GRNA NATURAL RESOURCES MANAGEMENT PLAN
2020-2025

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I. INTRODUCTION

Purpose/Vision: The GRNA Natural Resources Management Plan (NRMP) 2020-2025 is an update to the 2012 NRMP. The NRMP provides a roadmap and recommendations to GRNA, Inc. and Antrim County for long-term management, monitoring and maintaining the natural resources located within GRNA boundaries. It is based on sound science and best practices for managing natural resources.

Philosophy: Resource management decisions must:
- Be based on a broad range of scientific information.
- Sustain natural features, biological diversity and ecological integrity.
- Consider the impact on future generations.
- Be consistent with the mission of GRNA, Inc.

Goals: The GRNA Natural Resources Management Plan has four goals.
- Preserve the biological diversity and ecological integrity of the natural resources in GRNA.
- Monitor changes in the GRNA ecosystem.
- Provide actions for the special management of threatened, endangered or rare species, as well as species of concern or species particularly important in GRNA.
- Conduct and/or facilitate collaborative research to better understand the dynamics and structure of natural communities, the effectiveness of resource management, and the role of human history in GRNA.

Management Tools: Successful resource management of GRNA requires that the following documents, systems, and action plans be developed, and a tentative timeline established:

Data: An ongoing array of data sets need to be managed in the most efficient and strategically effective way. This will include the utilization of an on-site data base, and national, regional and other organization's data bases. Action items will include:
- Detailed review of the Community Delineation and Floristic Quality Assessment (FQA) conducted by Michigan Natural Features Inventory (MNFI, Hackett et al. 2017) to help establish monitoring and/or data collection priorities. See Appendix 1.
- Utilize the Floristic Quality Index (FQI) values provided by Hackett et al. 2017 to determine how to continue evaluating prioritized components of the biodiversity of management areas in GRNA.
- Research the available viability assessment tools or models for evaluating the viability of each special population of threatened, endangered, and/or rare species, as well as species of concern or species that are of particular importance in GRNA.
- Concurrently, continue collecting data on species' populations and threats to their existence.

Plans: Comprehensive annual plans will provide guidance for staff and volunteers to proceed each year. As this overall management plan will remain dynamic in nature, changes will be made as priorities change. Action items will include:
- Update the current Natural Resource Management Plan covering all management areas in GRNA.

- Develop a Species Protection Plan for managing each selected population of threatened, endangered, and/or rare species, as well as species of concern or species that are particularly important in GRNA.
- Develop a Scientific Research Plan that prioritizes a list of specific research areas of interest and initiate a Scientific Research Plan to coordinate with research organizations and/or universities to conduct collaborative efforts on specific scientific research projects in GRNA.
- Develop an annual 'Volunteer Training Plan' for training by conservation professionals if possible and increasing the number of volunteers and students involved in monitoring the ecosystems in GRNA. Should generate at least one Species Protection Plan for a GRNA species each year.
- Research and discuss plans for an Historic Research Plan for conducting historic and archaeological research in GRNA.

Policy Handbook: This document will provide guidance to successive generations of staff and volunteers. Action items will include:
- Create or edit existing relevant management policies.
- Provide a proposed draft of scientific research policies and make a recommendation to the Board of Directors.
- Investigate historical research policies for protecting important historical and anthropological sites and guiding historical and anthropological research.
- Determine if a Template for a Memorandum of Understanding (MOU) with appropriate research partner organizations, such as public agencies, college and university departments is needed

Protocol Handbook: There are many protocols available in the literature for most of the activities that will be proposed in the NRMP. If protocols are not applicable to the GRNA situation or if protocols for activities do not exist, then they need to be derived. Action items will include:
- Research the literature for appropriate protocols to be used in each specific (e.g. plants, insects, small mammals, etc.) monitoring project
- Use existing and established protocols for inventorying the special populations of indicator, threatened, endangered, and/or rare species, as well as species of concern or species that are of particular importance in GRNA

Reports: Regular reports from all projects and the Land Management Committee (LMC) need to be provided by the LMC to both management and the board directors on a to-be-specified time line. Action items will include:
- The condition of natural features, natural communities and indicator species.
- Progress made toward eliminating populations of invasive species.
- Results of ongoing specific monitoring activities.
- Progress made toward the conservation of monitored species for each natural community.
- Information on the changes in GRNA
- An evaluation of the effectiveness of the GRNA Natural Resources Management Plan.

II. LAND MANAGEMENT AREAS

NATURAL COMMUNITIES

In 2017, Michigan Natural Features Inventory (MNFI) contracted with GRNA to delineate natural communities within GRNA and to develop Floristic Quality Assessments (FQAs) of each natural community (Hackett et al. 2017). As outlined in Cohen et al. 2015 and in more detail in Kost et al. (2007), each natural community occurring in Michigan can be described as an assemblage of interacting plants and animals that occur in the relative absence of human intervention, and occur under similar environmental conditions, and in similar geographic or landscape settings. The 77 natural communities found in Michigan are organized into 5 ecological classes, which are further subdivided into 18 ecological groups (Cohen et al. 2015). Nine natural communities were identified at GRNA (Hackett et al. 2017).

Table 1. Classification and acreage of natural communities at Grass River Natural Area as of 2017.

Terrestrial Class
1. Forest
   1a. Dry-Mesic Northern Forest   Estimated acreage: 30 acres
   1b. Mesic Northern Forest   Estimated acreage: 283 acres

Palustrine Class
2. Marsh
   2a. Emergent Marsh   Estimated acreage: 6 acres
   2b. Northern Wet Meadow   Estimated acreage: 49 acres
3. Fen
   3a. Northern Fen   Estimated acreage: 185 acres
4. Shrub Wetland
   4a. Northern Shrub Thicket   Estimated acreage: 41 acres
5. Forested Wetland
   5a. Poor Conifer Swamp   Estimated acreage: 82 acres
   5b. Rich Conifer Swamp   Estimated acreage: 503 acres
   5c. Hardwood-conifer Swamp   Estimated acreage: 53 acres

Each of these nine natural communities is described in detail in Cohen et al. (2015) and Kost et al. 2007. Descriptions include the environmental setting in which the community occurs, and typical plants found in the community. In addition, expanded community descriptions can be found online at the MNFI webpage: https://mnfi.anr.msu.edu/communities/list (also in Appendix 2a-2i). The online resources include animals of note for each community, rare plants and animals, and biodiversity management considerations.

6. Anthropogenic Systems

Anthropogenically disturbed areas at GRNA comprise 113 acres that were identified as significantly altered by human activities. These acreages include pine plantations, old fields, old farmstead/residential areas, the

trail on the old railroad bed that crosses the southern portion of GRNA and the areas around the GRNA Center. These are described at the end of the descriptions of the management areas.

FLORISTIC QUALITY ASSESSMENTS OF THE GRNA MANAGEMENT AREAS

A Floristic Quality Assessment (FQA) is a means of determining a natural community's ecological integrity based on the species of plants found (Herman et al. 2001). Procedures used by MNFI for conducting the FQA at GRNA are in Hackett et al. (2017). In an FQA, a list of plant species in a given natural community is generated and species that are known to be restricted to particular environmental settings or conditions are given a higher rank (Conservatism or C value, ranging from 0 to 10) than those, such as invasive species, that are adapted to a broad range of environments. Using the C value for all species found, along with other measures of the species richness of a site, a Floristic Quality Index (FQI) is calculated. An FQI score less than 20 indicates low floristic value, while scores greater than 35 indicate some floristic importance, and scores greater than 50 indicate sites with "considerable biodiversity value to the state" (Hackett et al. 2017, Appendix 1.).

Table 2. Plant community characteristics at Grass River Natural Area (adapted from Table 1 of Hackett et al. 2017.)

NATURAL COMMUNITY	NUMBER OF PLANT SPECIES	PERCENT NATIVE PLANTS	TOTAL FQI
Emergent Marsh	19	94.7	22.7
Northern Wet Meadow	123	93.5	55.5
Northern Fen	170	91.8	68.7
Northern Shrub Thicket	26	96.2	26.5
Poor Conifer Swamp	65	98.5	46.0
Rich Conifer Swamp	207	92.3	69.1
Hardwood Conifer Swamp	97	92.8	32.4
Dry-mesic Northern Forest	26	89.1	19.4
Mesic Northern Forest	101	96.2	39.2
Anthropogenic Systems	109	67.9	24.0

Table 2. shows that the northern fen, rich conifer swamp, and northern wet meadow areas of GRNA are of considerable biodiversity value and should be targeted for protection and management. In fact, Hackett et al. (2017) indicate that the northern fen areas of GRNA are the second largest occurrence in Northern Lower Michigan and one of 6 in the region with an A/B (high) ranking. Hackett et al. (2017) state "As a whole, the

natural communities at GRNA comprise a significant biodiversity hotspot amidst a highly fragmented landscape that is highly deserving of its status and protection as a natural area."

By contrast, the anthropogenic systems at GRNA contained numerous non-native species. Hackett et al. (2017) identified 18 invasive species of high concern at GRNA, but indicated these were mostly in low abundance, thus providing a "window of opportunity" for surveying, mapping and prioritizing for management before further ecosystem degradation can occur.

WILDLIFE RESOURCES OF THE GRNA MANAGEMENT AREAS

More than 500 species of plants, 147 species of birds, 35 species of fish, and 33 reptiles and amphibians have been identified at GRNA as of 2017. A list of flora and fauna (mammals, reptiles, amphibians and fish) reported to be seen at GRNA through 2017 can be found at https://www.grassriver.org/flora-and-fauna.html. Among the fauna reported are Blanding's Turtle and Smooth Green Snake, both species of Special Concern in Michigan (https://mnfi.anr.msu.edu/species/animals), however the habitats occupied by these species are not recorded. In 2018, MNFI staff scientist Ashley Cole-Wick provided GRNA with a list of rare species (plants and wildlife), by habitat, that might be targets for GRNA surveys (Appendix 3).

In recent years Dr. Philip Myers (University of Michigan *emeritus*) has conducted small mammal surveys at GRNA using 100 traps set within mature aspens and maples (with lots of downed wood to provide cover) and within creek-side grasses and sedges. One trapping effort yielded 19 white-footed mice, 4 eastern chipmunks, 2 short-tailed shrews, 2 meadow voles, and 2 woodland jumping mice; the latter one of the species of "boreal" small mammals that is becoming very scarce in the northern Lower Peninsula according to Dr. Myers.

GRNA is a birding hotspot on eBird, a citizen-science online portal for recording bird sightings (https://ebird.org/about). Between 2011 and 2014, regular bird surveys were conducted at GRNA (see Grass River eBird Information link at https://www.grassriver.org/flora-and-fauna.html). The latest Bird Blitz report (2013; see above link) lists the Northern Goshawk (special concern, SC), the Red-Shouldered Hawk (threatened, T), Long-Eared owl (T), Northern Harrier (SC), Short-Eared Owl (endangered, E), Marsh Wren (SC), Common Loon (T), and Black tern (SC) as being sighted at GRNA, and identifies general habitat types where these species were found.

Surveys for bumble bees have been conducted in 2017-2019, consisting of routine walks along selected routes of the Rail Trail, Sedge Meadow Trail, and around the GRNA center where native plants have been established. In 2017, the Yellow-Banded Bumble Bee (SC) was identified at GRNA and the record of occurrence was uploaded to Bumble Bee Watch (bumblebeewatch.org) along with occurrences of other more common bumblebees. Additionally, the yellow-banded bumble bee occurrence was reported to MNFI using the Special Species Online Report (https://mnfi.anr.msu.edu/species/report). As new bumble bee species have been found at GRNA, additional Bumble Bee Watch reports have been uploaded (2018-2019).

A survey of beetles at GRNA was conducted in 2017 and a report on the species found is in preparation (Ruesink and Haack, 2020). Three terrestrial habitats were sampled: pine plantation, dry-mesic forest, and

rich conifer swamp. There were three sampling methods in each habitat: sweep-net sampling, pitfall traps, and baited funnel traps. In addition, the aquatic adult beetles collected since 2015 during routine stream surveys were examined and identified to species where possible. Over 400 species were identified, representing over 60 families of beetles. No listed rare species for Michigan were identified.

Lists of both common and rare flora and fauna anticipated in the natural communities at GRNA can be found in the MNFI community abstracts (Appendix 1 and 2a-2i). Additionally, the previous GRNA Natural Resources Management Plan listed common and rare species likely to be found (GRNA NRMP 2012-2016, Appendix 4.). In recent years GRNA has made great strides in identifying flora and fauna present. Nevertheless, much needs to be done to acquire the types of data that will allow assessment of the status and trends in populations and for management of GRNA habitats for protection of rare species. Specifically, there is little information about the habitats in which species have been found; there is little information on the numbers, health, or breeding status of most species; and there is no systematic repository for data acquired.

DESCRIPTION OF MANAGEMENT AREAS AND MANAGEMENT CONSIDERATIONS

In the course of describing each of the management areas, where management considerations and recommendations are discussed, there were important recommendations that have been deemed high priority and that are, in fact, common to numerous natural communities found and described for Grass River Natural Area. Rather than duplicate these recommendations in each natural community section, the following recommendations have been determined to be high priority across the board at GRNA. They are:

General **flora** management recommendations that apply across the board for all natural communities:
1. Minimize timber harvesting along any of the stream corridors.
2. Focus first on the eradication of the highly aggressive invasive species, and continue programs to aggressively control noxious invasive plant species.
3. Implement best management practices to provide habitat that will sustain diversity of native species.
4. Work with scientific professionals to conduct surveys of species at GRNA and assess population status and trends.
5. Continually survey plant populations of interest, importance, or vulnerability.

General **fauna** management recommendations that apply across the board for all natural communities:
1. Document fauna occurrence and habitat associations within GRNA.
2. Manage non-native, especially invasive, species.
3. Implement best management practices to provide habitat for key wildlife species.
4. Work with scientific professionals to conduct surveys of species at GRNA and assess population status and trends.

MANAGEMENT AREA 1. TERRESTRIAL CLASS (Forest Resources)

1. Forest
       1a. Dry-Mesic Northern Forest   Estimated acreage: 30 acres
       1b. Mesic Northern Forest   Estimated acreage: 283 acres

For more detailed descriptions of each management area see Appendices 2a-2i for general descriptions by the MNFI, and for specific descriptions see Appendix 1.

FOREST

Flora of the Dry-Mesic Northern Forest Habitat

Description: Dry-mesic northern forest is an upland forested community with a pine or pine-hardwood canopy typically dominated by white pine (*Pinus strobus*) and red pine (*Pinus resinosa*), with red oak (*Quercus rubra*), and/or hemlock (*Tsuga canadensis*) associates. It occurs on acidic well-drained sands, most frequently on glacial outwash plains and lake plains. The ground layer is often dominated by bracken fern (*Pteridium aquilinum*), with a diversity of shrubs, sedges, grasses and forbs intermixed. Historically, these forests originated from infrequent catastrophic fire and were maintained by frequent low-intensity ground fires. Fire creates areas of bare mineral soil that are most suitable for germination of the conifer dominants. Windthrow and insect outbreaks also influence the structure and composition of these forests.

Dry-mesic northern forest comprises approximately 30 acres of GRNA, bordering rich conifer swamp, hardwood conifer swamp, old field/residential areas and pine plantations. The species richness is 26, with 25 native and one non-native species, and the total FQI is 19.4. The canopy is almost exclusively white pine, with significant contributions from red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), red pine, quaking aspen (*Populus tremuloides*), red oak (*Quercus rubra*), and hemlock (*Tsuga canadensis*). The ground layer is mostly open with pockets of bracken fern (*Pteridium aquilinum*), clubmosses (*Lycopodium* spp.), and clumps of fibrous-root sedge (*Carex communis*). Occasional occurrences of the invasive Japanese barberry (*Berberis thunbergii*) are observed in the NSHC #2 parcel.

Six potential vernal pools are documented in this community. These are described further in the **Vernal** Pool section. (See Water Resources Management)

Location: Dry-mesic northern forest is located along Baginski Rd. (Baginski 1A and 1B, and Abbott and Maltby parcels), along Grass River Rd. (ASB parcels 1-3), and in the NSHC #2 parcel (north side of Lake Bellaire).

Current Condition: The plant species richness is 26, with 25 native and one non-native species, and the total FQI is 19.4, indicating little floristic importance. The only invasive species of significance is Japanese barberry on the NHSC #2 parcel.

Flora of the Mesic Northern Forest

Description: Mesic northern forest comprises approximately 283 acres, the second most abundant community in GRNA. Mesic northern forest is an upland forested community dominated by northern hardwoods, including sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), with frequent associates of yellow birch, red oak, and hemlock and white pine (*Pinus strobus*). Soils are typically loamy sands to sandy loams (Cohen 2000). Mesic northern forests are sustained by frequent, small windthrow events that create canopy gaps and allow shade-tolerant canopy seedlings to regenerate. These forests occurred as a matrix community, covering over 12 million acres in Michigan prior to European settlement and logging. They were multigenerational, persisted for long time periods and experienced infrequent catastrophic windthrow events. In GRNA, mesic northern forest borders rich conifer swamp, poor conifer swamp, and hardwood-conifer swamp.

The canopy is comprised mostly of sugar maple, red maple, yellow birch, beech, red oak, and hemlock, with occasional white spruce (*Picea glauca*), white pine and northern white cedar (*Thuja occidentalis*). There are pockets of balsam fir (*Abies balsamea*) and inclusions of small wetlands with sedge species such as *Carex crinita, C. disperma, C. intumescens, and C. lupulina.*

Five potential vernal pools are documented in this community. These are described further in the Vernal Pool section (see Water Resources).

Location: Mesic Northern Forest occurred primarily north and south of the Rail Trail, with significant acreage in the Delange #1B, Gorsuch N, Dewey, and Gorsuch, H 1A and 1B properties.

Current Condition: The plant species richness reached 101, with 90 native and 11 non-native species, and the total FQI is 39.2 indicating some floristic importance. Occasional occurrences of invasive marsh thistle (*Cirsium palustre*), autumn olive (*Elaeagnus umbellata*), hybrid honeysuckle (*Lonicera* x *bella*), and hybrid honeysuckle (*Lonicera morrowii*) are observed. Non-native species of less immediate concern include red-top (*Agrostis gigantea*), helleborine (*Epipactis helleborine*), orange hawkweed (*Pilosella aurantiaca*), blue spruce (*Picea pungens*), bittersweet nightshade (*Solanum dulcamara*), common dandelion (*Taraxacum officinale*) and common speedwell (*Veronica officinalis*).

Flora Management Considerations for Dry-Mesic and Mesic Forest

The following management considerations are adapted from the MNFI Community Abstracts (Appendices 1 and 2a-2i and found at https://mnfi.anr.msu.edu/communities).

Dry-mesic northern forest "historically originated in the wake of catastrophic fire and was maintained by frequent, low-intensity ground fires." Fire suppression can result in conversion to mesic northern forest. Alternative physical methods as well as underplanting with pine can help to maintain the dry-mesic

community. MNFI emphasizes that "Monitoring and control efforts to detect and remove invasive species are critical to the long-term viability of dry-mesic northern forest."

In contrast, mesic northern forest was historically maintained by "frequent, small-scale wind disturbance or gap-phase dynamics and infrequent intermediate- and large-scale wind events," which allow shade-tolerant species to grow. MNFI suggests this forest type can be managed by leaving "large tracts (especially old-growth and late-successional forest) unharvested and allow natural processes to operate unhindered." In addition, reduction of deer densities may be required to allow natural regeneration of trees such as cedar, white pine and hemlock, and to permit greater floral diversity.

Threats

Natural: fire, over-browsing by white-tail deer, pest outbreaks such as emerald ash borer, hypoxylon aspen canker, pine bark beetle, beech bark disease, and hemlock woolly adelgid

Man-made: fire suppression, clear cutting for development of public access and educational facilities, impacts of thousands of visitors and vehicles (ER Squiers and Associates 1983) and invasive species.

Flora Management Recommendations for the Dry-Mesic and Mesic Forest
In addition to the general management recommendations on page 9.

1. Allow natural processes to operate unhindered.
2. Focus on providing minimal access to areas that have dwindling populations of threatened or protected species.
3. Manage deer densities

Fauna of the Dry-Mesic and Mesic Forests

The MNFI Community Abstracts (see Appendices 1 and 2a-2i) list both rare and common species likely to be found in mesic and dry-mesic northern forests. Among the rare species of concern for these habitats, the bald eagle (Comfort Road) and osprey (Alden Highway) nest just outside the boundaries of GRNA, but they use the Dry-Mesic and Mesic Forest for food and perching. A Northern Goshawk was reported as present in "upland forest and thicket" in the GRNA 2013 Bird List by Habitat (https://www.grassriver.org/uploads/7/6/5/7/7657490/grna_birds_by_habitat2013.pdf).

Mesic species:
- Cooper's hawk (*Accipiter* cooperii), state special concern
- northern goshawk (*Accipiter gentilis*), state special concern
- red-shouldered hawk (*Buteo lineatus*), state threatened
- woodland vole (*Microtus pinetorum*), state special concern

Dry-Mesic species:
- merlin (*Falco columbarius*), state threatened
- bald eagle (*Haliaeetus leucocephalus*), state threatened
- osprey (*Pandion haliaetus*), state threatened
- black-backed woodpecker (*Picoides arcticus*), state special concern

Fauna Management Considerations for the Dry-Mesic and Mesic Forest

The natural habitats at GRNA have only recently been delineated (Hackett et al. 2017). Although various fauna have been documented at GRNA (see Wildlife Resources of the GRNA Management Areas above), few have been specifically associated with the newly-delineated natural habitats. Maintaining high-quality natural habitats through flora management strategies should promote their use by the appropriate fauna. This is the most significant management consideration at this point.

Fauna Management Recommendations for the Dry-Mesic and Mesic Forest
In addition to the general management recommendations on page 9

Prioritize management strategies that address the requirements for areas set aside for natural succession, areas that provide sustainable forestry product harvest, as requested by Antrim County, and areas to be left alone to achieve old growth forest characteristics.

1. Implement systematic recording of species (both common and rare/threatened) seen at GRNA.
2. Work with scientific professionals to conduct surveys of species at GRNA and assess population status and trends.
3. Implement best management practices to provide habitat for key wildlife species.
4. Research and identify strategies to increase populations of protected animal species.

Overall Management Goal for the Dry-Mesic/Mesic Forest Future Condition

To maintain and/or encourage the historical natural biodiversity of plants and animals as described in all available reliable documentation of either Grass River Natural Area, or comparable wetland habitats in the region. In this and all of the subsequent Management Areas, utilize methods such as GIS to locate, record, and help identify critical geographical locations that require attention and action.

MANAGEMENT AREA 2. PALUSTRINE CLASS (Wetland Resources)

2. Marsh
    2a. Emergent Marsh   Estimated acreage: 6 acres
    2b. Northern Wet Meadow   Estimated acreage: 49 acres
3. Fen
    3a. Northern Fen   Estimated acreage: 185 acres
4. Shrub Wetland
    4a. Northern Shrub Thicket   Estimated acreage: 41 acres
5. Forested Wetland
    5a. Poor Conifer Swamp   Estimated acreage: 82 acres
    5b. Rich Conifer Swamp   Estimated acreage: 503 acres
    5c. Hardwood-conifer Swamp Estimated acreage: 53 acres

For more detailed descriptions of each management area see Appendices 2a-2i for general descriptions by the MNFI, and for specific descriptions see Appendix 1.

MARSH

Flora of the Emergent Marsh

Description: The GRNA Emergent Marsh comprises approximately six acres. It is an herbaceous wetland that is typically inundated with at least six inches of water the majority of the year. These marshes typically occur along the shores of rivers, lakes, and streams and are subject to fluctuating water levels, seasonal flooding and flooding by beaver. Due to the continuous flooding of these wetlands, the vegetative community is composed predominantly of emergent and floating plants (Kost et al. 2007).

Location: They are primarily near the juncture of the Grass River and Clam Lake and along the Grass River just south of Lake Bellaire.

Current condition: The species richness is 19, with 18 native and one non-native species, and the total FQI is 22.7. The marshes are dominated by sedge (*Carex aquatilis*), wire sedge (*Carex lasiocarpa*), tussock sedge (*Carex stricta*), whorled loosestrife (*Decodon verticillat*), duckweed (*Lemna* spp.), yellow pond-lilies (*Nuphar variegata*), sweet-scented waterlily (*Nymphaea odorata*), water smartweed (*Persicaria amphibia*), pickerel-weed (*Pontederia cordata*), hardstem bulrush (*Schoenoplectus acutus*), softstem bulrush (*S. tabernaemontani*), green-fruited bur-reed (*Sparganium emersum*), common bur-reed (*S. eurycarpum*) and broad- leavedcattail (*T. latifolia*). In areas more protected from wave action, common bladderwort (*Utricularia vulgaris*) is found. Patches of native reed/ phragmites (*Phragmites australis* var. *americanus*) were also noted in this community type.

Flora of the Northern Wet Meadow

Description: The Northern Wet Meadow is an open wetland community dominated by sedges, grasses, and occasional small shrubs. It typically occurs along the borders of rivers and streams, and occasionally lakes and ponds, on strongly acidic to circumneutral sapric peat or sometimes on saturated mineral soils. It is primarily groundwater fed and is subject to seasonally fluctuating water levels. Water levels typically remain at or near the surface throughout the year.

Location: Northern wet meadow comprises approximately 49 acres of GRNA, bordering northern fen, rich conifer swamp, poor conifer swamp, and emergent marsh.

Current condition: The species richness is 123, with 115 native and 8 non-native species, and the total FQI is 55.5. The gradual transition between highly diverse and similar communities likely contributes to its high species richness. The community is mostly dominated by sedge (*Carex stricta*), with an abundance of wiregrass sedge (*C. lasiocarpa*), twig-rush (*Cladium mariscoides*), and narrow-leaved reedgrass (*Calamagrostis stricta*) with occasional sedge (*Carex utriculata*) and inland sedge (*C. interior*). Shrubby areas of sweet gale (*Myrica gale*) and shrubby cinquefoil (*Dasiphora fruticosa*) are frequent, and stunted northern white cedar (*Thuja occidentalis*) and tamarack (*Larix laricina*) dot the landscape. pitcher plant (*Sarracenia purpurea*) and purple fringed orchid (*Platanthera psycodes*) are occasionally observed. Patches of native phragmites were also noted here.

Flora Management Considerations for the Emergent Marsh and Northern Wet Meadow

The following management considerations are adapted from the MNFI Community Abstracts (Appendices 1 and 2a-2i and found at https://mnfi.anr.msu.edu/communities).

Eliminating nutrient and sediment inputs, dredging, ditching, and draining activity, and invasive species populations is integral to protecting the ecological integrity of high-quality emergent marsh and Northern Wet Meadow. Ditching and subsequent drainage allow shrubs and trees to establish and eventually replace emergent marshes. In addition to purple loosestrife (*Lythrum salicaria*) and narrow-leavedcattail (*Typha angustifolia*), invasive species that threaten diversity in emergent marsh include reed (*Phragmites australis* subsp. *australis*), reed canary grass (*Phalaris arundinacea*), hybridcattail (*Typha* x *glauca*), frogbit (*Hydrocharis morsus-ranae*), watercress (*Nasturtium microphyllum*), and European marsh thistle (*Cirsium palustre*). Increased nutrient input in the form of runoff from agricultural fields and lawns, leaking septic systems, and sewage discharge can result in an expansion of invasive plants such as narrow-leaved cattail,

hybrid cattail, reed, and reed canary grass, and accompanying loss of native plant and animal diversity. Increased sedimentation resulting from soil disturbances upslope creates ideal conditions for colonization and expansion of reed canary grass and purple loosestrife.

Threats

Natural: The only non-native species observed in emergent marsh is the invasive *Typha angustifolia* (narrow-leaved cattail) which is sparse. In the Northern Wet Meadow occasional occurrences of invasive marsh thistle (*Cirsium palustre*), autumn olive (*Elaeagnus umbellata*), yellow flag (*Iris pseudacorus*), purple loosestrife (*Lythrum salicaria*) and narrow-leaved cattails were documented. These species are highly invasive and can spread quickly, displacing native species. Several other non-native species of less immediate concern were observed occasionally, including white poplar (*Populus alba*), bittersweet nightshade (*Solanum dulcamara*) and peppermint (*Mentha* x *piperita*).

Man-made: Nutrient and sediment inputs, dredging, ditching, and draining activity.

Flora Management Recommendations for the Emergent Marsh and Northern Wet Meadow
In addition to the general management recommendations on page 9

1. Monitor water chemistry and develop strategies to reduce nutrient input to the lower reaches of the creeks and ultimately Grass River.
2. Monitor water flow and sediment input
3. Work with stakeholders in the region to maintain high quality water and water flow.

Fauna of the Emergent Marsh and Northern Wet Meadow

Emergent marshes provide habitat to a broad diversity of aquatic invertebrates, many of which occupy and feed on decomposing vegetation. The invertebrates support numerous species of fish, amphibians (frogs), reptiles (snakes and turtles), waterfowl, water birds, and wetland mammals like muskrat (*Ondatra zibethicus*). Muskrats and beaver (*Castor canadensis*) can profoundly influence the hydrology of emergent marshes and surrounding wetlands. Muskrats create open water channels, and beavers can cause substantial flooding through their dam-building activities. Emergent marshes flood seasonally, especially in the spring, providing temporary habitat and spawning grounds for fish such as northern pike (*Esox lucius*), and many other organisms listed above.

The MNFI Community Abstracts (see Appendices 1 and 2a-2i) list both rare and common species likely to be found in the marsh areas. Among the rare species of concern for these habitats are:
- short-eared owl (*Asio flammeus*), state endangered
- American bittern (*Botaurus lentiginosus*), state special concern
- black tern (*Chlidonias niger*), state special concern
- northern harrier (*Circus cyaneus*), state special concern
- marsh wren (*Cistothorus palustris*), state special concern

- spotted turtle (*Clemmys guttata*), state threatened
- yellow rail (*Coturnicops noveboracensis*), state threatened
- Blanding's turtle (*Emydoidea blandingii*), state special concern
- common moorhen (*Gallinula chloropus*), state special concern
- wood turtle (*Glyptemys insculpta*), state special concern
- least bittern (*Ixobrychus exilis*), state threatened
- northern blue butterfly (*Lycaeides idas nabokovi*), state threatened
- Wilson's phalarope (*Phalaropus tricolor*), state special concern
- boreal chorus frog (*Pseudacris triseriata maculata*), state special concern
- king rail (*Rallus elegans*), state endangered
- eastern massasauga (*Sistrurus c. catenatus*), federal candidate species and state special concern
- Forster's tern (*Sterna forsteri*), state special concern

Of these, the American Bittern, Short-Eared Owl, Marsh Wren, Northern Harrier, and Black Tern have all been reported from "wet meadow and open water" at GRNA (https://www.grassriver.org/uploads/7/6/5/7/7657490/grna_birds_by_habitat2013.pdf). In addition, Blanding's Turtle has been reported at GRNA but the habitat is not recorded.

Fauna Management Considerations for the Emergent Marsh and Northern Wet Meadow

Management of swamp wildlife can be as simple as doing nothing or it can be very complex and involve the manipulation of wildlife habitat. Swamps that have a steady, stable flow of water year-round function naturally. Usually they can be managed by protecting the water source and enhancing the adjacent uplands.

The natural habitats at GRNA have only recently been delineated (Hackett et al. 2017). Although various fauna species have been documented at GRNA (see Wildlife Resources of the GRNA Management Areas above), few have been specifically associated with the newly-delineated natural habitats. Maintaining high-quality natural habitats through flora management strategies should promote their use by the appropriate fauna. Additionally, it is critical to document fauna occurrence and habitat associations within GRNA.

Fauna Management Recommendations for the Emergent Marsh and Northern Wet Meadow
In addition to the general management recommendations on page 9

1. Implement systematic recording of species (common and/or rare/threatened) seen at GRNA.
2. Identify ways to sustain populations of protected animal species.
3. Identify non-native animal species and develop a management strategy.
4. Consider targeted surveys for the rare species suggested by Cole-Wick (Appendix 3).

Overall Management Goal for the Marsh/Northern Wet Meadow Future Condition

The main focus will be to try to maintain as pristine a habitat as possible considering that Grass River serves as the passage way between two heavily utilized recreation lakes. This would necessarily include minimizing physical degradation to the waterways caused by pesticides, siltation from upstream sources and physical disruption from boaters, as well as minimizing water quality degradation from nutrients, pesticides, etc.

]

FEN

Flora of the Northern Fen

Description: Northern fen is a highly diverse, open canopy wetland system dominated by sedges rushes, forbs and shrubs, growing on neutral to moderately alkaline saturated peat and marl. It is where water infiltrates down through steep moraines overlaying dolomite and limestone bedrock producing cold, calcareous groundwater that seeps out from the base. Peat mounds carpeted by sphagnum, low-growing shrubby patches, and stunted conifers occur. Variations in the amount of calcareous ground water seepage and lateral flow, flooding by beaver and occasional fires can influence the species composition and structure and the formation of distinct vegetative zones.

Location: Northern fen comprised approximately 185 acres of GRNA, the third most abundant natural community documented during the recent inventory. It borders northern wet meadow, poor conifer swamp, and rich conifer swamp.

Current condition: The species richness is 170, with 156 native and 14 non-native species and the total FQI is 65.2. The marl zones are dominated by twig-rush (*Cladium mariscoides*), beak rush (*Rhynchospora alba*), beak rush (*Rhynchospora capillacea*), bulrushes (*Schoenoplectus* spp.), common bog arrow-grass (*Triglochin maritima*), and bladderworts (*Utricularia* spp.). This zone transitions to a diversity of sedges, grasses, forbs, and small shrubs in the surrounding areas. Several orchids, including grass- pink (*Calopogon tuberosus*), yellow lady-slipper (*Cypripedium parviflorum*), rose pogonia (*Pogonia ophioglossoides*), and nodding ladies-tresses (*Spiranthes cernua*), are observed, as well as carnivorous pitcher plant (*Sarracenia purpurea*) and round-leaved sundew (*Drosera rotundifolia*). Patches of native phragmites are also noted.

Flora Management Considerations for the Northern Fen

Due to the high species richness and FQI, representative composition and structure, large acreage (185 acres) and low abundance of invasive species, the northern fen areas at GRNA qualify as a new A/B-ranked Element Occurrence (EO) for the MNFI Biotics database.

Having pointed this out, the following management considerations are adapted from the MNFI Community Abstracts (Appendices 1 and 2a-2i and found at https://mnfi.anr.msu.edu/communities).

The primary mechanism for preserving fens is to maintain their hydrology, as slight changes in water chemistry or hydrology result in significant shifts in vegetation. Reduction of access to peatland systems will help decrease detrimental impacts.

Monitoring and control efforts to detect and remove invasive species are critical to the long-term viability of northern fen. Particularly aggressive invasive species that have colonized similar habitats such as prairie fen in southern Lower Michigan and thus have the potential to reduce diversity and alter community structure of northern fen in the future include glossy buckthorn (*Frangula alnus*), multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), purple loosestrife (*Lythrum salicaria*), narrow-leaved cattail (*Typha angustifolia*), hybridcattail (*Typha* x *glauca*), reed canary grass (*Phalaris arundinacea*), and reed (*Phragmites australis* subsp. *australis*).

Conversion to more eutrophic wetlands has occurred as the result of nutrient enrichment and raised water levels. Eutrophication favors establishment of invasive species. Lower water tables from drainage facilitate tree and shrub encroachment, followed by decreased species richness. In addition, lowering the water table can reduce marl accumulation and thus cause loss of rare calciphilic vegetation.

Threats

> *Natural:* Several highly invasive species were observed in low numbers including marsh thistle, autumn olive, yellow flag and reed canary grass (*Phalaris arundinacea*). Several dense patches of narrow-leaved cattail were noted in the fen areas south of Grass River, but were absent from the large northern fen 'island' near the SE end of Lake Bellaire (MI parcels).

> Several other non-native species of less concern were occasionally observed, including orange hawkweed (*Hieracium aurantiacum*), yellow hawkweed (*Hieracium caespitosum*), king devil (*Hieracium piloselloides*), ox-eye daisy (*Leucanthemum vulgare*), timothy grass (*Phleum pretense*), Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*Poa pratensis*), tall buttercup (*Ranunculus acris*), sheep sorrel (*Rumex acetosella*), and common chickweed (*Stellaria media*).

> *Man-made:* Nutrient enrichment and raised water levels

Flora Management Recommendations for the Northern Fen
In addition to the general management recommendations on page 9

1. Work with stakeholders in the region to maintain high quality water and water flow

2. Implement best management practices to provide habitat for key wildlife species.

Fauna of the Northern Fen

The MNFI Community Abstracts (see Appendices 1 and 2a-2i) list both rare and common species likely to be found in the northern fen areas. Among the rare species of concern for these habitats are:
- Secretive locust (*Appalachia arcana*), state special concern
- great blue heron (*Ardea herodias*), protected by the Migratory Bird Treaty Act of 1918
- short-eared owl (*Asio flammeus*), state endangered
- American bittern (*Botaurus lentiginosus*), state special concern
- Pleistocene catinella (*Catinella exile*), state special concern
- northern harrier (*Circus cyaneus*), state special concern
- spotted turtle (*Clemmys guttata* , state threatened
- yellow rail (*Coturnicops noveboracensis*), state threatened
- Blanding's turtle (*Emydoidea blandingii*), state special concern
- land snail (*Euconulus alderi*), state special concern
- merlin (*Falco columbarius*), state threatened
- bald eagle (*Haliaeetus leucocephalus*), state threatened
- cherrystone drop (*Hendersonia occulta*), state threatened
- Doll's merolonche moth (*Merolonche dolli*), state special concern
- osprey (*Pandion haliaetus*), state threatened
- tawny crescent (*Phyciodes batesii*), state special concern
- black-backed woodpecker (*Picoides arcticus*), state special concern
- eastern flat-whorl (*Planogyra asteriscus*), state special concern
- boreal chorus frog (*Pseudacris triseriata maculata*), state special concern
- eastern massasauga (*Sistrurus c. catenatus*), federal candidate species and state special concern
- Hine's emerald (*Somatochlora hineana*), federal/state endangered
- incurvate emerald (*Somatochlora incurvata*), state special concern
- eastern box turtle (*Terrapene c. carolina*), state special concern
- tapered vertigo (*Vertigo elatior*), state special concern
- six-whorl vertigo (*Vertigo morsei*), state special concern
  crested vertigo (*Vertigo pygmaea* (), state special concern

Of these, the American Bittern, Short-eared owl, Marsh Wren, Northern Harrier, Great Blue Heron, and Black Tern have all been reported from "wet meadow and open water" at GRNA (https://www.grassriver.org/uploads/7/6/5/7/7657490/grna_birds_by_habitat2013.pdf). In addition, Blanding's Turtle has been reported at GRNA but the habitat was not recorded.

Fauna Management Considerations for the Northern Fen

Management of swamp wildlife can be as simple as doing nothing or it can be very complex and involve the manipulation of wildlife habitat. Swamps that have a steady, stable flow of water year-round function naturally. Usually they can be managed by protecting the water source and enhancing the adjacent uplands.

The natural habitats at GRNA have only recently been delineated (Hackett et al. 2017). Although various fauna have been documented at GRNA (see Wildlife Resources of the GRNA Management Areas above), few have been specifically associated with the newly-delineated natural habitats. Maintaining high-quality natural habitats through flora management strategies should promote their use by the appropriate fauna. Additionally, it is critical to document fauna occurrence and habitat associations within GRNA.

Fauna Management Recommendations for the Northern Fen
In addition to the general management recommendations on page 9

1. Implement systematic recording of species (common, rare, and/or threatened).
2. Work with scientific professionals to conduct surveys of species at GRNA and assess population status and trends.
3. Consider targeted surveys for the rare species suggested by Cole-Wick (Appendix 2).
4. Identify ways to increase populations of protected animal species.
5. Manage non-native wildlife species.

Overall Management Goal for the Northern Fen Future Condition

Due to the high quality and large size of the northern fen at GRNA, management of the northern fen should be among the top priorities for management at GRNA. Working with regional stakeholders to avoid nutrient enrichment and to manage water levels are critical goals.

SHRUB WETLAND

Flora of Northern Shrub Thicket

Description: Northern shrub thicket is a mostly-closed, low-canopy wetland community dominated by shrubs including tag alder (*Alnus incana*), dogwoods (*Cornus* spp.) and willows (*Salix* spp.), with few mature trees. It occurs along the borders of rivers and streams, and occasionally ponds and lakes. The soils are saturated, nutrient-rich organics, often with peat. Northern shrub thickets are subject to frequent water level fluctuations, flooding by beaver, and windthrows which influence the community composition and structure. Dense tag alder shrubs and lack of mature tree canopy distinguish it from other open and forested wetlands. Tag alder shades and crowds out many herbaceous species and tree saplings often resulting in lower diversity than surrounding communities.

Location: Northern shrub thicket comprises approximately 41 acres of GRNA, mostly in parcels on the north shore of Lake Bellaire, where it occurs adjacent to northern wet meadow and rich conifer swamp.

Current condition: The species richness is 26, with 25 native and one non-native species, and the total FQI is 26.5. It is dominated by tag alder (*Alnus incana*), poison sumac (*Toxicodendron vernix*), silky dogwood (*Cornus amomum*), sweet gale (*Myrica gale*), tussock sedge (*Carex stricta*), gooseberry, currant (*Ribes* spp.), sensitive fern (*Onoclea sensibilis*), and royal fern (*Osmunda regalis*), with occasional northern white cedar

(*Thuja occidentalis*), black spruce (*Picea mariana*), tamarack (*Larix laricina*), and black ash (*Fraxinus nigra*) trees less than 10 m tall. In the parcels on the north shore of Lake Bellaire, poison sumac is especially dense in both the northern shrub thicket and rich conifer swamp. An occurrence of leafy spurge (*Euphorbia virgata*) is observed on the shoreline of Lake Bellaire bordering the shrub thicket.

Flora Management Considerations for the Northern Shrub Thicket

The following management considerations are adapted from the MNFI Community Abstracts (Appendices 1 and 2a-2i and found at https://mnfi.anr.msu.edu/communities).

The northern shrub thicket is a community type that has dramatically increased in acreage from its historical extent due to anthropogenic disturbance. The increase in northern shrub thicket is the result of the logging of swamp forests, alteration of hydrologic regimes, and fire suppression. Northern shrub thicket has also been maintained and expanded by wildlife management geared toward providing favorable habitat for game species of early-successional habitat, particularly white-tailed deer, American woodcock, and ruffed grouse.

Alder swamps contribute significantly to the overall biodiversity of northern Michigan by providing habitat to a wide variety of plant and animal species including several rare species. However, northern shrub thickets have replaced many rare and declining wetland communities such as rich conifer swamp and northern fen. Northern shrub thicket can be maintained by cutting overstory trees and where feasible, mild intensity burning can be used to encourage alder regeneration. While northern shrub thicket has replaced many declining and rare communities, it does provide important ecosystem services, protecting water quality by assimilating nutrients, trapping sediment, and retaining stormwater and floodwater.

Monitoring and control efforts to detect and remove invasive species are critical to the long-term viability of northern shrub thicket and associated wetlands. Particularly aggressive invasive species that threaten the diversity and community structure include glossy buckthorn (*Frangula alnus*), multiflora rose (*Rosa multiflora*), purple loosestrife (*Lythrum salicaria*), narrow-leavedcattail (*Typha angustifolia*), hybridcattail (*Typha* x *glauca*), reed canary grass (*Phalaris arundinacea*), and reed (*Phragmites australis* subsp. *australis*).

Threats

> *Natural:* Low beaver populations, invasive species

> *Man-made:* Logging of swamp forests, alteration of hydrologic regimes, fire suppression, management to provide enhanced game-species wildlife.

Flora Management Recommendations for the Northern Shrub Thicket
In addition to the general management recommendations on page 9

1. Implement systematic recording of species (common, rare, and/or threatened).
2. Consider targeted surveys for the rare species suggested by Cole-Wick (Appendix 2).
3. Work with scientific professionals to conduct surveys of species at GRNA and assess population status and trends.

Given the MNFI comments on shrub thicket, and the relatively small size of the habitat, GRNA could decide to allow it to grade to alternative wetland types, such as northern fen or rich conifer swamp. The critical actions seem to be avoiding invasive flora species, as well as maintaining water levels and water quality. Note that if water levels remain high, it might grade to northern fen, and if water levels are lowered, it might grade to conifer swamp.

Fauna of the Northern Shrub Thicket

The MNFI Community Abstracts (see Appendices 1 and 2a-2i) list both rare and common species likely to be found in the northern shrub thicket. Among the rare species of concern for this habitat are:
- great blue heron (*Ardea herodias*), protected by the Migratory Bird Treaty Act of 1918
- Blanding's turtle (*Emydoidea blandingii*), state special concern
- wood turtle (*Glyptemys insculpta*), state special concern
- bald eagle (*Haliaeetus leucocephalus*), state threatened
- three-striped oncocnemis (*Oncocnemis piffardi*), state special concern
- osprey (*Pandion haliaetus*), state threatened
- boreal chorus frog (*Pseudacris triseriata maculata*), state special concern
- eastern massasauga (*Sistrurus c. catenatus*), federal candidate species and state special concern

Of these, Great Blue Heron, Blanding's Turtle, Bald Eagle, and Osprey are all known to occur within and near GRNA, but use of the shrub thicket habitat has not been recorded. During the natural community delineation at GRNA in 2017, Hackett et al. noted river otter (*Lutra canadensis*) scat with anal jelly near the mouth of the Intermediate River and several ground dwelling birds were flushed in the interior of the shrub thicket on the north shore of Lake Bellaire. Positive species identification could not be made due to the dense growth and shadows, but they were likely ruffed grouse (*Bonasa umbellus*).

Fauna Management Considerations for Northern Shrub Thicket

Management of swamp wildlife can be as simple as doing nothing or it can be very complex and involve the manipulation of wildlife habitat. Swamps that have a steady, stable flow of water year-round function naturally. Usually they can be managed by protecting the water source and enhancing the adjacent uplands.

The natural habitats at GRNA have only recently been delineated (Hackett et al. 2017). Although various fauna have been documented at GRNA (see Wildlife Resources of the GRNA Management Areas above), few have been specifically associated with the newly-delineated natural habitats. Maintaining high-quality natural habitats through flora management strategies should promote their use by the appropriate fauna. Additionally, it is critical to document fauna occurrence and habitat associations within GRNA.

Fauna Management Recommendations for Northern Shrub Thicket:
In addition to the general management recommendations on page 9

1. Consider targeted surveys for the rare species suggested by Cole-Wick (Appendix 2).
2. Identify ways to sustain populations of special target animal species.

3. Implement systematic recording of species (both common and rare/threatened)
4. Work with stakeholders in the region to maintain high quality water and water flow.

Overall Management Goal for the Northern Shrub Thicket Future Condition

Given the relatively small size of the shrub thicket habitat at GRNA, allowing it to remain in its current state, or grade naturally to an alternative wetland type, such as northern fen or rich conifer swamp, seems a reasonable management goal. Monitoring for invasive plant species, and maintenance of high water quality and appropriate water flow will be important to achieving this goal.

FORESTED WETLAND

Flora of the Poor Conifer Swamp

Description: Poor conifer swamp is a forested wetland community dominated by black spruce (*Picea mariana*) and tamarack (*Larix laricina*) with a ground layer of sphagnum mosses and abundant ericaceous shrubs (heath family). It is a nutrient poor system with little groundwater influence and occurs on acidic, saturated peat soils, predominantly in depressions and kettles in glacial outwash and glacial lake plains. The community structure and composition are influenced by windthrow, flooding by beaver, insect outbreaks, peat accumulation and occasionally fire.

Location: Poor conifer swamp comprises approximately 82 acres of GRNA adjacent to the rich conifer swamp and northern fen areas along the south side of Clam Lake (north of the Rail Trail) and in the Banfield parcel on the east side of Grass River

Current condition: The species richness is 65, with 64 native and one non-native species, and the total FQI is 46. The canopy is co-dominated by black spruce and tamarack with occasional northern white cedar (*Thuja occidentalis*) and balsam fir (*Abies balsamea*), and ranged from 25-70% closure. Poison sumac is common. Ericaceous species are abundant including bog-rosemary (*Andromeda glaucophylla*), leatherleaf (*Chamaedaphne calyculata*), creeping- snowberry (*Gaultheria hispidula*), wintergreen (*Gaultheria procumbens*), huckleberry (*Gaylussacia baccata*), Labrador-tea (*Rhododendron groenlandicum*), Canada blueberry (*Vaccinium myrtilloides*), and small cranberry (*Vaccinium oxycoccos*). There are many pockets of pitcher plant and grass-of-Parnassus (*Parnassia glauca*), occasionally with round-leaved sundew (*Drosera rotundifolia*). Grass-pink (*Calopogon tuberosus)*and showy lady-slipper orchids (*Cypripedium reginae)*are occasionally observed.

In the Gorsuch H #1B parcel near the northern fen and west of 'Otter Creek', there are pitcher plants lacking red coloration in the leaves that are suspected to be the recently delisted yellow pitcher plant (*Sarracenia purpurea* f. *heterophylla*). These plants are unusually large compared to other pitcher plants observed in GRNA.

The only invasive species observed in poor conifer swamp during this study was autumn olive (*Elaeagnus umbellata*) which was occasional

Flora of the Rich Conifer Swamp

Description: Rich conifer swamp is a groundwater-influenced, nutrient-rich forested wetland dominated by northern white cedar (*Thuja occidentalis*). It occurs in outwash channels and depressions in moraines, outwash plains and lakeplains, and is often associated with headwaters of cold, calcareous streams and groundwater springs. Soils are usually saturated circumneutral to moderately alkaline peats with frequent peat mounds covered by acidic *Sphagnum* spp. (sphagnum) mosses. Community composition and structure are influenced by groundwater seepage, seasonal water-level fluctuations, windthrow, flooding by beaver, hummock and hollow development, and occasionally fire.

Location: Rich conifer swamp is the most abundant community in GRNA, covering approximately 503 acres. It lies adjacent to northern fen, northern wet meadow, northern shrub thicket, poor conifer swamp, dry-mesic northern forest, and mesic-northern forest, occupying much of the riparian land along Grass River, and occurring abundantly in parcels on the south side of Clam Lake.

Current condition: Rich conifer swamp at GRNA has high species diversity with 207 total species (191 native and 16 non-native), and a total FQI of 69.1. Northern white cedar dominates most of the canopy with co- or sub-dominants of tamarack (*Larix laricina*) and balsam fir. Less common canopy associates included white pine (*Pinus strobus*), red maple (*Acer rubrum*), black ash (*Fraxinus nigra*), and yellow birch (*Betula alleghaniensis*). Tag alder (*Alnus serrulata*) dominated the understory, but poison sumac (*Toxicodendron vernix*) is abundant or co-dominant in several parcels, most densely in the north shore of the Lake Bellaire. Other shrubs and small trees include alternate leaved dogwood (*Cornus alternifolia*), silky dogwood (*Cornus*

amomum), and red-osier dogwood (*Cornus sericea*), winterberry (*Ilex verticillata*), *Lonicera oblongifolia* (swamp fly honeysuckle), *Lonicera dioica* (red honeysuckle), Labrador-tea, wild red raspberry (*Rubus strigosus*), dwarf raspberry (*Rubus pubescens*) hemlock (*Tsuga canadensis*), and blueberries (*Vaccinium* spp.). The forest floor is uneven with many exposed roots, downed woody debris, and sphagnum mounds. Ferns, sedges, blueberries*,* grasses and bare ground are common. Occasional occurrences of *Lobelia cardinalis* (cardinal flower) are a striking contrast in the understory. Several carnivorous plants and orchids are also observed, including round-leafed sundew (*Drosera rotundifolia*), pitcher plant, *Corallorhiza trifida* (early coral-root), yellow lady-slipper (*Cypripedium parviflorum*), showy lady-slipper (*Cypripedium reginae*), and purple fringed orchid (*Platanthera psycodes*).

Invasive species observed include garlic mustard (*Alliaria petiolata*), Japanese barberry, marsh thistle, autumn olive, yellow flag (*Iris pseudacorus*), forget-me-not (*Myosotis scorpioides*), reed canary grass, multiflora rose (*Rosa multiflora*) and narrow-leaved cattail . Non-native species of less immediate concern included willow-herb (*Epilobium parviflorum*), orange hawkweed (*Pilosella aurantiaca*), yellow hawkweed (Hieracium caespitosum), common St. John's-wort (*Hypericum perforatum*), tall buttercup (*Ranunculus acris*), bittersweet nightshade (*Solanum dulcamara*), common dandelion (*Taraxacum officinale*) and corn speedwell (*Veronica arvensis*).

Wildlife and wildlife signs observed included a green heron (*Butorides virescens*) and large padded down sedge-areas littered with shell-filled scat indicating otter presence.

Flora of the Hardwood-Conifer Swamp

Description: Hardwood-Conifer Swamp is a forested wetland community dominated by a mix of lowland deciduous hardwoods and conifers. It is groundwater influenced and often associated with groundwater seepage areas and headwaters of streams. Water level fluctuations, windthrow, and flooding by beaver influence community composition and structure. Hardwood- conifer swamp is confined to ecotonal areas between uplands and other wetland communities and does not occur where peat accumulation isolates it from the groundwater. The canopy varies regionally, but is often dominated by balsam fir, red maple, yellow birch, white pine, quaking aspen, northern white cedar and hemlock. Tag alder is common in the subcanopy, in gaps and along the borders.

Location: Hardwood-conifer swamp comprises approximately 53 acres of GRNA and occurs adjacent to northern wet meadow and dry-mesic northern forest along the east side of Grass River as it exits Lake Bellaire, and bordering Finch Creek for much of its course through GRNA.

Current condition: There is a total species richness of 97, with 90 native and seven non-native species, and the total FQI is 39.4. The canopy is dominated by northern white cedar (*Thuja occidentalis*) and yellow birch (*Betula alleghaniensis*) with frequent occurrences of balsam poplar (*Populus balsamifera*) and big-tooth aspen (*Populus grandidentata*). Common shrubs included tag alder, Canadian fly honeysuckle (*Lonicera canadensis*), alder-leaved buckthorn (*Rhamnus alnifolia*), wild red raspberry (*Rubus idaeus*), dwarf raspberry (*Rubus pubescens*), elderberry (*Sambucus canadensis*), and poison sumac (*Toxicodendron vernix*). Common herbaceous plants documented included horsetails (*Equisetum* spp.) sedges (*Carex disperma, C. hystericina, C. interior, C. intumescens, C. lupulina, C. stricta, C. utriculata, C. vulpinoidea*), tufted loosestrife

(*Lysimachia thyrsiflora*), sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmunda cinnamomea*), goldenrods (*Solidago* spp.) and star-flower (*Trientalis borealis*).

Invasive species observed included marsh thistle, autumn olive, moneywort (*Lysimachia nummularia*), forget-me-not (*Mysotis* spp.), and reed canary grass (*Phalaris arundinacea*). Non-native species of less immediate concern included orange hawkweed (*Pilosella aurantiaca*), yellow hawkweed (Hieracium caespitosum), and bittersweet nightshade (*Solanum dulcamara*).

Flora Management Considerations for the Forested Wetland

The following management considerations are adapted from the MNFI Community Abstracts (Appendices 1 and 2a-2i and found at https://mnfi.anr.msu.edu/communities).

Poor Conifer Swamp: To maintain biodiversity of poor conifer swamps, the best management strategy is to leave large tracts unharvested and allow natural processes (fire, beaver flooding, and insect defoliation) to operate and to allow dead and dying wood to become snags, stumps, and fallen logs. In addition, alteration of hydrology, both flooding and draining, due to e.g., road building, drainage ditches and dams, runoff from logging and agriculture should be avoided. Finally, as with most habitats, control of invasive species is very important.

Rich Conifer Swamp: Rich conifer swamp is a self-maintaining, stable community that relies on gap-phase dynamics to regenerate long-lived, shade-tolerant, northern white cedar. A major threat to natural regeneration of cedar in northern rich conifer swamps is high density of deer. Long-term conservation of rich conifer swamps will require reducing deer densities across the landscape and allowing natural disturbances such as windthrow to create the complex structure that creates habitat for late-successional species.

Hardwood-Conifer Swamp: Conservation and management of hardwood-conifer swamp should focus on the following key areas: maintenance of the coarse woody debris resource; protection of mature seed-bearing trees; maintenance of canopy gap structure; protection of groundwater and surface water hydrology; reduction of deer browse pressure; and control and monitoring of invasive species, including plants, animals, and invasive insects, such as the hemlock woolly adelgid (*Adelges tsugae*), which has the potential to cause significant hemlock mortality if it spreads throughout Michigan, and the emerald ash borer (*Agrilus planipennis*).
(MNFI Community Abstracts (Appendices 1 and 2a-2i and found at https://mnfi.anr.msu.edu/communities).

Threats

> *Natural:* High water tables, a high deer population, beavers, storms, insects and disease

> *Man-made:* Invasive species, over browsing by deer, logging, fluctuating water levels,   pathogens

Flora Management Recommendations for the Forested Wetland
In addition to the general management recommendations on page 9

The overall goal for all forested wetland habitats at GRNA is to maintain natural conditions by allowing natural processes to operate unhindered. This goal will require attention to hydrologic regimes, anthropogenic disturbance, deer densities, and the occurrence of invasive plant species.

Fauna of the Forested Wetland Habitats

The MNFI Community Abstracts (see Appendices 1 and 2a-2i) list both rare and common species likely to be found in the forested wetlands. Among the rare species of concern for these habitats are:

- Cooper's hawk (*Accipiter cooperii*), state special concern
- northern goshawk (*Accipiter gentilis*), state special concern
- spike-lip crater (*Appalachina sayanus*)state special concern
- great blue heron (*Ardea Herodias*), protected by the Migratory Bird Treaty Act of 1918
- long-eared owl (*Asio otus*), state special concern
- red-shouldered hawk (*Buteo lineatus*), state threatened
- Blanding's turtle (*Emydoidea blandingii*), state special concern
- spruce grouse (*Falcipennis canadensis*), state special concern
- merlin (*Falco columbarius*), state threatened
- wood turtle (*Glyptemys insculpta*), state special concern
- rapids clubtail (*Gomphus quadricolor*), state special concern
- bald eagle (*Haliaeetus leucocephalus*), state threatened
- cherrystone drop (*Hendersonia occulta*), state threatened
- Henry's elfin (*Incisalia henrici*), state special concern
- three-horned moth (*Pachypolia atricornis*), state special concern
- osprey (*Pandion haliaetus*), state threatened
- regal fern borer (*Papaipema speciosissima*), state special concern
- black-backed woodpecker (*Picoides arcticus*), state special concern
- eastern massasauga (*Sistrurus c. catenatus*), federal candidate species and state special concern
- Hine's emerald (*Somatochlora hineana*), federal/state endangered
- grey petaltail (*Tachopteryx thoreyi*), state special concern
- eastern box turtle (*Terrapene c. carolina*), state special concern
- sharp-tailed grouse (*Tympanuchus phasianellus*), state special concern
- ebony boghaunter (*Williamsonia fletcheri*), state special concern

Of these, Northern Goshawk, Great Blue Heron, Blanding's Turtle, Bald Eagle, and Osprey are all known to occur within and near GRNA, but use of forested wetlands habitats has not been recorded. Red-Shouldered Hawk and Long-Eared Owl were detected in "wet forest and thicket" in 2013.

Fauna Management Considerations for the Forested Wetland

Management of swamp wildlife can be as simple as doing nothing or it can be very complex and involve the manipulation of wildlife habitat. Swamps that have a steady, stable flow of water year-round function naturally. Usually they can be managed by protecting the water source and enhancing the adjacent uplands.

The natural habitats at GRNA have only recently been delineated (Hackett et al. 2017). Although various fauna have been documented at GRNA (see Wildlife Resources of the GRNA Management Areas above), few have been specifically associated with the newly-delineated natural habitats. Maintaining high-quality natural habitats through flora management strategies should promote their use by the appropriate fauna. Additionally, it is critical to document fauna occurrence and habitat associations within GRNA. Deer densities will be a constant consideration, as you can't maintain cedar with high deer densities.

Fauna Management Recommendations for the Forested Wetland

In addition to the general management recommendations on page 9

1. Prohibit timber harvesting along stream corridors and lakeshores.
2. Provide adequate habitat for native wildlife species.
3. Implement systematic recording of species (both common and rare/threatened)
4. Work with scientific professionals to conduct surveys of species at GRNA and assess population status and trends.
5. Consider targeted surveys for the rare species suggested by Cole-Wick (Appendix 3).
6. Implement best management practices for wildlife management, particularly with regard to deer densities

Overall Management Goal for the Forested Wetland Habitats Future Condition

The overall goal for all forested wetland habitats at GRNA is to maintain natural conditions by allowing natural processes to operate unhindered. This goal will require attention to hydrologic regimes, anthropogenic disturbance, deer densities, and the occurrence of invasive plant species.

ANTHROPOGENIC SYSTEMS

Description: Approximately 113 acres of GRNA had strong anthropogenic disturbance and were delineated as anthropogenic systems. These areas included old farmstead/residential areas, the rail-trail, utility right-of-ways, educational areas for the nature center, and old red pine plantations.

Locations: There are two pine plantations in GRNA. Each is less than 5 acres and together they contain the only red pine found within GRNA. The pine plantations are well stocked and have good quality trees (Antrim County Forester 2011). One area was planted in 1965 and contains a mixture of red pine and Eastern white pine ranging from 6 to 15 inches in diameter. Density is 150BA. The other area was planted in 1958 and also contains a mixture of red pine and Eastern white pine. Trees are primarily 10 to 18 inches in diameter. Density is 235BA.

In 1997, the lack of new aspen regeneration was identified as a concern. An 11.95 acre parcel of forest (three 2 to 5-acre sites) was clear cut to simulate natural processes with the intent of regenerating new aspen seedlings. As of 2011, the aspen were 8-10 feet tall. The clear-cut farthest to the west has shown an increase in red-osier dogwood. (Site Index-80, Density- N/A). By 2010, these areas were well stocked with 12-20 foot aspen.

There are four small, open areas (meadows) in the Upland Forest, at GRNA's higher elevations. These occur Southwest of the Rail Trail and south of the former Speet homestead; South along the Alden Highway and the entrance road and including the former W. Dewey farmstead; West of M-88 across from the Bellaire Golf Course and including the former Kierstead farmstead; and East of Cottage Drive next to a pine plantation. These are the only open upland areas within the natural area.

During the early 1990s, GRNA, Inc. constructed five upland hiking trails. A portion of a sixth trail called Glacial Plain was renamed the Rail Trail. Trails are maintained year round for walking and cross country skiing.

In 2011 the new Grass River Center was constructed. The center provides restrooms, a book store, a meeting room with interpretive displays, a classroom with a science laboratory, and an outdoor pavilion with fireplace. In 2019 the road to the Center was rerouted and improved to allow winter plowing.

Current Condition. These were mostly upland areas bordering upland forests, with many non-native invasive and weedy species. However, the rail-trail does bisect portions of rich and poor conifer swamp at the western edge of GRNA.

Flora of the Anthropogenic Systems

A total of 109 plant species, 74 native and 35 non-native, were identified in the anthropogenic systems combined, and the total FQI is 24. pinesap (*Hypopitys monotropa*) was observed in the plantation in the Baginski parcels. The old field/residential area in the Gorsuch H #1B parcel south of the rail-trail contained large patches of native little bluestem (*Schizachyrium scoparium*), shrubby cinquefoil (*Dasiphora fruticosa*), and raspberry/blackberry bushes (*Rubus* spp., both favorites of local wildlife for the fruits themselves or the insects that reside there. Unfortunately, these areas also contained the invasive spotted knapweed (*Centaurea stoebe*), which often expands to form monocultures in open upland communities. A pond that is isolated from the surface waters of Finch Creek occurs in the old field/residential area on the Milock parcels. It is surrounded by an assortment of native, non-native and cultivar species in a small open canopy area, and harbored a variety of wildlife. A patch of the non-native common speedwell (*Veronica officinalis*) was also observed in this plantation.

The meadows have a mixture of native and non-native grasses, herbs and shrubs. Many invasive species have become established there. These areas have been subject to considerable historical disturbance and intensive human activities such as railroads, roads, home sites, lawns and farming activities. On areas of nutrient poor, sandy upland soils, regeneration after disturbance is slow. Trees are lacking and shrubs are adapted to extreme conditions of wind and strong sunlight (ER Squiers and Associates, 1983). Non-native species such as spotted knapweed (*Centaurea stoebe*), chicory (*Cichorium intybus*), Queen Anne's lace (*Daucus carota*), ox-eye daisy (*Leucanthemum vulgare*), autumn olive (*Elaeagnus umbellata*) and staghorn sumac (*Rhus typhina*) have invaded these open areas.

Flora Management Considerations for the Anthropogenic Systems

Hackett et al. (2017) stated that "The old field/residential areas are highly fragmented and altered from historical conditions and are a source of numerous weedy and invasive species, including the highly invasive spotted knapweed (*Centaurea stoebe*). There are some large pockets of little bluestem (*Schizachyrium scoparium*), native forbs and shrubs of interest to wildlife, however, these represent novel ecosystems. It is recommended that specific management goals be determined for these areas. Of greatest concern is keeping the many weedy and invasive species from spreading to higher quality areas."

Threats

> *Natural:* Increasing abundance of invasive species

> *Manmade:* subsequent spread of invasive species to the natural communities of GRNA via landscape alteration, visitor traffic, etc.

Flora Management Recommendations for Anthropogenic Systems

1. Document invasive species
2. Develop and prioritize management plans to remove invasive species from specific anthropogenic habitats
3. Consider restoration programs for selected areas, especially those adjacent to high-quality natural habitats

Fauna of Anthropogenic Systems

Wildlife at GRNA cross between natural communities and anthropogenic systems. The anthropogenic systems likely support a portion of the wildlife that would occupy adjacent natural communities. Aspen management at GRNA has focused on enhancing wild game (deer, grouse, etc.).

Fauna Management Recommendations of Anthropogenic Systems

1. As fauna are documented in association with natural habitats at GRNA, identify ways in which anthropogenic systems may affect those habitat-species relationships.
2. Carefully consider wildlife (game) management activities within GRNA in the context of native fauna management

Overall Management Goal for Anthropogenic Systems

As noted in Hackett et al. (2017) management of these areas should focus on invasive species removal and efforts to avoid further invasive species encroachment into natural communities at GRNA.

III. WATER RESOURCES

There are six bodies of water that occur within GRNA's boundaries: Lake Bellaire, Grass River, Shanty Creek, Cold Creek, Finch Creek and Clam Lake. Water in this complex system of lakes and streams is affected by the quality and quantity of the water entering the system as precipitation, surface flow from upstream portions of the Elk River Chain of Lakes watershed, surface flow from the three tributaries and numerous smaller channels, overland flow from the forested wetlands and uplands and groundwater flow. This income is balanced by an outflow of surface water to Clam Lake via Grass River, seepage into the groundwater and loss through evaporation and transpiration. (ER Squiers and Associates 1983)

In addition, Hackett et al. (2017) identified eleven potential vernal pools within the mesic and dry-mesic natural communities at GRNA. Vernal pools are seasonal wetlands unconnected to surface water that offer critical habitat for reptiles and amphibians, since fish are absent from these pools (Thomas et. al. 2010). Vernal pools may support several threatened and/or endangered plants and animals.

LAKES

Lake Bellaire is a moderately productive (mesotrophic) lake that is 90% developed along the shoreline. Most of the undeveloped parcels along the lakeshore are wetlands. The surface area is about 3 square miles and the average depth is 42 feet. Its immediate watershed is 42 square miles (Fuller, 2001). There are thirteen tributaries, the two major streams being Grass Creek in the northwest and the Intermediate River in the northeast. Most of the near shore sediments are sand or gravelly sand which limits fish spawning. About 25 different macro-invertebrates have been found in Lake Bellaire (Three Lakes Association 2009).

Lake Bellaire supports planted non-native brown trout and walleye. It has natural populations of lake herring, lake whitefish, yellow perch, smallmouth bass, northern pike, bluegill , black crappie, largemouth bass and bullhead. Since Lake Bellaire has few aquatic plants, the habitat is better suited to smallmouth bass, rather than largemouth bass (MDNR 2010, Fuller 2002). Also reported along the northwest shore of the island were Johnny and Iowa darters, banded killifish, largemouth bass, and bluntnose minnow. A total of 29 species has been collected from Lake Bellaire over the past fifty years. Some species reported in the 1930's have not been reported since (Kelly 1981).

A Final Draft Watershed Management Plan for the Elk River Chain of Lakes (ERCOL) watershed was published in 2016 (https://www.watershedcouncil.org/uploads/7/2/5/1/7251350/ercol-final-pdf_1.pdf). The ERCOL Watershed Management Plan (WMP) indicates that, based on data from 2000-2016, Lake Bellaire secchi depth, average dissolved oxygen values, chlorophyll a levels, total nitrogen, phosphorus levels, specific conductance and chloride levels are generally similar to or below regional averages and recommendations.

Clam Lake is a highly productive (eutrophic) lake that is 90% developed along the shoreline. There are 53 parcels on the shoreline and 40% have been protected within GRNA. On the west side of the river, of the 26 parcels, 13 have been protected; on the east side of the 27 parcels, 8 have been protected. Most of the undeveloped parcels are wetlands located at the east end within the Grass River Natural Area. About 70% of the shoreline has submergent vegetation and 10% has emergent vegetation. The only tributary is Grass River (Fuller 2001).

Clam Lake has diverse vegetation and a good variety of species. Black crappie and northern pike are abundant. Brown bullhead, yellow bullhead, black bullhead, yellow perch, largemouth bass, bluegill, pumpkinseed sunfish, northern longear sunfish, Johnny darter, blackchin shiner, blacknose shiner, sand shiner, white crappie, longnose gar, bluntnose minnow, central mudminnow, brook silverside have been found here, also. (Fuller 2001) In the past six decades over twenty-four fish species have been reported from Clam Lake. The Department of Conservation planted walleye and largemouth bass during the 1930's (Kelly 1981).

The ERCOL Watershed Management Plan (ERCOL WMP) indicates that, based on data from 2000-2016, Clam Lake secchi depth is generally higher than state or regional levels but that average dissolved oxygen values, chlorophyll a levels, total nitrogen, phosphorus levels, specific conductance and chloride levels are generally similar to or below regional averages and recommendations.

RIVERS AND STREAMS

Grass River is 2.5 miles long and its immediate watershed is 14 square miles. The river's annual flow is 268.3 cubic feet per second which makes its navigable by moderate-sized powerboats. The inflow to Grass River is affected by seasonal precipitation and by adjustments to the lake level of Intermediate Lake. In 1973, the 86th Judicial Circuit Court in Antrim County established lake levels at two locations in the Elk River Chain of Lakes Watershed, Intermediate River in Bellaire and Elk River in Elk Rapids. The levels are adjusted gradually over a two-week period at each seasonal changeover. The Antrim County Drain Commissioner is responsible for maintaining the levels.

Grass River is classified as a warm water stream, because it is shallow (less than 10 feet) and the current is slow and non-turbulent. The river's elevation drops less than 6 inches over its course (Fuller, 2001). There are three major tributaries to Grass River: Shanty Creek, Cold Creek and Finch Creek.

Shanty Creek flows into the Grass River, and according to the US geological Survey (USGS) has no tributaries. The stream originates 2.75 miles above its mouth in forested uplands on the Shanty Creek Resort property. The greatest elevation of the creek's headwaters is 738 feet, and the stream drops at a rate of about 53 feet per mile through GRNA property to Grass River. The stream water is reported to be normally clear and cold (Fuller 2001).

Cold Creek discharges directly into Grass River. The stream originates 2.5 miles upstream of its mouth, at the base of forested moraines. The lower reach within GRNA flows into Rich Conifer Swamp and Northern Wet Meadow. The greatest elevation of the stream is at 640 feet, and the stream drops at an average gradient of 19 feet per mile through GRNA. Estimated stream flow is 20 cubic feet per second. The water is unstained and clear. (Fuller, 2001) Cold Creek is known for having steady, low summer temperatures due to high levels of ground water input. The observed temperature range throughout the year is 38-60 F. Cold Creek is designated as a trout stream by the MDNR.

Finch Creek and Scrabble Creek Portions of Finch Creek and Scrabble Creek flow through the center of the Dry-Mesic Northern Forest in GRNA. Finch Creek is 6.5 miles long, but only the last 0.5 miles flows through

the natural area. For half of this distance, it flows through the Dry-Mesic Northern Forest. Scrabble Creek is 1.0 miles long and 0.5 miles flows through the Dry-Mesic Northern Forest where it meets Finch Creek along the Woodland Wildfire Trail. Its course and flow have been significantly altered. Both creeks are meandering streams with steep banks as they enter GRNA, but their shores are more level as they flow through the natural area.

 In 2012 a study was commissioned (Richards 2012) to investigate sediment loads to Grass River, based on stakeholder concerns about sedimentation affecting channel depths (Kendall et al. 2014).   Models developed by Richards (2012) indicate that the three tributaries deliver 363 cubic meters of sediments to Grass River every year (described as 47 dump truck loads), that Finch Creek is the largest source of these sediments, with Cold Creek second, and that much eroded sediment is captured by the tributaries before it reaches Grass River.

Clement (2016) evaluated water and habitat quality at four sites on each of Finch, Cold and Shanty Creeks. The major issues identified were increased sedimentation and poor stream road crossing structures, and high nitrogen load in Finch and Shanty Creeks. The increased nitrogen was deemed to originate from fertilization along some stream riparian zones. Additionally, Clement (2016) indicated limited macroinvertebrate populations might restrict fish populations. This interpretation was based on Michigan Clean Water Corps (MiCorp; https://micorps.net/stream-monitoring/) Volunteer Stream Monitoring data from 2014 and 2015.

Likewise, the ERCOL WMP indicates that Grass River and its three tributaries have only poor to fair water quality with respect to their macroinvertebrate communities, again based on MiCorp data from 2000-2015. This assessment included 31 observations on Cold Creek, 25 on Finch Creek and 23 on Shanty Creek, but only 4 observations on Grass River itself. Generally, macroinvertebrate communities assessed as *poor* or *fair* indicate "…stressed areas with an overall reduction in stream quality that are of most concern for remediation efforts (ERCOL WMP, 2016)". Volunteer Stream Monitoring continues at GRNA on a spring and fall basis. More recent data continues to show generally poor to fair water quality in the three Grass River tributaries, based on macroinvertebrate communities.

The ERCOL WMP (2016) identified 10 Critical Areas within the watershed as target areas within the ERCOL watershed for prioritization of implementation of management efforts to achieve reductions in pollutant loads (as identified in the ERCOL WMP). Shanty, Cold and Finch Creek were one Critical Area, with a focus on loss of riparian buffers, failing water control structures, and severe impact road stream crossings all contributing to high sediment load and loss of fish habitat in these creeks designated as cold-water fisheries.

Water Resources Management

There has been little water resources management within GRNA. Conventional tree harvesting can cause severe, perhaps irreparable, damage to water resources, so no cedar harvesting has occurred since the natural area was established. Bridge and boardwalk construction have been done with minimal disturbance to the shore and bottomlands, and erosion control fencing has limited nutrient inputs. There has been no study of vernal pools at GRNA, other than the documentation provided in Hackett et al. 2017. As vernal pools occur within forested landscapes at GRNA, forested landscape management should take into consideration the occurrence of vernal pools.

In a collaborative effort (http://3lakes.com/large-woody-debris-demonstration-project/) a Large Woody Debris (LWD) Demonstration Project was installed as a pilot project of several log structures (large woody debris) along the banks of the Grass River between Lake Bellaire and Clam Lake. This project was to determine if log structures could improve the aquatic habitat of a river laden with sediment and to determine if log structures along the banks of Grass River could be a useful technique to improve the navigability of a connecting river by deepening portions of the channel that have become shallow, due to the buildup of sediment. Evaluation is continuing to assess the effectiveness of this project (http://3lakes.com/wp-content/uploads/2016/11/LWD_Prsent_10_16-sm.pdf).

Water Resources Management Recommendations

According to the Tip of the Mitt Watershed Council (Petoskey, MI) "*A watershed management plan identifies problems and threats to water resources and develops a framework to address these issues within a specific watershed. The primary purpose of a watershed management plan is to guide watershed coordinators, resource managers, policy makers, and community organizations to restore and protect the quality of lakes, rivers, streams, and wetlands in a given watershed. The plan is intended to be a practical tool with specific recommendations on practices to improve and sustain water quality.*" This is a variation of the Elk River Chain Of Lakes Water Management Plan that lists 6 Goals for resources management in the ERCOL watershed:

1. Manage and protect the diversity of riparian and aquatic habitats
2. Monitor water chemistry and physical characteristics as a reference point to develop strategies to protect and improve water quality
3. Enhance and maintain recreational opportunities that also serve to preserve water quality yet support the local economy
4. Promote sustainable land management practices that conserve and protect the natural resources, character, and heritage of the watershed
5. Integrate climate-resilient practices and efforts throughout the watershed
6. Develop and maintain effective education, outreach and efforts coordinated with other riparian organizations to support watershed protection

Since many of the impairments to water quality and aquatic habitat affecting waterbodies within GRNA occur outside GRNA boundaries (i.e., road stream crossings, upstream riparian buffers), GRNA should work closely with partners and stakeholders to achieve the Goals of the ERCOL WMP both broadly and especially for Grass River and its tributaries. Additionally, GRNA could play a key role in effective education and outreach regarding water quality and water resources management. Vernal pool management could take place completely within GRNA, and provides another opportunity for education and outreach.

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V. LIST OF TABLES

VI. APPENDICES

Appendix 1. Find this at:

https://www.grassriver.org/uploads/7/6/5/7/7657490/draft_grna_final_report_mnfi_w.edits.compressed-ilovepdf-compressed.pdf

Natural Community Delineation and Floristic Quality Assessments of Grass River Natural Area, Antrim County, Michigan

Prepared by:

Rachel Hackett, Phyllis Higman, and Liana May

Appendix 2. MNFI Descriptions

Appendix 2a Dry-mesic Northern Forest - Michigan Natural Features Inventory.html

file:///Users/richardhannan/Documents/GRNA/Land%20Management/Natural%20Resource%20Management%20Plan%202019/2019%20plan/Appendices/Appendix%202a%20Dry-mesic%20Northern%20Forest%20-%20Michigan%20Natural%20Features%20Inventory.html

Appendix 2b Mesic Northern Forest - Michigan Natural Features Inventory.html

file:///Users/richardhannan/Documents/GRNA/Land%20Management/Natural%20Resource%20Management%20Plan%202019/2019%20plan/Appendices/Appendix%202b%20Mesic%20Northern%20Forest%20-%20Michigan%20Natural%20Features%20Inventory.html

Appendix 2c Emergent Marsh - Michigan Natural Features Inventory.html

file:///Users/richardhannan/Documents/GRNA/Land%20Management/Natural%20Resource%20Management%20Plan%202019/2019%20plan/Appendices/Appendix%202c%20Emergent%20Marsh%20-%20Michigan%20Natural%20Features%20Inventory.html

Appendix 2d Northern Wet Meadow - Michigan Natural Features Inventory.html

file:///Users/richardhannan/Documents/GRNA/Land%20Management/Natural%20Resource%20Management%20Plan%202019/2019%20plan/Appendices/Appendix%202d%20Northern%20Wet%20Meadow%20-%20Michigan%20Natural%20Features%20Inventory.html

Appendix 2e Northern Fen - Michigan Natural Features Inventory.html

file:///Users/richardhannan/Documents/GRNA/Land%20Management/Natural%20Resource%20Management%20Plan%202019/2019%20plan/Appendices/Appendix%202e%20Northern%20Fen%20-%20Michigan%20Natural%20Features%20Inventory.html

Appendix 2f Northern Shrub Thicket - Michigan Natural Features Inventory.html

file:///Users/richardhannan/Documents/GRNA/Land%20Management/Natural%20Resource%20Management%20Plan%202019/2019%20plan/Appendices/Appendix%202f%20Northern%20Shrub%20Thicket%20-%20Michigan%20Natural%20Features%20Inventory.html

Appendix 2g Poor Conifer Swamp - Michigan Natural Features Inventory.html

file:///Users/richardhannan/Documents/GRNA/Land%20Management/Natural%20Resource%20Management%20Plan%202019/2019%20plan/Appendices/Appendix%202g%20Poor%20Conifer%20Swamp%20-%20Michigan%20Natural%20Features%20Inventory.html

Appendix 2h Rich Conifer Swamp - Michigan Natural Features Inventory.html

file:///Users/richardhannan/Documents/GRNA/Land%20Management/Natural%20Resource%20Management%20Plan%202019/2019%20plan/Appendices/Appendix%202h%20Rich%20Conifer%20Swamp%20-%20Michigan%20Natural%20Features%20Inventory.html

Appendix 2i Hardwood-Conifer Swamp - Michigan Natural Features Inventory.html

file:///Users/richardhannan/Documents/GRNA/Land%20Management/Natural%20Resource%20Management%20Plan%202019/2019%20plan/Appendices/Appendix%202i%20Hardwood-Conifer%20Swamp%20-%20Michigan%20Natural%20Features%20Inventory.html

Appendix 3.

<div align="center">

Possible targets for rare species surveys at GRNA - Ashley Cole-Wick (MNFI)
November 13, 2018

</div>

1. Rich conifer swamp
    a. *Sistrurus c. catenatus* (eastern massasauga, federal candidate species and state special concern)
    b. *Somatochlora hineana* (Hine's emerald, federal/state endangered)
    c. *Asio otus* (long-eared owl, state special concern)
    d. *Clemmys insculpta* (wood turtle, state threatened)
    e. *Dendragapus canadensis* (spruce grouse, state special concern)

2. Mesic northern forest
    a. *Accipiter cooperii* (Cooper's hawk, state special concern)
    b. *Accipiter gentilis* (northern goshawk, state special concern)

3. Northern fen
    a. *Appalachia arcana* (secretive locust, state special concern)
    b. *Catinella exile* (Pleistocene catinella, state special concern)
    c. *Circus cyaneus* (northern harrier, state special concern)
    d. *Clemmys guttata* (spotted turtle, state threatened)
    e. *Coturnicops noveboracensis* (yellow rail, state threatened)
    f. *Emydoidea blandingii* (Blanding's turtle, state special concern)
    g. *Euconulus alderi* (land snail, state special concern)
    h. *Phyciodes batesii* (tawny crescent, state special concern)
    i. *Pseudacris triseriata maculata* (boreal chorus frog, state special concern)
    j. *Sistrurus c. catenatus* (eastern massasauga, federal candidate species and state special concern)
    k. *Somatochlora hineana* (Hine's emerald, federal/state endangered)
    l. *Somatochlora incurvata* (incurvate emerald, state special concern)
    m. *Terrapene c. carolina* (eastern box turtle, state special concern)
    n. *Lithobates [Rana] palustris* (pickerel frog, state special concern)
    o. *Papaipema beeriana (*blazing star borer; where Liatris grows (I did not see this in 2017 report, which is surprising)

4. Other / potential
    a. *Chlosyne gorgone* where *Helianthus* or *Lysimachia* are found (Gorgone checkerspot, state special concern)
    b. *Chlosyne harrisii* (Harris' checkerspot, possible new county record) if *Aster umbellatus* is present in wetter areas
    c. *Erynnis martialis* where New Jersey tea is found (Mottled duskywing, state special concern)
    d. *Pyrgus Wyandot* (Grizzled skipper, state special concern) where wild strawberry, cinquefoil, cloudberry might be found
    e. General bumblebee surveys in fen and/or human dominated open areas
    f. *Callophrys niphon* (Eastern pine elfin) where pines occur

g. *Erora laeta* (Early hairstreak) in beech habitat
h. *Callophrys augustinus* (Brown elfin) where heaths and Labrador tea grow
i. *Myotis lucifugus* (little brown bat, state special concern)
j. *Myotis septentrionalis* (northern long-eared bat, federally threatened, state special concern) - forests
k. *Opheodrys vernalis* (smooth green snake, state special concern) – moist, grassy areas in prairies, marshes, and near lakes
l. *Regina septemvittata* (queen snake, state special concern) - along streams and rivers in aquatic plants, overhanging shrubs, or among or under rocks at the water's edge. Warm, shallow streams with shrubs and trees nearby are the preferred habitat.

Appendix 4. Grass River Natural Area Natural Resource Management Plan 2012-2015

Find at https://www.grassriver.org/uploads/7/6/5/7/7657490/grnanatresmgtplan_final.pdf.

VII. ACTION PLAN 2020-2025

General Area of Focus	Task Description
Data management	Detailed review of the Community Delineation and Floristic Quality Assessment (FQI) conducted by Michigan Natural Features Inventory (MNFI, Hackett et al. 2017) to help establish monitoring and/or data collection priorities.
Data management	Utilize the (FQI) values provided by Hackett et al. 2017 to determine how to continue evaluating prioritized components of the biodiversity of management areas in GRNA.
Data management	Research the available viability assessment tools or models for evaluating the viability of each special population of threatened, endangered, and/or rare species, as well as species of concern or species that are of particular importance in GRNA.
Data management	Continue collecting data on species' populations and threats to their existence.
Plans	Update the current Natural Resource Management Plan covering all management areas in GRNA.
Plans	Develop a Species Protection Plan for managing each selected population of threatened, endangered, and/or rare species, as well as species of concern or species that are particularly important in GRNA
Plans	Develop a Scientific Research Plan that prioritizes a list of specific research areas of interest, and initiate a Scientific Research Plan to coordinate with research organizations and/or universities to conduct collaborative efforts on specific scientific research projects in GRNA.
Plans	Develop an annual 'Volunteer Training Plan' for training by conservation professionals if possible, and increasing the number of volunteers and students involved in monitoring the ecosystems in GRNA. Should generate at least one Species Protection Plan for a GRNA species each year.
Plans	Research and discuss plans for a Historic Research Plan for conducting historic and archaeological research in GRNA.
Policy	Create or edit existing relevant management policies
Policy	Provide a proposed draft of scientific research policies and make a recommendation to the Board of Directors.
Policy	Determine if a Template for a Memorandum of Understanding (MOU) with appropriate research partner organizations, such as public agencies, college and university departments is needed
Documentation	Research the literature for appropriate protocols to be used in each specific (e.g. plants, insects, small mammals, etc.) monitoring project
Documentation	Use existing and established protocols for inventorying the special populations of indicator, threatened, endangered, and/or rare species, as well as species of concern or species that are of particular importance in GRNA
Reports	The condition of natural features, natural communities and indicator species
Reports	Progress made toward eliminating populations of invasive species.
Reports	Results of ongoing specific monitoring activities
Reports	Progress made toward the conservation of monitored species for each natural community.
Reports	An evaluation of the effectiveness of the GRNA Natural Resources Management Plan.