, which would result in

water levels that fluctuate seasonally and annually with changes in Lake Superior levels, could influence the current natural communities and plant and animal species using the site.

Table 1. Rare plant species with potential to occur at Sand Point Wetland targeted during meander surveys conducted by MNFI in fall 2019.

Natural Community Type(s)	Scientific Name	Common Name	Federal Status ¹	State Status ²
Open dunes, Great Lakes barrens, Sand and gravel beach	<i>Adlumia fungosa</i>	climbing fumitory		SC
	<i>Calamagrostis stricta</i>	northern reedgrass		T
	<i>Cirsium pitcheri</i>	Pitcher's thistle	LT	T
	<i>Cypripedium arietinum</i>	ram's head lady-slipper		SC
	<i>Elymus glaucus</i>	blue wild-rye		SC
	<i>Iris lacustris</i>	dwarf lake iris	LT	T
	<i>Leymus mollis</i>	American dune wild-rye		SC
	<i>Mimulus michiganensis</i>	Michigan monkey-flower	LE	E
	<i>Neottia auriculata</i>	auricled twayblade		SC
	<i>Orobanche fasciculata</i>	clustered broomrape		T
	<i>Salix pellita</i>	satiny willow		SC
	<i>Solidago houghtonii</i>	Houghton's goldenrod	LT	T
	<i>Tanacetum bipinnatum</i>	Lake Huron tansy		T
Dry-mesic northern forest	<i>Pterospora andromedea</i>	pine-drops		T
	<i>Pyrola minor</i>	lesser pyrola		**
Localized sandstone cliff	<i>Cystopteris laurentiana</i>	Laurentian fragile fern		SC
	<i>Dryopteris filix-mas</i>	male fern		SC
	<i>Empetrum nigrum</i>	black crowberry		T
Rich conifer swamp, Hardwood-conifer swamp	<i>Calypso bulbosa</i>	calypso orchid		T
	<i>Coptidium laponicus</i>	Lapland buttercup		T
	<i>Cypripedium arietinum</i>	Ram's head lady-slipper		SC
	<i>Empetrum nigrum</i>	black crowberry		T
	<i>Mimulus michiganensis</i>	Michigan monkey-flower		T
	<i>Pinguicula vulgaris</i>	butterwort		SC
	<i>Pyrola minor</i>	lesser pyrola		**
	<i>Stellaria crassifolia</i>	fleshy stitchwort		E
Poor fen	<i>Carex wiegandii</i>	Wiegand's sedge		SC
	<i>Drosera anglica</i>	English sundew		SC
	<i>Rubus acaulis</i>	dwarf raspberry		E
Northern shrub thicket	<i>Neottia auriculata</i>	auricled twayblade		SC
	<i>Pyrola minor</i>	lesser pyrola		**
	<i>Stellaria crassifolia</i>	fleshy stitchwort		E
Emergent marsh, Submergent marsh	<i>Callitriche hermaphrodita</i>	autumnal water-starwort		SC
	<i>Myriophyllum alterniflorum</i>	alternate-leaved water-milfoil		SC
	<i>Myriophyllum farwellii</i>	Farwell's water-milfoil		T
	<i>Nuphar microphylla</i>	Small yellow pond-lily		E
	<i>Potamogeton confervoides</i>	alga pondweed		SC
	<i>Potamogeton pulcher</i>	spotted pondweed		E

¹LE = federally listed as endangered, LT = federally listed as threatened.

²E = state endangered, T = state threatened, SC = state special concern, ** = no longer listed.

Results and Discussion

Natural Communities

Past and Current Community Types

Little information is available about the natural community types that existed in SPW prior to construction of Sand Point Road. Vegetation circa 1800 information (Comer et al. 1995) suggests SPW consisted of mixed conifer swamp; however, these data are known to do a poor job of describing wetlands at small spatial scales, so this classification is likely inaccurate. The current composition of the wetland and surrounding uplands is best described as the wooded dune and swale natural community type (Kost et al. 2007, Cohen et al. 2015). Dune and swale complexes across the Great Lakes region developed over several thousand years (Albert and Comer 1999). Although species composition and structure of the wetland and adjacent uplands have undoubtedly changed with fluctuations in Lake Superior water levels and climate, natural disturbances (e.g., wildfire, windthrow, and beaver flooding), as well as anthropogenic disturbances (e.g., fire suppression, logging), we believe the natural community types observed today are generally consistent with those most likely present prior to European settlement.

Sand Point represents a unique variant of wooded dune and swale complex. Occurring in a channel in Island Harbor between Lake Superior and Munising Bay, Sand Point is protected by Grand Island, which has allowed the formation of alternating low, narrow dune ridges and broad swales through wave and wind action. Sand point occurs at the base of a steep slope under a sandstone escarpment with localized sandstone cliff. The point is a cusplate foreland formed by predominant currents flowing in two directions from southwest to northeast (eddy current) and from northeast to southwest (longshore current). As a result, this Great Lakes coastal wetland is subject to dynamic change in space and time with the depositional and erosional forces of the Great Lakes shifting seasonally and from year to year as the water level of Lake Superior changes (Figure 3). Low water levels result in the expansion of the point due to deposition of sand, and high water levels result in the gradual shrinking of the complex due to erosion. Within the complex, the swales expand and become wetter as the lake levels rise and shrink and become less wet as the lake levels fall. In addition, the hydrology of the swale that occurs adjacent to the upland slope is also influenced by groundwater and inputs from a small stream that meanders through the swale, has numerous small branches, and outlets along the southwestern portion of the point. The hydrology of the wetland complex is also impacted by beaver, which build dams along the stream and its channels.

Swales within the complex vary in composition and include four open water areas, or ponds (Figure 1), but are primarily characterized as poor fen. Additional wetland types include submergent marsh, bog, northern shrub thicket, and rich conifer swamp. The areas of poor fen (Figure 4) are dominated by a low shrub cover with sweet gale (*Myrica gale*) and leatherleaf (*Chamaedaphne calyculata*) and characteristic graminoids, including bluejoint grass (*Calamagrostis canadensis*) and wiregrass sedge (*Carex lasiocarpa*). Broad-leaved cat-tail (*Typha latifolia*) is locally dominant (Figure 5) and has likely increased with stagnation of water flow, potentially elevated nutrient levels, and increased temperature (Gucker 2008) associated with partial impoundment. Wisheu and Keddy (1992) found that broad-leaved species such as cat-tails tend to outcompete other species in wetlands with high fertility and low disturbance (e.g., stabilized water levels). Impounded Great Lakes coastal wetlands have been found to trap organic matter and nutrients (Herrick et al. 2007), thus the altered hydrology of SPW could be creating conditions more conducive to cat-tail expansion.



Figure 4. Poor fen zone of Sand Point Wetland. Photograph by J.G. Cohen.



Figure 5. Broad-leaved cat-tail in Sand Point Wetland. Photograph by J.G. Cohen.

Tall shrubs and conifer saplings occur scattered within the poor fen and include northern white-cedar (*Thuja occidentalis*), tag alder (*Alnus rugosa*), white pine (*Pinus strobus*), and mountain holly (*Ilex mucronata*), and along with the low shrubs, increased due to the prolonged period of low water levels prior to 2015 (Figure 3). Four consecutive years of high water levels in the poor fen has resulted in the mortality of woody species, most notably northern white-cedar. The areas of poor fen are minerotrophic with slightly acidic to circumneutral (pH 6.8-7.0) peats of variable depth occurring over circumneutral sands (pH 7.0). Poor fen is concentrated in the open wetland swales just west of the upland slope in areas influenced by groundwater seepage (Figure 1). Areas of submergent marsh occur within these poor fens and are dominated by yellow pond-lily (*Nuphar variegata*). The margins of the poor fen swales are characterized by ecotonal northern shrub thicket and rich conifer swamp (Figure 6). Portions of swales that support northern shrub thicket are dominated by sweet gale and tag alder with winterberry (*Ilex verticillata*) locally common. Forested portions of the swales support rich conifer swamp dominated by northern white-cedar. A bog swale dominated by leatherleaf occurs to the west of the poor fen swales (Figure 1), is not influenced by groundwater inputs, and is characterized by strongly acidic (pH 4.5) peats overlying acidic sands (pH 5.0-6.0).



Figure 6. Northern shrub thicket (foreground) transitioning to rich conifer swamp (background) near wetland perimeter. Photograph by J.G. Cohen.

The low dune ridges are primarily dry-mesic northern forest with localized areas of open canopy dominated by beach-heath (*Hudsonia tomentosa*; Figure 7). Forested ridges are dominated by white pine (*Pinus strobus*) and red pine (*Pinus resinosa*) occurring on fine-textured dune sands that are slightly acidic (pH 6.0). A 47.5 cm dbh red pine was cored and estimated to be over 100 years old with good growth for the first 60 years. Fire sign was noted in the upland suggesting that fire is an important disturbance factor within these upland dune ridges.



Figure 7. Dune ridge with open-canopied dry-mesic northern forest. Photograph by J.G. Cohen.

Anthropogenic impacts to the complex include the establishment of the revetment at the tip of the point to protect cultural resources (i.e., the former Coast Guard Station and current Ranger's Station) and the construction of the paved road to access the station. The access road along the west side of the complex was constructed in the 1930s and drastically altered the hydrology of the adjacent swale. Construction included the placement of approximately 300 m (1000 ft) of fill within the wetland complex oriented perpendicular to the main outlet of the wetland and also the establishment of two metal-pipe culverts intended for drainage. These culverts are routinely blocked by beach sands and beaver dams resulting in elevated water levels in the swale adjacent to the road. The road, fill, and inefficient culverts have created an artificial impoundment that not only increases water levels in the swale but also reduces the connection of the wetland complex to Lake Superior. The backwater effect has likely contributed to the

localized increase in submergent marsh and inundated poor fen in the swale just east of the road. We expect natural community changes have been primarily localized to the swale near the culvert, where the hydrologic changes have been most pronounced and peat development more limited compared to areas less affected by water impoundment. Portions of the wetland further away from the culvert and thus less affected by hydrologic change have accumulated greater depths of peat. Peat accumulated above the water table serves to buffer these areas from hydrological changes, thus making them more resilient to water level fluctuations. In addition to locally raising water levels, the road has likely altered the hydroperiod of the swale. Coastal wetlands typically have peak water levels in mid to late summer while those that are impounded typically peak in the spring and then gradually decline during the summer. This shift in hydroperiod impacts the species composition and structure of the impacted swale and likely favors species associated with prolonged spring inundation and the expansion of submergent marsh.

Expected Community Types

The proposed restoration project will involve the removal of the fill and replacement of the failing culverts with a natural-bottom box culvert or short bridge span with the intended goal of restoration of the natural hydrologic condition and unobstructed hydrologic exchange between the lake and the wetland. Multiple factors are impacting this complex including fluctuation of lake levels, local impacts of the road and revetment, beaver flooding, windthrow, groundwater seepage, surface flow, and fire. Because of the complex interaction of these disturbance factors, it is hard to definitively predict how the wetland will change with establishment of a box culvert or causeway to improve the connection of the wetland to Lake Superior. The impacts will be localized and include improved connectivity to Lake Superior. As lake levels rise, we expect that the swales will become wetter and expand in size. How long these high lake levels are sustained will determine impacts to natural community composition and structure. High water levels for several years will result in the increase in submergent and emergent marsh and the decrease in shrub-dominated wetland (shrub fen). We expect an overall increase in submergent floating plants and emergent graminoids and a decrease in ericaceous shrubs and the scattered conifers that now occur within the fen swales. Inundation of wetlands will slow the decomposition of organic soils and will likely lead to the overall increase in extent and depth of organic soils throughout the complex. Prolonged periods of low lake levels will likely result in a decrease in submergent marsh and emergent marsh and the expansion of poor fen as peats develop. Shrub and tree cover within these fen swales will likely increase during prolonged periods of low water levels. Low water levels may lead to the decomposition of organic soils that are exposed to air. We expect an overall decrease in organic soil extent and depth during prolonged dry periods. Where groundwater influences the swales and conditions remain inundated or saturated, soil conditions will likely remain stable. Where the road has created an artificial impoundment, we expect that the re-establishment of natural outflow will result in the localized reduction in submergent marsh and the increase in emergent marsh and poor fen. However, these predicted trends could be altered by disturbance factors that are independent of lake level fluctuations (e.g., beaver flooding and fire) and the restoration efforts.

To conclude, in terms of natural communities, fixing the culverts will benefit the complex by locally restoring the hydrologic connection to Lake Superior. This connection will increase the stochastic change of this dynamic complex.

Vegetation

Past and Current Plant Diversity

Comprehensive plant inventories of each vegetation type have not been conducted in SPW. The earliest documentation of the flora in the Sand Point area that we uncovered was an MNFI site survey conducted in 1982 (Chapman 1982); however, sampling was conducted in the uplands and only a general description was made of the wetland complex. A subsequent botanical inventory conducted along the marsh boardwalk resulted in the documentation of 75 species (Schultz 1989). Following these early studies, the NPS Vegetation Inventory Program was implemented for the Pictured Rocks National Lakeshore and a vegetation map was generated for the entire park (Hop et al. 2010). Derived from reiterative aerial imagery interpretation and plot sampling, the vegetation map for SPW includes a mosaic of six different wetland types that were concisely described by Wagner et al. (2018) as: “shallow ponds with floating-leaved or submerged aquatic plants, leatherleaf sweet gale shore fen, gray alder and dogwood-willow shrubland, and white cedar-alder swamp. These wetlands are interspersed in some areas with fingers of white cedar-boreal conifer mesic forest.” Plot sampling conducted within SPW for the NPS vegetation inventory documented 43 vascular plant species, including 11 trees, 14 shrubs, 11 forbs, two ferns, and five graminoids (Bozic and Previant 2006). These plot data included nine wetland species not detected by Schultz (1989), whereas Schultz found 40 species that were not detected in the 2006 vegetation plot sampling. Wagner et al. (2018) noted five woody species and five herbaceous species observed when conducting the wetland delineation, two of which were not previously documented. In addition, the Coastal Wetland Monitoring Program (CWMP; Uzarski et al. 2017) sampled SPW in 2019 and recorded 15 vascular plant species, four of which had not been documented in the previous studies. A single occurrence of *Pyrola minor* (lesser pyrola), previously listed as state special concern, was documented at SPW on 15 August 1973. Twelve occurrences of this species are known in five counties in Michigan’s Upper Peninsula (Keweenaw [including Isle Royale], Houghton, Alger, Luce, and Chippewa). To date, no other listed plant species have been reported and confirmed from SPW in the MNFI NHD.

During our October 2019 site visit, MNFI conducted meander surveys to generally ground truth the reported vegetation types, seek out potential microhabitats that could support rare species, and assess the potential impacts of hydrologic restoration to overall plant species diversity and potential rare plant species that could occur at the site. Conducting a systematic plant inventory was beyond the scope of this study; however, all species noted during the 2019 site visit were compiled along with species noted in previous studies to begin the development of a comprehensive plant species list specific to Sand Point (Appendix A). For ease of reporting this list was compiled using the Floristic Quality Assessment (FQA; Reznicek et al. 2014); however, it should not be construed as an official FQA for the site. Although it does provide a glimpse of the overall flora of SPW, thorough surveys have not been conducted for each natural community across the growing season. Such surveys are recommended to provide better baseline data for comparison over time and would likely substantially increase the number of species known from the site.

Currently, SPW is a relatively small mosaic of poor fen with patches of northern shrub thicket and rich conifer swamp, surrounding four large swales with varying degrees of emergent marsh, submergent marsh, and open water. To the east is a hardwood-conifer swamp with pockets of mesic northern forest and boreal forest that extends to the base of a vertical sandstone cliff escarpment. Mesic northern forest occurs at the summit of the cliff eastward. Numerous seepage streams emerge from the cliff coursing through the swamp and forest complex towards the swales. These seeps increase the groundwater influence at the eastern-most edge of the

wetland. The lakeward edge of the point is primarily sand beach and dry-mesic forested dune ridges. These findings largely mirror the findings in previous studies. Dominant species of these natural communities are provided in the natural community section of this report. We were able to expand the list of species observed at SPW substantially during our brief visit, bringing the total to 133 species. All species documented to date from our survey and in studies available to us are compiled in Appendix A.

Except for the sand beach and dune ridges, few disturbances and non-native species were observed at SPW. An exception is the establishment of cat-tails in several of the swales. These populations were studied both genetically and through pollen analysis (Marburger and Kainulainen 2010, Marburger 2012) to determine whether they are native *Typha latifolia* (broad-leaved cat-tail), non-native *Typha angustifolia* (narrow-leaved cat-tail), *Typha Xglauca* (hybrid cat-tail), or some combination thereof. There is widespread agreement that the morphological characters typically used to distinguish cat-tail species (e.g., leaf width, length of female inflorescence, gap width between male and female flowers) are too variable and genetic studies are needed to reliably distinguish them. However, the genetic and pollen studies have not been convincingly conclusive for cat-tail samples at SPW. Non-native and hybrid taxa were not detected using 6 chromosomal microsatellite markers, but morphological measures indicated the presence of hybrids and Marburger (2012) recommended the study be redone using at least four additional satellite markers. Pollen grain samples of individual plants from the site contained a mixture of pollen grain morphology, which is the signature for hybrid cat-tails. Further work is clearly needed to definitively identify cat-tail species at SPW.

The sandy beach has been highly disturbed by visitor use over the years and was the only area with a considerable number of non-native invasive species, such as *Bromus inermis* (brome grass), *Dactylis glomerata* (orchard grass), *Phalaris arundinacea* (reed-canary grass), *Hypericum perforatum* (common St. John's-wort), *Silene vulgaris* (bladder campion) and *Vinca minor* (periwinkle). The active zone is narrow and subject to continual erosion and depositional processes that have been impacted by the stone revetment on the northern shore. None of the typical dune rarities were observed and it is not likely that the majority of the potential rare target species for open dunes and sand and gravel beach occur at Sand Point. Two possible exceptions include pinedrops and ram's-head orchid, both of which require dedicated effort to find. Pinedrops is sporadic, not appearing every year, and the tiny ram's head orchid is not only difficult to find but has a short early spring flowering window. Both species could occur in the low back dune ridges that border the wetland. Interdunal wetlands, often associated with open dunes and frequently harboring Houghton's goldenrod, were not detected at the SPW.

We found no evidence of rich fen pockets or significant zones of rich conifer swamp that might harbor rare species, such as butterwort, English sundew, Lapland buttercup, black crowberry, Michigan monkey-flower, limestone oak fern, or calypso orchid; however, the seeps and the swamp complex have high microhabitat heterogeneity and it would be worth surveying for these species, as well as the endangered fleshy stitchwort, that could occur along the seepage streams. The latter species and auricled twayblade could also be sought along the margins of the swales that grade into northern shrub thicket.

Several collections of pyrola leaves were taken from the hardwood-conifer swamp complex and dry-mesic forested dune; however, no occurrences were observed flowering, which is necessary for a definitive species determination. Suitable habitat was plentiful and it is likely that lesser pyrola persists at Sand Point. Although lesser pyrola is no longer considered a special concern species, it remains uncommon in Michigan.

No rare plant species were observed on the sandstone cliff during our site visit, but the site appears to be suitable habitat for Laurentian fragile fern, which typically occurs on calcareous rock outcrops of limestone and sandstone. The association of the escarpment with pockets of mesic northern forest to the east and expansive mesic northern forest from the summit westward, provides motivation for seeking male fern in the future.

There are few rarities known from the poor fen community type; however, it would be worth searching diligently for *Carex wiegandii* and, although not likely, dwarf raspberry, which can occur in poor fen. The emergent and submergent zones of the swales should be surveyed by meander snorkeling and rake-toss sampling for autumnal water-starwort, alternate-leaved and Farwell's water-milfoils, as well as alga and spotted pondweeds. Table 2 lists the rarities noted above, where they might be found at Sand Point, and microhabitat descriptions derived from known occurrence data in Michigan's NHD.

Expected Plant Diversity

Replacement of the culverts along the west shoreline will improve the hydrologic connection between the wetland and Lake Superior, resulting in natural fluctuations of water levels with little expected change in overall plant species diversity. The frequent blockage of the existing culverts largely affects water levels in the swales closest to the lake by increasing and maintaining high water levels artificially. The main effect is the loss of woody species and an increase in emergent and submergent marsh, which will continue with longer duration of high water. High water levels facilitate cat-tail establishment, persistence, and expansion, to the detriment of wetland plant diversity. The artificial blockage of the existing culverts also reduces water flushing which can elevate nutrient levels, also favoring establishment and expansion of cat-tail and potentially other invasive species (e.g., *Phragmites australis*). Re-establishment of the near-natural ebb and flow of water levels with Lake Superior will favor a reduction in these impacts over time and long-term loss of species diversity is not anticipated. No rare species have been documented to date in the swales that are most affected by the blocked culverts and it seems unlikely that natural fluctuations in emergent and submergent marsh would substantially impact potential aquatic rarities should they be documented there in the future.

Although improving natural water flow between SPW and Lake Superior will favor a reduction in the impacts noted above, the expansion of cat-tails remains of particular concern. Restoration will make conditions less conducive to cat-tail expansion, but the existing population is likely to survive and could continue to expand. Populations of narrow-leaved and hybrid cat-tail are spreading rapidly throughout the state at the expense of native wetland diversity, and early detection and response is warranted. Native cat-tail does not appear to have ever been a significant component of SPW, and we recommend consideration of proactive control prior to the inevitable arrival of narrow-leaved and hybrid cat-tail. Once established, these species will be much more difficult and costly to control and will be devastating to SPW and the habitat diversity it now provides. Control can be accomplished by targeted and permitted herbicide application by experienced and licensed applicators.

Table 2. Rare plant species with potential to occur at Sand Point and the natural community types, habitats, and microhabitats in which they occur.

Scientific Name	Common Name	Status ¹	Natural Community Type and Habitat	Microhabitat Description
<i>Calypso bulbosa</i>	calypso orchid	T	Old beach ridges, hardwood-conifer swamp	Spruce-balsam-cedar swamps, moist coniferous forests with cool soils, and Great Lakes shoreline forests dominated by spruce, cedar, fir, and paper birch.
<i>Callitriche hermaphroditica</i>	autumnal water-starwort	SC	Submergent marsh of swales	Shallow water, up to 3-4 ft deep, often stranded on sand flats or muddy stream edges, or in shallow portions of marshes.
<i>Carex wiegandii</i>	Wiegand's sedge	SC	Edges of east 'bog swale' and openings in poor fen	Thin peatlands on glacial lakeplains, occasionally in open bogs, and often in transition zones between poor conifer swamp and sedge meadow or shrub thickets. Bogs and acidic swamps.
<i>Cypripedium arietinum</i>	ram's head lady-slipper	SC	Dune ridges, dry-mesic northern forest, hardwood-conifer swamp	Cedar-fir-spruce beach ridges and in forests along the Great Lakes shoreline in northern Michigan. Also occurs in upland jack, red, and white pine forests, in conifer-dominated swamps, and at the margins of bedrock glades.
<i>Cystopteris laurentiana</i>	Laurentian fragile fern	SC	Localized sandstone cliff	Calcareous rock outcrops, usually limestone or sandstone, mostly in partial shade or shade.
<i>Dryopteris filix-mas</i>	male fern	SC	Localized sandstone cliff	Rocky, sheltered sites (cliffs, sinkholes, ravines, crevices) in mixed northern hardwood forests in the NLP and UP. Often on limestone bedrock but not restricted to calcareous substrates.
<i>Empetrum nigrum</i>	black crowberry	T	Dune ridges, hardwood-conifer swamp near seeps	Sandstone rock outcrops, in open, marly cedar or black spruce fens, and on exposed sandy bluffs and pine-dominated dune ridges. One historic record from an acidic peatland complex.
<i>Gymnocarpium robertianum</i>	limestone oak fern	T	Localized sandstone cliff, rich conifer swamp pockets	Primarily in northern white cedar-dominated swamps in NLP and UP, but can also occur in shaded, cedar-dominated limestone glades and shaded limestone cliffs.
<i>Myriophyllum alterniflorum</i>	alternate-leaved water-milfoil	SC	Submergent marsh of swales	In soft water lakes of UP, in particular, the St. Mary's River channel and bays of Isle Royale.
<i>Myriophyllum farwellii</i>	Farwell's water-milfoil	T	Submergent marsh of swales	In shallow water of lakes, ponds, and marshes with mucky or peaty (occasionally sandy) bottoms in the UP.

Table 2. Continued.				
Scientific Name	Common Name	Status ¹	Natural Community Type and Habitat	Microhabitat Description
<i>Neottia auriculata</i>	auricled twayblade	SC	Northern shrub thicket; potentially in hardwood-conifer swamp	Along small stream drainages near the bare sand and on rocky ledges of the shoreline. This species has a strong preference for moist, acid, sandy to humic soils and a cool microclimate.
<i>Nuphar microphylla</i>	small yellow pond-lily	E	Emergent marsh	Perennial aquatic of softwater lakes and marshes in the UP.
<i>Potamogeton confervoides</i>	alga pondweed	SC	Submergent marsh of swales	This species usually occurs in somewhat acidic lakes, where it may be found in both shallow and deep water.
<i>Potamogeton pulcher</i>	spotted pondweed	T	Swales, especially the western - most 'bog-swale'	Michigan collections have come from 1-9 feet of water, usually rooted in a peaty bottom, with one collection obtained from a sandy-gravelly lake bottom substrate.
<i>Pterospora andromedea</i>	pinedrops	T	Dry-mesic northern forest on dune ridges	Dry to moist woods dominated by pines or mixed conifers, usually with a well-developed needle duff. Along Great Lakes shorelines, found in boreal forest and on forested backdunes.
<i>Pyrola minor</i>	lesser pyrola	**	Dry-mesic northern forest on dune ridges, hardwood-conifer swamp	Locally in mixed boreal forest & thickets along and near Lake Superior. Very local under conifers (cedar, jack pine) and edges of alder or spruce-fir thickets, usually near Lake Superior.
<i>Rubus acaulis</i>	dwarf raspberry	E	Poor fen swales towards sandstone cliff	Open to partially forested poor to rich fens, often on hummocks at the margins of large peatland complexes
<i>Stellaria crassifolia</i>	fleshy stitchwort	T	Northern shrub thicket, seeps of hardwood-conifer swamp	Cold springs and seepy areas along river edges.

¹E = state endangered, T = state threatened, SC = state special concern, ** = no longer listed.

Macroinvertebrates

Past and Current Use

Invertebrates are one of the most diverse groups of animals in inland and coastal freshwater wetlands. They are crucially important to the overall function of wetland ecosystems because of their role in food webs (Schwaritz and Batzer 1999). They feed on a variety of wetland plants and algae and are consumed themselves by a wide variety of birds, fish, and bats (Schwaritz and Batzer 1999, and references therein). Aquatic macroinvertebrates have been widely used as indicators when evaluating the condition of wetlands (Burton et al. 1999, Environmental Protection Agency 2003). In the Great Lakes Region, a coordinated effort to carry-out standardized bioassessment procedures and collect baseline reference data on the condition of Great Lakes coastal wetlands was initiated in 2010 through the Great Lakes Coastal Wetland Monitoring Program (CWMP; Uzarski et al. 2017). These procedures include aquatic macroinvertebrate community composition as one factor in assessing conditions. The SPW was sampled by the CWMP in 2019 and the results are summarized in Table 3. The major macroinvertebrate taxa groups with potential to occur at SPW are the Crustaceans (Isopods, Amphipods, and Decapods), Insects, Mollusks (Gastropods, Sphaeriidae, Unionidae), Annelids (Oligochaeta and Hirudiniformes), and Nematodes.

Aquatic Macroinvertebrates

There is an apparent absence of unionids (native freshwater mussels) and very low abundance of Sphaeriids (fingernail clams) in the wetlands at Sand Point as indicated by the results of the CWMP survey in 2019 (Table 3). The acidic or circumneutral soils of the natural community types present at SPW may indicate low levels of calcium availability for mollusks, which could be a potential limiting factor for these aquatic taxa. However, the pH of water in Sand Point wetlands ranged from 7.19 to 7.76, and total alkalinity ranged from 112 to 115 as measured by CWMP in 2019. These values appear sufficient to support freshwater mollusks. Aquatic snail populations have been shown to tolerate pH as low as 5.2 without being extirpated from inland lakes (Okland 1992).

We queried the NHD and the only rare aquatic invertebrate species documented within an 8-km (5-mile) radius of SPW is the unionid mussel eastern elliptio (*Elliptio complanata*, state special concern). This species was documented at the southern end of Grand Island in Murray Bay approximately 3 km (2 miles) west-northwest of Sand Point in 1979 and in Deer Lake approximately 26 km (16 miles) west of Sand Point in 1962. Eastern elliptio occurs in both river and lake habitats.

Another rare mussel with some potential to occur in the SPW is the state threatened slippershell (*Alasmodonta viridis*), which was documented as close as 29 km (18 miles) south in the Indian River. Slippershell typically occurs in small headwater streams and would be most likely to inhabit the stream channels connecting the four ponds/swales. Other rare aquatic macroinvertebrate species with potential to occur in SPW include campeloma spire snail (*Cincinnatia cincinnatiensis*) and Great Lakes physa (*Physella magnalacustris*), both species of special concern in Michigan. Campeloma spire snail occurs in rivers, lakes, and springs, and Great Lakes physa occurs in cobble substrates of Great Lakes and inland lakes. There may be some potential for the boulder and cobble habitat along the north facing shoreline of Sand Point to be suitable for Great Lakes physa.

Table 3. Macroinvertebrate taxa identified during sampling conducted by the Great Lakes Coastal Wetland Monitoring Program during 2019.

Phylum	Class	Order	Family	Lowest Taxonomic Level
Annelida	Clitellata			Oligochaeta (subclass)
Arthropoda	Arachnida	Acari		Acari (order)
Arthropoda	Insecta	Coleoptera	Hydrophilidae	<i>Tropisternus</i> (genus)
Arthropoda	Insecta	Diptera	Ceratopogonidae	<i>Bezzia</i> / <i>Palpomyia</i> (genus)
Arthropoda	Insecta	Diptera	Chironomidae	Chironomini/Pseudochironomini (tribe)
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae (subfamily)
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae (subfamily)
Arthropoda	Insecta	Diptera	Chironomidae	Tanytarsini (tribe)
Arthropoda	Insecta	Diptera	Culicidae	Culicidae (family)
Arthropoda	Insecta	Diptera	Tabanidae	<i>Chrysops</i> (genus)
Arthropoda	Insecta	Ephemeroptera	Baetidae	Baetidae (family)
Arthropoda	Insecta	Ephemeroptera	Baetidae	<i>Cloeon dipterum</i>
Arthropoda	Insecta	Ephemeroptera	Caenidae	<i>Caenis</i> (genus)
Arthropoda	Insecta	Hemiptera	Belostomatidae	<i>Belostoma</i> (genus)
Arthropoda	Insecta	Hemiptera	Belostomatidae	<i>Lethocerus</i> (genus)
Arthropoda	Insecta	Hemiptera	Corixidae	Corixidae (family)
Arthropoda	Insecta	Hemiptera	Corixidae	<i>Sigara</i> (genus)
Arthropoda	Insecta	Hemiptera	Gerridae	Gerridae (family)
Arthropoda	Insecta	Hemiptera	Mesoveliidae	<i>Mesovelis</i> (genus)
Arthropoda	Insecta	Hemiptera	Nepidae	<i>Ranatra</i> (genus)
Arthropoda	Insecta	Hemiptera	Veliidae	<i>Microvelis</i> (genus)
Arthropoda	Insecta	Lepidoptera	Crambidae	<i>Acentria</i> (genus)
Arthropoda	Insecta	Lepidoptera	Crambidae	<i>Parapoynx</i> (genus)
Arthropoda	Insecta	Odonata	Aeshnidae	<i>Aeshna</i> (genus)
Arthropoda	Insecta	Odonata	Coenagrionidae	Coenagrionidae (family)
Arthropoda	Insecta	Odonata	Corduliidae	<i>Epitheca</i> (genus)
Arthropoda	Insecta	Odonata	Libellulidae	<i>Sympetrum</i> (genus)
Arthropoda	Insecta	Trichoptera	Phryganeidae	<i>Phryganea</i> (genus)
Arthropoda	Malacostraca	Amphipoda	Hyalellidae	<i>Hyalella</i> (genus)
Arthropoda	Malacostraca	Isopoda	Asellidae	<i>Caecidotea</i> (genus)
Cnidaria	Hydrozoa	Anthoathecatae	Hydridae	<i>Hydra</i> (genus)
Mollusca	Bivalvia	Veneroida	Sphaeriidae	<i>Sphaerium</i> / <i>Musculium</i> (genus)
Mollusca	Gastropoda	Basommatophora	Physidae	<i>Physa</i> (genus)
Mollusca	Gastropoda	Basommatophora	Planorbidae	<i>Gyraulus</i> (genus)
Mollusca	Gastropoda	Basommatophora	Planorbidae	<i>Helisoma</i> (genus)
Mollusca	Gastropoda	Basommatophora	Planorbidae	Planorbidae (family)
Mollusca	Gastropoda	Neotaenioglossa		Rissooidea (superfamily)

We queried the NHD for rare aquatic insect records and none have been documented in the area. The only possible aquatic insect with slight potential to occur within the SPW would be the incurvate emerald dragonfly (*Somatochlora incurvata*, state special concern). This species has been documented approximately 32 km (20 miles) to the southeast. Incurvate emeralds occur in a variety of wetland types, including patterned peatlands, bogs, and fens (Slaughter and Cuthrell 2016). If it were to occur at this site, it would likely be in the poor fen zone.

There are no known studies of aquatic insects in the Sand Point Area, except for the work undertaken by the CWMP in 2019 (Table 3). Clearly, more research is needed on benthic insect communities residing in the unique Great Lakes coastal wetlands, their food web structure, and links to upland systems (MacKenzie and Kaster 2004). More studies are needed to further our understanding of these systems and the extent of their overall ecological value.

Current conditions for aquatic macroinvertebrates are influenced by the constriction of water flow through the culverts under Sand Point Road and by the roadbed itself. The relatively small size of the culverts combined with beaver activity and deposition of beach sand results in elevated water levels within the SPW adjacent to the road. The water depth and amount of water coverage within the wetland influences the plant community, which in turn influences the aquatic macroinvertebrate community. There is some evidence that invertebrate communities change within vegetation zones when water levels change. For example, Gathman and Burton (2011) found that many insect taxa quickly took advantage of newly flooded wet meadow and hummock zones and then shifted back to lower elevations again as the water level fell in the subsequent year.

Terrestrial Insects

The terrestrial insect fauna has been poorly studied in the Upper Peninsula of Michigan and is even less known for the Sand Point area. A total of 103 insect species (including one species which is dubious) have been recorded from the area (Table 4; PRNL Wildlife Database, Maskey and Loope 2006). The documented species consist of one wasp, 50 butterflies, and 52 moths. This is not surprising in terms of insect studies as either showy, well-known groups or those species that could be of pest status are usually targeted in general entomological surveys. Comprehensive insect surveys can be very expensive and generally take multiple years, and rare insect species usually require expert knowledge of specific insect foodplants, microhabitats, and knowledge of very specific and time sensitive activity periods.

While there are no records for any rare terrestrial insects (endangered, threatened, or special concern) from Sand Point in the NHD, three species have potential to occur within the project area or immediately adjacent to it. These species are the regal fern borer (*Papaipema speciosissima*), Lake Huron locust (*Trimerotropis huroniana*), and yellow-banded bumble bee (*Bombus terricola*). The species with the best potential to occur within the project area is the state special concern regal fern borer. This moth feeds as a caterpillar on royal fern (*Osmunda regalis*; Cuthrell 2007), a plant found in the swamp forest at the perimeter of the wetland complex. Sand Point would likely be at the northern edge of the regal fern borer's range, and although there are currently no known Upper Peninsula records, there are some occurrences in northeastern Canada at or above the same latitude (Moth Photographers Group 2020). The state threatened Lake Huron locust has potential to occur in dunes adjacent to the wetlands at Sand Point. This species occupies sparsely vegetated coastal sand dunes and sandy Great Lakes shorelines (Rabe 1999). The nearest known population for the locust is approximately 40 km (25 miles) to the northeast in the Grand Sable Dunes (MNFI 2020). We recommend searching the sandy shorelines and low dunes of Sand Point and sandy shorelines between Sand Point and Grand Sable for this species. The state special concern yellow-banded bumble

bee has been found in or around wooded areas of the Upper Peninsula and seems to have some affinity for old barrow pits or sandy areas near woodlands (Cuthrell unpublished data). The nearest records to the study area are a 2014 sighting on Grand Island approximately 5.6 km (3.5 miles) to the northwest and a 1911 museum record simply labeled “Munising, MI” (MNFI 2020).

Table 4. Terrestrial insect species recorded from the Sand Point area by source.

Common Name	Scientific Name	Data Source
Bees and Wasps		
Thimbleberry gallmaker	<i>Diastrophus kincaidii</i>	PRNL Wildlife Database
Butterflies		
Black swallowtail	<i>Papilio polyxenes</i>	PRNL Wildlife Database
Northern pine looper	<i>Caripeta piniata</i>	PRNL Wildlife Database
Spear-marked black moth	<i>Rheumaptera hastata</i>	PRNL Wildlife Database
Canada tiger swallowtail	<i>Papilio canadensis</i>	Maskey & Loope 2006
Mustard white	<i>Pieris napi oleracea</i>	Maskey & Loope 2006
Cabbage butterfly	<i>Pieris rapae</i>	Maskey & Loope 2006
Clouded sulphur	<i>Colias philodice</i>	Maskey & Loope 2006
Pink-edged sulphur	<i>Colias interior</i>	Maskey & Loope 2006
Brown elfin	<i>Incisalia augustinus</i>	Maskey & Loope 2006
Hoary elfin	<i>Incisalia polia</i>	Maskey & Loope 2006
Western pine elfin	<i>Incisalia eryphon</i>	Maskey & Loope 2006
Eastern pine elfin	<i>Incisalia niphon clarki</i>	Maskey & Loope 2006
Acadian hairstreak	<i>Satyrrium acadicum</i>	Maskey & Loope 2006
Striped hairstreak	<i>Satyrrium liparops strigosum</i>	Maskey & Loope 2006
Coral hairstreak	<i>Satyrrium titus</i>	Maskey & Loope 2006
Northern spring azure	<i>Celastrina lucia</i>	Maskey & Loope 2006
Summer azure	<i>Celastrina neglecta</i>	Maskey & Loope 2006
Greenish blue	<i>Plebejus saepiolus amica</i>	Maskey & Loope 2006
American copper	<i>Lycaena phlaeas americana</i>	Maskey & Loope 2006
Bog copper	<i>Lycaena epixanthe</i>	Maskey & Loope 2006
Krautwurm’s fritillary	<i>Speyeria cybele krautwurmi</i>	Maskey & Loope 2006
Atlantis fritillary	<i>Speyeria atlantis</i>	Maskey & Loope 2006
Bog silver-bordered fritillary	<i>Boloria selene atrocotalis</i>	Maskey & Loope 2006
Northern pearl crescent	<i>Phyciodes selenis</i>	Maskey & Loope 2006
Baltimore	<i>Euphydryas phaeton</i>	Maskey & Loope 2006
American painted lady	<i>Vanessa virginiensis</i>	Maskey & Loope 2006
Painted lady	<i>Vanessa cardui</i>	Maskey & Loope 2006
Red admiral	<i>Vanessa atlanta</i>	Maskey & Loope 2006
Buckeye	<i>Junonia coenia</i>	Maskey & Loope 2006
Comma	<i>Polygonia comma</i>	Maskey & Loope 2006
Gray comma	<i>Polygonia progne</i>	Maskey & Loope 2006
Question mark	<i>Polygonia interrogationis</i>	Maskey & Loope 2006
Milbert’s tortoise shell	<i>Nymphalis milberti</i>	Maskey & Loope 2006

Table 4. Continued.

Common Name	Scientific Name	Data Source
White admiral	<i>Limenitis arthemis arthemis</i>	Maskey & Loope 2006
Inornate ringlet	<i>Coenonympha tullia inornata</i>	Maskey & Loope 2006
Wood nymph	<i>Cercyonis pegla nephele</i>	Maskey & Loope 2006
Little wood satyr	<i>Megisto cymela</i>	Maskey & Loope 2006
Monarch	<i>Danaus plexippus</i>	Maskey & Loope 2006
Northern pearly eye	<i>Enodia anthedon</i>	Maskey & Loope 2006
Chryxus arctic	<i>Oeneis chryxus strigulosa</i>	Maskey & Loope 2006
Arctic skipper	<i>Caterocephalus palaemon mandan</i>	Maskey & Loope 2006
Northern cloudywing	<i>Thorybes pylades</i>	Maskey & Loope 2006
Dreamy duskywing	<i>Erynnis icelus</i>	Maskey & Loope 2006
Hobomok skipper	<i>Poanes hobomok</i>	Maskey & Loope 2006
Tawny-edged skipper	<i>Polites Themistocles</i>	Maskey & Loope 2006
Long dash	<i>Polites mystic</i>	Maskey & Loope 2006
Black Dash ¹	<i>Euphyes conspicuus</i>	PRNL Wildlife Database
European skipper	<i>Thymelicus lineola</i>	Maskey & Loope 2006
Laurentian skipper	<i>Hesperia comma laurentina</i>	Maskey & Loope 2006
Leonard's skipper	<i>Hesperia leonardus</i>	Maskey & Loope 2006
Dun skipper	<i>Euphyes vestris Metacomet</i>	Maskey & Loope 2006
Least skipper	<i>Ancyloxypha numitor</i>	Maskey & Loope 2006
Salt and pepper skipper	<i>Amblyscirtes hegon</i>	Maskey & Loope 2006
Roadside skipper	<i>Amblyscirtes vialis</i>	Maskey & Loope 2006
Moths		
Hummingbird clearwing	<i>Hemaris thysbe</i>	Maskey & Loope 2006
Modest sphinx	<i>Pachysphinx modesta</i>	Maskey & Loope 2006
Luna moth	<i>Actias luna</i>	Maskey & Loope 2006
Cecropia silkmoth	<i>Hyalophora cecropia</i>	Maskey & Loope 2006
Parthenice tiger moth	<i>Grammia parthenice intermedia</i>	Maskey & Loope 2006
Virginia ctenucha	<i>Ctenucha virginica</i>	Maskey & Loope 2006
Gypsy moth	<i>Lymantria dispar</i>	Maskey & Loope 2006
Cranberry spanworm	<i>Ematurga amitaria</i>	Maskey & Loope 2006
Crocus geometer	<i>Xanthotype sp.</i>	Maskey & Loope 2006
Elm spanworm	<i>Ennomos subsignaria</i>	Maskey & Loope 2006
Hemlock looper	<i>Lambdina fiscellaria</i>	Maskey & Loope 2006
Sharp-lined powder moth	<i>Eufidonia discospilata</i>	Maskey & Loope 2006
no common name	<i>Eufidonia cf convergaria</i>	Maskey & Loope 2006
Alien probole moth	<i>Probole alienaria</i>	Maskey & Loope 2006
Friendly probole	<i>Probole amicaria</i>	Maskey & Loope 2006
Canada melanolophia moth	<i>Melanolophia canadaria</i>	Maskey & Loope 2006
Signate melanolophia moth	<i>Melanolophia signatoria</i>	Maskey & Loope 2006
no common name	<i>Petrophora subaequaria</i>	Maskey & Loope 2006
Hubner's pero	<i>Pero ancetaria</i>	Maskey & Loope 2006

Table 4. Continued.

Common Name	Scientific Name	Data Source
no common name	<i>Plagodis</i> sp.	Maskey & Loope 2006
Spear-marked black	<i>Rheumaptera subhastata</i>	Maskey & Loope 2006
Spear marked black	<i>Rheumaptera hastata</i>	Maskey & Loope 2006
Cherry scallop shell	<i>Rheumaptera prunivorata</i>	Maskey & Loope 2006
The beggar moth	<i>Eubaphe mendica</i>	Maskey & Loope 2006
no common name	<i>Venusia comparia</i>	Maskey & Loope 2006
Large lace-bordered moth	<i>Scopola limboundata</i>	Maskey & Loope 2006
no common name	<i>Scopola</i> sp.	Maskey & Loope 2006
Master's dart	<i>Feltia herilis</i>	Maskey & Loope 2006
Celery looper	<i>Anagrapha falcifera</i>	Maskey & Loope 2006
Glassy cutworm	<i>Crymodes devastator</i>	Maskey & Loope 2006
no common name	<i>Eurois occulata</i>	Maskey & Loope 2006
no common name	<i>Anaplectoides prasina</i>	Maskey & Loope 2006
Decorated owlet	<i>Pangrapta decoralis</i>	Maskey & Loope 2006
Speared dagger moth	<i>Acrionicta hasta</i>	Maskey & Loope 2006
no common name	<i>Apamea inordinate</i>	Maskey & Loope 2006
Green leuconycta	<i>Leuconycta diptheroides</i>	Maskey & Loope 2006
no common name	<i>Phalaenophana pyramusalis</i>	Maskey & Loope 2006
no common name	<i>Lithacodia albidula</i>	Maskey & Loope 2006
White-spotted sable moth	<i>Anania funebris glomeralis</i>	Maskey & Loope 2006
no common name	<i>Pyrausta orphisalis</i>	Maskey & Loope 2006
Dusty clearwing	<i>Paranthrene tabaniformis</i>	Maskey & Loope 2006
Lesser peach tree borer	<i>Synanthedon pictipes</i>	Maskey & Loope 2006
Grape root-borer	<i>Vitacea polistiformis</i>	Maskey & Loope 2006
no common name	<i>Drepana arcuate</i>	Maskey & Loope 2006
no common name	<i>Crambus leachellus</i>	Maskey & Loope 2006
Cranberry girdler	<i>Chrysotetuchia topiaria</i>	Maskey & Loope 2006
no common name	<i>Emmelina monodactyla</i>	Maskey & Loope 2006
no common name	<i>Phanenta formosana</i>	Maskey & Loope 2006
no common name	<i>Clepsis melaleucana</i>	Maskey & Loope 2006
no common name	<i>Choristoneura</i> sp.	Maskey & Loope 2006

¹Questionable record as none known from the UP; most likely the very similar *Euphyes bimacula* (DLC).

Expected Use

Aquatic Macroinvertebrates

Given the current water level of Lake Superior is 183.75 m (602.85 ft) International Great Lakes Datum (U.S. Army Corps of Engineers, June 2020), the elevation of the Sand Point access road at the culvert is approximately 184.30 m above sea level (masl; 604.66 ft), and the western most lake, which is the lowest of the four, is between 184 and 185 masl (604-607 ft), increasing the capacity of the culvert would allow for a more natural flow of water from the wetlands to Lake Superior. Because Great Lakes water levels are currently near record highs, it does not appear likely that the water depth of the Sand Point ponds/swales will increase much more above the level recorded in 2019 (Figure 3). With the construction of a larger box culvert that allows for an improved connection to Lake Superior, the swales at SPW will likely be influenced more by Great Lakes water levels and less by artificial impoundment. Measurements taken by NPS Water Resources Division in June 2018 confirm there is only a slight elevation difference between the Sand Point wetlands and Lake Superior. The surface water elevation of the inlet pond is 0.15 meters (0.49 ft) above Lake Superior and the surface water elevation of the outlet pond is only 0.01 meters (0.03 ft) above Lake Superior. After restoration, we expect the Sand Point ponds/swales may become shallower under lower Lake Superior water levels, whereas the amount of Lake Superior water mixing with the wetlands would likely increase with higher levels. The effect of more emergent vegetation and shallower depths would influence the aquatic macroinvertebrate community of Sand Point in ways that are not easy to predict but this influence is expected to more closely resemble the natural hydrologic interaction between SPW and Lake Superior that existed prior to road construction.

Patterns in aquatic macroinvertebrate response to changing Great Lakes water levels have been documented in coastal wetlands (Gathman and Burton 2011). In Mackinac Bay, Lake Huron, macroinvertebrates displayed four generalized patterns of response to flooding and subsequent lowering of water levels over a three-year period. Though the wetland plant communities vary from those at Sand Point, these patterns might help predict the response of aquatic macroinvertebrates in the wetland complex to future water level fluctuations. In this study, the hummock zone was defined as an infrequently flooded community of hummock-forming graminoids with scattered shrubs; wet meadow as a broad sedge-meadow community; the transition zone as a narrow zone where cattails were prevalent along with a subset of species from the adjacent zones; and emergent marsh a permanently flooded emergent/floating-leaved/submergent community visually dominated by bulrush (*Schoenoplectus*) and water lilies (*Nuphar*).

- 1) “High elevation specialists” typically had the greatest relative abundance in the wet meadow zone in year one, in the higher elevation hummock zone during high water in year two, and then in the wet meadow zone again when water level lowered in year three. High elevation specialists included Cyclopoida and Harpacticoida (Copepods), Chydoridae (water fleas), Gyraulus and Planorbula (planorbid snails), and Succineidae (pulmonate snails); along with the insects/arachnids Ceratopogonidae (midges), Dytiscidae (predaceous diving beetles), Isotomidae (springtails), Limnephilidae (caddisflies), and Halacarida and Oribatei (aquatic mites).
- 2) “Rapid reversing taxa” rapidly moved into the wet meadow zone in high water conditions, becoming some of the most abundant taxa in that zone. They moved back into the lower elevation transition and emergent marsh zones when the water came back down in year three. Rapid reversers included Ostracoda (seed shrimp), Daphniidae (water fleas), Lumbriculidae (annelids), Nematoda, Physidae (pulmonate snails), and Sphaeriidae

(fingernail clams); along with the insects/arachnids Chironomidae (midges), Coenagrionidae (damselflies), Hydroptilidae (caddisflies), and Hydracarina (water mites)

- 3) “Time-lagged responders” gradually moved to the higher elevation zones over the two years the water level was rising and were present at high relative abundance in these zones during year three when water levels had dropped. These included the Amphipoda (side swimmers) and Caecidotea (isopods); along with the insects Caenidae (mayflies), Aeshnidae (dragonflies), and Phryganeidae (caddisflies).
- 4) “Low elevation specialists” remained most abundant in the emergent marsh zone and tended to not move to higher elevations in response to higher water levels. These taxa include Lirceus (isopods), Ancyliidae (limpets), Hirudinea (leeches), and Sididae (water fleas), along with Chrysomelidae (leaf beetles) and Corduliidae (dragonflies).

Proposed restoration would reestablish a more natural hydrologic connection between Lake Superior and SPW, which would likely lead to greater fish passage between the two systems. Increased fish passage between Lake Superior and SPW could result in increased predation pressure on macroinvertebrate communities; however, this pressure is not expected to be greater than what would have been present under natural hydrologic conditions. With increased fish movement between Sand Point and Lake Superior, there would be an increased potential for unionid mussels to become established at Sand Point. The special concern eastern elliptio and state threatened slippershell are two rare mollusks whose potential to occur at Sand Point would increase following an improvement of fish passage through the culvert. Unionid mussels migrate to new habitats and exchange individuals among populations by hitching a ride on host fish during their larval stage. Documented host fish for eastern elliptio include yellow perch (*Perca flavescens*), white crappie (*Pomoxis annularis*), largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), orangespotted sunfish (*Lepomis humilis*), pumpkinseed (*Lepomis gibbosus*), green sunfish (*Lepomis cyanellus*), and banded killifish (*Fundulus diaphanous*). Slippershell are known to use mottled sculpin (*Cottus bairdi*), banded sculpin (*Cottus carolinae*), and Johnny darter (*Etheostoma nigrum*) as hosts (Watters et al. 2009). Though some of these fish species are not known from Lake Superior, there are likely fish species that eastern elliptio and slippershell utilize in the wild in addition to these species that were determined by laboratory experiments.

Given the lack of information about the aquatic insect community at SPW, we are not sure of the consequences of the proposed activities. However, as described above, aquatic macroinvertebrate communities by their very ecology are resilient to fluctuating water levels. We expect reconnecting the interior wetlands back to Lake Superior would allow for the greatest diversity of aquatic insects to be found in the SPW.

Terrestrial Insects

The only rare insect (if present in the area) that could be impacted by the restored hydrology is the regal fern borer. As lake levels rise, we expect that the swales will become wetter. How quickly the water levels increase and how long they are sustained will determine impacts to royal fern populations and therefore the potential to impact the borer moth. Rapidly increasing water levels (e.g., 30-40 cm [12-15 inches] in one year) sustained over several years would pose the greatest threat to this species, because flooded host plants could cause mortality of larvae and make recolonization difficult. Gradual water level increases are not likely to be a threat as the royal fern and moth populations could shift inland in response to increased water depth. Periods of low water levels would be less of an issue, but if prolonged, could lead to the decomposition of organic soils exposed to air. We would expect an overall decrease in royal

ferns during prolonged dry periods unless they are found growing in conditions where groundwater influences the swales and conditions remain inundated or saturated. However, as mentioned previously, these predicted conditions could be altered by disturbance factors independent of lake level fluctuations (e.g., beaver flooding and fire). In terms of terrestrial insects, fixing the culverts will have very little effect on the only rare species that may occur here (regal fern borer moth) and on the terrestrial insect fauna in general. Any changes in insect populations that may occur due to restoration would be very local and short-lived. This potential impact should not outweigh the increased benefits of restoring the hydrologic connection to Lake Superior that occurred historically at this site.

Fish

Past and Current Use

Fish sampling within SPW has been limited to work done by the CWMP in 2019 and surveys done by U.S. Fish and Wildlife Service staff in 2004 (Newman 2005) as part of a broader survey effort within PRNL. The CWMP surveyed the fish community at SPW on 31 July 2019 and found the following species in order of highest abundance to lowest: brassy minnow (*Hybognathus hankinsoni*); blacknose shiner (*Notropis heterolepis*); fathead minnow (*Pimephales promelas*); brook stickleback (*Culaea inconstans*); central mudminnow (*Umbra limi*); and white sucker (*Catostomus commersonii*). Jude and Pappas (1992) considered blacknose shiner, fathead minnow, brook stickleback, and central mudminnow as part of a coastal marsh complex of fish species. White sucker was within the intermediate fish species complex indicative of species that use the Great Lakes and wetland habitats for some part of their life cycle (Jude and Pappas 1992). Although Newman (2005) documented a wider diversity of fish species within PRNL, fish surveys conducted within the swales of SPW only revealed three species, northern redbelly dace (*Chrosomus eos*), brook stickleback, and central mudminnow, with northern redbelly dace being the most abundant.

Two state threatened and two special concern fish species have been documented in Lake Superior near Sand Point. Occurrences of the state threatened cisco (*Coregonus artedii*) and special concern kiyi (*Coregonus kiyi*) were documented around Grand Island within 16 km (10 miles) of Sand Point in 2001 and 1991, respectively. Cisco have also been reported from inland lakes near Sand Point including Deer Lake and Au Train Lake. The state threatened shortjaw cisco (*Coregonus zenithicus*) was recorded in Lake Superior approximately 48 km (30 miles) northwest of Sand Point. Spoonhead sculpin (*Cottus ricei*), a species of special concern, was documented in Lake Superior in 1998, 24 km (15 miles) west northwest of Sand Point. These four species are primarily deep-water fishes and have low potential to occur in the swales of SPW.

Blockage of the existing culvert created by beavers and sand movement has likely restricted fish passage at the culvert and reduced the potential for fish movement between the ponds of Sand Point and Lake Superior. This may be causing reduced gene flow between fish populations within SPW and other habitats and may contribute to a decline in fish diversity within the ponds.

Expected Use

A larger culvert that remains free of beaver dams and sand blockage would likely create a connection between SPW and Lake Superior that functions more closely to what existed before the road was built. A better functioning hydrologic connection should increase fish passage. Restoring the movement of fish between SPW and Lake Superior could have a beneficial effect on the fish community by increasing fish diversity and gene flow. As water levels in the swales of Sand Point fluctuate across seasons and years, an improved connection to Lake Superior

would allow fish to better react to this ever-changing coastal system. Jude and Pappas (1992) noted that connectedness with a Great Lake was a key component of maximal utilization of coastal wetlands by fish, with wetlands connected to lakes having more diverse communities than those lacking connections. Improved connectivity with Lake Superior could lead to greater fish diversity within SPW, except perhaps for years with below-average lake levels. Those fish species closely associated with coastal wetlands will likely continue to occur within the wetland complex, but a better connection to Lake Superior could allow greater use by migratory species that use wetlands periodically for spawning, nursery habitat, or foraging.

Herpetofauna

Past and Current Use

To assess current conditions for amphibians and reptiles (i.e., herpetofauna or herps) within SPW, MNFI reviewed several data sources and references to compile information on observations of herp species and available habitat within and adjacent to the area. Information sources reviewed included the Michigan NHD (MNFI 2020), Michigan Herp Atlas (2019; data on rare species only), Great Lakes Coastal Wetland Monitoring Program frog and toad sampling data (CWMP 2019), PRNL wildlife observation database (as of October 2019), vegetation sampling data from 2006, and available literature and research reports (e.g., Casper 2005, Resh et al. 2013, Egan et al. 2014). Potential habitat for amphibian and reptile species also was assessed during a site visit to SPW in fall of 2019.

Fifteen amphibian and reptile species have been documented within and/or adjacent to the SPW, consisting of six frog and toad species, four salamander species, two turtle species, and three snake species (Table 5). Only one of these, mink frog (*Lithobates septentrionalis*), is of conservation concern (Table 5). Of the 15 species that have been documented in the SPW area, thirteen have been observed within the last 20 years and are assumed to still be extant (Table 5). The remaining two species (i.e., mink frog and eastern newt [*Notophthalmus viridescens*]) were last reported from the Sand Point area over 20 years ago but still have potential to occur within this area based on available habitat (Werner and Davis 1989, Casper 2005). Three additional species (northern leopard frog [*Lithobates pipiens*], spotted salamander [*Ambystoma maculatum*], and northern water snake (*Nerodia sipedon sipedon*)) have not been documented in the Sand Point area but have potential to occur there based on available habitat (Table 5; Casper 2005).

Table 5. Amphibian and reptile species that have been documented or have potential to occur in the Sand Point Wetland and surrounding vicinity of Pictured Rocks National Lakeshore. State/Federal status codes: SC – State special concern; and SGCN – Species of greatest conservation need (Derosier et al. 2015). PIRO-Sand Point status codes: E – Extant or presumed extant (documented within last 20 years); H – Historical (documented over 20 years ago but still has potential to occur in area); and P – Potential (species not previously documented but has potential to occur in the area based on available habitat).

Common Name	Scientific Name	State/ Federal Status	Habitat ¹	Sand Point Status	Data Source(s)
Frogs & Toads					
Northern Spring Peeper	<i>Pseudacris crucifer crucifer</i>		Temporary and permanent ponds, marshes, floodings, and ditches; forests, old fields, shrubby areas	E (common)	Casper 2005 Werner & Davis 1989 CWMP 2019
Green Frog	<i>Lithobates [Rana] clamitans</i>		Ponds, lakes, swamps, sloughs, impoundments, and slow streams; open, sparsely vegetated sites.	E (common)	Casper 2005 Werner & Davis 1989 CWMP 2019
Eastern American Toad	<i>Anaxyrus [Bufo] americanus americanus</i>		Open forests, forest edges, prairies, marshes, meadows, suburban yards, and agricultural areas; often buried in moist soil, leaf litter, or under logs or rocks.	E	Casper 2005 Werner & Davis 1989
Eastern Gray Treefrog	<i>Hyla versicolor</i>		Temporary ponds, swamps, floodings, shallow edges of permanent lakes, and sloughs, surrounded by forested or open habitats; deciduous or mixed forests, farm woodlots, swamps, old fields, suburban yards.	E	Casper 2005 Werner & Davis 1989 CWMP 2019
Wood Frog	<i>Lithobates [Rana] sylvaticus</i>		Moist, forested habitats; breeding - vernal ponds, floodings, forested swamps, and quiet stream backwaters.	E	Casper 2005 Werner & Davis 1989
Mink Frog	<i>Lithobates [Rana] septentrionalis</i>	SGCN	Cool permanent waters with ample emergent and floating vegetation; sluggish streams, boggy lake inlets, spring-fed ponds.	H	Casper 2005 Werner & Davis 1989 Museum specimens 1961
Northern Leopard Frog	<i>Lithobates [Rana] pipiens</i>		Open wetland habitats including marshes, bogs, lake and stream edges, and sedge meadows, and adjacent open uplands including hay fields, lawns.	P	Casper 2005
Salamanders					
Blue-spotted Salamander	<i>Ambystoma laterale</i>		Deciduous and coniferous forests from moist bottomlands to dry uplands; vernal pools.	E	Casper 2005 Werner & Davis 1989
Four-toed Salamander	<i>Hemidactylium scutatum</i>		Moist deciduous, coniferous, or mixed forests, usually in vicinity of spring-fed creeks, sphagnum seepages, bogs, or boggy ponds.	E	Casper 2005
Eastern Red-backed Salamander	<i>Plethodon cinereus</i>		Deciduous, coniferous, and mixed forests; often under logs, fallen bark, leaf litter, and rocks.	E	Casper 2005 Werner & Davis 1989

Table 5. Continued.					
Common Name	Scientific Name	State/ Federal Status	Habitat ¹	Sand Point Status	Data Source(s)
Eastern Newt	<i>Notophthalmus viridescens</i>		Small, permanent ponds, temporary ponds, and shallows of large lakes, river sloughs and backwaters with abundant aquatic vegetation.	H (in all 4 ponds)	Casper 2005 Werner & Davis 1989
Spotted Salamander	<i>Ambystoma maculatum</i>		Moist closed canopy deciduous or mixed forests, temporary/semi-permanent ponds within or adjacent to woods.	P	Casper 2005
Turtles					
Eastern Snapping Turtle	<i>Chelydra serpentina serpentina</i>		Permanent waterbodies including shallow, weedy Great Lakes inlets and bays; muddy ponds, lakes, sloughs and slow streams with dense aquatic vegetation.	E	Casper 2005 Werner & Davis 1989 PIRO Wildlife Database 1986, 2012 CWMP 2019
Painted Turtle	<i>Chrysemys picta</i>		Quiet, slow-moving permanent water bodies with soft bottom substrates, abundant aquatic vegetation and basking sites; vernal ponds, impoundments, ditches and faster streams and rivers.	E	Casper 2005 Werner & Davis 1989 CWMP 2019
Snakes					
Northern Red-bellied Snake	<i>Storeria occipitomaculata occipitomaculata</i>		Deciduous or mixed forests, adjacent fields, pastures, marshes, sphagnum bogs.	E	Casper 2005
Eastern Garter Snake	<i>Thamnophis sirtalis sirtalis</i>		Open and forested habitats and moist grassy places - edges of ponds, lakes, streams ditches.	E	Casper 2005 PIRO Wildlife Database 1986
Smooth Green Snake	<i>Opheodrys vernalis</i>	SC, SGCN	Moist grassy places - prairie remnants and savannas, meadows, old fields, pastures, marsh and lake edges, and open deciduous and pine forests.	E	Casper 2005 PIRO Wildlife Database 1989
Northern Water Snake	<i>Nerodia sipedon sipedon</i>		Permanent water bodies - rivers, streams sloughs, lakes, ponds, bogs, marshes, swamps, wet meadows, impoundments; also utilize shallow, small temporary ponds/wetlands including vernal pools, shrub swamps.	P	Casper 2005

¹Habitat descriptions from Harding and Mifsud 2017.

The amphibian and reptile species documented within and/or near the project area are associated with several different habitat types. Several species are associated with shallow waterbodies and wetlands including temporary and/or permanent ponds, marshes, swamps, floodings, edges of lakes, and slow-moving streams and rivers (Table 5; Harding and Mifsud 2017). These species include the northern spring peeper (*Pseudacris crucifer crucifer*), green frog (*Lithobates clamitans*), eastern gray treefrog (*Hyla versicolor*), mink frog, eastern newt, eastern snapping turtle (*Chelydra serpentina serpentina*), and painted turtle (*Chrysemys picta*). These species have likely occurred within and around the four open water ponds and adjacent poor fen, submergent marsh, and/or northern shrub thicket. The remaining species documented in the Sand Point area are primarily associated with moist and/or dry forested habitats adjacent to or near wetland or aquatic habitats, including vernal pools, bogs, marshes, ponds, lakes, and/or streams (Table 5; Harding and Mifsud 2017). These include the eastern American toad (*Anaxyrus americanus americanus*), wood frog (*Lithobates sylvaticus*), blue-spotted salamander (*Ambystoma laterale*), four-toed salamander (*Hemidactylium scutatum*), eastern red-backed salamander (*Plethodon cinereus*), northern red-bellied snake (*Storeria occipitomaculata occipitomaculata*), eastern garter snake (*Thamnophis sirtalis sirtalis*), and smooth green snake (*Opheodrys vernalis*). Eastern American toad, northern red-bellied snake, eastern garter snake, and smooth green snake also utilize moist grassy habitats along the edge of open wetlands, ponds, lakes, and streams (Harding and Mifsud 2017). At Sand Point, herp species associated with forested and/or grassy habitats have likely occurred in the upland forest and/or open habitats on the dune ridges and/or rich conifer swamp adjacent to the open and/or shrubby wetlands within this complex. It also is important to note that many of the frog and salamander species within the SPW area depend on seasonally or semi-permanently flooded wetlands and/or other shallow wetlands that lack fish predators for successful reproduction (Colburn 2004, Casper 2005, Harding and Mifsud 2017).

Expected Use

Overall, the proposed restoration is not expected to significantly impact the amphibian and reptile community in the SPW area due to the expected localized nature of the impacts of the proposed restoration, diversity of habitats present within this complex, and broad habitat requirements of most of the herp species in the area. Impacts also may vary by species or groups of species. The effects of the proposed restoration on the wetland complex are expected to be localized and include improved connectivity to Lake Superior. High lake levels for several years after the restoration would likely result in an increase in submergent and emergent marsh and a decrease in shrub-dominated wetland or poor fen habitats. Conversely, low lake levels would likely result in a decrease in submergent and emergent marsh and expansion of poor fen habitats including shrub and tree cover in these areas.

Amphibian and reptile species in the SPW area that are primarily associated with shallow waterbodies or wetlands would likely not be impacted by or may benefit from the proposed restoration with high lake levels and an increase in submergent and emergent marsh habitats. Most of these species are habitat generalists and can utilize a variety of habitats. Similarly, it is expected these species would not be significantly impacted by a decrease in submergent and emergent marsh and expansion of poor fen habitats with low lake levels unless water levels and extent of suitable habitat were dramatically reduced. For example, the ponds within SPW appear to be permanent and would continue to provide habitat for these species. For amphibian and reptile species associated with forested and/or open grassy habitats adjacent to or near wetland/aquatic habitats, increases or decreases in submergent and emergent marsh habitats in response to prolonged high or low lake levels after proposed restoration would likely not significantly impact habitat availability for most of these species unless changes were dramatic. However, increased water levels could negatively impact breeding habitat for four-toed

salamanders which include shrub wetlands with moss-covered hummocks, such as those found in the SPW area (Casper 2005). Increased connectivity between the Sand Lake wetland complex and Lake Superior after the proposed restoration may introduce more fish into the wetlands within the complex. This may reduce the reproductive success of some frog and salamander species within the complex that rely on shallow wetlands that lack fish predators for breeding and successful reproduction. Identifying and maintaining shallow wetlands that provide suitable breeding habitats for these species within the wetland complex could help reduce or mitigate this potential impact.

Birds

Past and Current Use

We compiled data on bird use of SPW and the surrounding vicinity from several sources (Table 6), which provided records of 173 species using the area across all seasons, 30 species of which were documented in three or more of the data sets examined. These more regularly recorded species consisted of wetland birds, raptors, and songbirds that breed in emergent/scrub-shrub wetlands, neotropical migrant songbirds, and species typical of adjacent uplands or edge habitats. Sand Point Wetland provides breeding and non-breeding habitat for an array of bird species but is especially important to waterfowl and waterbirds using open water and emergent zones during breeding and migration periods and songbirds that use emergent, shrub, and forested habitats for nesting and during migration. Several raptor species have been recorded in the area and could be using the wetland for foraging and potentially nesting.

Several bird species of conservation concern, primarily raptors and waterbirds, have been observed in or around the SPW. The NHD contains records for two species, peregrine falcon (*Falco peregrinus*; state endangered, SGCN) and merlin (*Falco columbarius*; state threatened, SGCN). Peregrine falcon has been documented nesting on cliffs located on the mainland within PRNL (last confirmed in 2018) and on Grand Island (last confirmed in 2016) and Au Train Island (last confirmed in 2016). Peregrines were known to be breeding in PRNL in 2019 and 2020 as well but the nesting sites were not determined (C. Heyd [NPS], personal communication). This occurrence represents one of a small number of extant natural nesting sites for peregrine falcons in Michigan. Merlin was recorded successfully nesting within a white pine in the Sand Point area in 2012, and the breeding territory was known to be active in 2019 and 2020 (C. Heyd [NPS], personal communication). With nearby nesting sites, both falcon species could use the SPW for foraging. Although we did not find known nesting locations in the Sand Point vicinity for osprey (*Pandion haliaetus*; state special concern), bald eagle (*Haliaeetus leucocephalus*; state special concern), or red-shouldered hawk (*Buteo lineatus*; state threatened), all three species have been recorded in the area and are known to nest in PRNL or the central Upper Peninsula and could use the wetland for foraging. Northern harrier (*Circus hudsonius*; state special concern) has been observed at the site during the non-breeding season; however, in addition to foraging, there is potential for the species to use the graminoid and low shrub dominated zones for nesting (Currier 2001).

Table 6. Bird species documented in and around the Sand Point Wetland, with data source, period of observation (B = breeding or NB = non-breeding), and date of the most recent record provided. Species recorded in three or more data sets are indicated with an “*”.

Common Name	Scientific Name	Data Source ¹						Period	Most Recent Date
		Site Visit	NHD	PRNL	CWMP	BBS	eBird		
Canada goose	<i>Branta canadensis</i>			X			X	B	05/21/2020
Trumpeter swan	<i>Cygnus buccinator</i>			X			X	B, NB	11/15/2013
Tundra swan	<i>Cygnus columbianus</i>			X				NB	04/04/1999
Wood duck	<i>Aix sponsa</i>					X	X	B	06/22/2020
Mallard*	<i>Anas platyrhynchos</i>	X		X	X	X	X	B, NB	06/21/2020
American wigeon	<i>Mareca americana</i>						X	NB	04/28/2020
Blue-winged teal	<i>Spatula discors</i>						X	NB	09/29/2018
Northern shoveler	<i>Spatula clypeata</i>			X			X	B	05/17/2016
Green-winged teal	<i>Anas crecca</i>						X	NB	04/28/2020
Redhead	<i>Aythya americana</i>						X	NB	10/19/2019
Ring-necked duck	<i>Aythya collaris</i>						X	NB	04/09/2017
Greater scaup	<i>Aythya marila</i>						X	NB	09/28/2019
Lesser scaup	<i>Aythya affinis</i>						X	NB	10/14/2018
Surf scoter	<i>Melanitta perspicillata</i>						X	NB	10/17/2017
Long-tailed duck	<i>Clangula hyemalis</i>						X	NB	10/14/2018
Bufflehead	<i>Bucephala albeola</i>						X	NB	11/05/2019
Common goldeneye	<i>Bucephala clangula</i>					X	X	NB	04/09/2017
Hooded merganser	<i>Lophodytes cucullatus</i>			X			X	B	05/17/2020
Common merganser	<i>Mergus merganser</i>						X	B	05/17/2020
Red-breasted merganser	<i>Mergus serrator</i>						X	B	06/02/2018
Ruffed grouse	<i>Bonasa umbellus</i>					X	X	B	05/17/2020
Wild turkey	<i>Meleagris gallopavo</i>			X			X	B	07/27/2011
Pied-billed grebe	<i>Podilymbus podiceps</i>	X					X	NB	10/19/2019
Horned grebe	<i>Podiceps auritus</i>			X			X	NB	10/19/2019
Red-necked grebe	<i>Podiceps grisegena</i>						X	NB	04/28/2020
Rock pigeon	<i>Columba livia</i>						X	B	08/06/2015
Mourning dove*	<i>Zenaidura macroura</i>				X	X	X	B	06/03/2020
Yellow-billed cuckoo	<i>Coccyzus americanus</i>			X				B	07/20/1989
Chimney swift	<i>Chaetura pelagica</i>						X	B	05/27/2007
Ruby-throated hummingbird	<i>Archilochus colubris</i>						X	B	08/21/2019
Virginia rail*	<i>Rallus limicola</i>			X	X	X	X	B	05/30/2020
Sora	<i>Porzana carolina</i>						X	B	08/21/2019
Common gallinule	<i>Gallinula galeata</i>			X				B	05/13/2007
American coot	<i>Fulica americana</i>						X	NB	09/28/2016
Sandhill crane*	<i>Antigone canadensis</i>			X		X	X	B	05/31/2019
American avocet	<i>Recurvirostra americana</i>			X				NB	07/23/2001
Killdeer	<i>Charadrius vociferus</i>						X	B	05/13/2020

Table 6. Continued.

Common Name	Scientific Name	Data Source ¹						Period	Most Recent Date
		Site Visit	NHD	PRNL	CWMP	BBS	eBird		
Semipalmated plover	<i>Charadrius semipalmatus</i>						X	NB	08/25/2018
Piping plover	<i>Charadrius melodus</i>			X				NB	08/28/2012
Sanderling	<i>Calidris alba</i>						X	NB	08/27/2015
Baird's sandpiper	<i>Calidris bairdii</i>						X	NB	08/27/2015
Short-billed dowitcher	<i>Limnodromus griseus</i>						X	NB	05/27/2006
American woodcock	<i>Scolopax minor</i>						X	B	08/21/2008
Wilson's snipe	<i>Gallinago delicata</i>						X	B	05/27/2006
Spotted sandpiper	<i>Actitis macularius</i>						X	B	05/17/2020
Solitary sandpiper	<i>Tringa solitaria</i>						X	B	05/17/2020
Lesser yellowlegs	<i>Tringa flavipes</i>						X	NB	05/21/2012
Greater yellowlegs	<i>Tringa melanoleuca</i>						X	NB	05/21/2020
Bonaparte's gull	<i>Chroicocephalus philadelphia</i>			X			X	NB	08/13/2013
Ring-billed gull	<i>Larus delawarensis</i>						X	B	06/20/2020
Herring gull	<i>Larus argentatus</i>					X	X	B	06/22/2020
Glaucous gull	<i>Larus hyperboreus</i>			X				NB	12/09/2014
Caspian tern	<i>Hydroprogne caspia</i>						X	B	08/08/2017
Common loon*	<i>Gavia immer</i>			X	X		X	B	06/20/2020
Double-crested cormorant	<i>Phalacrocorax auritus</i>						X	NB	04/28/2020
American white pelican	<i>Pelecanus erythrorhynchos</i>			X			X	B	06/29/2017
American bittern	<i>Botaurus lentiginosus</i>			X			X	B	05/30/2020
Least bittern	<i>Ixobrychus exilis</i>			X			X	B	06/03/2020
Great blue heron	<i>Ardea herodias</i>						X	B	06/25/2019
Green heron	<i>Butorides virescens</i>						X	B	05/21/2012
Turkey vulture	<i>Cathartes aura</i>					X	X	B	05/30/2020
Osprey	<i>Pandion haliaetus</i>			X			X	B	06/03/2013
Northern harrier	<i>Circus hudsonius</i>						X	NB	09/18/2019
Sharp-shinned hawk	<i>Accipiter striatus</i>			X			X	B	05/27/2006
Bald eagle*	<i>Haliaeetus leucocephalus</i>	X		X	X		X	B, NB	06/20/2020
Red-shouldered hawk	<i>Buteo lineatus</i>			X				B	04/28/1995
Broad-winged hawk	<i>Buteo platypterus</i>			X			X	B	05/13/2020
Red-tailed hawk	<i>Buteo jamaicensis</i>						X	NB	10/05/2019
Snowy owl	<i>Bubo scandiacus</i>			X				NB	11/25/2011
Barred owl	<i>Strix varia</i>						X	B	07/15/2013
Belted kingfisher*	<i>Megaceryle alcyon</i>			X		X	X	B	06/03/2020
Red-bellied woodpecker	<i>Melanerpes carolinus</i>						X	NB	09/28/2019
Yellow-bellied sapsucker	<i>Sphyrapicus varius</i>					X	X	B	06/21/2018
Downy woodpecker	<i>Dryobates pubescens</i>						X	B	05/17/2020
Hairy woodpecker	<i>Dryobates villosus</i>						X	B	08/21/2019

Table 6. Continued.

Common Name	Scientific Name	Data Source ¹						Period	Most Recent Date
		Site Visit	NHD	PRNL	CWMP	BBS	eBird		
Northern flicker	<i>Colaptes auratus</i>					X	X	B	05/21/2020
Pileated woodpecker	<i>Dryocopus pileatus</i>			X			X	B	06/03/2020
Merlin*	<i>Falco columbarius</i>		X	X		X	X	B	05/17/2020
Peregrine falcon*	<i>Falco peregrinus</i>			X		X	X	B	06/09/2017
Great crested flycatcher	<i>Myiarchus crinitus</i>					X	X	NB	09/04/2019
Eastern kingbird*	<i>Tyrannus tyrannus</i>				X	X	X	B	06/20/2020
Olive-sided flycatcher	<i>Contopus cooperi</i>						X	B	05/21/2020
Eastern wood-pewee	<i>Contopus virens</i>						X	B	05/30/2020
Yellow-bellied flycatcher	<i>Empidonax flaviventris</i>						X	B	05/31/2019
Alder flycatcher*	<i>Empidonax alhorum</i>				X	X	X	B	06/03/2020
Least flycatcher	<i>Empidonax minimus</i>						X	B	06/03/2020
Eastern phoebe	<i>Sayornis phoebe</i>						X	B	08/18/2018
Blue-headed vireo	<i>Vireo solitarius</i>					X	X	B	05/30/2020
Philadelphia vireo	<i>Vireo philadelphicus</i>						X	B	05/23/2015
Red-eyed vireo*	<i>Vireo olivaceus</i>				X	X	X	B	06/21/2020
Blue jay*	<i>Cyanocitta cristata</i>	X			X	X	X	B, NB	06/20/2020
American crow*	<i>Corvus brachyrhynchos</i>				X	X	X	B	06/21/2020
Common raven*	<i>Corvus corax</i>	X				X	X	B, NB	06/21/2020
Horned lark	<i>Eremophila alpestris</i>			X				NB	09/16/2013
Tree swallow	<i>Tachycineta bicolor</i>						X	B	06/23/2020
Northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>						X	B	07/01/1999
Barn swallow	<i>Hirundo rustica</i>						X	B	05/30/2020
Black-capped chickadee*	<i>Poecile atricapillus</i>	X				X	X	B, NB	06/20/2020
Boreal chickadee	<i>Poecile hudsonicus</i>			X				B	08/26/1989
Red-breasted nuthatch	<i>Sitta canadensis</i>					X	X	B	05/30/2020
White-breasted nuthatch	<i>Sitta carolinensis</i>						X	B	06/17/2020
Brown creeper	<i>Certhia americana</i>						X	B	05/17/2020
Rock wren	<i>Salpinctes obsoletus</i>			X				NB	10/15/2006
House wren	<i>Troglodytes aedon</i>						X	B	05/31/2019
Winter wren	<i>Troglodytes hiemalis</i>					X	X	B	05/17/2020
Sedge wren	<i>Cistothorus platensis</i>				X		X	B	06/10/2019
Blue-gray gnatcatcher	<i>Poliophtila caerulea</i>						X	B	05/17/2020
Golden-crowned kinglet	<i>Regulus satrapa</i>					X	X	B	05/13/2020
Ruby-crowned kinglet	<i>Regulus calendula</i>					X	X	B	05/17/2020
Veery	<i>Catharus fuscescens</i>					X	X	B	06/22/2020
Swainson's thrush	<i>Catharus ustulatus</i>					X	X	B	07/03/2011
Hermit thrush	<i>Catharus guttatus</i>					X	X	B	06/03/2020
Wood thrush	<i>Hylocichla mustelina</i>						X	B	05/24/2019

Table 6. Continued.

Common Name	Scientific Name	Data Source ¹						Period	Most Recent Date
		Site Visit	NHD	PRNL	CWMP	BBS	eBird		
American robin*	<i>Turdus migratorius</i>				X	X	X	B	06/22/2020
Gray catbird*	<i>Dumetella carolinensis</i>				X	X	X	B	06/03/2020
Northern mockingbird	<i>Mimus polyglottos</i>			X				B	06/22/1999
European starling	<i>Sturnus vulgaris</i>						X	B	07/27/2011
Bohemian waxwing	<i>Bombycilla garrulus</i>						X	NB	12/14/2018
Cedar waxwing*	<i>Bombycilla cedrorum</i>				X	X	X	B	06/17/2020
House sparrow	<i>Passer domesticus</i>						X	B	07/27/2011
Pine grosbeak	<i>Pinicola enucleator</i>						X	NB	01/26/2012
Purple finch	<i>Haemorhous purpureus</i>					X	X	NB	10/19/2019
Common redpoll	<i>Acanthis flammea</i>						X	NB	11/10/2017
Red crossbill	<i>Loxia curvirostra</i>					X	X	B	06/21/2018
White-winged crossbill	<i>Loxia leucoptera</i>						X	B	07/02/2015
Pine siskin	<i>Spinus pinus</i>					X	X	B	05/21/2020
American goldfinch*	<i>Spinus tristis</i>				X	X	X	B	06/22/2020
Lapland longspur	<i>Calcarius lapponicus</i>			X				NB	04/19/2017
Snow bunting	<i>Plectrophenax nivalis</i>						X	NB	11/05/2019
Chipping sparrow	<i>Spizella passerina</i>					X	X	B	06/21/2020
Field sparrow	<i>Spizella pusilla</i>						X	B	08/02/2015
American tree sparrow	<i>Spizelloides arborea</i>						X	NB	10/14/2018
Dark-eyed junco	<i>Junco hyemalis</i>						X	B	06/17/2020
White-crowned sparrow	<i>Zonotrichia leucophrys</i>						X	B	05/30/2016
White-throated sparrow*	<i>Zonotrichia albicollis</i>				X	X	X	B	06/22/2020
Savannah sparrow	<i>Passerculus sandwichensis</i>						X	B	07/08/2019
Song sparrow*	<i>Melospiza melodia</i>				X	X	X	B	06/22/2020
Lincoln's sparrow	<i>Melospiza lincolnii</i>						X	B	05/20/2016
Swamp sparrow*	<i>Melospiza georgiana</i>				X	X	X	B	06/22/2020
Eastern towhee	<i>Pipilo erythrophthalmus</i>						X	B	07/08/2019
Bobolink	<i>Dolichonyx oryzivorus</i>						X	B	06/06/2018
Baltimore oriole	<i>Icterus galbula</i>						X	B	06/03/2020
Red-winged blackbird*	<i>Agelaius phoeniceus</i>				X	X	X	B	06/22/2020
Brown-headed cowbird	<i>Molothrus ater</i>						X	B	06/21/2020
Rusty blackbird	<i>Euphagus carolinus</i>						X	NB	10/17/2017
Common grackle*	<i>Quiscalus quiscula</i>				X	X	X	B	06/22/2020
Ovenbird	<i>Seiurus aurocapilla</i>					X	X	B	05/21/2020
Northern waterthrush	<i>Parkesia noveboracensis</i>					X	X	B	06/03/2020
Black-and-white warbler	<i>Mniotilta varia</i>					X	X	B	05/30/2020
Tennessee warbler	<i>Leiothlypis peregrina</i>						X	NB	09/20/2019
Orange-crowned warbler	<i>Leiothlypis celata</i>			X			X	NB	10/05/2019

Table 6. Continued.

Common Name	Scientific Name	Data Source ¹						Period	Most Recent Date
		Site Visit	NHD	PRNL	CWMP	BBS	eBird		
Nashville warbler*	<i>Leiothlypis ruficapilla</i>				X	X	X	B	05/30/2020
Mourning warbler	<i>Geothlypis philadelphia</i>					X	X	B	06/04/2019
Common yellowthroat*	<i>Geothlypis trichas</i>				X	X	X	B	06/22/2020
American redstart*	<i>Setophaga ruticilla</i>				X	X	X	B	06/21/2020
Cape May warbler	<i>Setophaga tigrina</i>						X	B	05/24/2019
Northern parula*	<i>Setophaga americana</i>				X	X	X	B, NB	09/20/2019
Magnolia Warbler	<i>Setophaga magnolia</i>					X	X	B	05/30/2020
Bay-breasted warbler	<i>Setophaga castanea</i>						X	B	05/24/2019
Blackburnian warbler	<i>Setophaga fusca</i>					X	X	B	05/20/2020
Yellow warbler	<i>Setophaga petechia</i>					X	X	B	06/20/2020
Chestnut-sided warbler	<i>Setophaga pensylvanica</i>					X	X	B	08/25/2018
Blackpoll warbler	<i>Setophaga striata</i>						X	B	05/30/2020
Black-throated blue warbler	<i>Setophaga caerulescens</i>						X	NB	09/20/2019
Palm warbler	<i>Setophaga palmarum</i>						X	B	05/20/2020
Pine warbler	<i>Setophaga pinus</i>					X	X	B	06/03/2020
Yellow-rumped warbler*	<i>Setophaga coronata</i>			X		X	X	B	06/20/2020
Black-throated-green warbler	<i>Setophaga virens</i>					X	X	B	05/30/2020
Canada warbler	<i>Cardellina canadensis</i>					X	X	B	05/30/2020
Wilson's warbler	<i>Cardellina pusilla</i>			X			X	B	06/03/2020
Scarlet tanager	<i>Piranga olivacea</i>					X	X	B	2017
Rose-breasted grosbeak	<i>Pheucticus ludovicianus</i>						X	B	06/23/2019
Indigo bunting	<i>Passerina cyanea</i>					X	X	B	05/31/2019

¹Data sources: Site Visit – information gathered by MNFI when reviewing site in fall 2019; NHD – MNFI's Natural Heritage Database; PRNL – Pictured Rocks National Lakeshore wildlife observation database; CWMP – Great Lakes Coastal Wetland Monitoring Program sampling at Sand Point Wetland in 2019; BBS – North American Breeding Bird Survey data from nearby route during 2011-2019; and eBird – all checklists from Sand Point Marsh Trail through 30 June 2020.

Piping plover (*Charadrius melodus*; federal and state endangered) was documented using beach along Sand Point in 2012, but SPW does not contain suitable habitats for the species. Trumpeter swan (*Cygnus buccinator*; state threatened), common gallinule (*Gallinula galeata*; state threatened), common loon (*Gavia immer*; state threatened), American bittern (*Botaurus lentiginosus*; state special concern), and least bittern (*Ixobrychus exilis*; state threatened) were observed at SPW during the breeding season and could use the site for nesting. Caspian tern (*Hydroprogne caspia*; state threatened) has been documented in the Sand Point area; it uses open sand and pebble beaches for nesting, especially on Great Lakes islands (Hyde 1996). Although SPW does not provide nesting habitat for Caspian tern, open water areas within the complex could provide foraging habitat during breeding and migration periods.

In addition to the rare species mentioned above, several wetland-dependent species are likely to use the wetland during the breeding season. Several waterfowl species, such as mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), and hooded merganser (*Lophodytes cucullatus*), could use the emergent and open water areas for breeding pair and brood rearing habitat. Marsh birds, such as pied-billed grebe (*Podilymbus podiceps*), American bittern, least bittern, Wilson's snipe (*Gallinago delicata*), Virginia rail (*Rallus limicola*), sora (*Porzana carolina*), and sandhill crane (*Antigone canadensis*), could use emergent marsh for nesting. Marsh and open water zones could also be used for foraging. Several passerine species nest in emergent- and shrub-dominated wetlands, such as alder flycatcher (*Empidonax alnorum*), sedge wren (*Cistothorus platensis*), swamp sparrow (*Melospiza georgiana*), song sparrow (*Melospiza melodia*), common yellowthroat (*Geothlypis trichas*), yellow warbler (*Setophaga petechia*), and Nashville warbler (*Leiothlypis ruficapilla*). Forested portions of the wetland could support a variety of breeding species, such as red-eyed vireo (*Vireo olivaceus*), black-capped chickadee (*Poecile atricapillus*), American robin (*Turdus migratorius*), white-throated sparrow (*Zonotrichia albicollis*), and American redstart (*Setophaga ruticilla*).

The emergent and open water portions of SPW provide stopover habitat for migrant waterfowl and waterbirds (e.g., bitterns, rails, etc.), with numerous species being detected (Table 6). Shrub and forested zones also provide migration habitat for numerous songbird species, such as those previously recorded in and around the site during non-breeding periods (Table 6). Forested areas of SPW likely provide habitat for permanent resident bird species during winter, including ruffed grouse, owls, woodpeckers, black-capped chickadee, American crow, and blue jay.

Expected Use

The proposed restoration project would improve the hydrologic connection between SPW and Lake Superior, thus restoring the normal seasonal and long-term water level fluctuations experienced by unaltered coastal wetlands. The restored hydrology could influence bird use through changes to vegetation zonation and water depths. For example, prolonged high water levels could increase the size of open water areas, shift inland and potentially decrease the area of the emergent vegetation zone, and reduce shrub and tree cover through mortality caused by inundation. Conversely, prolonged low water levels could decrease the area of the open water zone, increase the amount of emergent vegetation, and increase shrub and tree cover. Less dramatic vegetation changes would occur with less extreme and shorter duration water level fluctuations.

Bird species that mainly use SPW for foraging and/or as migration stopovers, such as raptors and migrant waterfowl and waterbirds, would likely see minimal impact from changes related to water level fluctuations. Numbers of birds using the site might increase or decrease slightly with changes in area of the wetland types, but some foraging habitat is likely to remain throughout all

stages of the Lake Superior water level cycle, so any changes would probably be small. If hydrologic restoration results in greater fish use of the wetland, a variety of piscivorous bird species could potentially benefit, including mergansers, grebes, loons, herons, gulls, and terns. Increased water level fluctuations could also increase the germination of annual plant species, thus replenishing the seed bank. The seeds of annual plants are an important food source to a variety of migrant wetland birds (Fredrickson and Taylor 1982).

The amount, distribution, and structure of wetland plant zones are important factors in the selection of breeding and nesting habitats by wetland-dependent bird species, so changes to the wetland types in SPW associated with restoration could affect breeding bird use of the site. Wildlife ecologists have long understood how wetland bird diversity and abundance are closely linked to changes in hydrology, which in turn affects vegetation germination, growth, and interspersions (e.g., Weller and Spatcher 1965). Abundance and diversity of wetland birds could be reduced during extreme high and low Lake Superior water levels in response to changes in vegetation and is likely to be greatest under water levels that result in the greatest interspersions of emergent vegetation and open water, such as near average levels. Wetland-dependent bird species are well adapted to respond to the dynamic nature of wetland ecosystems, so potential impacts to diversity and abundance related to restored hydrology in SPW are likely to be small and temporary.

Overall, we do not expect the bird community to be significantly impacted by the proposed restoration of SPW. The relatively small size of the wetland complex, presence of the major wetland types during all stages of the water level cycle (i.e., some habitat always present), and the adaptability of the bird species using the site, mean that any changes to the bird community are likely to be short-term and biologically insignificant at the population scale. Furthermore, reestablishment of a more natural hydrology could promote healthy wetland functioning and increase vegetation diversity and structural heterogeneity that could benefit bird use through provision of microhabitats for breeding and feeding.

Mammals

Past and Current Use

Information on documented mammal use of the project area was limited to incidental sightings recorded in the NPS PRNL wildlife observation database and bat surveys conducted in 2003 and 2015-2016. Twenty-four (24) mammal species have been recorded in or near the SPW (Table 7), including 12 species of carnivores and six species of bats. This list is not exhaustive of the mammal species likely to occur at SPW and only represents those species detected by NPS staff incidentally and bat species observed during intensive sampling conducted because of the high conservation concern for these species due to declining populations. Although many of the incidental mammal observations are more than 20 years old (Table 7), we expect these species still occur in the area. Kruger and Peterson (2008) conducted surveys for bats within PRNL in 2003, which included sampling done in the Sand Point area. They used mist netting and active and passive acoustic monitoring to survey bats. They detected six bat species across all sampling methods (little brown bat [*Myotis lucifugus*], northern long-eared bat [*M. septentrionalis*], eastern red bat [*Lasiurus borealis*], hoary bat [*L. cinereus*], silver-haired bat [*Lasionycteris noctivagans*], and big brown bat [*Eptesicus fuscus*]). The same six species were reconfirmed during acoustic monitoring conducted at SPW during 2015 and 2016 (C. Heyd, NPS, personal communication).

Of the 24 mammal species detected in or near the wetland complex, three are of conservation concern: gray wolf (federal endangered, state special concern), little brown bat (state special

concern, SGCN), and northern long-eared bat (federal threatened, state special concern, SGCN). With large home ranges (50-800 km²) and expansive daily movements (Kurta 2017), gray wolves use a variety of habitats within largely forested landscapes. Little brown bats tend to eat insects with aquatic life stages, so foraging often occurs over water bodies, whereas northern long-eared bats typically forage within forests and less regularly over ponds (Kurta 2017). In addition to man-made structures (e.g., barns, homes), these bats will roost in natural habitats, such as tree cavities, under peeling bark, and trunk crevices (Kurta 2017).

Several additional species have potential to occur at the site, especially small mammals not easily detected without dedicated trapping and many of which can use a range of habitat types. The following species could be found at SPW based on known distributions and available habitat: masked shrew (*Sorex cinereus*), American water shrew (*Sorex palustris*), star-nosed mole (*Condylura cristata*), red squirrel (*Tamiasciurus hudsonicus*), deer mouse (*Peromyscus maniculatus*), southern red-backed vole (*Myodes gapperi*), common muskrat (*Ondatra zibethicus*), southern bog lemming (*Synaptomys cooperi*), and meadow jumping mouse (*Zapus hudsonius*). In addition to the small mammals, the water bodies within SPW could support northern river otter (*Lontra canadensis*).

Expected Use

Proposed hydrologic restoration of SPW would improve the normal seasonal and long-term water level fluctuations previously experienced at the site. As described in earlier sections, plant communities are expected to shift in response to fluctuating water levels. Most of the mammal species previously documented (Table 4) or potentially occurring within SPW are unlikely to be affected by the naturally changing Lake Superior water levels. The medium- to large-bodied carnivores have home ranges far exceeding the size of the wetland complex. Furthermore, these and many of the smaller mammal species use a variety of habitat types, making them able to shift to adjacent uplands should conditions within SPW become unsuitable. Small mammal species requiring wetland habitats, such as American water shrew and southern bog lemming, are most likely to be impacted by extreme periods of the Lake Superior water level cycle (i.e., extended high or low water levels). Because these species require wetland habitats and have less mobility than larger mammals, their populations could decrease during extreme flooding or drought. However, some suitable habitat is likely to be present even during high or low water levels, allowing some animals to survive the extreme conditions and populations to rebound when more typical water levels return. Although muskrat numbers at SPW are likely low due to the low abundance of preferred food plants (e.g., cat-tails, bulrushes), populations could be reduced during periods of high water and low emergent vegetation availability. However, muskrats are well adapted to the water level fluctuations of wetlands, being able to disperse to other areas and producing up to three litters per year to repopulate areas where populations have crashed. In summary, as with the other taxonomic groups, we expect impacts to mammal populations associated with hydrologic restoration to be minimal and temporary. The long-term benefits of improved wetland functioning likely outweigh any short-term effects to mammal populations.

Table 7. Mammal species recorded from the Sand Point area, with the general locations and most recent observation dates provided.

Common Name	Scientific Name	General Location	Most Recent Date
American beaver	<i>Castor canadensis</i>	Sand Point ponds	07/05/1990
Meadow vole	<i>Microtus pennsylvanicus</i>	Sand Point Road near Headquarters	08/08/1995
Eastern gray squirrel	<i>Sciurus carolinensis</i>	Sand Point general	08/20/1990
Northern flying squirrel	<i>Glaucomys sabrinus</i>	Sand Point general	Not available
Snowshoe hare	<i>Lepus americanus</i>	Sand Point general	Not available
Little brown bat	<i>Myotis lucifugus</i>	Sand Point Wetland	07/20/2016-08/04/2016
Northern long-eared bat	<i>Myotis septentrionalis</i>	Sand Point Wetland	05/27/2015-06/09/2015
Eastern red bat	<i>Lasiurus borealis</i>	Sand Point Wetland	07/20/2016-08/04/2016
Hoary bat	<i>Lasiurus cinereus</i>	Sand Point Wetland	07/20/2016-08/04/2016
Silver-haired bat	<i>Lasionycteris noctivagans</i>	Sand Point Wetland	07/20/2016-08/04/2016
Big brown bat	<i>Eptesicus fuscus</i>	Sand Point Wetland	07/20/2016-08/04/2016
Bobcat	<i>Lynx rufus</i>	Sand Point boat launch	04/25/1997
Gray wolf	<i>Canis lupus</i>	Sand Point Road	01/10/2015
Coyote	<i>Canis latrans</i>	Sand Point general	12/15/1989
Red fox	<i>Vulpes vulpes</i>	Sand Point Road and boat launch	06/15/1992
Gray fox	<i>Urocyon cinereoargenteus</i>	Sand Point Marsh Trail, boat launch	12/18/2012
Black bear	<i>Ursus americanus</i>	Sand Point general, road, boat launch, and boardwalk	06/26/2000
American marten	<i>Martes americana</i>	Sand Point general	05/31/1994
Fisher	<i>Pekania pennanti</i>	Sand Point general	06/08/1993
Ermine	<i>Mustela erminea</i>	Sand Point Headquarters, residence, and Lakeshore Trail	03/02/1987
Long-tailed weasel	<i>Mustela frenata</i>	Sand Point near Headquarters, Rim	10/31/2016
American mink	<i>Neovison vison</i>	Sand Point general, road	08/26/1992
Northern racoon	<i>Procyon lotor</i>	Sand Point general	Not available
White-tailed deer	<i>Odocoileus virginianus</i>	Sand Point boat launch	07/29/1990

Conclusions

Fill deposited for Sand Point Road and the installation of drainage culverts inadequate to maintain normal connections with Lake Superior have artificially raised water levels within the wetland and reduced the natural seasonal and long-term water level fluctuations characteristic of Great Lakes coastal wetlands. The altered hydrology is likely causing localized changes to wetland functioning, such as nutrient cycling, peat formation/decomposition, water retention patterns, and plant and animal community composition. Elevated and more stable water levels and reduced water exchange with Lake Superior could be increasing nutrient levels through entrapment and reducing disturbance associated water level fluctuations, thus creating an environment more conducive to the expansion of cat-tails and other clonal species, such as *Phragmites australis*. The limited connection to Lake Superior is also likely limiting fish use of the wetland to those species tolerant of low oxygen conditions. Despite changes caused to the wetland's hydrology, SPW remains a relatively intact dune and swale community that is providing habitat for diverse plant and animal assemblages. Although occurrences of rare plant and animal species were probably limited by the site's small size, we found records in and around SPW for 133 plant species, 37 aquatic macroinvertebrate taxa, 103 terrestrial insect species, seven fish species, 15 amphibian and reptile species, 173 bird species, and 24 mammal species, including 18 species considered threatened, special concern, or species of greatest conservation need.

The consensus among the MNFI scientists charged with assessing the potential effects of the proposed restoration of SPW is that the project is unlikely to cause detrimental effects to the natural communities or plant and animal species present at the site. Improvement of the hydrologic connection between SPW and Lake Superior is likely to result in a more naturally functioning wetland representative of conditions that occurred prior to road construction. However, the hydrologic changes proposed by the restoration are expected to be small compared to the natural range of variation occurring within the wetland complex when it was connected to Lake Superior. Restoring natural water level fluctuations should reduce the likelihood for invasive plant species expansion and could increase plant diversity through the formation of microhabitats created through greater water exchange and more frequent changes in water depths. Although changes in plant and animal composition could occur during extreme high and low Lake Superior water levels, we expect those changes to be minor and temporary, with generally stable natural community and plant and animal assemblages over the long term. Although the size and location of microhabitats may change with fluctuating water levels, we expect them to persist across the range of future water levels, thus helping to maintain overall biodiversity over time. In summary, we believe the benefits of restoring the hydrology of SPW and having a more naturally functioning system outweigh any potential minor, short-term impacts.

In addition to conducting the proposed restoration activities, we highly recommend ecological monitoring be designed and implemented. Monitoring of restored ecosystems is often lacking due to resource constraints; however, the information gained can be invaluable in assessing success and informing adaptive management. Tracking the distribution and abundance of invasive species should be an important component of any monitoring program, because it would allow assessment of changes in their occurrence in response to restoration, inform an early detection and response effort, and facilitate the evaluation of the effectiveness of control activities (e.g., cat-tail management). Substantial data have already been gathered at the site by PRNL staff, the CWMP, and other partners, which along with additional targeted sampling to

address remaining gaps (e.g., plants, insects, small mammals) could be used as baseline data. This baseline information could then be compared to follow-up sampling after restoration, ideally over multiple seasons representing the range of Lake Superior water levels. Having a better understanding of how coastal wetlands respond to hydrologic restoration could help other entities considering similar projects elsewhere in the Great Lakes. The MNFI has substantial experience evaluating the success of wetlands management and restoration actions and would be happy to assist the NPS in developing and implementing a monitoring plan for SPW.

Acknowledgements

Funding for this project was provided by the National Park Service (NPS). Cindy Heyd (NPS) acquired the internal NPS funding to support MNFI work on the project and provided substantial advice, information, feedback, and support throughout the project. Cindy Heyd and Bruce Leutscher (NPS) met with MNFI staff and provided background on the project and a tour of the wetland and proposed restoration area. Matthew Cooper (Muskegon Community College) provided data for Sand Point Wetland from the Great Lakes Coastal Wetland Monitoring Program. Brian Klatt, Nancy Toben, Ashley Adkins, and Sarah Carter of MNFI provided administrative support.

Literature Cited

- Albert, D.A., and P.J. Comer. 1999. Natural community abstract for wooded dune and swale complex. Michigan Natural Features Inventory, Lansing, MI.
- Bozic A., and W. Previant. 2006. Survey forms for plots 46-51 from the National Park Service Vegetation Inventory Program. National Park Service, Pictured Rocks National Lakeshore, Munising, Michigan.
- Burton, T.M., D.G. Uzarski, J.P. Gathman, J.A. Genet, B.E. Keas, C.A. Stricker. 1999. The development of an index of biotic integrity for Great Lakes coastal wetlands of Lake Huron. *Wetlands* 19:869–882.
- Casper, G.S. 2005. An amphibian and reptile inventory of Pictured Rocks National Lakeshore. National Park Service, Great Lakes Inventory and Monitoring Network Report GLKN/2005/05.
- Chapman, K. 1972. Sand Point site summary. Michigan Natural Features Inventory, Lansing, Michigan.
- Cohen, J.G., M.A. Kost, B.S. Slaughter, and D.A. Albert. 2015. A Field Guide to the Natural Communities of Michigan. Michigan State University Press, East Lansing, MI.
- Colburn, E.A. 2004. Vernal pools: natural history and conservation. The McDonald and Woodward Publishing Company, Granville, Ohio.
- Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A. Corner, and D.W. Schuen (map interpretation); T.R. Leibfreid, M.B. Austin, C.J. DeLain, L. Prange-Gregory, L.J. Scrimger, K.M. Korroch, and J.G. Spitzley (digital map production). 1995. Michigan's presettlement vegetation, as interpreted from the General Land Office surveys 1816-1856. Michigan Natural Features Inventory, Lansing, MI. digital map.
- Currier, C. 2001. Special animal abstract for *Circus cyaneus* (northern harrier). Michigan Natural Features Inventory. Lansing, Michigan.
- Cuthrell, D.L. 2007. Special animal abstract for *Papaipema speciosissima* (regal fern borer moth). Michigan Natural Features Inventory, Lansing, Michigan.
- Derosier, A.L., S.K. Hanshue, K.E. Wehrly, J.K. Farkas, and M.J. Nichols. 2015. Michigan's wildlife action plan. Michigan Department of Natural Resources, Lansing, Michigan.
- Egan, A.T., T. Lafrancois, M.B. Edlund, L.C. Ferrington, Jr., and J. Glase. 2014. Biological studies and mapping of shoreline rock pools in three Lake Superior national parks. Natural Resource Technical Report NPS/MWRO/NRTR—2014/907. National Park Service, Fort Collins, Colorado.
- Environmental Protection Agency. 2003. Methods for evaluating wetland condition: wetland biological assessment case studies. Office of Water, U.S. Environmental Protection Agency, Washington, DC. EPA-822-R-03-013.
- Fredrickson, L.H., and T.S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. Resource Publication 148, U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C.
- Gathman, J.P. and T.M. Burton. 2011. A Great Lakes coastal wetland invertebrate community gradient: relative influence of flooding regime and vegetation zonation. *Wetlands* 31:329–341.
- Great Lakes Coastal Wetland Monitoring Program. 2019. Unpublished data from Sand Point Wetland.
- Gucker, C.L. 2008. *Typha latifolia*. In: Fire Effects Information System, [Online]. U.S.

- Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <https://www.fs.fed.us/database/feis/plants/graminoid/typlat/all.html> Accessed 9 August 2020.
- Harding, J.H., and D.A. Mifsud. 2017. Amphibians and reptiles of the Great Lakes region, revised edition. University of Michigan Press, Ann Arbor, Michigan.
- Herrick, B.M., M.D. Morgan, and A.T. Wolf. 2007. Seed banks in diked and undiked Great Lakes coastal wetlands. *American Midland Naturalist* 158:191–205.
- Hop, K., S. Menard, J. Drake, S. Lubinski, and J. Dieck. 2010. National Park Service Vegetation Inventory Program, Pictured Rocks National Lakeshore, Michigan. Natural Resources Report NPS/GLKN/NRR—210-201. National Park Service, Fort Collins, Colorado.
- Hyde, D.A. 1996. Special animal abstract for *Sterna caspia* (Caspian tern). Michigan Natural Features Inventory, Lansing, Michigan.
- Jude, D.J., and J. Pappas. 1992. Fish utilization of Great Lakes coastal wetlands. *Journal of Great Lakes Research* 18:651-672.
- Kost, M.A., D.A. Albert, J.G. Cohen, B.S. Slaughter, R.K. Schillo, C.R. Weber, and K.A. Chapman. 2007. Natural Communities of Michigan: classification and description. Michigan Natural Features Inventory, Report Number 2007-21, Lansing, Michigan.
- Kruger, L., and R.O. Peterson. 2008. Occurrence of temperate bat species at three national parks in the Great Lakes region. Natural Resource Technical Report NPS/GLKN/NRTR—2008/128. National Park Service, Fort Collins, Colorado.
- Kurta, A. 2017. Mammals of the Great Lakes region, third edition. University of Michigan Press, Ann Arbor, Michigan.
- MacKenzie, R.A., and J.L. Kaster. 2004. Temporal and spatial patterns of insect emergence from a Lake Michigan coastal wetland. *Wetlands* 24:688-700.
- Marburger, J. 2012. Locate and identify native, exotic, and hybrid cattail populations in Cuyahoga Valley National Park, Pictured Rocks National Lakeshore, and Sleeping Bear Dunes National Lakeshore. Final report for cooperative agreement H6000082000.
- Marburger, J., and L. Kainulainen. 2010. Cattail pollen morphology at 4 sites in Pictured Rocks National Lakeshore. Draft Report.
- Martin, M. 2018. Memorandum report regarding Sand Point restoration. National Park Service, Water Resources Division.
- Maskey, A.E., and L.M. Loope. 2006. Butterfly and moth (Lepidopteran) survey of Pictured Rocks National Lakeshore, 2000-2006. National Park Service, Science and Natural Resources Division, Pictured Rocks National Lakeshore, Munising, Michigan.
- Michigan Herp Atlas. 2019. Michigan Herp Atlas - A Statewide Herpetological Atlas and Data Hub. Michigan. <http://www.miherpatlas.com>. Accessed 10 June 2020.
- Michigan Natural Features Inventory. 2020. Michigan natural heritage database. Michigan Natural Features Inventory, Lansing, Michigan.
- Moth Photographers Group. 2020. *Papaipema speciosissima*. <http://mothphotographersgroup.msstate.edu/species.php?hodges=9482> Accessed 10 June 2020.
- National Park Service. 2019. Pictured Rocks National Lakeshore wildlife observation database. National Park Service, Pictured Rocks National Lakeshore, Munising, MI.
- Newman, L. 2005. Fish species inventory of inland waters of Pictured Rocks National Lakeshore, Mich. National Park Service, Great Lakes Inventory and Monitoring Network, Ashland, WI. 54806. Great Lakes Network Technical Report: GLKN/2005/04
- Okland, J. 1992. Effects of acidic water on freshwater snails: results from a study of 1,000 lakes throughout Norway. *Environmental Pollution* 78:127-30.
- Rabe, M.L. 1999. Special animal abstract for *Trimerotropis huroniana* (Lake Huron locust). Michigan Natural Features Inventory, Lansing, Michigan.
- Resh, S.C., A.J. Schrank, W.J. Previant, and R.A. Chimner. 2013. Vernal pool assessment in

- Pictured Rocks National Lakeshore in a dry year. Natural Resource Technical Report NPS/PIRO/NRTR—2013/766. National Park Service, Fort Collins, Colorado.
- Reznicek, A.A., M.R. Penskar, B.S. Walters, and B.S. Slaughter. 2014. Michigan Floristic Quality Assessment Database. Herbarium, University of Michigan, Ann Arbor, MI and Michigan Natural Features Inventory, Michigan State University Extension, Lansing, MI.
- Schultz, J. 1989. Sand Point Marsh Trail, Pictured Rocks National Lakeshore. T47N, R18W, Section 19, Alger County, Michigan. Botanical Survey.
- Schwaritz, R., and D.P. Batzer. 1999. An introduction to freshwater wetlands in North America and their invertebrates. Pages 1-24 *in* D. P. Batzer, R. B. Rader, and S. A. Wissinger (eds.). *Invertebrates in freshwater wetlands of North America*. John Wiley and Sons, New York, New York.
- Slaughter, B.S., and D.L. Cuthrell. 2016. Groundwater-Dependent ecosystem (GDE) and associated rare species surveys, Hiawatha National Forest, MI: summary of 2013 – 2015 activities. Michigan Natural Features Inventory, Report No. 2016-07, Lansing, MI.
- Uzarski, D.G., V.J. Brady, M.J. Cooper, D.A. Wilcox, D.A. Albert, R.P. Axler, P. Bostwick, T.N. Brown, J.J.H. Ciborowski, N.P. Danz, J.P. Gathman, T.M. Gehring, G.P. Grabas, A. Garwood, R.W. Howe, L.B. Johnson, G.A. Lamberti, A.H. Moerke, B.A. Murry, G.J. Niemi, C.J. Norment, C.R. Ruetz, A.D. Steinman, D.C. Tozer, R. Wheeler, T.K. O'Donnell, and J.P. Schneider. 2017. Standardized measures of coastal wetland condition: implementation at a Laurentian Great Lakes basin-wide scale. *Wetlands* 37:15–32.
- Wagner, J., D. Schook, and M. Martin. 2018. Technical assistance report: install hydrologic monitoring wells and perform wetland delineation at the Sand Point Wetland Complex, Pictured Rocks National Lakeshore. Internal report, National Park Service, Water Resources Division, Fort Collins, Colorado.
- Watters, G.T., M.A. Hoggarth, and D.H. Stansbery. 2009. *The freshwater mussels of Ohio*. The Ohio State University Press, Columbus.
- Weller, M.W., and C.S. Spatcher. 1965. Role of habitat in the distribution and abundance of marsh birds. Department of Zoology and Entomology, Special Report 43, Agricultural and Home Economics Experiment Station, Iowa State University, Ames, Iowa.
- Werner, J.K., and J.S. Davis. 1989. Amphibian/reptile survey of Sand Point Area, Pictured Rocks National Lakeshore, Munising, Michigan. Technical Report.
- Wisheu, I.C., and P.A. Keddy. 1992. Competition and centrifugal organization of plant communities: theory and tests. *Journal of Vegetation Science* 3:147–156.

APPENDIX A: Combined list of plant species detected at Sand Point Wetland across multiple data sources.

Sand Point - All Species; Munising, Alger County, Michigan, USA
Brief Floristic Quality Assessment; Michigan. FQA DB Publication, Rezinick et al. 2014
Phyllis Higman 6/20/20

Conservatism-Based Metrics:		Species Richness:		Duration Metrics:	
Total Mean C:	4.3	Total Species:	133	Annual:	1 0.8%
Native Mean C:	4.9	Native Species:	116 87.2%	Perennial:	127 95.5%
Total FQI:	49.6	Non-native Species:	17 12.8%	Biennial:	5 3.8%
Native FQI:	52.8	Species Wetness:		Native Annual:	1 0.8%
Adjusted FQI:	45.8	Mean Wetness:	-0.8	Native Perennial:	112 84.2%
% C value 0:	15	Native Mean Wetness:	-1.4	Native Biennial:	3 2.3%
% C value 1-3:	21.8	Physiognomy Metrics:			
% C value 4-6:	41.4	Tree:	15 11.3%	Sedge:	9 6.8%
% C value 7-10:	21.8	Shrub:	31 23.3%	Rush:	2 1.5%
Native Tree Mean C:	4.3	Vine:	1 0.8%	Fern:	11 8.3%
Native Shrub Mean C:	6	Forb:	54 40.6%	Bryophyte:	0 0%
Native Herbaceous Mean C:	4.7	Grass:	10 7.5%		

Species Documented:						
Scientific Name	Common Name	C	W	Native?	Phsiog.	Duration
<i>Abies balsamea</i>	balsam fir	3	0	native	tree	perennial
<i>Acer rubrum</i>	red maple	1	0	native	tree	perennial
<i>Acer saccharum</i>	sugar maple	5	3	native	tree	perennial
<i>Actaea rubra</i>	red baneberry	7	3	native	forb	perennial
<i>Agrostis gigantea</i>	redtop	0	-3	non-native	grass	perennial
<i>Alnus incana; a. rugosa</i>	speckled alder	5	-3	native	shrub	perennial
<i>Ammophila breviligulata</i>	marram grass	10	5	native	grass	perennial
<i>Anaphalis margaritacea</i>	pearly everlasting	3	5	native	forb	perennial
<i>Aralia nudicaulis</i>	wild sarsaparilla	5	3	native	forb	perennial
<i>Artemisia campestris</i>	wormwood	5	5	native	forb	biennial
<i>Asclepias syriaca</i>	common milkweed	1	5	native	forb	perennial
<i>Athyrium filix-femina</i>	lady fern	4	0	native	fern	perennial
<i>Avenella flexuosa; deschampsia f.</i>	hair grass	6	5	native	grass	perennial
<i>Betula alleghaniensis</i>	yellow birch	7	0	native	tree	perennial
<i>Betula papyrifera</i>	paper birch	2	3	native	tree	perennial
<i>Bromus inermis</i>	smooth brome	0	5	non-native	grass	perennial
<i>Calamagrostis canadensis</i>	blue-joint	3	-5	native	grass	perennial
<i>Cardamine pensylvanica</i>	Pennsylvania bitter cress	1	-3	native	forb	biennial
<i>Carex aquatilis</i>	sedge	7	-5	native	sedge	perennial
<i>Carex cryptolepis</i>	sedge	8	-5	native	sedge	perennial
<i>Carex lacustris</i>	sedge	6	-5	native	sedge	perennial

Scientific Name	Common Name	C	W	Native?	Phsiog.	Duration
<i>Carex lasiocarpa</i>	sedge	8	-5	native	sedge	perennial
<i>Carex lurida</i>	sedge	3	-5	native	sedge	perennial
<i>Carex rostrata</i>	sedge	10	-5	native	sedge	perennial
<i>Carex stricta</i>	sedge	4	-5	native	sedge	perennial
<i>Carex utriculata</i> ; <i>c. rostrata</i>	sedge	5	-5	native	sedge	perennial
<i>Chamaedaphne calyculata</i>	leatherleaf	8	-5	native	shrub	perennial
<i>Cichorium intybus</i>	chicory	0	3	non-native	forb	perennial
<i>Cirsium vulgare</i>	bull thistle	0	3	non-native	forb	biennial
<i>Clintonia borealis</i>	bluebead-lily; corn-lily	5	0	native	forb	perennial
<i>Comarum palustre</i> ; <i>potentilla p.</i>	marsh cinquefoil	7	-5	native	forb	perennial
<i>Cornus sericea</i> ; <i>c. stolonifera</i>	red-osier	2	-3	native	shrub	perennial
<i>Cypripedium acaule</i>	pink lady-slipper	5	-3	native	forb	perennial
<i>Cystopteris bulbifera</i>	bulblet fern	5	-3	native	fern	perennial
<i>Dactylis glomerata</i>	orchard grass	0	3	non-native	grass	perennial
<i>Daucus carota</i>	Queen-Anne's-lace	0	5	non-native	forb	biennial
<i>Dryopteris carthusiana</i>	spinulose woodfern	5	-3	native	fern	perennial
<i>Dryopteris intermedia</i>	evergreen woodfern	5	0	native	fern	perennial
<i>Elymus canadensis</i>	Canada wild rye	5	3	native	grass	perennial
<i>Epigaea repens</i>	trailing-arbutus	7	3	native	shrub	perennial
<i>Epipactis helleborine</i>	Helleborine	0	0	non-native	forb	perennial
<i>Equisetum arvense</i>	common horsetail	0	0	native	fern	perennial
<i>Euthamia graminifolia</i>	grass-leaved goldenrod	3	0	native	forb	perennial
<i>Eutrochium maculatum</i>	joe-pye-weed	4	-5	native	forb	perennial
<i>Fagus grandifolia</i>	American beech	6	3	native	tree	perennial
<i>Fragaria virginiana</i>	wild strawberry	2	3	native	forb	perennial
<i>Fraxinus nigra</i>	black ash	6	-3	native	tree	perennial
<i>Galium trifidum</i>	small bedstraw	6	-3	native	forb	perennial
<i>Galium triflorum</i>	fragrant bedstraw	4	3	native	forb	perennial
<i>Gaultheria procumbens</i>	Wintergreen	5	3	native	shrub	perennial
<i>Gaylussacia baccata</i>	Huckleberry	7	3	native	shrub	perennial
<i>Geranium maculatum</i>	wild geranium	4	3	native	forb	perennial
<i>Geum macrophyllum</i>	large-leaved avens	5	-3	native	forb	perennial
<i>Glyceria striata</i>	fowl manna grass	4	-5	native	grass	perennial
<i>Goodyera oblongifolia</i>	Menzies' rattlesnake plantain	8	3	native	forb	perennial
<i>Hieracium piloselloides</i>	king devil	0	5	non-native	forb	perennial
<i>Hudsonia tomentosa</i>	beach-heath	10	5	native	shrub	perennial
<i>Hypericum perforatum</i>	common St. John's-wort	0	5	non-native	forb	perennial
<i>Ilex mucronata</i> ; <i>nemopanthus m.</i>	mountain holly	7	-5	native	shrub	perennial
<i>Ilex verticillata</i>	Michigan holly	5	-3	native	shrub	perennial
<i>Impatiens capensis</i>	spotted touch-me-not	2	-3	native	forb	annual
<i>Iris versicolor</i>	wild blue flag	5	-5	native	forb	perennial
<i>Juncus acuminatus</i>	sharp-fruited rush	8	-5	native	rush	perennial
<i>Juncus balticus</i>	Rush	4	-5	native	rush	perennial

Scientific Name	Common Name	C	W	Native?	Phsiog.	Duration
<i>Juniperus horizontalis</i>	creeping juniper	10	3	native	shrub	perennial
<i>Larix laricina</i>	Tamarack	5	-3	native	tree	perennial
<i>Lathyrus palustris</i>	marsh pea	7	-3	native	vine	perennial
<i>Leucanthemum vulgare</i>	ox-eye daisy	0	5	non-native	forb	perennial
<i>Lonicera canadensis</i>	Canadian fly honeysuckle	5	3	native	shrub	perennial
<i>Lonicera tatarica</i>	tartarian honeysuckle	0	3	non-native	shrub	perennial
<i>Lonicera villosa</i>	mountain fly honeysuckle	8	-3	native	shrub	perennial
<i>Lycopus americanus</i>	common water horehound	2	-5	native	forb	perennial
<i>Lycopus uniflorus</i>	northern bugle weed	2	-5	native	forb	perennial
<i>Maianthemum canadense</i>	Canada mayflower	4	3	native	forb	perennial
<i>Mitella nuda</i>	naked miterwort	8	-3	native	forb	perennial
<i>Myrica gale</i>	sweet gale	6	-5	native	shrub	perennial
<i>Nuphar variegata</i>	yellow pond-lily	7	-5	native	forb	perennial
<i>Nymphaea odorata</i>	sweet-scented waterlily	6	-5	native	forb	perennial
<i>Oenothera biennis</i>	common evening-primrose	2	3	native	forb	biennial
<i>Onoclea sensibilis</i>	sensitive fern	2	-3	native	fern	perennial
<i>Osmunda cinnamomea</i>	cinnamon fern	5	-3	native	fern	perennial
<i>Osmunda regalis</i>	royal fern	5	-5	native	fern	perennial
<i>Persicaria amphibia</i>	water smartweed	6	-5	native	forb	perennial
<i>Phalaris arundinacea</i>	reed canary grass	0	-3	native	grass	perennial
<i>Phegopteris connectilis</i>	northern beech-fern	5	3	native	fern	perennial
<i>Phleum pratense</i>	Timothy	0	3	non-native	grass	perennial
<i>Picea mariana</i>	black spruce	6	-3	native	tree	perennial
<i>Pinus resinosa</i>	red pine	6	3	native	tree	perennial
<i>Pinus strobus</i>	white pine	3	3	native	tree	perennial
<i>Populus balsamifera</i>	balsam poplar	2	-3	native	tree	perennial
<i>Prenanthes altissima</i>	tall white lettuce	5	3	native	forb	perennial
<i>Primula mistassinica</i>	birds-eye primrose	10	-3	native	forb	perennial
<i>Prunus pumila</i>	sand cherry	8	5	native	shrub	perennial
<i>Pteridium aquilinum</i>	bracken fern	0	3	native	fern	perennial
<i>Pyrola elliptica</i>	large-leaved shinleaf	6	3	native	forb	perennial
<i>Rhamnus alnifolia</i>	alder-leaved buckthorn	8	-5	native	shrub	perennial
<i>Rhododendron groenlandicum</i>	Labrador-tea	8	-5	native	shrub	perennial
<i>Ribes hudsonianum</i>	northern black currant	10	-5	native	shrub	perennial
<i>Ribes lacustre</i>	swamp black currant	6	-3	native	shrub	perennial
<i>Rosa palustris</i>	swamp rose	5	-5	native	shrub	perennial
<i>Rubus pubescens</i>	dwarf raspberry	4	-3	native	shrub	perennial
<i>Rudbeckia hirta</i>	black-eyed Susan	1	3	native	forb	perennial
<i>Rumex acetosella</i>	sheep sorrel	0	3	non-native	forb	perennial
<i>Rumex orbiculatus</i>	great water dock	9	-5	native	forb	perennial
<i>Salix bebbiana</i>	Bebb's willow	1	-3	native	shrub	perennial
<i>Salix eriocephala</i>	Willow	2	-3	native	shrub	perennial
<i>Salix exigua</i>	sandbar willow	1	-3	native	shrub	perennial

Scientific Name	Common Name	C	W	Native?	Phsiog.	Duration
<i>Salix pedicellaris</i>	bog willow	8	-5	native	shrub	perennial
<i>Scirpus cyperinus</i>	wool-grass	5	-5	native	sedge	perennial
<i>Scutellaria galericulata</i>	marsh skullcap	5	-5	native	forb	perennial
<i>Scutellaria lateriflora</i>	mad-dog skullcap	5	-5	native	forb	perennial
<i>Silene vulgaris</i>	bladder campion	0	5	non-native	forb	perennial
<i>Solidago canadensis</i>	Canada goldenrod	1	3	native	forb	perennial
<i>Solidago rugosa</i>	rough-leaved goldenrod	3	0	native	forb	perennial
<i>Sorbus americana</i>	American mountain-ash	4	0	native	tree	perennial
<i>Symphoricarpos occidentalis</i>	Wolfberry	0	3	non-native	shrub	perennial
<i>Symphyotrichum lanceolatum</i>	panicked aster	2	-3	native	forb	perennial
<i>Symphyotrichum lateriflorum</i>	calico aster	2	0	native	forb	perennial
<i>Tanacetum vulgare</i>	garden tansy	0	3	non-native	forb	perennial
<i>Thalictrum dasycarpum</i>	purple meadow-rue	3	-3	native	forb	perennial
<i>Thelypteris palustris</i>	marsh fern	2	-3	native	fern	perennial
<i>Thuja occidentalis</i>	arbor vitae	4	-3	native	tree	perennial
<i>Triadenum fraseri</i>	marsh St. John's-wort	6	-5	native	forb	perennial
<i>Triadenum virginicum</i>	marsh St. John's-wort	10	-5	native	forb	perennial
<i>Trientalis borealis</i>	star-flower	5	0	native	forb	perennial
<i>Tsuga canadensis</i>	Hemlock	5	3	native	tree	perennial
<i>Typha latifolia</i>	broad-leaved cat-tail	1	-5	native	forb	perennial
<i>Vaccinium angustifolium</i>	low sweet blueberry	4	3	native	shrub	perennial
<i>Vaccinium macrocarpon</i>	large cranberry	8	-5	native	shrub	perennial
<i>Vaccinium myrtilloides</i>	Canada blueberry	4	-3	native	shrub	perennial
<i>Viburnum cassinoides</i>	wild-raisin	6	3	native	shrub	perennial
<i>Vinca minor</i>	Periwinkle	0	5	non-native	shrub	perennial
<i>Viola macloskeyi</i>	smooth white violet	6	-5	native	forb	perennial