2017-2018 Forest Understory Adaptation Project

Final Report prepared by:

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Introduction

Michigan Anishinaabeg have adaptively maintained relationships with, and knowledges of, Great Lakes forests, seasons, and cycles, including recent climate-driven change. Climate adaptation in Michigan can be guided by Anishinaabe knowledges and perspectives, as well as Western scientific knowledges and tools. With this purpose, the Inter-Tribal Council of Michigan facilitated a collaborative adaptation project with the Bay Mills Indian Community, Lac Vieux Desert Band of Lake Superior Ojibwe, Pokagon Band of Potawatomi, and Saginaw Chippewa Indian Tribe natural resource programs, with assistance from Michigan Natural Features Inventory and the Northern Institute for Applied Climate Science. Through this project, we: 1) created opportunities for biological and cultural experts to share knowledges and identify needs and opportunities for species- and coupled human-ecological community-focused adaptation at multiple scales, 2) conducted practitioner- and tribal community-based vulnerability assessments for forest understory species and plant communities identified by Anishinaabe tribal members and citizens, and 3) developed tribal and inter-tribal adaptation strategies to facilitate adaptive management of forest resources across jurisdictional boundaries and to support and revitalize Anishinaabe relationships with focal plants and plant communities. Through this work, we aim to enhance forest and tribal community resiliency and relationships in a changing climate.

Background

In 2014, the Inter-Tribal Council of Michigan (ITCMI) established the Michigan Tribal Climate Change Adaptation Project to facilitate collaborative climate change adaptation planning among Michigan Tribes, funded by the Bureau of Indian Affairs Tribal Climate Change Program. During that project, ITCMI worked with nine tribes in Michigan to conduct vulnerability assessments and adaptation planning for over 120 different plant, fish, and wildlife species, as well as analyses for human health and reservation infrastructure impacts from climate-driven change. The results of this initial project were useful for tribal tribal natural resource decision-making and grant proposals for continued work. However, tribal community member engagement varied greatly by tribe and was limited by the project timeline.

The Forest Understory Adaptation Project revised and expanded our original work by: 1) creating opportunities for biological and cultural experts to share knowledges and identify needs and opportunities for species- and coupled human-ecological community-focused adaptation at multiple scales, 2) conducting practitioner- and tribal community-based vulnerability assessments for forest understory species and plant communities identified by Anishinaabe tribal members and citizens, and 3) developing inter-tribal adaptation strategies to facilitate adaptive management of forest resources across

jurisdictional boundaries and to support and revitalize Anishinaabe relationships with focal plants and plant communities throughout future climate-driven change.

Within the field of forest adaptation, resources and planning efforts have tended to focus on tree species, leaving gaps in information and resources for understory plant adaptation planning and management. Forest understory plants provide traditional foods and medicines to the Anishinaabeg, maintain roles in Anishinaabe teachings and ceremony, and are vital members of the forest communities that have supported Anishinaabeg for generations. Anishinaabe knowledges and relationships with forest understory plants are vital perspectives, which may lead and guide forest adaptation efforts. Anishinaabe gatherers and community members understand local species interactions, phenology, nuanced changes through time, and acknowledge spiritual dimensions of life that are not otherwise addressed in Western science-led adaptation planning.

Within the field of climate adaptation, gaps exist in methods for: tribal community engagement appropriate for the diversity of tribal governance and natural resource management; adaptation planning based on Indigenous knowledges and paradigms; adaptation planning that draws from both Indigenous and Western scientific knowledges and paradigms; and coordinated landscape-scale adaptation efforts across tribal jurisdictions and cultures. Through this project, we tended to each of these gaps, as appropriate for the four participating tribes. Each tribal program's experience was unique and we worked together as a learning collaborative.

Maintaining and revitalizing cultural and physical relationships among Anishinaabeg and forest understory plants is an essential aspect of climate adaptation among the Anishinaabe community and tribal natural resource program partners on this project. Through this project, we conducted vulnerability assessments and adaptation planning that explicitly addressed these cultural and physical relationships. We shared forest species and plant community information, resources, and *appropriate* knowledges from Anishinaabe and Western scientific perspectives, in an initial effort to promote forest resiliency and long-term tribal access to, and relationships with, forest understory plants and plant communities in a changing climate.

Project Objectives

The purpose of this project was to help ensure that the long term cultural and natural resource goals of participating tribes related to key forest understory species and plant communities are attainable in a future climate. This goal was accomplished through planning cross-jurisdictional species- and plant community-specific adaptation, achieving the following objectives:

Objective 1: Establish an inter-tribal adaptation working group, which includes Anishinaabe and Western scientists, cultural leaders, and community members from participating Tribes, ITCMI, the Northern Institute of Climate Science (NIACS), Michigan Natural Features Inventory (MNFI), and consultation by other cultural leaders, tribal community members, and tribal, federal, state, and university scientists.

> Outcome: Adaptation efforts will be guided by Anishinaabe and Western scientific knowledges. Analyses will be developed, reviewed, and shared across jurisdictions, with regular communication and collaboration among partners.

Objective 2: Develop collaborative species and community-specific needs assessments and identify potential opportunities for short- and long-term adaptation at multiple scales across Michigan.

> Outcome: Focused inter-tribal and inter-agency evaluation of vulnerabilities, potential adaptation strategies, and opportunities for increased tribal participation in federal and/or state efforts, will increase forest resource resilience and tribal capacity for adaptation.

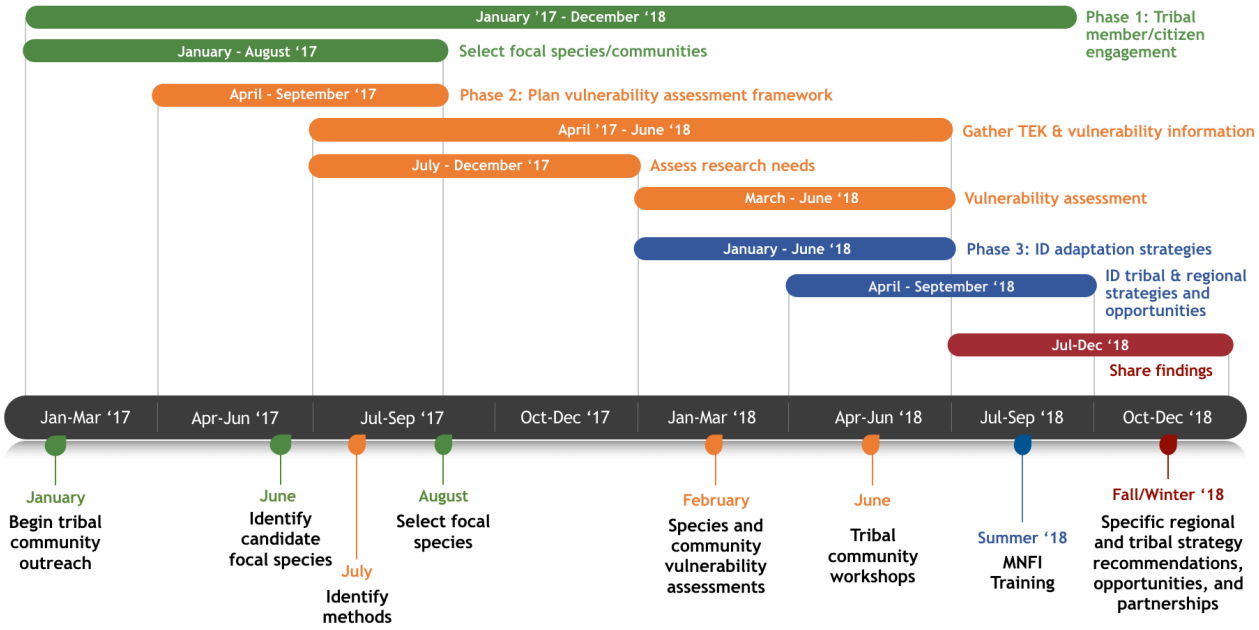
Objective 3: Develop regional programmatic adaptation recommendations with Tribe-specific components that will address potential impacts of climate change on key forest understory plants across tribal, state, and federal forest lands in the geographic service area.

> Outcome: Integrated development of adaptation strategies and planning resources will allow Tribes to anticipate probable climate impacts and implement the best strategies to protect critical forest resources. Tribal forest-related climate change priorities will be identified and communicated to both tribal and non-tribal leadership for inclusion in current and future decision-making on tribal, state, and federal lands.

Timeline

The 24-month project began January 1, 2017, and ended December 31, 2018. Project activities were organized into four phases: tribal member engagement (entire project period), vulnerability assessment (April 2017 - June 2018), adaptation strategy development (January - September 2018), and sharing of findings (July - December 2018). Project activities, milestones, and general timeframes are shown in Figure 1.

Figure 1. Inter-Tribal Forest Understory Adaptation Project Timeline



Project Partners

The project team included staff from Bay Mills Indian Community's Biological Services Division, Lac Vieux Desert Band of Lake Superior Ojibwe's Planning Department, Pokagon Band of Potawatomi's Natural Resource Department, Saginaw Chippewa Indian Tribe Planning Department, Michigan Natural Features Inventory, the Northern Institute of Applied Climate Science, and was facilitated by the Inter-Tribal Council of Michigan's Environmental Services Division. The project team met monthly or semi-semi-monthly throughout the project period, using an online meeting platform and coordinating in-person meetings with Michigan Tribal Environmental Group meetings. Project methods were developed collaboratively, to suit individual tribal needs and opportunities while meeting group objectives. Other agencies and programs contributed to the project, including Great Lakes Indian Fish and Wildlife Commission's Climate Change Program, Seventh Generation - Elijah Elk Cultural Center, Ziibiwing Center of Anishinabe Culture and Lifeways, Lac Vieux Desert Band Northern Waters Casino Resort, and Bay Mills Community College.

Anishinaabe Community Engagement

Michigan Anishinaabeg maintain important relationships with, and knowledges of, Great Lakes forests, waters, plants, animals, and other non-human beings. Tribal natural resource management and climate adaptation can be guided by Anishinaabe knowledges and perspectives, through formal and informal outreach and engagement with tribal member-citizens and cultural leaders. Natural resource program staff from each tribe and ITCMI conducted outreach and engagement with tribal member-citizens throughout the project period.

Member-citizen engagement began at the outset of the project, with the goals of: 1) building and maintaining long-term relationships, rooted in respect and trust, and 2) engaging tribal member-citizens in project planning and activities. In many cases, initial conversations were followed-up by formal interviews, which were conducted by all four tribes and ITCMI throughout the project period. Interview questions and protocols are included in **Appendix C**. Community gatherings were also hosted in the spring and summer of 2017 by the Saginaw Chippewa Indian Tribe and Lac Vieux Desert Band of Lake Superior Ojibwe. Through these initial conversations, interviews, and community gatherings, the project team developed a list of candidate plants and fungi. Considering tribal member-citizen guidance, tribal program staff determined focal species by consensus voting and discussion. It is important to note that the focal species were not discussed as the most "culturally-important" or "climate vulnerable" plants; they were identified by tribal member-citizens as plants of-interest, due to their importance in daily life, cultural traditions, food/medicine sovereignty, or due to observed changes in their health or abundance over time. In asking about and selecting focal plants, project team members stressed that the focal plants offer a place to start in forest adaptation planning with Anishinaabe and Western scientific ways.

Tribal member-citizens were invited to working group meetings to plan project methods, conduct initial vulnerability assessments, and review findings. Tribal member-citizens were also invited to tribal community-based adaptation planning workshops in the spring and summer of 2018, at the Bay Mills Indian Community and at the Saginaw Chippewa Indian Tribe (co-hosted by Pokagon Band of Potawatomi). During these workshops, tribal member-citizens shared experiences with focal plants, discussed observations and predictions of current and future change within their locales, conducted vulnerability assessments for each species and location, and identified

Tribal Community Workshop participants visited a leek patch in May, 2018.

strategies for individual, tribal, and inter-tribal adaptation in support of focal plants, forest communities, and long-term Anishinaabe relationships with them. Workshop findings are included in **Table C**. A workshop agenda and materials are included in **Appendix C.**

Focal Plants

Five focal plants were selected for this project (**Table 1**), based on tribal member-citizen input through tribal natural resource program and ITCMI staff outreach and engagement, individual tribal natural resource program goals, and inter-tribal project goals. Focal species included a range of growth forms (e.g. spring ephemeral to evergreen shrub), forest community types (e.g. rich mesic forest to acidic bogs), and spatial distribution among ecoregions in Michigan (e.g. southern lower peninsula and western upper peninsula).

Table 1. Inter-Tribal Forest Understory Adaptation Project Focal Plants

Ojibwe	Bodéwadmik	English	Latin
Bagwaji zhigaagawinzhiig	Bgwëtth Zhegagozhik	Wild leek	*Allium burdickii; Allium tricoccum*
Jiisens	Thisés	Wild ginseng	*Panax quinquefolius*
Mashkiigobag	Wézawbegëk	Labrador tea	*Rhododendron groenlandicum*
Miinagaawanzh	Minmesh	Lowbush blueberry	*Vaccinium angustifolium; Vaccinium myrtilloides*
Opin	Pen	Groundnut; Indian potato	*Apios americana*

Throughout the project period, the project team researched: historic, current and projected climate-driven changes within four ecoregion of Michigan; the status, trends, ecological and biological requirements and traits of focal plants and their forest communities; observed, modeled, and predicted changes in focal plants and forest communities; and other information from Anishinaabe and Western scientific lenses. Sources included tribal member-citizens, other Anishinaabe cultural leaders, peer-reviewed literature, gray literature, and professional experience. Climate localizations and vulnerability assessments for some focal species had been completed during the ITCMI's 2015-2016 Inter-Tribal Adaptation Planning Project. Vulnerability assessments had also been completed for some focal species by the Great Lakes Indian Fish and Wildlife Commission. Information from these previous vulnerability

assessment and adaptation planning efforts, which relied heavily on published literature and natural resource manager experience, was considered in the vulnerability assessment and adaptation planning processes.

Vulnerability Assessment

Vulnerability assessments were conducted in two phases: an initial project team assessment with NatureServe's Climate Change Vulnerability Index (CCVI) and a final assessment through tribal member-citizen workshop. The initial assessment involved literature review and group discussions based on tribal member-citizen guidance and professional experience, guided by the CCVI framework and extending to address socio-cultural aspects of vulnerability.

The CCVI addresses the comparative vulnerability of species and the importance of specific factors contributing to that vulnerability (Young et. al 2011). Within the tool, vulnerability is a measure of the likelihood that climate-driven change will have an adverse impact on a species population and/or range within a specific geographic area, for the year 2050. The tool considers species' exposure to climate-driven change, sensitivity to that change, and adaptive capacity to minimize or adapt to that change (Schneider et. al. 2007; Williams et al. 2008; part Glick et al. 2011). Species' vulnerability was assessed via 23 factors, including indirect exposure to climate change and species-specific sensitivity and adaptive capacity. Each factor was assessed and rated for its impact on each species' vulnerability: greatly increase, increase, somewhat increase, neutral, or unknown. The project team selected multiple ratings for factors where their impacts were less certain. Each species' exposure to climate change was integrated into the tool as a modifier of sensitivity and adaptive capacity (Young et. al 2011).

We also considered tribal community relationships, including harvest levels, access, and management ease in the draft vulnerability assessment process (**Table 2**). The community relationship factors were identified by the project team and based on tribal staff outreach with tribal member-citizens, as well as, professional experiences in tribal natural resource management.

Table 2. Tribal Community Relationship Considerations in Vulnerability Assessment

Community Relationship	Impact on Vulnerability
Harvest level	Over and under harvest increase vulnerability
Access: timing	Phenological change that limits harvest/practices increase vulnerability
Access: production	Decreases in production increase vulnerability
Access: geographic distribution	Limitation to occurrence on lands with limited physical access increase vulnerability
Access: political boundaries	Limitation to occurrence on lands with limited access or authority increase vulnerability
Management ease	Difficulty of ecological/political management increases vulnerability

The project team incorporated the CCVI vulnerability assessments and Community Relationship Considerations into draft vulnerability ratings. These vulnerability ratings ranged from extremely vulnerable to less vulnerable (**Table 3**) and addressed the potential for future changes in species abundance, range extent, and tribal access (Community Relationship Considerations).

Table 3. Inter-Tribal Forest Understory Project Vulnerability Ratings

Vulnerability Rating	Definition
Extremely vulnerable (**EV**)	Abundance, range extent, or tribal access may substantially decrease or disappear within the geographic area assessed by 2050
Highly vulnerable (**HV**)	Abundance, range extent, or tribal access may decrease greatly in the geographic area assessed by the year 2050
Moderately vulnerable (**MV**)	Abundance, range extent, or tribal access may decrease in the geographic area assessed by the year 2050
Less vulnerable (**LV**)	There may be an increase or no change in abundance, range extent, or tribal access in the geographic area assessed by the year 2050

Draft vulnerability assessment findings were packaged into one-page hand-outs and shared with tribal member-citizens during outreach and in the tribal community adaptation planning workshops. During the workshops, tribal member-citizens conducted and shared their own vulnerability assessments of focal species, with rationales, suggested adaptation strategies, and unanswered questions or research needs (**Appendix B**).

Uncertainty in the vulnerability ratings was partially captured in a confidence rating on a scale of Low to Very High. Confidence was calculated within the CCVI using a Monte Carlo simulation, which considers the completeness of data entered and the proximity of a species' score to thresholds. Final confidence ratings reflect confidence in the overall assessment process, including the CCVI confidence ratings, consideration of Tribal Community Relationship factors, and the confidence levels determined by consensus during Tribal Community Workshop assessments.

The draft vulnerability assessment hand-outs were reviewed and revised to reflect tribal member-citizen review and project team synthesis of the assessment process. Results are presented in **Table 4** and in revised hand-outs, included in **Appendix A**. Project hand-outs include brief descriptions of each species, their habitat requirements, and growth habits. The hand-outs also include questions related to species habitats and growth habits, meant to inspire tribal member-citizens, non-tribal citizens, and natural resource management professionals alike to become more aware of each species, and to understand and assess species-specific climate-driven change wherever they are.

During one tribal community workshop and several follow-up interviews, tribal member-citizens discussed the incongruence between Western science-based vulnerability assessments and Anishinaabe ways of analysis and adaptation. An Anishinaabe means of assessing future change among non-human beings wouldn't focus on vulnerability; it would acknowledge the autonomy of non-human beings (plants) as our original teachers and emphasize opportunities within climate-driven change for the well-being of our communities. For this reason, future adaptation planning will assess and plan for plant responses (not vulnerability) to climate-driven change in a holistic framework, such as was pursued in this project.

Table 4. Predicted Plant Responses to Climate-Driven Change

Plants		Response Rating and Confidence Level							
Ojibwe	**Bodéwadmik**	**SLP Rating ***	**SLP Confidence ****	**NLP Rating ***	**NLP Confidence ****	**EUP Rating ***	**EUP Confidence ****	**WUP Rating ***	**WUP Confidence ****
Bagwaji zhigaagawinzhiig	Bgwëtth Zhegagozhik	EV	VH	HV	VH	HV	Mod	HV	Mod
Jiisens	Thisés	HV	VH	HV	VH	HV	VH	HV	VH
Mashkiigobag	Wézawbegëk	EV	VH	HV	Mod	MV	VH	MV	Low
Miinagaawanzh	Minmesh	LV	VH	LV	VH	LV	VH	LV	VH
Opin	Pen	HV	VH	HV	VH	HV	VH	HV	VH

*LV = Less Vulnerable; MV = Moderately Vulnerable; HV = Highly Vulnerable; EV = Extremely Vulnerable

**VH = Very High Confidence; H = High Confidence; Mod = Moderate Confidence; Low = Low Confidence

Climate-driven change is one of many systemic stressors, similar to land use change. Impacts may be cumulative over long periods of time and become apparent only after reaching certain thresholds. The presence of multiple stressors is an important issue in vulnerability assessment, adaptation planning, and associated uncertainty. For example, all of the focal species confront landscape change and habitat loss; climate change may exacerbate the process of habitat loss and/or decrease the ability of a species to move to more suitable habitat. However, Anishinaabe tribal member-citizens maintain important relationships with each species, which can and do impact individual species and forest community response to climate-driven change. The roles of non-native invasive species, whom are acknowledged in Anishinaabe ways as non-human beings with purpose and teachings to share, present more systemic considerations in vulnerability assessment and adaptation planning. With these systemic considerations in mind, the project team purposefully, and qualitatively, considered the role of tribal member-citizen harvesting, transplanting, and other *relations* in the vulnerability assessment and adaptation planning processes.

Adaptation Strategies

In September 2018, ITCMI and NIACS facilitated an adaptation planning workshop for the project team, with visiting staff from the Bureau of Indian Affairs Midwest Region and the Great Lakes Indian Fish and Wildlife Commission. During the workshop, the project team reviewed findings from each phase of the project: tribal member-citizen interviews, gatherings, and workshops; CCVI findings; literature reviews; group discussions; and professional experience. Staff from each tribe used a draft Tribal Adaptation Menu to identify individual tribal adaptation strategies. The Menu was developed by a network of organizations, including NIACS and ITCMI, facilitated by Great Lakes Indian Fish and Wildlife Commission. The project team identified inter-tribal and collaborative adaptation strategies to address local to regional-scale issues, which are described in **Table 5**.

Table 5. Individual and Inter-Tribal Forest Understory Adaptation Strategies

Strategy	Approach	Tactics
1. Consider cultural practices and seek spiritual guidance	1.1 Consult community members	Develop and maintain relationships with the gathering community; include tribal member-citizen input and guidance in management planning
1. Consider cultural practices and seek spiritual guidance	1.5 Maintain dynamic relationships in a changing landscape	Hire tribal member-citizens in tribal natural resource departments; develop intern exchange program so tribal member-citizens gain experiences with different tribes and situations
2. Learn through careful and respectful observation	2.1 Learn from being and natural communities	Continue and expand vegetation monitoring on tribal lands and territories; conduct understory plant surveys or monitoring; develop protocol to survey understory plants in conjunction with Continuous Forest Inventory and USFS Forest Inventory and Analysis Programs; Establish coordinated leek monitoring network on tribal and public lands
3. Support tribal engagement in the environment	3.1 Maintain and revitalize traditional relationships & uses	Continue adult and childhood education in traditional ways and language; Organize workshops to share information and cultural practices with community members (e.g. culture camp); Develop harvesting guidebook with Best Practices for tribal member-citizen use; Clarify gathering regulations on tribal, state, federal, and private lands; Work with community members to transplant leeks to new areas (e.g. transplant to elder home gardens)

Strategy	Approach	Tactics
3. Support tribal engagement in the environment	3.6 Participate in local and landscape level management with partner agencies	Develop tribal forest management goals; develop forest adaptation recommendations; share goals/recommendations/ ideas with USFS, State of Michigan, land conservancies, and other partners on adjacent lands
4. Sustain fundamental ecological and cultural functions	4.1 Maintain and restore hydrology and soils	Restore former agricultural lands; limit wetland development; culvert replacement to restore flow and prepare for extreme precipitation; underplant in aagimak die-back areas; develop tribal forest management goals and forest adaptation recommendations for focal species and forest communities
4. Sustain fundamental ecological and cultural functions	4.4 Support specific plant/ communities with essential requirements	Bring cedar and sugar bush back to the landscape; develop tribal forest management goals and forest adaptation recommendations for focal species and forest communities; conduct assessments to understand essential requirements
4. Sustain fundamental ecological and cultural functions	4.6 Maintain and revitalize cultural approaches to harvest and care taking	Organize gathering workshops for, and led by, tribal member-citizens; work with gatherers to develop gathering guidebook with Best Practices; continue adult and childhood education in traditional ways and language; engage tribal member-citizens in monitoring efforts
5. Reduce the impact of biological and anthropogenic stressors	5.2 Maintain or improve the ability of communities to balance the affects of baakan ingoji ondaadag	Develop tribal forest management goals and forest adaptation recommendations related to non-native species; continue or establish non-native species monitoring efforts
5. Reduce the impact of biological and anthropogenic stressors	5.4 Reduce negative impacts from anthropogenic disturbances	Work with tribal member-citizens to understand important areas and work with other agencies on timber sales/ management in those areas; develop forest adaptation recommendations; plan and build infrastructure to support access (define the use in tribal codes, install interpretive materials on trails, and develop trails, parking lots, facilities)
5. Reduce the impact of biological and anthropogenic stressors	5.5 Monitor and reduce ambient air pollution	Monitor and reduce air pollution; develop bike paths in local areas

Strategy	Approach	Tactics
7. Establish, support, and recognize opportunities for beings or sites of concern to the community to withstand climate change	7.1 Identify, prioritize, and maintain cultural sites and/or culturally sensitive areas	Develop tribal land management plans and establish protection plans for special areas on tribal, federal, state, and other lands
7. Establish, support, and recognize opportunities for beings or sites of concern to the community to withstand climate change	7.5 Create and/or maintain access routes to traditional gathering and harvesting sites; Plan and build infrastructure to support tribal community access to forests/harvest sites	Define tribal community access and use of forests/gathering sites in tribal codes; develop trails, parking lots, facilities needed to support tribal community access and use of forests/gathering sites; install interpretive materials on trails; understand and promote historic routes to gathering and harvesting sites
7. Establish, support, and recognize opportunities for beings or sites of concern to withstand climate change	7.6 Work across treaty or tribal areas with partners and other tribes to manage at-risk beings	Maintain and increase collaboration with northern tribes; work with US Forest Service and private partners to reduce logging impacts on leek and ginseng habitat; conduct cross-jurisdiction understory plant surveys or monitoring
9. Increase ecosystem redundancy and promote connectivity across the landscape	9.1 Manage habitats and access opportunities over a range of sites and conditions	Transplant leeks to new areas, and work with community members to do this (e.g. transplant leeks into home gardens for elders who have access issues)
Share knowledge and resources across Tribes	Share strategies and advice for working with tribal member-citizens in a good way	Create "Best Practices" or success stories for engaging community members, share on Northeastern Indigenous Climate Resilience Network (NICRN) website, ITCMI website, and other media; present project resources, guidance, and lessons learned on NICRN webinar, The Stewardship Network webinar, and/or Indigenous Phenology Network online meeting

Strategy	Approach	Tactics
Share knowledge and resources across Tribes	Establish inter-tribal discussions about partnering, sharing, and gathering understory plants	Short session/presentation at December Michigan Tribal Environmental Group Meeting; Working session at June Michigan Tribal Environmental Group Meeting with fish/ wildlife/forestry/botany staff invitation; Working session/ presentation at joint meeting of The Wildlife Society & NorthEast Climate Adaptation Science Center; establish leek monitoring network
Share knowledge and resources across Tribes	Develop a Directory of tribal member-citizens with plant knowledges	Create a shared and confidential document for tribal program staff use; float idea with elders/gatherers in each community and revisit elders/gatherers for ongoing permissions; develop a one-pager for outreach to tribal member-citizens and permission

All adaptation strategies are to be undertaken in a good way, following cultural protocols specific to each tribal community. The adaptation strategies identified by the project team emphasized methods and opportunities for increased tribal engagement in local to regional forest resource management. The strategies also emphasized continued collaboration among tribal natural resource, cultural, education, and community health programs, and tribal member-citizens to promote: 1) Anishinaabe relationships with focal species and forest communities, 2) long-term access to focal species and forest communities across land ownership types, and 3) tribal community-centered forest management and adaptation planning that draws from Anishinaabe and Western scientific knowledges.

One of the main goals of the project was to enhance relationships between tribal natural resource program staff and tribal member-citizens for the purpose of engaging member-citizens in tribal natural resource management planning; as such, most project activities tended to *Adaptation Strategy 1.1*. The project team took action on other priority adaptation strategies identified in **Table 5** by: developing resources for working with tribal and non-tribal forest management agencies (*Adaptation Approach 1.1, 2.1, 3.1, 3.6, 4.1, 4.4, 5.2, 5.4, 7.1, 7.5, 7.6*); planning tribal and collaborative forest understory surveys and monitoring efforts (*Adaptation Approach 1.1, 2.1, 3.6, 4.4, 4.6, 5.2, 7.6; Adaptation Strategy: Share knowledge and resources across tribes*); planning tribal community workshops on sustainable, cultural gathering methods (*Adaptation Approach 3.1, 4.6*); and sharing project methods and findings across tribes (*Adaptation Strategy: Share knowledge and resources across tribes*).

The project team developed a list of Forest Adaptation Strategies for Focal Species (**Appendix D**), which included forest management strategies to enhance individual focal species and overall forest

health for use on tribal, federal, state, conservancy, and private lands. This list was developed for use by tribal natural resource staff in working with tribal, federal, state, conservancy, and private land-owners on forest management and adaptation planning (e.g. Forest Service project planning or State of Michigan compartment review processes).

The project team also created a Monitoring and Assessment Options document tailored to focal species, which included monitoring goals and species-appropriate methods for assessment and data analysis (**Appendix E**). The Monitoring and Assessment Options document built upon a September, 2018, vegetation assessment training led by MNFI and hosted by the Bay Mills Indian Community and ITCMI. The vegetation assessment training addressed quantitative and qualitative methods for species- and ecosystem-focused monitoring and assessments, with field-based instruction in wild leek and Labrador tea forest ecosystems. Methods for assessment planning, data analysis, and tools for tribal member-citizen engagement were discussed. Nineteen staff participated from five Michigan Tribes, two inter-tribal consortia, Bureau of Indian Affairs - Midwest Region, and MNFI.

Vegetation Assessment Training participants visited a forested wetland to conduct plant identification and discuss Labrador tea assessment options.

The project team initiated the process of establishing coordinated leek monitoring within Michigan and the Great Lakes Region, which would integrate phenology, ecology, and plant biology assessments. Project team members are currently collaborating with US Forest Service researchers to implement field-based populations monitoring, the Great Lakes Indian Fish and Wildlife Commission to implement phenocam monitoring, and propose to establish new remote sensing-based population monitoring methods. There are numerous opportunities for tribal member-citizen engagement in a coordinated inter-tribal leek monitoring network, as well.

The project team scheduled online meetings with Botany Program staff from three National Forests in Michigan, with additional calls planned in 2019. During these meetings, attendees held staff-level discussions about the project goals and findings, recommended Forest Adaptation Strategies for Focal Species, tribal community access to focal species and forest communities on the National Forests,

research needs, and potential collaborations. Future staff-level meetings with State of Michigan Forestry Programs are in the planning stage.

The project team has conducted outreach and engagement across tribes, agencies, and organizations in Michigan and the Great Lakes Region with the purpose of: increasing the visibility of the project, sharing methods and lessons-learned, and encouraging partnerships beyond the project team. We presented at multiple venues during 2018, including the Bureau of Indian Affairs Midwest Partners In Action Meeting, Great Lakes Adaptation Forum, Native American Fish and Wildlife Society Midwest Conference, and The Stewardship Network's November webinar. ITCMI has shared updates at Michigan Tribal Environmental Group Meetings throughout the entire project period, as well.

The project team revised and collated resources from project outreach and tribal member-citizen engagement to create an Outreach Guidance Document (**Appendix C**). This document was shared on ITCMI's website and distributed via email to Michigan Tribes, for use in forest-focused tribal adaptation planning.

Conclusions

The Forest Understory Adaptation Project team was successful in creating opportunities for biological and cultural experts to share knowledges and identify needs and opportunities for species- and coupled human-ecological community-focused adaptation at multiple scales. The team conducted practitioner- and tribal community-based vulnerability assessments for five forest understory species identified by Anishinaabe tribal member-citizens, which addressed plant- and human-community relationships. The team also identified and began working on inter-tribal adaptation strategies to facilitate adaptive management of forest resources across jurisdictional boundaries and to support and revitalize Anishinaabe relationships with focal plants and plant communities. As described above, future Anishinaabe forest adaptation planning efforts may address plant and community responses to climate-driven change, not defined as or limited to species vulnerability, in a holistic framework, such as was pursued in this project.

Project methods will be used for continued work by the project team in understanding and planning for climate-driven change among forest understory plants and communities. In addition to collaborating directly with other Anishinaabe tribes across the region, it is our hope that project methods will be improved upon and used by other Anishinaabe tribes as they pursue forest adaptation planning with Anishinaabe and Western scientific knoweldges and ways.

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Appendix A: Inter-Tribal Forest Understory Project Handouts

Inter-Tribal Forest Adaptation

Honoring our forest communities on a changing landscape

Bagwaji zhigaagawinzhiig; Bgwëtth zhegagozhik

Wild leek (*Allium tricoccum*)

Bagwaji zhigaagawinzhiig is a long-lived herb that grows in rich upland and floodplain forests under the closed canopy of mature beech, maple, and hemlock trees. They are native to North America and provide food and medicine for Anishinaabek, other people and animals. They are also at risk from over-harvesting and certain forest management practices.

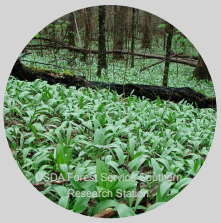
How might Bagwaji zhigaagawinzhiig respond to climate-driven change in Michigan?

VULNERABILITY




LOW	MODERATE	HIGH	EXTREME
Increase or no change in abundance, range extent, or tribal access by the year 2050	Abundance, range extent, or tribal access may decrease by the year 2050	Abundance, range, or tribal access may decrease greatly by the year 2050	Abundance, range, or tribal access may decrease or disappear by 2050

Growth
Grows slowly as clones and rarely by seed.



Habitat
Grows in rich soils under the shade of mature hardwoods.

Harvest
Harvesting just 5-10% of bulbs in an area may cause population decline.

Changes in climate may impact how and where Bagwaji zhigaagawinzhiig grows

Climate-driven changes	Possible impacts	What to watch for
Increasing temperatures The average temperature increased by 2 F° over the past century and may increase 4-6 F° by 2050.	Bagwaji zhigaagawinzhiig grows in cooler areas of the forest, which may become warmer as air temperatures increase.	Have you noticed changes in where or how Bagwaji zhigaagawinzhiig grow?
Drier soils Increased air temperatures may lead to warmer and drier soils, especially in mid- to late-summer.	Bagwaji zhigaagawinzhiig grows best in shady areas with damp soil throughout the year. Dry soils may reduce growth and reproduction.	Have there been changes in how moist local forests are throughout the year?
Extreme storms Heavy storms have increased in number and intensity and may continue increasing in the future.	Disturbance from storms and wind may decrease Bagwaji zhigaagawinzhiig habitat by opening up the tree canopy.	Have Bagwaji zhigaagawinzhiig patches changed in size?
Increasing invasive species Invasive species may increase due to climate-driven change.	Increased competition from invasive species may reduce Bagwaji zhigaagawinzhiig growth and reproduction.	Have you noticed new plants or earthworms around Bagwaji zhigaagawinzhiig?

Working together to support native forest understory plants

Anishinaabeg maintain important knowledges on, and relationships with, local forests, waters, seasons, and cycles. The Inter-Tribal Council of Michigan is working with the Bay Mills Indian Community, Lac Vieux Desert Band of Lake Superior Ojibwe, Pokagon Band of Potawatomi, Saginaw Chippewa Indian Tribe, Michigan Natural Features Inventory, and Northern Institute of Applied Climate Science to understand and support forest understory plants across Michigan, based on Anishinaabe and Western scientific knowledges and ways.

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Inter-Tribal Forest Adaptation

Honoring our forest communities on a changing landscape

Jiisens; Thisés

Wild ginseng (*Panax quinquefolius*)

Jiisens is a long-lived herb that grows in rich, undisturbed forests of closed-canopy sugar maple, beech, and other hardwood trees. They are native to North America and provide food and medicine for Anishinaabek, other people and animals. Jiisens has declined in North America because of habitat loss, over-harvest of large roots, and changing forest management.

How might Jiisens respond to climate-driven change in Michigan?

VULNERABILITY RATING

LOW	MODERATE	HIGH	EXTREME
Increase or no change in abundance, range extent, or tribal access by the year 2050	Abundance, range extent, or tribal access may decrease by the year 2050	Abundance, range, or tribal access may decrease greatly by the year 2050	Abundance, tribal access, or range may decrease or disappear by year 2050

Growth
Jiisens grows slowly, in small groups, and lives to be 25-30 years.

Habitat
Jiisens grows in cool, moist soils under the shade of mature hardwoods.

Protections
Jiisens is listed as threatened in Michigan and a species of federal concern.

Changes in climate may impact how and where Jiisens grows

Climate-driven changes	Possible impacts on Jiisens	What to watch for
Increasing temperatures The average temperature increased by 2 F° over the past century and may increase 4-6 F° by 2050.	Jiisens grows in cooler areas of the forest, which may become warmer as air temperatures increase.	Do Jiisens grow in the coolest areas of local forests?
Increasing freeze-thaw cycles Erratic freeze-thaw cycles occur in spring and fall.	Increasing freeze-thaw cycles harm Jiisens in the springtime and lead to reduced survival, growth, and reproduction.	Have you noticed a decrease in the size of Jiisens?
Extreme storms Heavy storms have increased in number and intensity and may continue increasing in the future.	Disturbance from storms and wind may decrease Jiisens habitat by opening up the tree canopy.	Have you noticed more or less Jiisens growing locally?
Increasing invasive species and deer browse Invasive species and deer may increase due to climate-driven change.	Increased competition from invasive species and browsing by white-tailed deer may reduce Jiisens growth and reproduction.	Have you noticed new plants or earthworms around Jiisens?

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Inter-Tribal Forest Adaptation

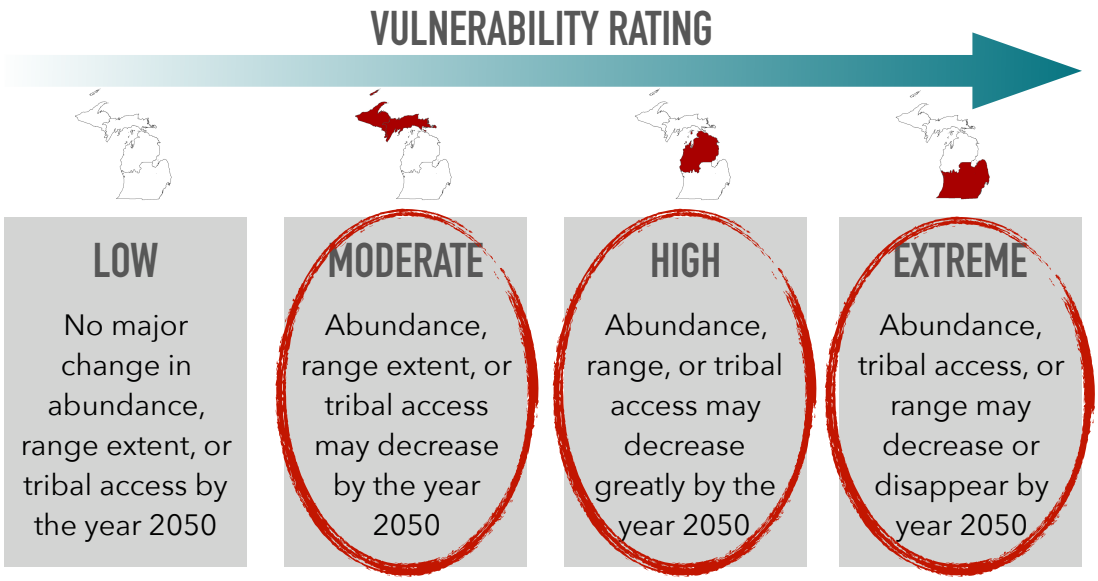
Honoring our forest communities on a changing landscape

Mashkiigobag; Wézawbegëk

Labrador tea (*Rhododendron groenlandicum*)

Mashkiigobag is an evergreen shrub that grows in cool bogs, conifer swamps, and other wetlands. They are native to North America and provide food and medicine to Anishinaabek, other people, and animals. Mashkiigobag leaves are fragrant and have wooly undersides that turn from bright white to rusty brown within the first two years of age.

How vulnerable is Mashkiigobag to climate-driven change in Michigan?



Growth

Mashkiigobag reproduces by seed and layering.

Habitat

Mashkiigobag grows in cool forests with spruce and other conifers.

Protections

Mashkiigobag habitat has declined in Michigan due to changing land use and wetland loss.

Changes in climate may impact how and where Mashkiigobag grows

Climate-driven changes	Possible impacts on Mashkiigobag	What to watch for
Increasing temperatures The average temperature increased by 2 F° over the past century and may increase 4-6 F° by 2050.	Mashkiigobag is at it's southern limit in Michigan and grows in cooler areas of the forest, which may become too warm for Mashkiigobag to grow.	Have you noticed changes in how or where Mashkiigobag grows? Are they limited to the coolest areas of the forest?
Drier soils Increased air temperatures may lead to warmer and drier soils, especially in mid- to late-summer.	Mashkiigobag may be out-competed by other plants as soils warm, dry out, and become more nutrient-rich.	Have there been changes in how wet or dry the places are where Mashkiigobag grows?
Other considerations	**Possible impacts on Mashkiigobag**	**What to watch for**
Dependence on other plants Bog habitats are controlled by sphagnum moss, which maintains soil conditions.	Loss of spagnum moss may change soils and water availability. This may lower Mashkiigobag growth and reproduction.	Have you noticed changes in the plants that grow with Mashkiigobag?

Working together to support native forest understory plants

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Inter-Tribal Forest Adaptation

Honoring our forest communities on a changing landscape

Miinagaawanzh; Minmesh

Lowbush blueberry (*Vaccinium angustifolium*)
Huckleberry (*Vaccinium myrtilloides*)

Miinagaawanzh is a low shrub that grows in a wide variety of forests and openings, often in dry and acidic soils. Miinagaawanzh also grows on hummocks in peatlands, including bogs, muskegs, fens, and conifer swamps. Miinagaawanzh is native to North America and provides food and medicine to Anishinaabek, other people, and animals across Michigan.

How vulnerable is Miinagaawanzh to climate-driven change in Michigan?

VULNERABILITY RATING

LOW	MODERATE	HIGH	EXTREME
No major change in abundance, range extent, or tribal access by the year 2050	Abundance, range extent, or tribal access may decrease by the year 2050	Abundance, range, or tribal access may decrease greatly by the year 2050	Abundance, tribal access, or range may decrease or disappear by year 2050

Growth
Miinagaawanzh benefits from small fires and other disturbances.

Habitat
Miinagaawanzh grows in a variety of forests & openings, often in dry soils.

Harvest
Miinagaawaanzh flowers and begins growing berries at four years of age.

Changes in climate may impact how and where Miinagaawanzh grows

Climate-driven changes	Possible impact on Miinagaawanzh	Questions to discuss
Increasing temperatures The average temperature increased by 2 F° over the past century and may increase 4-6 F° by 2050.	Warmer summer temperatures may lead to drier soils, which may benefit Miinagaawanzh. Warmer winter temperatures may reduce snowpack, allowing cold winter temperatures to harm Miinagaawanzh.	Have Miinagaawanzh been growing in new or different places? Has there been less snowpack in recent years?
Increasing freeze-thaw cycles Erratic freeze-thaw cycles occur in spring and fall.	Increasing freeze-thaw cycles in the springtime may reduce Miinagaawanzh flowering and fruit production.	Have late spring freezes caused less berries or other changes?
Extreme storms and fire Heavy storms may increase in number and intensity.	Heavy rain during flowering and pollination may decrease Miinagaawanzh fruit production.	Have storms changed how many berries grow in a season?
Increasing invasive species Invasive species may increase due to climate-driven change.	Increased competition from invasive species may reduce Miinagaawanzh growth and reproduction.	What other plants and animals impact Miinagaawanzh?

Working together to support native forest understory plants

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Inter-Tribal Forest Adaptation

Honoring our forest communities on a changing landscape

Opin; Pen

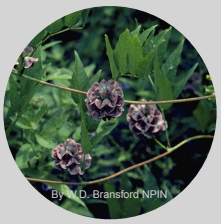
Ground nut; Wild potato (*Apios americana*)

Opin is a perennial twining plant with fragrant, brown-purple flowers that bloom from mid-summer to early fall. They are native to North America and grow in a wide variety of habitats: forested swamps, along streams, marshes, and meadows. Opin grows edible tubers along underground rhizomes that have been a staple food for Great Lakes Anishinaabek. These tubers are also the main way that Opin reproduces and grows in new places.

How vulnerable is Opin to climate-driven change in Michigan?

VULNERABILITY RATING

LOW	MODERATE	HIGH	EXTREME
No major change in abundance, range extent, or tribal access by the year 2050	Abundance, range extent, or tribal access may decrease by the year 2050	Abundance, range, or tribal access may decrease greatly by the year 2050	Abundance, tribal access, or range may decrease or disappear by year 2050



Growth

Opin reproduces by tubers and sometimes by seed.

Habitat

Opin grows in swamps, stream-sides, marshes, and meadows.

Harvest

Opin tubers and seeds are harvested and eaten like other potatoes and peas.

Changes in climate may impact how and where Opin grows

Climate-driven changes	Possible impacts on Opin	What to watch for
Extreme storms Heavy storms have increased in number and intensity and may continue increasing in the future. These storms may cause flooding.	Small patches of Opin may be completely removed by large floods. Large patches of Opin may benefit from floods that move tubers to grow in new places.	How large or small are patches of Opin locally? Have recent storms changed how or where Opin grows?
Other considerations	**Possible impacts on Opin**	**What to watch for**
Dependence on pollinators Opin are pollinated by a few kinds of bees, which may be vulnerable to climate-driven changes.	If the few kinds of bees that pollinate Opin decline, Opin flowers may not be pollinated and will not produce seeds. This may decrease reproduction and health of Opin.	Have there been changes in local bee populations? Have there been changes in how many seeds Opin makes?

Working together to support native forest understory plants

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Appendix B: Tribal Community Workshop Findings

Inter-Tribal Forest Understory Adaptation Project
2018 Spring Workshop Findings

Two tribal community workshops were hosted by participating Tribes during the spring of 2018. Bay Mills Indian Community (BMIC) organized a community workshop on April 12, 2018, in Bay Mills, Michigan. Three BMIC community members, three BMIC Biological Services staff, and two ITCMI staff attended. Saginaw Chippewa Indian Tribe (SCIT) and Pokagon Band of Potawatomi organized a community workshop on May 3, 2018, in Mt. Pleasant, Michigan. Twenty SCIT community members, one SCIT Planning Department staff, one Pokagon Band Natural Resource Department staff, two Michigan Natural Features Inventory (MNFI) staff, and one Inter-Tribal Council of Michigan (ITCMI) staff attended.

During each workshop, Tribal and ITCMI staff facilitated introductions, gave brief presentations on the project, and led participants through an iterative process of individual worksheets and group discussions on project focal plants. The workshop in Mt. Pleasant included a field trip and presentations led by MNFI staff, as well. Through each workshop, participants reflected on their experiences with each plant, reviewed draft vulnerability assessment information, and co-developed vulnerability ratings specific to their Tribe and region. Participants identified potential adaptation strategies, remaining questions/research needs, and plants of interest for future adaptation planning work. The findings from these workshops are summarized in the table below.

Focal Plant	Tribe & Region	Vulnerability Assessment	Rationale	Adaptation Strategies	Research Needs
Bagwaji zhigaagawinzhiig; Wild leek; *Allium burdickii & A. tricoccum*	Bay Mills Indian Community; Eastern Upper Peninsula	 Extremely Vulnerable Medium - High Confidence	• Decrease in number and thickness of patches • Decrease in suitable habitat due to development and forest change • Slow growth cycle	• Protect/restore habitat • Strategic planning/development • Transplant leeks • Teachings and guidelines for harvest	• Ways to facilitate spread of leeks? • Relationship between leeks and bloodroot?
Bagwaji zhigaagawinzhiig; Wild leek; *Allium burdickii & A. tricoccum*	Saginaw Chippewa Indian Tribe; Lower Peninsula	 Moderately to Extremely Vulnerable Low - High Confidence	• Decrease in size of bulbs, leaves, and patches • Fluctuating spring weather • Decrease in suitable habitat due to development, forest change, and pollution • Competition from invasive species • Lack of tribal community knowledge on and cultural use of leeks • Uncertainty about harvesting regulations on tribal, public, and private lands	• Protect/restore habitat • Strategic planning/development • Transplant leeks • Teachings on plant uses, relations, and respectful harvest • Clarify harvesting regulations on tribal, state, and other lands • Clarify locations of tribal, state, and other lands • Pollution reduction • Adapt to using plants that will thrive in the future • Assisted migration?	• What plants will do well in the future and how can Anishinaabeg use these for a good life? • What do leeks need to grow well?

Inter-Tribal Forest Understory Adaptation Project
2018 Spring Workshop Findings

Focal Plant	Tribe & Region	Vulnerability Assessment	Rationale	Adaptation Strategies	Research Needs
Mashkiigobag; Labrador tea; *Rhododendron groenlandicum*	Bay Mills Indian Community; Eastern Upper Peninsula	 Highly - Moderately - Less Vulnerable Medium - High Confidence	• Decrease in suitable habitat due to development • Potential future invasive species • Unknown climate-driven change	• Protect/restore suitable wetlands • Maintain wetland preserve • Strategic planning/development • Monitor for invasive species • Teachings and guidelines for harvest	• Impact of flooding/ inundation? • Response to harvest? • Suitable habitat requirements?
Miinaagaawanzh; Blueberry; *Vaccinium angustifolium & V. myrtilloides*	Bay Mills Indian Community; Eastern Upper Peninsula	 Moderately - Less Vulnerable High Confidence	• Fluctuation in berry production • Increase in huckleberries • Smaller berries • New insects at flowering • Potential future competition from invasive species • Decrease in suitable habitat due to development • Unknown climate driven change	• Prescribed fire • Logging • Monitoring for invasive species • Teachings and guidelines for harvest	• Why is the proportion of huckleberries increasing? • Role of seasonal changes? • Role of shoreline and inland microclimates? • Why do spring blossoms not produce berries in the summer? • Role of FS fire and logging interventions on current status?
Additional plants:	Wild ginger, lady slipper (all species), chokecherries, cranberries, saskatoon/sugar plum, hazelnuts				

Appendix C: Community Outreach and Engagement Guide

Community Outreach & Engagement Guide

Tribal Adaptation Planning with Anishinaabe Ways

Michigan Anishinaabeg maintain important relationships with, and knowledges of, Great Lakes forests, waters, plants, animals, and other non-human beings. Tribal natural resource management and climate adaptation can be guided by Anishinaabe knowledges and perspectives, through formal and informal outreach and engagement with tribal member-citizens. Such engagement requires building and maintaining long-term relationships, rooted in respect and trust. The knowledges and perspectives shared by tribal members should be respected and protected beyond the lifecycle of any individual project.

This document includes ideas and prompts for engaging tribal member-citizens in forest adaptation. The following methods were developed by natural resource staff from four Michigan Tribes, inter-tribal consortium, and partners during a Forest Understory Adaptation Project. Staff from each Tribe pursued unique combinations of outreach and engagement methods, all focused on relationship-building for long-term partnerships in tribal natural resource management and climate adaptation.

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Working with tribal member-citizens in a good way

The seven grandfather teachings can help you approach tribal member-citizens in a good way. Approach members with honesty and bravery (*be clear about your intentions and the project purpose*), wisdom and respect (*actively value and safe-guard their knowledge, time, and perspectives*), humility and love (*actively listen with an open mind and heart*), and *make the commitment to work with them and take care of what they share for the long-term*.

It is often appropriate to offer asemaa (*tobacco*) or kinnickinnick to tribal members when asking for their time and guidance. Asemaa is both a gift and a spiritual contract, which acknowledges the wisdom and time being requested and may facilitate the assistance of manidoog (*spirits*) in fulfilling the request. Contact tribal elders, cultural leaders, and staff for guidance on proper asemaa relations. It is also appropriate to offer a small gift and food or drinks during a conversation, meeting, or interview, in gratitude for the time and knowledge shared.

When documenting outreach, try to transcribe member thoughts and ideas verbatim, without interpretation. It is appropriate for tribal members to maintain ownership and authority over their ideas shared during engagement, including ownership of conversation or interview transcripts, throughout and beyond any individual project lifecycle. It is essential to follow-up after conversations and allow members to review and revise the notes/transcripts or main ideas, either verbally or in written form. It is also important to follow-up with members to share how their ideas and guidance impacted the Tribe's efforts and allow the opportunity for ongoing feedback or guidance.

Tribal natural resource managers have unique opportunities to engage Western and Anishinaabe ways in tribal natural resource management.

Outreach for Project Planning

Initial Outreach Prompts

1. We are working on a project to learn about local forest plants and how they might respond to changes in climate. We've already seen some changes in temperatures, snow, storms, and the seasons – and these changes might impact forest plants…
2. Through this project, we want to understand how certain plants might do in the future. We also want to find ways to protect plants that might not be as plentiful or healthy in the future…
3. Your experiences with these forests can help guide this project. I'd appreciate it if we could talk sometime about local forest plants… *[If appropriate, offer asemaa and plan a visit or interview]*

General Questions for Starting Conversations

1. Have you noticed any changes in forest plants? More or less of any plants or groups of plants?
2. Are there any particular plants that the Tribe should be looking at? e.*g. Learning about, protecting, and/or increasing harvesting opportunities?*
3. Can you think of any plants that are harder to find now than they were in the past?

Community Gathering Focused Conversation

Tribal community gatherings are a way to engage tribal member-citizens in tribal natural resource management and climate adaptation. Member-citizen attendance at community gatherings may be promoted by: extending personal invitations with asemaa, advertising with social media, coordinating with multiple tribal programs (e.g. elders, cultural, youth), hosting gatherings in community spaces and at family-friendly times, and serving a meal.

A focused conversation can engage community gathering attendees in a group discussion, which allows collective sharing of experiences, memories, and ideas, as well as, consensus-building. After giving a brief overview of the project, a focused conversation may include the following questions:

1. Your experiences with local forests can help guide this project. I'm going to ask the group some questions and invite everyone to share their thoughts in a group discussion. If you don't feel comfortable talking in the group, I would be happy to talk with you later on.
2. After hearing about this project, what stands out to you?
3. When thinking about changes in the woods, what plants or places come to mind? And why?
4. When you go out into the woods, to gather or for any reason, what changes have you noticed?
   - *Kinds of plants growing, where or how they grow? Any plants that are harder to find now than they were in the past?*
   - *How about [specific plant]? Have you noticed any changes in [specific plant]?*
5. Why do you think these changes are happening?
6. What can we do to help the plants and places that we've talked about today?
7. What are the next steps we need to take to move this project forward here in a good way?
8. Miigwech to everyone here for sharing your thoughts and listening to each other. We'll type up the notes from today's conversation and share them with you, to make sure we understand your thoughts and ideas [*specify how and when the notes will be shared*]. If you'd be willing to talk more about this project and forest plants, please let us know and we can set up a time to meet.

Interview Questions

Adapted from GLIFWC TEK Interview Questions
These questions are best asked in a conversational format, with *examples* shared as needed.

Informed Consent Example: Thank you for talking with me today. I'm here to learn about our forests and any changes that might be happening there. I have a few questions here that are meant to help *Tribe's Natural Resource Program* learn more about changes in the woods. You are free to choose *not* to answer any of these questions – and you don't have to share any information that you feel uncomfortable sharing. What you do share will help guide the *Tribe's* work. *[Information specific to project/uses]*. This conversation will only take 20-30 minutes, unless you'd like to talk longer.

Is it ok to record our conversation? *[If yes, share what will be done with the recording. Will you transcribe it and then erase it? Send it to the interviewee? Keep it within the Department? If no, share what will be done with the notes. Will you type and deliver or email them to interviewee for their review? Will you meet with them to review the notes and make changes? Where will the notes be stored and for how long? Will they be used to guide other projects?]*

Before we begin, do you have any questions or concerns?

1. When you go out in the woods, to gather or any reason, have you noticed any changes over time?
   Changes in the woods, kinds and numbers of trees or plants, the places that you'd expect to find them, the time of year that they flower/fruits ripen, or anything that has disappeared/appeared
   - Are there any particular changes that concern you? If so, why?
   - Is there anything that we can learn from these changes?

2. When you go out gathering, are there important dates or other things that you look for, to know when it's time to start or stop gathering?
   Spring peepers, thunderstorms, etc.

3. When you think back about stories your elders told you, or when you were young, do you notice any changes in gathering from the forests then compared with now?
   Change in the kinds of plants gathered, number of plants/leaves/fruits, size or health; gathering ways, who does the gathering; how gathered items are handled

4. Are there any particular plants that the Tribe should be looking at?
   Learning about, protecting, and/or increasing harvesting opportunities

5. Can you share any Anishinaabemowin or stories about the plants or other forest beings of this area?

6. Are there any other community members that you would suggest we talk with?

Miigwech for talking with me today. I'll type these notes and share them with you, to make sure they reflect your thoughts. If there is any information that you've shared today, that you decide you don't want to be used in any way, you can let me know and it will be respected. *[Make plans for transcript review and repeat long-term plans for use of notes by Tribe]*

Tribal Community Adaptation Planning Workshops

Developed by the Inter-Tribal Council of Michigan and Northern Institute of Applied Climate Science

Tribal community workshops are a way to engage community members and their knowledges in vulnerability assessment and climate adaptation planning. Below are resources for conducting workshops for forest understory-focused adaptation planning.

Purpose and Aim of Workshop

Purpose: A gathering of tribal staff and community members to talk about selected forest plants and communities, how they might respond to climate-driven change, and ways to support them for future generations.

Aim: To share our stories and experience with these plants, better understand how they may respond to climate-driven change, and find ways to support them for future generations.

Deliverables: A documented discussion on the habitat needs of selected plants, how they are doing now, and how they might respond to future change in *a specific geographic area*; a determination of relative risk (VH, H, Mod, Low) and confidence (High, Medium, Low) for each plant; and worksheets documenting how risk and confidence was determined by each participant.

Workshop Invitees

- Interested tribal members; previous discussion, gathering, and interview participants
- Tribal leaders
- Tribal staff: natural resources, environmental, cultural, education, planning, health, traditional medicine, etc.
- Tribal elders, youth (e.g. tribal youth council), and families

Workshop Logistics

It is beneficial to host a workshop at a time and place that works best for the invitees. If tribal program staff and retired elders are the invitees, a daytime workshop may work best. If tribal families and youth are invited, a weekend or evening workshop may work best. In either case, it may be beneficial to host a workshop:

- At a community center with access to a kitchen and to provide meals for attendees
- During spring, summer, or fall, and to plan a walk in the woods or community harvest
  - *This will allow attendees to focus on their personal relationships with forest plants and get comfortable sharing stories about their experiences with forest plants/places*
- During winter, when certain stories about forest plants and other beings can be told

Example Tribal Community Workshop Agenda

8:30am **Breakfast**

9am **Welcome and Introductions**

Project overview

Workshop purpose and aims

9:30am **Field Trip**

Forest plant identification and discussion

11:30pm **Return/Recap**

12:00pm **Lunch**

12:30pm **Community Assessment of Future Change in Focal Plants**

Review handouts

Framing future change

Group assessment of future change

Unanswered questions

2:30pm **Adaptation Strategies**

What can we do to help these plants?

2:45pm **Next steps**

What next steps can we take to move this project forward here in a good way?

3:00pm **Closing**

Workshop Facilitator's Notes

Facilitator notes for a tribal community adaptation planning project focused on forest plants are provided below. Section headings correspond to the Example Tribal Community Workshop Agenda, above.

Project Overview

The purpose of this workshop is to share our stories and experience with these plants, better understand how they might respond to climate-driven change, and to determine how *this community* thinks they will do in the future, here in *geographic area*.

In order to do this as a group, we'll consider each plant, where and how they grow, any changes they might be going through now, and how future changes might impact them. It's a big task and we

asked all of you to participate because you have important experiences and knowledges about these plants and/or the forests that they live in.

At the end of the workshop, we'll have created an assessment of how each plant might do in the future and identified some ways that the Tribe can support each plant. After the workshop, you'll be able to review this assessment, which we will use to guide the Tribe's efforts to support these plants and their habitats.

A lot of climate-related work has focused on trees - how trees might respond to future changes. Not many people are looking at and working with understory plants, which provide us with foods, medicines, and are important in healthy forests. We want to support these plants now and in the future, so that future generations can continue to know and use them for min-bimaadiziwin. This workshop is an important step.

Climate-driven Change: Here in *geographic area*, we've seen changes in summer and winter temperatures, snowfall, and rain - and we expect to see more changes. These changes are different in each area of the forest - and have different impacts on each plant. That's why your perspective is so important. Your experiences and observations - what you've seen in the forests here - is the best gauge for understanding and planning for future change.

Focal Plants: Today, we're going to focus on *xxxx plants*. We're focusing on these because they stood out in *Tribal Natural Resource/Planning Department* outreach with tribal members - and because we have limited time together. All forest plants are important, but we have to start somewhere!

Group Introductions: Let's do introductions now - please share your name and one experience with any of our focal plants.

Field Trip

The discussion can be tailored to the forest community and can start with informal sharing of plant identification, including Anishinaabemowin, English, and Latin names. A field trip to a site with *species* may include the following discussion prompts:

1. Has anyone been to this forest before?
2. What are your experiences with *species*? When did you first learn about them?
3. What kinds of places do *species* grow in? Do they need anything special to grow? Are they grouped with any particular plants or animals?
4. What do healthy *species* look like? What does healthy *species* habitat/forest look like? How do you know if it is not healthy?
5. Have you noticed changes in the places that *species* grow? Any changes in how they grow? Why do you think these changes are happening?
6. Are *species* harder to find now than they were in the past? Why do you think these changes are happening?
7. What about *other species*?

Field Trip Recap

We've visited a forest with *species*, talked about *species*, how and where they grow, and how they might be impacted by climate. Let's bring those discussions together now so that they can guide our work this afternoon. We'll start with a question to the group:

- After our field trip what stands out to you about *species* and the forests that they grow in?

Community Assessment of Future Change

Review Handouts: In this project, we are looking one or two generations forward - to the year 2050. *We have a draft vulnerability rating of EXTREMELY HIGH for how LEEKS might be in the year 2050 - which means that they, or the places that they grow, may DECREASE or DISAPPEAR here by 2050. [See Inter-Tribal Council of Michigan Project Handouts:* http://www.itcmi.org/environmental-services*]*

We came up with that draft vulnerability rating by using a tool called the Climate Change Vulnerability Index, where we answered a bunch of questions about the plant and what they need to grow well. The tool focuses on three things: how much change the plant will experience, how sensitive the plant is to that change, and the plant's ability to respond to or withstand that change.

In this tool, the ratings (Low - Extremely High) address future decreases in how many plants there will be and how much area they can grow in. A plant with Low vulnerability may not change much, or they may grow much **better** in the future and we'll see more of them growing in more places.

This is a good start, however, the tool and these ratings don't consider important things that might matter to the Tribe - like your ability to go out and harvest enough of that plant for your family. Today, we want to do a different assessment, that is based on your experiences, ideas, and needs.

Framing future change: Today, we want to talk about future changes in each of these plants, including changes in their:

- Health: if they become sick, start dying, produce less fruit, or other changes
- Habitat: if they can't grow in as many places in this area or they can't grow with the same plants as as they used to
- Community access: if you can't access or harvest them due to -
    - Timing: too hot in summer to gather; mismatch with giizis/traditional harvest time
    - Geography: must travel further to find or harvest them; they are hard to get to
    - Authority: they are only available on private or other lands with regulations that limit your ability to find and gather

How does this sound? Is there anything else that we should consider?

Group assessment of future change: Now that we've decided what kind of future changes to consider, we can start an assessment. This will probably take longer at first and by the next plant or two, it'll be faster. We'll use the worksheets to record our ideas as we go.

First, please take a few minutes to write down responses to the first four questions on the worksheet for *species*. *[See **Species Worksheet**, page 9-10]*

Next, find a partner and share your ideas. Add any new ideas to your worksheets. You'll have 8 minutes to talk.

Now, lets go through each question together - what is one idea that stood out in your conversation about Question 1, 2, etc.:

Is there anything else that should be added to this list? *Changes in when they emerge in spring - other plants - invasive plants/earthworms - pollinators - animals move seeds - forest structure - Are there special local conditions that might help species survive better in some places?*

With these ideas in mind, please use the graphs on your worksheets to rate how you think *species* might do in the future. Remember to consider each aspect of future change: health, habitat, community, access, harvest, etc. ***For example..*** Use your best guess and circle your level of confidence in your answer.

Now, using these stickers, let's put all of our ratings on one big graph here. You should put 1 sticker on this graph. [Use large colored graph from **Species Worksheet** page 2]

Here's what we found… How does this sit with you? How confident are you in these ratings?

Let's take this one step further. With this rating in mind, and the reasons for it, let's think about our options for the future. What actions can the Tribe take to support and enhance *species* - and tribal access to them - into the future?

[Repeat Community Assessment of Future Change for additional species]

Adaptation Strategies

We've identified some ways that the *Tribe* can support *species* - and member access to them - in the future. What actions can the Tribes take to support *species*:

- On tribal, federal, state, private, land trust lands?
- Tribal community access to them?
- How can the Tribes work together to support these plants across the state or region?

Next Steps

What next steps can we take to move this project forward here in a good way?

Closing

Miigwech for sharing your knowledge, experiences, guidance, and time with us today. We will pull together the notes and work we did today into a summary report and share it with you, for your review. If you'd like to talk through anything in the meantime, contact us by phone, email, or stop in for a visit.

Species Worksheet

1. Have you noticed any changes in how *species* grows?

- ☐ Flowers at different time
- ☐ Harvest at different time
- ☐ Patches are larger or thicker
- ☐ Patches are smaller or thinner
- ☐ _____
- ☐ Grows in new areas
- ☐ Grows in less areas
- ☐ Less fruit
- ☐ More fruit
- ☐ _____

Why do you think these changes are happening?

2. Have you noticed any changes in the places where *species* grows?

☐ Yes ☐ No ☐ Maybe

What changes have you noticed?

3. How easy is it to find and gather *species* in *geographic area* now?

☐ Very easy ☐ Easy ☐ Medium ☐ Difficult

What makes it easier or harder?

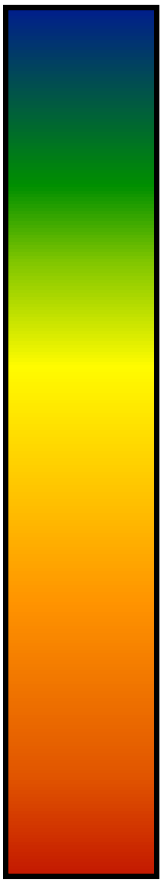
4. Do you know of any ways to increase *species* populations or health?

☐ Yes ☐ No ☐ Maybe

If so, please share:

Assessment of Future Change

5. Please rate how you think *species* will do in the future on the graph below with an 'X.'



Increase

Increase in number of plants, habitat for these plants, and/or tribal community access to these plants by the year 2050

Small Decrease

No major decrease in number of plants, habitat for these plants, and/or tribal community access to these plants by the year 2050

Moderate Decrease

Number of plants, habitat for these plants, and/or tribal community access to these plants may decrease by the year 2050

Major Decrease

Number of plants, habitat for these plants, and/or tribal community access to these plants may decrease greatly by the year 2050

Extreme Decrease

Number of plants, habitat for these plants, and/or tribal community access to these plants may decrease or disappear by the year 2050

6. Why did you select this rating?

Please share:

7. How confident are you in the rating above?

☐ High ☐ Medium ☐ Low

Why?

Plant Identification Resources

Compiled by Michigan Natural Features Inventory and Inter-Tribal Council of Michigan

When talking with tribal members about forest plants, it is important to make sure you're talking about the same plants. Overlap and confusion among English, latin, and Anishinaabemowin names can make it difficult to confirm the identification of specific plants.

Talking with tribal members in the field can allow you to identify plants together. If you can't confidently identify a plant in the field, take pictures the plant and key parts that are critical for identification (i.e., leaf, flower, buds, bud scars, bark, branching pattern, fruits, seeds). The photos can later be used to key out the Latin name of the species.

If you can't confirm identification of a plant and don't have access to it (e.g. during an interview in the middle of winter) the following questions may be helpful:

- *Where do you find this plant?*
- *What kinds of places do they grow in? What other plants grow with them?*
- *What is the soil or dirt like in the places they grow? Sandy? Clay? Thick with roots?*
- *Do they grow in wet or dry areas?*
- *Do they grow in standing water? If so, how deep?*
- *Can you draw or describe the leaf shape?*
- *Can you draw or describe the flower?*
- *What does the bark look like?*
- *What does the bark smell like?*
- *What does the plant smell like?*
- *What does the plant taste like?*
- *How many flowers does the plant have?*
- *Where on the plant are the flowers?*
- *Are the leaves opposite or do they alternate?*
- *Are the leaves compound or simple?*
- *What are the edges of the leaves like? Toothed or smooth?*

Recommended online identification tool: http://michiganflora.net/
Recommended field guides:

Newcomb's Wildflower Guide by Newcomb

Michigan Trees by Barnes and Wagner

Field Manual of Michigan Flora by Voss and Reznicek

The Illustrated Companion to Gleason and Cronquist's Manual by Holmgren

Additional Resources

Climate and Traditional Knowledges Workgroup (CTKW). (2014). Guidelines for Considering Traditional Knowledges in Climate Change Initiatives. https://climatetkw.wordpress.com.

Great Lakes Indian Fish and Wildlife Commission. (n.d.). Guidelines for Conducting Traditional Ecological Knowledge Interviews. http://www.glifwc.org/climatechange.

Inter-Tribal Council of Michigan, Inc. (2018). Inter-Tribal Forest Understory Adaptation Project Handouts. http://www.itcmi.org/environmental-services.

Kovach, M. (2010). Indigenous methodologies: Characteristics, conversations, and contexts. University of Toronto Press.

Smith, L. T. (2013). Decolonizing methodologies: Research and indigenous peoples. Zed Books Ltd.

Tribal Climate Adaptation Guidebook Writing Team (Meghan Dalton, Samantha Chisholm Hatfield, and Alexander"Sascha" Petersen). (2018). Tribal Climate Adaptation Guidebook. Corvallis, OR: Oregon State University. http://www.occri.net/projects/tribal-climate-adaptation-guidebook/

Wilson, S. (2008). Research is ceremony: Indigenous research methods. Fernwood Publishing, Black Point, NS, Canada.

Working together to support native forest understory plants

The Inter-Tribal Council of Michigan, Bay Mills Indian Community, Lac Vieux Desert Band of Lake Superior Ojibwe, Pokagon Band of Potawatomi, Saginaw Chippewa Indian Tribe, Michigan Natural Features Inventory, and Northern Institute of Applied Climate Science worked together from 2017-2018 to understand and support forest understory plants across Michigan, based on Anishinaabe and Western scientific knowledges and ways.

For more information, contact the Inter-Tribal Council of Michigan or visit our website: **www.itcmi.org**.

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Appendix D: Forest Understory Adaptation Recommendations

Inter-Tribal Forest Understory Adaptation Project
2018 Forest Adaptation Recommendations

From 2017-2018, the Inter-Tribal Council of Michigan, Bay Mills Indian Community, Lac Vieux Desert Band of Lake Superior Chippewa, Pokagon Band of Potawatomi, Saginaw Chippewa Indian Tribe, Michigan Natural Features Inventory, and Northern Institute of Applied Climate Science collaborated on inter-tribal adaptation planning for five understory plants. Through tribal community engagement (individual interviews with elders and harvesters, small group gatherings, and community workshops), literature review, and collective discussions among natural resource and botany professionals, the following forest adaptation recommendations were identified.

Plant	Forest Type	Strategy
Any	Any	Identify and monitor populations and associates (include community interest/access)
		Include identification of culturally significant understory and ground cover species within continuous forest inventory protocols.
		Monitor and remove invasive species
		Diversify forest structure and composition through forest management actions (species, age classes, horizontal and vertical structure)
		Diversify forest structure and composition of potential habitat through forest management actions (species, age classes, horizontal and vertical structure)
		Protect understory plant populations and sensitive soils during timber harvests or other management actions; require frozen soils as a prerequisite for management, don't just use calendar dates for operating windows
		Clarify harvesting regulations and share sustainable harvesting strategies (e.g., only harvest certain number per site, only harvest individuals of certain size)
Leeks ***Allium tricoccum***	Mesic southern forest, Mesic northern forest, floodplain forest	Maintain mature overstory in areas with known leek populations - adjust age class & stocking goals where appropriate
		Retain canopy cover during timber harvest in areas with known leek populations - set an upper threshold for the percentage of a stand that should be put into canopy gaps during a harvest
		Protect leek populations and sensitive soils during timber harvests or other management actions (require frozen soils as a prerequisite for management, don't just use calendar dates for operating windows).

Inter-Tribal Forest Understory Adaptation Project
2018 Forest Adaptation Recommendations

Plant	Forest Type	Strategy
Leeks ***Allium tricoccum***	Mesic southern forest, Mesic northern forest, floodplain forest	In beech-scale infested forests, retain dying trees/snags; Release advanced regeneration of preferred trees (e.g. sugar maple/oak)
		Plan for long-term mature overstory prior to beech-scale infestation
		Transplant leeks to potential suitable habitat (e.g. southern to northern assisted migration)
		Identify suitable habitat for leeks using habitat suitability modeling, air photo interpretaiton, interviews with traditional gatherers, etc., Transplant leeks to potential suitable habitat (including southern to northern assisted migration)
Labrador tea ***Rhododendron groenlandicum***	Poor conifer swamp, bog, muskeg, rich conifer swamp, poor fen, and patterned fen	Limit hydrology impacts from roads/development: Actively restore hydrology in these areas by fixing water blockages, decommissioning drainage ditches, re-routing trails (consult historic trails)
		Limit hydrology impacts from roads/development: Install water control structures that would help manage the water levels through heavy rain and drought
		Limit forest and wetland conversion for development and peat harvest
		Prescribed burns to encourage sprouting from root crowns or rhizomes. Allow wildfires to burn peatland complexes. Avoid establishing new fire breaks within peatlands.
		Avoid management of paludified uplands: uplands with sphagnum peat occurring over sands, which typically occur on transverse dune ridges within large peatlands and support large populations of Labrador tea
Blueberries ***Vaccinium angustifolium***	Dry northern, dry southern, oak-pine barren...	Implement prescribed burns
		Restore dry forests and barrens that have experienced "mesophication" as a result of wildfire suppression. Implement harvests and prescribed burns. Identify areas with suitable soils to support dry plant communities to target these areas.
		Implement timber harvest
		Allow wildfires to burn peatland and upland complexes

Inter-Tribal Forest Understory Adaptation Project
2018 Forest Adaptation Recommendations

Plant	Forest Type	Strategy
Ground nut ***Apios americana***	Wet prairie, southern wet meadow, northern wet meadow, floodplain forest, hardwood-conifer swamp, southern hardwood swamp, rich tamarack swamp	Maintain riparian forest
		Use prescribed fire to maintain openings
		Identify suitable habitat for using habitat suitability modeling, air photo interpretaiton, interviews with traditional gatherers, etc. Transplant tubers to potential suitable habitat (including southern to northern assisted migration)
Ginseng ***Panax quinquefolius***	Mesic southern forest, Mesic northern forest	Restrict timber harvest in areas of known ginseng populations
		Increase late-successional habitat in landscape surrounding known habitat
		Maintain mature overstory - set an upper threshold for the percentage of a stand that should be put into canopy gaps during a harvest
		Use trail cameras and signage to deter poaching of ginseng
		Use exclosures to protect ginseng populations from deer
		Decrease deer densities to reduce deer browse pressure
		Identify suitable habitat for using habitat suitability modeling, air photo interpretaiton, interviews with traditional gatherers, etc., Transplant tubers to potential suitable habitat (including southern to northern assisted migration)

Appendix E: Forest Understory Monitoring and Assessment Options

Inter-Tribal Forest Understory Adaptation Project
2018 Forest Understory Assessment and Monitoring Options

From 2017-2018, the Inter-Tribal Council of Michigan, Bay Mills Indian Community, Lac Vieux Desert Band of Lake Superior Chippewa, Pokagon Band of Potawatomi, Saginaw Chippewa Indian Tribe, Michigan Natural Features Inventory, and Northern Institute of Applied Climate Science collaborated on inter-tribal adaptation planning for five understory plants. Through tribal community engagement, literature review, and collective discussions among natural resource, forestry, and botany professionals, the following assessment and monitoring options were identified.

Species	Goal	Data to collect	Sampling method	Sampling interval/timing	Data analysis	Existing protocols
Allium tricoccum	**Understand patch area growth status/trends**	Patch area extent; patch density	Plot; transect; UAV; CiSci, Worldview Data (8ban 1.24m)	Annual/ spring @maturity	Uni- or multivariate (e.g., ANOVA, MANOVA, linear regression correlation)	Baumfleck and Chamberlain
Allium tricoccum	**Understand average individual bulb size status/trends**	Bulb size; bulb mass	Plot; transect; CiSci	Annual/ spring @maturity	Univariate (e.g., ANOVA, linear regression)	Baumfleck and Chamberlain
Allium tricoccum	**Understand average individual leaf size status/trends**	Max leaf length; max leaf width; number of leaves	Plot; transect; CiSci	Annual/ spring @maturity	Univariate (e.g., ANOVA, linear regression)	Baumfleck and Chamberlain
Allium tricoccum	**Understand stem density status/trends**	Stem count; new ramet count	Plot; transect; UAV; CiSci	Annual/ spring @maturity	Univariate (e.g., ANOVA, linear regression)	Baumfleck and Chamberlain
Allium tricoccum	**Understand timing of emergence and senescence**	Emergence/ senescence dates; min/mean/max air temperature, ground temperature, soil moisture, precipitation, aspect/slope, hours of daylight	Fixed point photography; CiSci; weather station or local logger data	Annual to daily: pre-leaf out to leaf senescence or snow cover (capture seeding)		GLIFWC p8;

Inter-Tribal Forest Understory Adaptation Project
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Species	Goal	Data to collect	Sampling method	Sampling interval/timing	Data analysis	Existing protocols
Allium tricoccum	**Understand relationships between phenology and average individual size/density/ etc.**	Emergence/ sescense dates; mean leak size/ mass, patch density	Mixed	Multiple times per season		
Allium tricoccum	**Understand suitable habitat**	Tree species; basal area; percent canopy cover per species; soil type/ moisture	Plot; transect; CiSci	Once to annual	GIS modeling, MaxENT	Cohen; FIA Phase 2;
Allium tricoccum	**Understand relationships between suitable habitat and average individual size/ density/phenology/etc.**	Patch area extent; density; aspect/ slope, soil moisture, air temperature, mean canopy cover, suitable habitat area	Mixed	Once to multiple times per season	Multivariate (e.g., MANOVA, PCA, AIC)	
Allium tricoccum	**Understand relationships between weather/climate and health**	Patch area extent or mean leek size or mass ("health" of leek); precipitation, min/mean/max air temperature, relative humidity	Plot; transect; UAV; weather station or local logger data	Weather: multiple times per season (e.g., weekly); Climate - Annual/ spring @maturity	Modeling	Merow et al 2013; Guisan et al. 2005
Apios americana	**Understand patch area growth status/trends (RAH)**	Patch area extent	Plot; transect; UAV; CiSci, Worldview Data (8ban 1.24m)	Annual/ spring @maturity	Uni- or multivariate (e.g., ANOVA, MANOVA, linear regression correlation)	USGS Forest Vegetation Monitoring Protocol

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Species	Goal	Data to collect	Sampling method	Sampling interval/timing	Data analysis	Existing protocols
Apios americana	**Understand average tuber size status/trends (RAH)**	Tuber mass	Plot; transect; CiSci	Annual/ spring @maturity	Univariate (e.g., ANOVA, linear regression)	
Apios americana	**Understand habitat needs/trends and locate new patches (RAH)**	Known patch locations; weather/ climate; topography; land cover	Remote sensing; Targeted survyes; weather station or local logger data	Once to annual	MaxENT; modeling	Merow et al 2013; Guisan et al. 2005; Anderson and Spackman
Ledum groenlandicum	**Understand growth/ trends of patch size (RAH)**	Patch area extent; new shoots; leaf density/vigor; quantify vertical structure (optional); habitat conditions; weather	Plot; fixed point photography; transect; UAV; CitSci; imagery	Annually	ANOVA; PCA	USGS Forest Vegetation Monitoring Protocol
Ledum groenlandicum	**Understand trends in leaf production/yield (RAH)**	Individual height; quantification/ ranking of leaf density/vigor; new sprouts count; stem elongation; mean leaf area; leaf mass per area	Transect-plotless; UAS; fixed point photography	Annually	ANOVA/Kruskal-Wallis;	Kudo et al. 1999; Tendland et al. 2012
Ledum groenlandicum	**Understand habitat needs/trends and locate new patches (RAH)**	Known patch locations; weather/ climate; topography; land cover	Remote sensing; weather station or local logger data	Once to annual	MaxENT; modeling	Merow et al 2013; Guisan et al. 2005

Inter-Tribal Forest Understory Adaptation Project
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Species	Goal	Data to collect	Sampling method	Sampling interval/timing	Data analysis	Existing protocols
Ledum groenlandicum	**Monitor trends in peat/ soil moisture near patches (RAH)**	Organic layer depth, soil moisture (soil wetness/soil-water potential), depth to water table; new shoots, leaf density/vigor; weather conditions	Plot/point; weather station or local logger data	Annual; multiple times per season	Correlation; repeated ANOVA	Seneviratne et al. 2010; Dorigo et al. 2010; Hillel, D. 1998
Ledum groenlandicum	**Determine fire regrowth and optimal fire frequency (RAH)**	Patch area extent, growing season since fire, fire date, fire intensity, mean air temperature, mean ground surface temperature, rainfall, organic layer depth	Transect-plotless; UAV; nearby weather station or data logger	Annually; pre-treatment and one or more post-treatment	For 2 treatments (i.e., burned, unburned) with only 1 pre and 1 post: paired t-test; for > 2 treatments: generalized linear mixed models	Granath et al. 2018
Ledum groenlandicum	**Understand the effects of less snow and more compact snow (RAH)**	Snow depth, snow density, snow-water equivalent, ground temperature, temperature in shrub	Plots; nearby weather station or data logger; CitSci	At least 4 visits to plots in winter; annual visit to monitor for leaf vigor	ANOVA	Saarinen et al. 2016,
Ledum groenlandicum	**Determine sustainable harvest regime (RAH)**	Leaf production; stem elongation; mean leaf size or mass; trunk diameter	Permenant random shrub selection;	Annually	Repeated-measures ANOVA	Tendland et al. 2012;

Inter-Tribal Forest Understory Adaptation Project
2018 Forest Understory Assessment and Monitoring Options

Species	Goal	Data to collect	Sampling method	Sampling interval/timing	Data analysis	Existing protocols
Panax quinquefolius	**Understand growth/ trends of patch size (RAH)**	Patch area extent, new shoots, number of plants, size categories based on leaf number, habitat conditions, weather	Plot; fixed point photography; transect; UAV (?); CitSci	Annually	ANOVA; PCA	McGraw and Furedi 2005; Furedi 2004
Panax quinquefolius	**Understand habitat needs/trends and locate new patches (RAH)**	Known patch locations, weather/ climate, topography, land cover, slope/aspect	Remote sensing; Targeted survyes; weather station or local logger data	Once to annual	MaxENT; modeling	Merow et al 2013; Guisan et al. 2005; Anderson & Spackman
Panax quinquefolius	**Measure effects of deer browsing (RAH)**	Plant number, plant height, number of leaves, fruit presence, deer browse intensity or population estimate	Plots; trail cameras;	Multiple times per season	Log-likelihood analyses; logistic regressions	Furedi and McGraw 2004; Fuerdi 2004; Farrington et al. 2008
Panax quinquefolius	**Determine local presence of detrimental fungus (e.g., Alernaria blight, Botrytis cinerea, cylindrocarpon, Fusarium, rhexocercosporidium) in wild populations (RAH)**	Plant material for analysis (can be processed/dried)	Plots; transect-plotless	Once	Laboratory	Zenghui and Huang 2014;

Inter-Tribal Forest Understory Adaptation Project
2018 Forest Understory Assessment and Monitoring Options

Species	Goal	Data to collect	Sampling method	Sampling interval/timing	Data analysis	Existing protocols
Panax quinquefolius	**Understand effects of invasive plant species (RAH)**	Presense/absence and/or density; Panax vigor rating or number of leaves; soil moisture; soil chemistry (for allopathic substances related to invasive species; optional)	Transect-plotless	Annually	paired T-test; correlations; PCA;	Flinn et al. 2014
Panax quinquefolius	**Determine abundance of non-native earthworms (RAH)**	Abundance of adult and juvenile earthworms and cocoons in organic soil layers; GPS	Adaptive transect-quadrat;	Annually or less	spatial interpolation (e.g., krigging); mixed-effects logistic regression	Cameron and Bayne 2015
Vaccinium angustifolium	**Document trends in flower/berry production (RAH)**	Date range for flowers/berries, quantification/ ranking of flower/ berry density,	Plots; fixed point photography; CitSci	Annually or biannually	repeated measures ANOVA	Zaman et al. 2009; Granath et al. 2018
Vaccinium angustifolium	**Document yearly phenology (RAH)**	Date range for emergence of leaves/flowers/ berries, quantification/ ranking of leaf/ flower/berry density	Plots; fixed point photography; CitSci	Annually	repeated measures ANOVA	Crimmins et al. 2008; Ellwood et al. 2014

Inter-Tribal Forest Understory Adaptation Project
2018 Forest Understory Assessment and Monitoring Options

Species	Goal	Data to collect	Sampling method	Sampling interval/timing	Data analysis	Existing protocols
Vaccinium angustifolium	**Understand yearly changes in taste/ chemical properties of berries (RAH)**	Date of first, max, last fruits; chemical analysis on berries	Plots; CitSci	Annually		Bett-Garber et al. 2015; Barnuud et al. 2014
Vaccinium angustifolium	**Determine effects of fire intensity and frequency (RAH)**	Dimensions/area, height, growing season since fire, fire date, fire intensity, mean air temperature, mean ground surface temperature, rainfall, organic layer depth	Transect-plotless; UAV; weather station or local logger data	Annually; pre-treatment and one or more post-treatment	For 2 treatments (i.e., burned, unburned) with only 1 pre and 1 post: paired t-test; for > 2 treatments: generalized linear mixed models	Granath et al. 2018
Vaccinium angustifolium	**Determine impact of freeze/thaw cycles (RAH)**	Phenology, quantification/ ranking of flower/ berry density, plant percent cover; air temperature, ground surface temperature, temperature within ice, rainfall, organic layer depth, ice density	Nearby weather station or data logger	bi- or tri-annually	ANOVA; repeated measures ANOVA	Preece et al. 2014

Inter-Tribal Forest Understory Adaptation Project
2018 Forest Understory Assessment and Monitoring Options

Species	Goal	Data to collect	Sampling method	Sampling interval/timing	Data analysis	Existing protocols
Vaccinium angustifolium	**Understand possible effects of less snow and more compact snow (RAH)**	Snow depth, snow density, snow-water equivalent, melt-out date; ground temperature, temperature in shrub	Plots; nearby weather station or data logger; CitSci	At least 4 visits to plots in winter; spring and summer visits to monitor for flowering/ fruiting timing	ANOVA	Saarinen et al. 2016; Semenchuk et al. 2013
Vaccinium angustifolium	**Understand effects of deer browsing (RAH)**	Plant height, quantification/ ranking of flower/ berry density, deer browsing intensity or population estimate	Plots; deer population information	Annually or biannually	Regression; generalized mixed models	Hegland et al 2005; Hegland et al. 2016; USGS Forest Vegetation Monitoring Protocol
Vaccinium angustifolium	**Understand relationships to weather/climate change (RAH)**	Date of first, max, last blooms; air temperature; relative humidity; precipitation;	Releve; fixed point photography; CitSci; nearby weather station or data logger	Multiple times during flowering period	Univariate (ANOVA, linear regression)	Ellwood et al. 2014.
Vaccinium angustifolium	**Monitor trends in native bee visitation (RAH)**	Date of first, max, last blooms; climate/weather; bee species observations; berry density; surrounding landscape (optional)	Plots; fixed point photography; weather station or local logger data; NOAA C-CAP Land cover/land use map	Biannually or more	Shannon-Wiener diversity indices; Mann Whitney; Bray Curtis dissimilarity, PERMANOVA; AICc;	Gibbs et al. 2016