Climate Change Adaptation Plan

Sustainable Management of the Emily Min Hunt Nature Preserve

March 5, 2020

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Prepared using the Adaptation Workbook - AdaptationWorkbook.org

Property details

Acres: 428

Ownership: Private Non-Industrial

Huron Pines recently acquired a 428 acre property in Presque Isle County Michigan. The property is on Long Lake and is within the Lake Huron watershed. The property is primarily wooded with some open grassland area and alvar features. The management plan for the preserve is currently in development. By working through the Adaptation Workbook, we aim to guide this development.

Table of Contents

1. Project Goals and Objectives

Management goals and objectives capture fundamental information about the project area or property and provide a starting point for considering climate change.

1a. Northern hardwoods: Goals and Objectives

Northern hardwoods occur on mesic soils that provide consistent moisture and nutrients. Gap-sized disturbances are common, but stand-replacing events are very infrequent. Common species include sugar maple, red maple, American beech, American basswood, and eastern hemlock.

small aspen stand that may be of interest for management

Goal	Objectives and Timeframes
Maintain habitat diversity and each habitat's resiliency to disturbance.	• Create forest management plan that will establish a disturbance regime and management actions that will maintain age class, structural and species diversity. *(2020)* • Implement actions defined in forest management plan *(10 yrs)* • Investigate, track, and control forest pest species. *(on-going)*
Management here serves as a model or example for other community and private lands with similar resources. Continue to protect land in this area for surface water and habitat protection.	• Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

1b. Barrens: Goals and Objectives

Barrens occur on coarse-textured, droughty soils with frequent fire return intervals. Tree cover is typically 5 to 25 percent, and typically includes jack pine, black oak, northern pin oak, or white oak.

alvar glade

Goal	Objectives and Timeframes
Maintain habitat diversity and each habitat's resiliency to disturbance.	• Establish management actions that will increase species diversity including treating invasive species and planting native species. *(10 yrs)*
Management here serves as a model or example for other community and private lands with similar resources. Continue to protect land in this area for surface water and habitat protection.	• Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

1c. Lowland conifers: Goals and Objectives

This forest system occurs on peat or mineral soils that are saturated throughout growing season. Common tree species include northern white-cedar, black spruce, tamarack, and other boreal species.

Goal	Objectives and Timeframes
Maintain habitat diversity and each habitat's resiliency to disturbance.	• Maintain and protect hydrologic conditions, including riparian soil and vegetation, water quality, and aquatic habitat connectivity. Create a baseline report of these conditions (2yrs) *(2 yrs - 20yrs)*
Management here serves as a model or example for other community and private lands with similar resources. Continue to protect land in this area for surface water and habitat protection.	• Develop language to communicate with neighboring landowners re: management options and how to address deer pressure on these types of systems. *(2022)*

1d. Passive Recreation Access: Goals and Objectives

Creating safe and inviting access for the public to experience and learn on the property.

Goal	Objectives and Timeframes
Improve accessibility for passive recreation	• Create parking area and control poison ivy to ensure safe access *(2020)* • Build and design a trail system that takes into account resource protection and wildlife viewing opportunities. *(5 yr)*

2. Climate Change Impacts and Vulnerabilities

Climate change will not affect all places in the same way. This section describes the anticipated effects of climate change within a region, and then provides additional details how specific places within the project area may be affected.

2a. Regional Climate Impacts and Vulnerabilities

Potential Climate Impact - Regional	Property or Project Area Considerations
Low-diversity systems are at greater risk from climate change. (39, 40)	Deer herbivory affects diversity in our project.
Species in fragmented landscapes will have less opportunity to migrate in response to climate change. (41, 42)	Given parcel sizes in the project area, this impact may have less affect on our project. The project area/potential migration corridors are bound by large water bodies (inland lakes and Lake Huron).
Systems that are limited to particular environments will have less opportunity to migrate in response to climate change. (43)	Limestone glade on our project site is restricted by bedrock, making this particularly vulnerable. Water bodies also restrict expansion or migration.
Systems that are more tolerant of disturbance have less risk of declining on the landscape (44, 45)	
Northern Michigan temperatures will increase between 2 °F and 8 °F by the end of the century, with more warming during winter. (37)	Lowland conifer wetland might be most vulnerable.
Northern Michigan's winter snowpack will be reduced from 30-80% by the end of the century. (37, 2, 46, 47)	Lowland conifer wetland more susceptible to drought conditions. Subnivean zones for small mammals in northern hardwoods also could be at risk.
Northern Michigan will have 30-50 fewer days of frozen ground during the winter by the end of the century. (37, 47)	wildlife impacts here are probably highest concern. Soil impacts here could mean changes to permeability, temperature and susceptibility to invasive species and forest pests.
Northern Michigan's growing season will increase by 30 to 70 days by the end of the century. (37, 48)	Increase in invasive species and forest pest pressure. Hardwoods probably better able to adapt.
Intense precipitation events will continue to become more frequent in northern Michigan. (37)	potential flooding in wetland system. Not a large concern for our site.
Northern Michigan soil moisture patterns will change, with drier soil conditions later in the growing season. (37)	

Potential Climate Impact - Regional	Property or Project Area Considerations
Climate conditions will increase fire risks in northern Michigan by the end of the century. (49, 37, 16, 50)	Fire disturbance here could be positive for many systems on our project site. Rx fire is a tool for reducing wildfire risk.
Many invasive species, insect pests, and pathogens in northern Michigan forests will increase or become more damaging by the end of the century. (37, 51, 52)	hardwood forest species at highest risk - could potentially change the system completely.
Northern Michigan's boreal species will face increasing stress from climate change. (37)	
Southern or temperate species in northern Michigan will be favored by climate change. (37)	Will want to consider this as management moves forward.
Northern Michigan's forest productivity will increase by the end of the century. (37, 53)	
Forest composition will change across the landscape (54)	
Tree regeneration and recruitment will change (54)	
Forest productivity will increase during the next several decades in the absence of significant stressors (54)	Could this create a succession from our barren/glade system into a forested system?

2b. Northern hardwoods: Climate Impacts and Vulnerabilities

Potential Impacts: Mixed/Neutral **Adaptive Capacity:** Moderate-High **Vulnerability:** Moderate

Potential Climate Impact - Northern hardwoods	Property or Project Area Considerations
Deer herbivory on preferred species may hinder regeneration. (55, 56)	Significant concern. Already an existing stressor although deer disease impacts populations.
Northern hardwood forests may be susceptible to increased drought and moisture stress due to climate change. (37, 57)	
Most dominant tree species in northern hardwood forests in Michigan are expected to tolerate a mild amount of warming, but many species could deline under a warmer, drier climate by the end of the century. (37)	
Northern hardwood forests may be impacted by a reduced and more variable snowpack, as well as more frequent freeze-thaw events. (37, 57)	
Beech bark disease, white pine blister rust, and other diseases could become more active and virulent in Michigan's northern hardwood forests under a warmer climate. (37)	Beech bark disease is in the area and beech trees are on the project site.
High diversity may improve the adaptive capacity of northern hardwood forests. (37, 57)	

2c. Barrens: Climate Impacts and Vulnerabilities

Potential Impacts: Supportive **Adaptive Capacity:** Low-Moderate **Vulnerability:** Moderate

Potential Climate Impact - Barrens	Property or Project Area Considerations
Climate change-induced moisture stress or extended droughts may favor barrens systems in northern Michigan. (37)	Can also lead to favoring invasive species - spotted knapweed in particular.
Barrens may benefit from increased wildfire activity due to climate change. (37)	Project site is unlikely to be impacted by wildfire given the residential community and access to the site.
Invasive species such as leafy spurge, spotted knapweed, and St. John's wort have the potential to increase in barrens under climate change. (37)	

2d. Lowland conifers: Climate Impacts and Vulnerabilities

Potential Impacts: Very disruptive to ecosystem **Adaptive Capacity:** Moderate **Vulnerability:** High

Potential Climate Impact - Lowland conifers	Property or Project Area Considerations
Lowland conifer forests may have limited tolerance to changes in water tables. (37, 57)	The predicted change for our project area will create wetter conditions. Shallow soil types do present potential for vulnerability to drought conditions.
Most dominant tree species in lowland conifer forests are expected to decline across northern Michigan by the end of the century (balsam fir, black spruce, eastern hemlock, northern white-cedar, and tamarack). (37)	black and white spruce on project site.
Lowland conifer forests may not be able to migrate to other locations on the landscape to cope with climate change. (37, 57)	

2e. Passive Recreation Access: Climate Impacts and Vulnerabilities

Potential Impacts: Disruptive **Adaptive Capacity:** Moderate-High **Vulnerability:** Moderate

Potential Climate Impact - Passive Recreation Access	Property or Project Area Considerations
Warming trends will increase site availability and change the types of recreational uses.	

3. Evaluation of Management Objectives

Climate change might make management objectives for this property harder or easier to achieve, presenting challenges and opportunities. This section also includes a simple rating and description for the feasibility of meeting management objectives under current management. This is a critical step to evaluate whether management objectives are robust, or whether any might need to be changed.

3a. Northern hardwoods: Evaluation of Management Objectives

Management Goal: Maintain habitat diversity and each habitat's resiliency to disturbance.

Management Objective	Challenges and Opportunities	Feasibility
Create forest management plan that will establish a disturbance regime and management actions that will maintain age class, structural and species diversity. *(2020)*	**Challenges:** • Understanding appropriate diversity and/or species specificity for changes. Disturbances may create more or less desired effect than assumed. **Opportunities:** • We can proactively account for potential climate change impacts as we work through the Adaptation Workbook and develop the plan.	**Feasibility:** High **Feasibility Comment:** Have resources to create management plan - internal and external partners. Have regional partners and volunteers to help with input. **Other Considerations:** Organizational understanding of new way of management planning may create additional challenges.
Implement actions defined in forest management plan *(10 yrs)*	**Challenges:** • Adjusting management activities to changes in seasonality. • Adapting our management to future unknowns (i.e. catastrophic loss of dominant species). **Opportunities:** • As the owner of this property, we have the flexibility to try a variety of management strategies fairly quickly. • Longer growing season could benefit native tree species.	**Feasibility:** Medium **Feasibility Comment:** Some of the management options are still unknown since we are currently creating the plan. We are confident that we can implement sound forestry practices that maintain/improve resiliency. **Other Considerations:** Financial and neighborhood input considerations. By allowing public access, there are some obstacles to physical management.

Management Goal: Maintain habitat diversity and each habitat's resiliency to disturbance.

Management Objective	Challenges and Opportunities	Feasibility
Investigate, track, and control forest pest species. *(on-going)*	**Challenges:** • Pests may arrive more quickly. • Control measures are not tested or confirmed in some cases. **Opportunities:** • Opportunity to build the model for BMPs for monitoring	**Feasibility:** Medium **Feasibility Comment:** Staff is skilled enough, but body of knowledge is generally lower. **Other Considerations:** Recreational access may speed up introduction and make control efforts more difficult.

Management Goal: Management here serves as a model or example for other community and private lands with similar resources. Continue to protect land in this area for surface water and habitat protection.

Management Objective	Challenges and Opportunities	Feasibility
Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*	**Challenges:** • Demographics may make climate change communication difficult. **Opportunities:** • People are interested in exploring the property and the "pond". A demonstration of managing with change in mind can bring surrounding landowners in.	**Feasibility:** High **Feasibility Comment:** Landowner engagement is long-term game....our ownership is very recent so we have a long road of building relationships. **Other Considerations:** Institutional considerations regarding old apple orchard benefits.

3b. Barrens: Evaluation of Management Objectives

Management Goal: Maintain habitat diversity and each habitat's resiliency to disturbance.

Management Objective	Challenges and Opportunities	Feasibility
Establish management actions that will increase species diversity including treating invasive species and planting native species. *(10 yrs)*	**Challenges:** • Managing spotted knapweed is famously difficult. • Loss of frozen days and snow pack impacts are unknown (seed scarification, insect diversity, small mammals) and determining what indicators to track is a challenge. **Opportunities:** • Explore different techniques in different zones. Test methods. • By increasing diversity on our property, there is an opportunity to improve diversity of neighboring properties.	**Feasibility:** Medium **Feasibility Comment:** The unique characteristics of the alvar glade make restoration more challenging especially with climate change impacts. However, this is a priority for our organization to protect this unique system. **Other Considerations:** No other considerations

Management Goal: Management here serves as a model or example for other community and private lands with similar resources. Continue to protect land in this area for surface water and habitat protection.

Management Objective	Challenges and Opportunities	Feasibility
Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*	**Challenges:** • Demographics may make climate change communication difficult. **Opportunities:** • The barrens and glade area are the kinds of places people don't often see. This is an opportunity to engage people in thinking about spaces with multiple values (historical, environmental)	**Feasibility:** High **Feasibility Comment:** Engagement is a long term effort and an organizational priority. **Other Considerations:** No other considerations

3c. Lowland conifers: Evaluation of Management Objectives

Management Goal: Maintain habitat diversity and each habitat's resiliency to disturbance.

Management Objective	Challenges and Opportunities	Feasibility
Maintain and protect hydrologic conditions, including riparian soil and vegetation, water quality, and aquatic habitat connectivity. Create a baseline report of these conditions (2yrs) *(2 yrs - 20yrs)*	**Challenges:** • Many factors are outside of our control to manage. **Opportunities:** • By preparing the baseline report, we can identify the appropriate partners and adjacent landowners to aid in this effort.	**Feasibility:** Medium **Feasibility Comment:** Feasibility of completing the baseline report is high. We feel like there are still a lot of questions/unknowns regarding our ability to protect and maintain this ecosystem on our property. **Other Considerations:** No other considerations

Management Goal: Management here serves as a model or example for other community and private lands with similar resources. Continue to protect land in this area for surface water and habitat protection.

Management Objective	Challenges and Opportunities	Feasibility
Develop language to communicate with neighboring landowners re: management options and how to address deer pressure on these types of systems. *(2022)*	**Challenges:** • Balancing the cultural importance of deer hunting with understanding the detrimental effects that high deer populations have on the landscape. **Opportunities:** • Connect with landowners in the area and develop innovative ways to communicate and demonstrate deer pressure.	**Feasibility:** High **Feasibility Comment:** Our organization has the skills and history to develop these communication approaches. **Other Considerations:** No other considerations

3d. Passive Recreation Access: Evaluation of Management Objectives

Management Goal: Improve accessibility for passive recreation

Management Objective	Challenges and Opportunities	Feasibility
Create parking area and control poison ivy to ensure safe access *(2020)*	**Challenges:** • Poison Ivy may thrive and become stronger as it responds to dryer conditions. **Opportunities:** None identified	**Feasibility:** High **Feasibility Comment:** Neighbors will appreciate safer access and control of poison ivy. Neighborhood funding may be available if other funding is not. **Other Considerations:** No other considerations
Build and design a trail system that takes into account resource protection and wildlife viewing opportunities. *(5 yr)*	**Challenges:** • Water tables might change, washing out previously dry trails. • Protecting shallow soils and plant species that may be more vulnerable due to climate change. **Opportunities:** None identified	**Feasibility:** High **Feasibility Comment:** No comments **Other Considerations:** No other considerations

4. Adaptation Tactics

After considering the challenges and opportunities climate change might present for this management objective, these actions were identified to help prepare for climate change impacts. Each adaptation tactic is linked to one or more Adaptation Strategies and Approaches, which provide connections to more general concepts related to forest management and conservation. Tactics that are recommended can be implemented or explored further.

4a. Northern hardwoods: Adaptation Tactics

Tactic: Forest harvest using variable density treatments to achieve diverse age classes and increased heterogeneity on the landscape. *(2-5 yrs)*

Practicability: High

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Maintain or restore forests and vegetative cover (Forested watershed) • Enhance species age classes and structural diversity in forests	**Benefits:** Management addresses both species and age class diversity goals as well as landowner education goals for sustainable forest management modeling. Increasing age diversity will also increase resilience in our system specifically with regard to oak wilt and other forest pests. **Drawbacks and Barriers:** Forestry impacts outside of winter weather conditions may be harmful to our shallow soil system.	• Create forest management plan that will establish a disturbance regime and management actions that will maintain age class, structural and species diversity. *(2020)* • Implement actions defined in forest management plan *(10 yrs)* • Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

Tactic: Control deer pressure on cedar, birch and other species through facilitated hunts (sharp-shooter), deer exclosures, increased public hunting and adaptive management using emerging technologies. *(now - 30 yrs)*

Practicability: Low

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Sustain fundamental hydrologic processes (Forested watershed) • Maintain and restore forested wetlands and lowland areas	**Benefits:** Reducing deer browse will help guarantee better individual survival thereby maintaining species diversity and cover in the wetland areas. **Drawbacks and Barriers:** Our ability to truly impact the local deer population is limited by size of our property (influence).	• Create forest management plan that will establish a disturbance regime and management actions that will maintain age class, structural and species diversity. *(2020)* **Tactic not recommended for this objective**

Tactic: Explore options for expanding the Emily Min Hunt Nature Preserve including landowner outreach and funding mechanisms. Prioritize parcels with wetland and alvar systems. *(20 years)*

Practicability: Medium

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Promote landscape connectivity • Reduce landscape fragmentation	**Benefits:** Increased engagement in the Long Lake community, greater control of threats and invasive species vectors, efficiencies of scale. **Drawbacks and Barriers:** Barriers include costs and landowner interest.	• Create forest management plan that will establish a disturbance regime and management actions that will maintain age class, structural and species diversity. *(2020)*

Tactic: Promote diverse fire regime will result in ecosystem diversity. Alternate timing of fires throughout the year. *(3-5 yrs)*

Practicability: High

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Sustain fundamental ecological functions • Restore or maintain fire in fire-adapted ecosystems	**Benefits:** Programmatic benefit to demonstrate the safe use of fire in rare systems on our own property. Promote germination of species from the seed bank and control spotted knapweed. Reduce course woody debris. **Drawbacks and Barriers:** Institutional barrier- fire program still in development. Community and public awareness needs.	• Create forest management plan that will establish a disturbance regime and management actions that will maintain age class, structural and species diversity. *(2020)* • Investigate, track, and control forest pest species. *(on-going)* • Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

Tactic: Establish a monitoring protocol for invasive species (2x Annually) and implement control measures. *(1-10 yrs)*

Practicability: Medium

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Maintain or restore forests and vegetative cover (Forested watershed) • Prevent invasive species establishment and remove existing invasive species	**Benefits:** Invasive species management is business as usual, can assist in resiliency with increasing diversity, and is at a manageable stage (infestation low) **Drawbacks and Barriers:** Spotted knapweed in particular is very difficult to effectively control.	• Investigate, track, and control forest pest species. *(on-going)*

4b. Barrens: Adaptation Tactics

Tactic: Establish a monitoring protocol for invasive species (2x Annually) and implement control measures. *(1-10 yrs)*

Practicability: Medium

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Maintain or restore forests and vegetative cover (Forested watershed) • Prevent invasive species establishment and remove existing invasive species	**Benefits:** Invasive species management is business as usual, can assist in resiliency with increasing diversity, and is at a manageable stage (infestation low) **Drawbacks and Barriers:** Spotted knapweed in particular is very difficult to effectively control.	• Establish management actions that will increase species diversity including treating invasive species and planting native species. *(10 yrs)*

Tactic: Control deer pressure on cedar, birch and other species through facilitated hunts (sharp-shooter), deer exclosures, increased public hunting and adaptive management using emerging technologies. *(now - 30 yrs)*

Practicability: Low

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Sustain fundamental hydrologic processes (Forested watershed) • Maintain and restore forested wetlands and lowland areas	**Benefits:** Reducing deer browse will help guarantee better individual survival thereby maintaining species diversity and cover in the wetland areas. **Drawbacks and Barriers:** Our ability to truly impact the local deer population is limited by size of our property (influence).	• Establish management actions that will increase species diversity including treating invasive species and planting native species. *(10 yrs)* **Tactic not recommended for this objective**

Tactic: Barrens plantings with species (tbd) adapted for warmer/dryer conditions. *(2-5 yrs)*

Practicability: Medium

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Maintain and enhance genetic diversity • Favor existing genotypes that are better adapted to future conditions	**Benefits:** Promotes wildlife diversity through improved habitat. Improves passive recreation opportunities (especially birding). Restores a rare ecosystem type (fulfills organizational mission). **Drawbacks and Barriers:** Some resistance to bringing southern MI, Wisconsin, or Ohio sourced seeds to our site. Seed sourcing for this ecosystem type is challenging and limited.	• Establish management actions that will increase species diversity including treating invasive species and planting native species. *(10 yrs)* • Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

Tactic: Design a strategy to transition the apple orchard to resemble the adjacent barrens area (whether through tree removal, herbaceous introduction, soil loosening or other appropriate techniques) *(2-5 yrs)*

Practicability: Medium

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Increase ecosystem redundancy across the landscape • Expand the boundaries of reserves to increase diversity	**Benefits:** Add more of a rare system, good example for other orchards aging out, help with water infiltration and species diversity on property. Apple orchard attracts deer, which we are a threat to the system. **Drawbacks and Barriers:** Popular area for wildlife viewing, people go here instead of the healthier barrens area so removal may increase pressures on more intact systems	• Establish management actions that will increase species diversity including treating invasive species and planting native species. *(10 yrs)* • Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

Tactic: Explore options for expanding the Emily Min Hunt Nature Preserve including landowner outreach and funding mechanisms. Prioritize parcels with wetland and alvar systems. *(20 years)*

Practicability: Medium

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Promote landscape connectivity • Reduce landscape fragmentation	**Benefits:** Increased engagement in the Long Lake community, greater control of threats and invasive species vectors, efficiencies of scale. **Drawbacks and Barriers:** Barriers include costs and landowner interest.	• Establish management actions that will increase species diversity including treating invasive species and planting native species. *(10 yrs)* • Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

Tactic: Promote diverse fire regime will result in ecosystem diversity. Alternate timing of fires throughout the year. *(3-5 yrs)*

Practicability: High

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Sustain fundamental ecological functions • Restore or maintain fire in fire-adapted ecosystems	**Benefits:** Programmatic benefit to demonstrate the safe use of fire in rare systems on our own property. Promote germination of species from the seed bank and control spotted knapweed. Reduce course woody debris. **Drawbacks and Barriers:** Institutional barrier- fire program still in development. Community and public awareness needs.	• Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

4c. Lowland conifers: Adaptation Tactics

Tactic: Establish a monitoring protocol for invasive species (2x Annually) and implement control measures. *(1-10 yrs)*

Practicability: Medium

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Maintain or restore forests and vegetative cover (Forested watershed) • Prevent invasive species establishment and remove existing invasive species	**Benefits:** Invasive species management is business as usual, can assist in resiliency with increasing diversity, and is at a manageable stage (infestation low) **Drawbacks and Barriers:** Spotted knapweed in particular is very difficult to effectively control.	• Maintain and protect hydrologic conditions, including riparian soil and vegetation, water quality, and aquatic habitat connectivity. Create a baseline report of these conditions (2yrs) *(2 yrs - 20yrs)*

Tactic: Control deer pressure on cedar, birch and other species through facilitated hunts (sharp-shooter), deer exclosures, increased public hunting and adaptive management using emerging technologies. *(now - 30 yrs)*

Practicability: Low

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Sustain fundamental hydrologic processes (Forested watershed) • Maintain and restore forested wetlands and lowland areas	**Benefits:** Reducing deer browse will help guarantee better individual survival thereby maintaining species diversity and cover in the wetland areas. **Drawbacks and Barriers:** Our ability to truly impact the local deer population is limited by size of our property (influence).	• Maintain and protect hydrologic conditions, including riparian soil and vegetation, water quality, and aquatic habitat connectivity. Create a baseline report of these conditions (2yrs) *(2 yrs - 20yrs)* • Develop language to communicate with neighboring landowners re: management options and how to address deer pressure on these types of systems. *(2022)* **Tactic not recommended for this objective**

Tactic: Explore options for expanding the Emily Min Hunt Nature Preserve including landowner outreach and funding mechanisms. Prioritize parcels with wetland and alvar systems. *(20 years)*

Practicability: Medium

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Promote landscape connectivity • Reduce landscape fragmentation	**Benefits:** Increased engagement in the Long Lake community, greater control of threats and invasive species vectors, efficiencies of scale. **Drawbacks and Barriers:** Barriers include costs and landowner interest.	• Maintain and protect hydrologic conditions, including riparian soil and vegetation, water quality, and aquatic habitat connectivity. Create a baseline report of these conditions (2yrs) *(2 yrs - 20yrs)*

4d. Passive Recreation Access: Adaptation Tactics

Tactic: Build trails that provide access to the preserve while protecting sensitive features including limiting impacts to alvar glade through the use of overlooks and barriers, building with erosion and rain run-off in mind, and boardwalks when needed. *(1-2 yrs)*

Practicability: High

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Design and modify infrastructure to accommodate future conditions (Forested watershed) • Incorporate natural or low impact development into designs	**Benefits:** Achieves the goal of preserving natural features, facilitates public access to special places, keeping people on designated trails will help keep invasive species at bay. **Drawbacks and Barriers:** Currently used trails may be re-routed or closed entirely.	• Create parking area and control poison ivy to ensure safe access *(2020)* • Build and design a trail system that takes into account resource protection and wildlife viewing opportunities. *(5 yr)*

Tactic: For parking lot installation, LID will be used to balance access priority with maintaining infiltration and soil health *(1-3 yrs)*

Practicability: High

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Design and modify infrastructure to accommodate future conditions (Forested watershed) • Incorporate natural or low impact development into designs	**Benefits:** Serves as an example to others, protects water infiltration **Drawbacks and Barriers:** Price here may be an issue, some practices for parking lots require maintenance	• Create parking area and control poison ivy to ensure safe access *(2020)*

Tactic: Design a strategy to transition the apple orchard to resemble the adjacent barrens area (whether through tree removal, herbaceous introduction, soil loosening or other appropriate techniques) *(2-5 yrs)*

Practicability: Medium

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Increase ecosystem redundancy across the landscape • Expand the boundaries of reserves to increase diversity	**Benefits:** Add more of a rare system, good example for other orchards aging out, help with water infiltration and species diversity on property. Apple orchard attracts deer, which we are a threat to the system. **Drawbacks and Barriers:** Popular area for wildlife viewing, people go here instead of the healthier barrens area so removal may increase pressures on more intact systems	• Build and design a trail system that takes into account resource protection and wildlife viewing opportunities. *(5 yr)*

Tactic: Explore options for expanding the Emily Min Hunt Nature Preserve including landowner outreach and funding mechanisms. Prioritize parcels with wetland and alvar systems. *(20 years)*

Practicability: Medium

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Promote landscape connectivity • Reduce landscape fragmentation	**Benefits:** Increased engagement in the Long Lake community, greater control of threats and invasive species vectors, efficiencies of scale. **Drawbacks and Barriers:** Barriers include costs and landowner interest.	• Build and design a trail system that takes into account resource protection and wildlife viewing opportunities. *(5 yr)*

Tactic: Promote diverse fire regime will result in ecosystem diversity. Alternate timing of fires throughout the year. *(3-5 yrs)*

Practicability: High

Adaptation Strategies and Approaches	Benefits, Drawbacks and Barriers	Associated Management Objectives
Sustain fundamental ecological functions • Restore or maintain fire in fire-adapted ecosystems	**Benefits:** Programmatic benefit to demonstrate the safe use of fire in rare systems on our own property. Promote germination of species from the seed bank and control spotted knapweed. Reduce course woody debris. **Drawbacks and Barriers:** Institutional barrier- fire program still in development. Community and public awareness needs.	• Build and design a trail system that takes into account resource protection and wildlife viewing opportunities. *(5 yr)* **Tactic not recommended for this objective**

5. Monitoring Plan

Monitoring is critical for understanding if management actions are e·ective or if management should be altered in the future to account for new information. The following monitoring variables were described for this particular management objective and adaptation tactics.

5a. Northern hardwoods: Monitoring Plan

Monitoring Variable: Age class and structure diversity in northern hardwoods

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
Goal of 60% canopy cover; forest floor and mid-canopy regeneration is consistent with canopy goal and not being impeded by invasive species	10 years of monitoring post-harvest and burn activity to inform next action; intend to include volunteer monitors in this	• Create forest management plan that will establish a disturbance regime and management actions that will maintain age class, structural and species diversity. *(2020)* • Implement actions defined in forest management plan *(10 yrs)* • Investigate, track, and control forest pest species. *(on-going)* • Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

Monitoring Variable: Invasive plant species populations (Asian honeysuckle, spotted knapweed particularly noted)

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
Using baseline, each control season will see reduction in overall population density and size. Installation of one boot brush station.	Population data collected annually following baseline; use of GIS technology for tracking reductions. Use near trail data compared to interior habitat data to identify if human prevention techniques are working.	• Create forest management plan that will establish a disturbance regime and management actions that will maintain age class, structural and species diversity. *(2020)* • Implement actions defined in forest management plan *(10 yrs)*

Monitoring Variable: Forest pest species

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
Presence/absence; direction pest moving on the landscape	Using established protocol per pests likely to infest the property (oak wilt, beech bark disease, emerald ash borer); at least annually; use of volunteer monitors who are on the property more regularly and will notice subtle changes quicker	• Create forest management plan that will establish a disturbance regime and management actions that will maintain age class, structural and species diversity. *(2020)* • Implement actions defined in forest management plan *(10 yrs)* • Investigate, track, and control forest pest species. *(on-going)* • Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

Monitoring Variable: Wildlife (migratory birds, rare species including insects, amphibians)

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
Presence/absence; are the rare species' populations viable?; can we enable viewing for the public while maintaining species health?	Baseline inventory and every 2-year monitoring; once property is appealing to birders and other wildlife enthusiasts, rely on them; utilizing existing protocols and citizen sciences programs to build volunteer base focused on specific family groups like frogs/toads	• Implement actions defined in forest management plan *(10 yrs)*

Monitoring Variable: Neighboring landowner land management awareness and implementation

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
15% increase in neighboring landowner knowledge and behaviors around land management (specific to those identified as objectives in this workbook), including peer to peer advocacy elements	Following landowner outreach and education efforts, evaluation data will be collected to show changes; reach goal of collecting anecdotal stories from staff/public to do theme analysis and show any shifts/gains	• Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

5b. Barrens: Monitoring Plan

Monitoring Variable: Invasive plant species populations (Asian honeysuckle, spotted knapweed particularly noted)

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
Using baseline, each control season will see reduction in overall population density and size. Installation of one boot brush station.	Population data collected annually following baseline; use of GIS technology for tracking reductions. Use near trail data compared to interior habitat data to identify if human prevention techniques are working.	• Establish management actions that will increase species diversity including treating invasive species and planting native species. *(10 yrs)*

Monitoring Variable: Wildlife (migratory birds, rare species including insects, amphibians)

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
Presence/absence; are the rare species' populations viable?; can we enable viewing for the public while maintaining species health?	Baseline inventory and every 2-year monitoring; once property is appealing to birders and other wildlife enthusiasts, rely on them; utilizing existing protocols and citizen sciences programs to build volunteer base focused on specific family groups like frogs/toads	• Establish management actions that will increase species diversity including treating invasive species and planting native species. *(10 yrs)* • Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

Monitoring Variable: Success of plantings in barrens system

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
Seedlings survival (need to identify percentage for this type of system); native plant populations outcompeting/holding their own against invasive plant populations; are the plantings contributing to new/different wildlife populations (focus on birds and insects)?	Following planting activities, annual monitoring for first 3-5 years and then less frequently following (adaptative based on success)	• Establish management actions that will increase species diversity including treating invasive species and planting native species. *(10 yrs)* • Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

Monitoring Variable: Neighboring landowner land management awareness and implementation

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
15% increase in neighboring landowner knowledge and behaviors around land management (specific to those identified as objectives in this workbook), including peer to peer advocacy elements	Following landowner outreach and education efforts, evaluation data will be collected to show changes; reach goal of collecting anecdotal stories from staff/public to do theme analysis and show any shifts/gains	• Understand the benefits of manmade features on the property. Develop language to communicate with neighboring landowners re: management options. *(on-going)*

5c. Lowland conifers: Monitoring Plan

Monitoring Variable: Forest pest species

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
Presence/absence; direction pest moving on the landscape	Using established protocol per pests likely to infest the property (oak wilt, beech bark disease, emerald ash borer); at least annually; use of volunteer monitors who are on the property more regularly and will notice subtle changes quicker	• Maintain and protect hydrologic conditions, including riparian soil and vegetation, water quality, and aquatic habitat connectivity. Create a baseline report of these conditions (2yrs) *(2 yrs - 20yrs)*

Monitoring Variable: Riparian soil and vegetation, water quality, and aquatic habitat connectivity

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
Following baseline collection, quantitative criteria will be included. Cedar survival and regeneration; sedges, forbs population size/coverage/density and indicator species presence/absence (species TBD following baseline); indicator aquatic species; abiotic/chemical water quality factors; peat formation depth; road/culvert inventory and any off property impacts these may have	Establish baseline; monitoring data collected every 3-5 years; use of a photo point annually for peat, browse information; less use of volunteers because of more sensitive part of a preserve	• Maintain and protect hydrologic conditions, including riparian soil and vegetation, water quality, and aquatic habitat connectivity. Create a baseline report of these conditions (2yrs) *(2 yrs - 20yrs)* • Develop language to communicate with neighboring landowners re: management options and how to address deer pressure on these types of systems. *(2022)*

Monitoring Variable: Neighboring landowner land management awareness and implementation

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
15% increase in neighboring landowner knowledge and behaviors around land management (specific to those identified as objectives in this workbook), including peer to peer advocacy elements	Following landowner outreach and education efforts, evaluation data will be collected to show changes; reach goal of collecting anecdotal stories from staff/public to do theme analysis and show any shifts/gains	• Develop language to communicate with neighboring landowners re: management options and how to address deer pressure on these types of systems. *(2022)*

5d. Passive Recreation Access: Monitoring Plan

Monitoring Variable: Invasive plant species populations (Asian honeysuckle, spotted knapweed particularly noted)

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
Using baseline, each control season will see reduction in overall population density and size. Installation of one boot brush station.	Population data collected annually following baseline; use of GIS technology for tracking reductions. Use near trail data compared to interior habitat data to identify if human prevention techniques are working.	• Create parking area and control poison ivy to ensure safe access *(2020)* • Build and design a trail system that takes into account resource protection and wildlife viewing opportunities. *(5 yr)*

Monitoring Variable: Wildlife (migratory birds, rare species including insects, amphibians)

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
Presence/absence; are the rare species' populations viable?; can we enable viewing for the public while maintaining species health?	Baseline inventory and every 2-year monitoring; once property is appealing to birders and other wildlife enthusiasts, rely on them; utilizing existing protocols and citizen sciences programs to build volunteer base focused on specific family groups like frogs/toads	• Build and design a trail system that takes into account resource protection and wildlife viewing opportunities. *(5 yr)*

Monitoring Variable: Success of plantings in barrens system

Criteria for Evaluation	Plans for Implementation	Associated Management Objectives
Seedlings survival (need to identify percentage for this type of system); native plant populations outcompeting/holding their own against invasive plant populations; are the plantings contributing to new/different wildlife populations (focus on birds and insects)?	Following planting activities, annual monitoring for first 3-5 years and then less frequently following (adaptative based on success)	• Build and design a trail system that takes into account resource protection and wildlife viewing opportunities. *(5 yr)*

6. References

This adaptation plan was developed using the Adaptation Workbook (www.adaptationworkbook.org (https://www.adaptationworkbook.org)) and Adaptation Strategies and Approaches developed by the Northern Institute of Applied Climate Science. View the Adaptation Strategies and Approaches at: www.adaptationworkbook.org/strategies (https://www.adaptationworkbook.org/strategies).

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