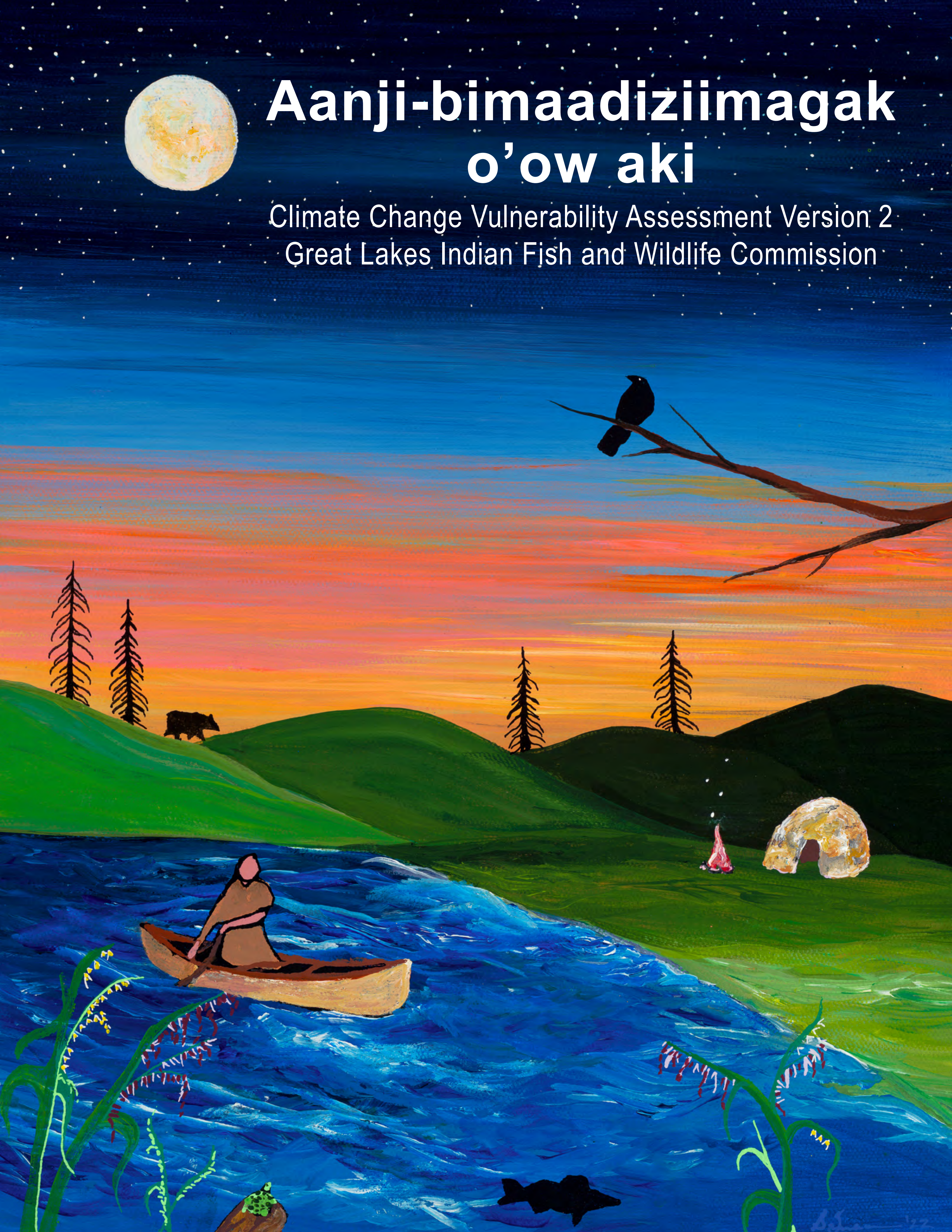
Aanji-bimaadiziimagak o'ow aki

Climate Change Vulnerability Assessment Version 2

Great Lakes Indian Fish and Wildlife Commission



So the Great Spirit created all of the natural rhythms, gave everything a physical shape, and so everything in the four orders of creation is related to each other and has a direct effect on everything in what we call the web of life. So nothing stands alone. And if any one of those orders is disturbed it affects everything else…

And then there were also prophecies. Great Spirit spoke of seven different ages, and we recently entered into the age of the Seventh Fire… And then it was prophesized that a new people would arise. The new people would be led by the Anishinaabe. So Anishinaabe turned and looked back and began to retrace that path that would take them back to ancient times and ancient knowledge. They began to pick up those sacred bundles that had fallen by the wayside because of persecution…

And so Anishinaabe were given a very special gift. We call it mashkiki. Loosely interpreted, it means medicine. But along with that medicine goes the knowledge and wisdom of how to live in harmony and balance with the four orders of creation – mother earth, the plant world, the animal world, and the human world. And so along with a gift as special as that goes a responsibility. So Anishinaabe have the responsibility of going out and sharing that knowledge of how to live in harmony and balance with all four orders in the creation. Because we're totally dependent on the first three orders of creation for our very existence – mother earth, plants, and animals. And so at this time we stand at this fork in the road, when those first three orders and human beings are threatened…

And so as we stand at this fork in the road… one path is said to be a hard surface and the other is to be a more natural path. We see that hard surface as the fast lane of unbridled technology that pollutes and destroys and upsets the balance among the four orders of creation, upsets the balance of mother earth. The other path is a more natural path. And so it depends on which path humankind chooses as to what's going to happen when the next new age is ushered in.

Moka'ang Giizis-Rising Sun Joe Rose Sr.
Ojibwe Elder
January 24, 2020

Aanji-bimaadiziimagak o'ow aki

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Great Lakes Indian Fish and Wildlife Commission
January 2023

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GLIFWC Climate Change Team

Aanji-bimaadiziimagak o'ow aki loosely means "the world is changing."

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Disclaimer:

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For information on the cover art, see the inside back cover.

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Acknowledgments:

This report is the product of a collaboration between GLIFWC and its 11 member tribes:

Misi-zaaga'iganiing (Mille Lacs Band of Ojibwe Indians)

Bikoganoogan (St. Croix Chippewa Indians of Wisconsin)

Mashkiiziibiing (Bad River Band of Lake Superior Tribe of Chippewa Indians)

Waaswaaganing (Lac du Flambeau Band of Lake Superior Chippewa Indians)

Zaka'aaganing (Sokaogon Chippewa Community (Mole Lake Band))

Odaawaa-zaaga'iganiing (Lac Courte Oreilles Band of Lake Superior Chippewa Indians)

Nagaajiwanaang (Fond du Lac Band of Lake Superior Chippewa)

Gaa-miskwaabikaang (Red Cliff Band of Lake Superior Chippewa Indians)

Ginoozhekaaning (Bay Mills Indian Community)

Gete-gitigaaning (Lac Vieux Desert Band of Lake Superior Chippewa Indians)

Gakiiwe'onaning (Keweenaw Bay Indian Community)

As an intertribal agency committed to the infusion of Ojibwe culture and values into all aspects of its work, we would first like to acknowledge the environment, the beings, and the manidoog (spirits) that assure the continuation of human life on this earth. We would like to thank the elders, harvesters, and community members who offered their time to speak with us about climate change and shared their knowledge. We believe it is important to rely on Traditional Ecological Knowledge (TEK) when addressing the effects of climate change impacts, and their openness and willingness to share made this possible. We would also like to thank the many people that reviewed these assessments, including those knowledgeable about each being, various GLIFWC staff, and a large team at the Northern Institute of Applied Climate Science (NIACS). Thank you to Karina Heim for helping us with visual representation of these data, to Sam Zimmerman for his thoughtful representation of our work in the cover art, and to Sophia and Bazile Panek for transcribing interviews. We would also like to thank Kailey Marcinkowski at NIACS for her work on the layout of this document.

Dedication:

Gidapiitenimaanaanig gi-gichi-aya'aabaniig, Gaa-gikendaasobaniig, gaye Gaa-anishinaabemobaniig gaa-nibowaad megwaa COVID-19 aakoziikaag – ingiw Anishinaabebaniig omaa GLIFWC oodenaang miinawaa dash gakina oodenaang Anishinaabe giiwitaakamig. Gaawiin wiikaa gigikenimaanaasiinaadog minik gaa-miizhiyangidwaa. Gizhawenimigoom apane go naa.

This work is dedicated to the elders, knowledge-holders and language speakers who passed on during the COVID-19 pandemic — those from our GLIFWC member tribes and from all Indigenous communities. The impact of their loss to their people and to the world may never be fully known or appreciated. You are all in our hearts. —The GLIFWC Climate Change Team

Abstract

Climate change is affecting beings (species) and ecosystems in the upper Midwest Ceded Territories, with which Ojibwe people have maintained relationships for centuries. As climate change continues, the ability of tribal members to exercise their off-reservation treaty rights to meet spiritual, ceremonial, medicinal, subsistence, and economic needs will be increasingly impacted. Aanji bimaadiziimagak o'ow aki, the second version of the GLIFWC Vulnerability Assessment, is an attempt to weave together Traditional and Scientific Ecological Knowledge (SEK) to examine the climate change vulnerability of a set of beings in the upper Midwest Ceded Territories by the mid-21st century. The assessment is divided into several parts: 1) an introduction, including an explanation of treaty rights and the origins and goals of the GLIFWC Climate Change Program; 2) a section on projected climate change impacts to the Ceded Territories and examples of impacts on cultural practices; 3) a methods section describing how the assessment was conducted, including a description of the Traditional Ecological Knowledge (TEK) interviews and the use of the NatureServe Climate Change Vulnerability Index; 4) a results section, with a summary of results from all beings in the assessment; 5) a discussion section that explores different themes found in the assessment and outlines next steps; and 6) a series of pages for each of the beings in the assessment, containing information from TEK and SEK on how each might be impacted by climate change. The assessment is meant as a resource for GLIFWC's member tribes and their tribal and non-tribal partners, to help them prepare for upcoming changes and to help them care for those who take care of us.

Table of Contents

Ojibwe Pronunciation Guide

For this document, we have chosen to use the double vowel system of the Ojibwe language which is commonly used today when writing in the Ojibwe language. Below is information that is intended to be used as a guide to assist when attempting to pronounce the Ojibwe words.

Ojibwe Alphabet

a, aa, b, c, d, e, g, h, ’, i, ii, j, k, m, n, o, oo, p, s, t, w, y, z

Vowel Type	Vowel	Ojibwe Example	English Example
Short	a	**a**sin, n**a**me, m**a**kw**a**, nik**a**, **a**goozim**a**k**a**kii, wiing**a**shk	th**u**nder, m**u**skellunge, m**u**skrat, Canad**a** goose, tam**a**rack
Long	aa	w**aa**w**aa**tesi, og**aa**, w**aa**booz, **aa**ndeg, mikin**aa**k, g**aa**gigebag	r**o**ck, w**a**lleye, b**o**bcat, c**o**mmon loon, fr**o**g, str**a**wberry
Long	e	as**e**maa, ginoozh**e**, waawaashk**e**shi, mizis**e**, miskwaad**e**si, nam**e**pin	l**a**ke trout, sandhill cr**a**ne, p**ai**nted turtle, sugar m**a**ple
Short	i	manoom**i**n**i**keshiinh, ash**i**gan, am**i**k, m**i**g**i**z**i**, mit**i**gwaakiing d**i**z**i** m**i**shiikenzh, bagwaj**i**p**i**n	spir**i**t, whitef**i**sh, r**i**ver otter, amph**i**bian, ostr**i**ch fern
Long	ii	animik**ii**kaa, odoonib**ii**ns, bapakwaanaaj**ii**nh, waabiz**ii**, agoozimakak**ii**g, j**ii**sens	s**ee**k, tullib**ee**, b**ea**ver, bald **ea**gle, spring p**ee**per, northern white c**e**dar
Short	o	ishk**o**de, noosa’**o**wesi, **o**jiig, mitig**o**ningwiishib, misk**o**min	tobacc**o**, n**o**rthern trout, cr**o**w, tadp**o**le, Indian potat**o**
Long	oo	manid**oo**, gin**oo**zheg, m**oo**z, aagask**oo**g, man**oo**min	m**oo**n, t**u**llibee, m**oo**se, common l**oo**n, bl**ue**berry

Other Sounds

Nasal Vowels	Ojibwe Example
aanh	banajaanh
enh	nisayenh
iinh	awesiinh
oonh	giigoonh

Note

Vowels in a word are nasalized before the letters ns, nz, and nzh. Also, long vowels (as seen in chart above: aa, e, ii, oo) after a nasal consonant (n or m) are often nasalized, especially when they come before s, sh, z, or zh.

Between the letters h and i in the Ojibwe alphabet is an apostrophe (’), which is a symbol used for a glottal stop.

Glossary

Aadizookaanag: Ojibwe word for sacred stories.

Aagimaak: Ojibwe word for white ash.

Aandeg: Ojibwe word for American crow.

Aanji-bimaadiziimagak o'ow aki: The Ojibwe title given for this vulnerability assessment. Loosely means "the world is changing."

Adaptation plan: A document that lays out actions to take to adjust to climate change impacts.

Adaptive capacity: When used to evaluate climate change vulnerability, the ability of a being to cope with climate changes.

Adikameg: Ojibwe word for lake whitefish.

Agoozimakakii: Ojibwe word for spring peeper.

Animikiig: Ojibwe word for thunderbeings or thunderbirds. The thunderbeings are giant, powerful beings that nurture and protect the earth by bringing wind, rain, lightning, and thunder. They live in families and are highly respected in Ojibwe culture.

Anishinaabe: A group of culturally related Indigenous peoples in Canada and the United States that include the Odawa, Ojibwe (including Mississaugas), Potawatomi, Oji-Cree, and Algonquin peoples. The term is also variously used to contrast humans with non-human beings, and native people with non-natives. Also commonly used by those who identify as Anishinaabe to refer to all Indigenous people. Anishinaabeg is the plural form of Anishinaabe.

Anishinaabe-zhiiwaagamizigan: Ojibwe word for maple syrup.

Asemaa: Ojibwe word for tobacco, which is used as a gift or offering when requesting permission or assistance from another being.

Ashigan: Ojibwe word for largemouth bass.

Baapaagimaak: Ojibwe word for black ash.

Bagwaji'zhigaagawanzh: Ojibwe word for wild leek.

Bakaan ingoji gaa-ondaadag: Ojibwe word for non-local beings, also called invasive species. Its meaning translates roughly to "that which comes from somewhere else and now resides here."

Being: An organism, creature, and/or spirit. Beings include those which are both animate (such as fish) and inanimate from the western perspective (such as rocks) and implies an equal importance to all.

Biindigen: Ojibwe word for enter.

Bikoganoogan: Ojibwe name for St. Croix Chippewa Indians of Wisconsin.

Ceded Territories: Regions in which hunting, fishing, and gathering rights were retained by tribes when they ceded their lands to the United States government.

Climate change: Long-term shifts in temperatures and weather patterns.

Crawlers: A category of being commonly used by Ojibwe people; beings who crawl on the ground.

Creator: Known in Ojibwe as gichi-manidoo, the Creator brought the universe and all its components into being.

Cultural burning: The Indigenous practice of lighting small, controlled fires to promote certain beings or accomplish other goals.

Cultural: In this assessment, "cultural" is used to describe tribal habits, beliefs, and traditions. It is often used interchangeably with "traditional."

Dibaajimowinan: Ojibwe word for stories.

Downscaling: A method of taking coarse-resolution climate models and using them to make projections at smaller scales. "Statistical downscaling" develops relationships between global atmospheric variables and local weather measurements and uses those relationships to generate models that are relevant at regional scales. "Dynamical downscaling" uses high-resolution regional climate models nested within global climate models to simulate regional conditions in much greater detail.

Exposure: When used to evaluate climate change vulnerability, the amount and type of climate changes a being is likely to experience.

Extirpated: A population of a being that is no longer located in a certain geographical area.

Flyers: A category of being commonly used by Ojibwe people; beings who fly in the air.

Four-leggeds: A category of being commonly used by Ojibwe people; beings who walk on four legs.

Free, Prior, and Informed Consent: A right recognized in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) that allows Indigenous peoples to give or withhold consent to a project that may affect them or their territories. Once they have given their consent, they can withdraw it at any stage. Free, prior, and informed consent also enables them to negotiate the conditions under which the project will be designed, implemented, monitored, and evaluated.

Gaa-miskwaabikaang: Ojibwe name for Red Cliff Band of Lake Superior Chippewa Indians.

Gakiiwe'onaning: Ojibwe name for Keweenaw Bay Indian Community.

General Circulation Models: Three-dimensional computer representations of the earth's climate, called General Circulation Models (GCMs). Because these models are produced at a global scale, they provide information at coarse geographical scales, roughly 2 to 3 degrees latitude and longitude, and are therefore less useful at regional scales.

Gete-gitigaaning: Ojibwe name for Lac Vieux Desert Band of Lake Superior Chippewa Indians.

Giizhikaatig: Ojibwe word for northern white cedar.

Gijigijigaaneshiinh: Ojibwe word for chickadee.

Ginoozhe: Ojibwe word for northern pike.

Ginoozhekaaning: Ojibwe name for Bay Mills Indian Community.

Gookooko'oo: Ojibwe word for owl.

Gooniikaa-Ginebig Ataadiiwin: Ojibwe word for Snow Snake, a traditional game played on ice or snow that is considered to be a rite of passage for some.

Greenhouse gas: A gas in Earth's atmosphere that absorbs and emits energy, trapping heat and creating the greenhouse effect.

Growing season: The part of the year with frost-free days.

Hamon AET:PET moisture metric: A measure of moisture availability which integrates temperature and precipitation through a ratio of actual evapotranspiration (AET) to potential evapotranspiration (PET), with consideration of total daylight hours and saturated vapor pressure.

Indigenous: In this assessment, "Indigenous" is used to describe the original inhabitants of a region, prior to colonization by another culture. Also used interchangeably with "native" or "native peoples."

Ininaandag: Ojibwe word for balsam fir.

Intergenerational trauma: Trauma that gets passed down from those who directly experience an incident to subsequent generations.

Ishkode: Ojibwe word for fire.

Lake-effect snow: Snow that occurs when cold air travels across an open body of water, accumulating warmth and moisture, creating clouds and causing snow to fall downwind of the water body.

Lifeways: Used in this document to describe Ojibwe culture and practices.

Ma'iingan: Ojibwe word for wolf.

Maashkinoozhe: Ojibwe word for muskellunge.

Manidoog: Ojibwe word for spirits.

Manidoonsag: Ojibwe word for little spirits. In our assessment, this concept replaces the concept of pests and pathogens. Ojibwe do not view pests or pathogens as negative, and view manidoonsag as being in existence for a reason.

Manoomin: Ojibwe word for wild rice.

Mashkiigobag: Ojibwe word for Labrador tea.

Mashkiigwaatig: Ojibwe word for tamarack.

Mashkiiziibiing: Ojibwe name for Bad River Band of Lake Superior Tribe of Chippewa Indians.

Mashkiki: Ojibwe word for medicine.

Migizi: Ojibwe word for bald eagle.

Miigis: Ojibwe word for shell. A miigis guided the Ojibwe people to the Great Lakes region during their migration.

Miin: Ojibwe word for blueberry.

Misi-zaaga'iganiing: Ojibwe name for Mille Lacs Band of Ojibwe Indians.

Miskomin: Ojibwe word for raspberry.

Mitigate: Reduce the emission of greenhouse gases into the atmosphere.

Mitigoningwiishib: Ojibwe word for wood duck.

Mooz: Ojibwe word for moose.

Nagaajiwanaang: Ojibwe name for Fond du Lac Band of Lake Superior Chippewa.

Name: Ojibwe word for sturgeon.

Namebinag: Ojibwe word for suckers.

Native: In this assessment, “native” is used to describe the original inhabitants of a region, prior to colonization by another culture. Also used interchangeably with “Indigenous.”

Niche: A specific set of environmental conditions to which a being is well suited.

Odaawaa-zaaga’iganiing: Ojibwe name for Lac Courte Oreilles Band of Lake Superior Chippewa Indians.

Odoonibiins: Ojibwe word for tullibee.

Ogaa: Ojibwe word for walleye.

Ojibwe: An Anishinaabe group of Indigenous peoples that originated from the northern United States and Canada; also, an Indigenous language.

Onaabani-Giizis: Ojibwe word for Crust-on-Snow Moon.

Original treaty: The very first treaty between humans and all other beings that agrees that other beings will help humans in exchange for humans helping to care for all other beings.

Projection: An estimate of what the future climate will look like, based on models.

Representative Concentration Pathways (RCPs): A scenario that simulates levels of atmospheric greenhouse gas concentrations from the year 2000 to 2100 based on a range of climate policy outcomes, population trends, economic growth, energy consumption and sources, and land use in the next century.

Reservation: A federal Indian reservation is an area of land reserved for a tribe or tribes under treaty or other agreement with the United States, executive order, or federal statute or administrative action as permanent tribal homelands, and where the federal government holds title to the land in trust on behalf of the tribe. Some reservations are the remnants of a tribe’s original land base. Others were created by the federal government for the resettling of Indian people forcibly relocated from their homelands. Not every federally recognized tribe has a reservation. Federal Indian reservations are generally exempt from state jurisdiction, including taxation, except when Congress specifically authorizes such jurisdiction (US Department of Interior: Indian Affairs 2017).

Scientific Ecological Knowledge (SEK): An alternative to the phrase “western science;” describes an objective and quantitative system of knowledge which relies on certain laws that have been established through the application of the scientific method. SEK often views humans as separate from the natural world.

Sensitivity: When used to evaluate climate change vulnerability, the degree to which a being is likely to be affected by climate change.

Seventh generation philosophy: An Indigenous concept that actions we take today should be planned while thinking about seven generations into the future.

Subsistence: The act of supporting oneself by living off the land.

Swimmers: A category of being commonly used by Ojibwe people; beings who swim in the water.

Traditional Ecological Knowledge (TEK): There are many definitions of TEK. Also known as Traditional Knowledge and Indigenous Knowledge, TEK can be defined as the ongoing accumulation of knowledge, practice, and belief about relationships between living beings in a specific ecosystem that is acquired by Indigenous people over hundreds or thousands of years through direct contact with the environment, handed down through generations and used for life sustaining ways (National Park Service 2020). TEK is typically expressed orally, through languages, stories, songs, and laws.

Traditional: In this assessment, "traditional" is used to describe tribal habits, beliefs, and traditions. It is often used interchangeably with "cultural."

Treaty rights: Inherent sovereign rights of the tribes retained when lands were ceded to the United States via treaty, including the rights to hunt, fish and gather for subsistence and for sale. Treaty rights were ignored or denied as states began regulating hunting and fishing. In the mid-20th century Ojibwe tribes began seeking legal affirmation of these rights, which have since been affirmed in court cases and interjurisdictional agreements.

Tribe: A political group existing before the development of states. The upper Midwest region includes Ojibwe (also known as Chippewa), Menominee, Ho-chunk, Potawatomi, Ottawa, and Dakota tribes, among others.

Vulnerability assessment: The process of identifying the greatest risks to a particular being, habitat, or ecosystem from climate change impacts.

Vulnerable: At risk from climate change impacts. In our assessment, beings were categorized into one of four categories of vulnerability. "Less vulnerable" indicates that available evidence does not suggest abundance and/or range extent within the geographic area assessed will change substantially. "Moderately vulnerable" indicates that the being's abundance and/or range extent within the geographic area assessed is likely to decrease. "Highly vulnerable" indicates the being's abundance and/or range extent within the geographic area assessed is likely to decrease significantly. "Extremely vulnerable" indicates the being's abundance and/or range extent within the geographic area assessed is extremely likely to substantially decrease or disappear by the mid-21st century.

Waabizheshi: Ojibwe word for American marten.

Waabooz: Ojibwe word for snowshoe hare.

Waaswaaganing: Ojibwe name for Lac du Flambeau Band of Lake Superior Chippewa Indians.

Waawaashkeshi: Ojibwe word for white-tailed deer.

Waawaatesi: Ojibwe word for firefly.

Wazhashk: Ojibwe word for muskrat.

Wenaboozhoo: A spirit being and Anishinaabe cultural icon. Also known by other variants of the name, including Nanabozho, Nenabozhoo, Nanaboozhoo, and Wenabozho. Wenaboozhoo stories are typically only told when snow is on the ground.

Wiigwaas: Ojibwe word for birch bark.

Wiigwaasaatig: Ojibwe word for paper birch.

Zaka'aaganing: Ojibwe name for Sokaogon Chippewa Community (Mole Lake Band).

Zhiiwaagamiziganike: Ojibwe word for making maple syrup.

Zhingos: Ojibwe word for weasel.

Ziinzibaakwadwaaboo: Ojibwe word for maple sap.

Ziinzibaakwadwaatig: Ojibwe word for sugar maple.

Introduction

As it has been for centuries, Anishinaabeg descendants of those who migrated to the Great Lakes from the east guided by the miigis (shell) continue to rely upon animal and plant relatives to meet spiritual, ceremonial, medicinal, subsistence, and economic needs. Their on- and off-reservation hunting, fishing, and gathering activities demonstrate their exercise of treaty rights, tribal sovereignty, and cultural survival. Historically, tribal members were prosecuted for the exercise of their treaty rights and persecuted for practicing their culture and spirituality. Over time, activism, litigation, and intergovernmental agreements have facilitated a resurgence of culture and its expression through subsistence lifeways. However, climate change poses a new and potentially existential threat to Indigenous lifeways, culture, and identity. Indigenous peoples, particularly those who express their culture and relationship to their ancestral lands through subsistence practices, will be uniquely and disproportionately affected by these changes in climate.

Treaty Rights and Climate Change

Throughout their history the Anishinaabeg have been known as an adaptable people. For generations, this adaptability was demonstrated by the “seasonal round,” where the people moved with the seasons, separating and coming together in semi-permanent villages to hunt, fish, and gather food and medicine. In the Great Lakes and upper Midwest this included activities such as spearing ogaa (walleye) and harvesting namebinag (suckers) during their spawning runs, making Anishinaabe-zhiiwaagamizigan (maple syrup) in spring sugar camps, gathering wiigwaas (birch bark), medicinal plants, tubers, berries, and nuts in the summer, harvesting manoomin (wild rice) in the early fall, and hunting waawaashkeshi (white-tailed deer) and trapping other animals and furbearers throughout the summer, fall, and winter. This seasonal subsistence lifeway was possible because the Ojibwe occupied large landscapes with diverse land- and water-based resources and their mobility allowed them to adapt more easily to changing environmental conditions.

Access to this large land base was lost as Euro-Americans began to exploit the natural resources of and settle in the Great Lakes region in the early to mid-19th century. In the Treaties of 1836, 1837, 1842, and 1854, Ojibwe bands who communally owned and controlled lands and waters that make up large parts of what are now known as Michigan, Wisconsin, and Minnesota were coerced by threat of war or forced removal to cede the bulk of their territory (over 60,000 square miles) to the United States and to live on reservations scattered throughout their former homeland (Figure 1). Each of the treaties contain variously worded guarantees, now described as treaty rights, that tribal members continue to hunt, fish, and gather and practice their lifeways in the ceded lands and waters (hereafter referred to as the Ceded Territories) in perpetuity. These treaty rights were not granted to the tribes by the United States government but represent inherent sovereign land use rights reserved by the tribes in the treaties for the benefit of future generations of tribal members.

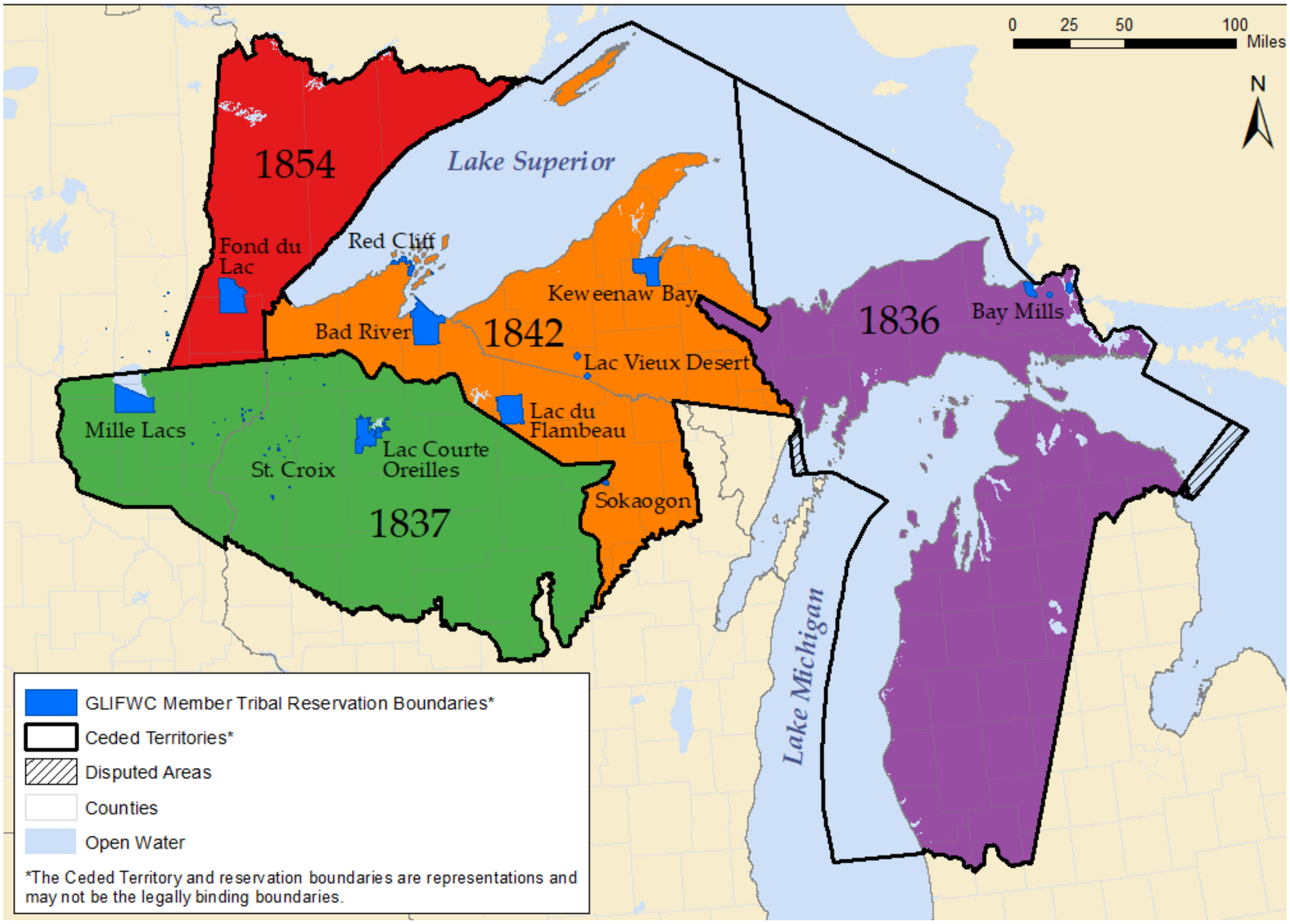


Figure 1. The 11 reservations of the tribes served by the Great Lakes Indian Fish and Wildlife Commission and the four Ceded Territories (1836, 1837, 1842, and 1854) in which they are situated.

Upon their formation in the mid-1800s, the states of Minnesota, Wisconsin, and Michigan began regulating hunting and fishing and refused to recognize that federally guaranteed treaty rights and tribal sovereignty preempted state regulation. State enforcement of hunting and fishing regulations, both off- and on-reservation, resulted in prosecution and incarceration of tribal members who continued practicing subsistence lifeways, separating families and intensifying ongoing intergenerational trauma.

After more than a century of conflict between the tribes and the states, multi-jurisdictional agreements and state and federal court decisions recognized, reaffirmed, and upheld the Ojibwe tribes' off-reservation treaty rights. This includes the ability to hunt, fish, and gather on ceded lands and waters, including areas of Lakes Superior, Michigan, and Huron, and to make a "modest living" from the land, which includes the harvest of resources for subsistence and for sale. Also guaranteed and reaffirmed is the sovereign authority of tribes to regulate the behavior of their members and cooperatively manage the natural resources of the Ceded Territories. Today each of the 11 Ojibwe tribes served by the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) has adopted on- and off-reservation conservation codes that guide tribal members in the exercise of their treaty rights and protect vulnerable or important beings (species) in a culturally aware and appropriate fashion. GLIFWC and tribal natural resources staff work to protect beings and habitats throughout the Ceded Territories, both unilaterally and in concert with their state and federal co-managers. Since the late 20th century, tribal members have been able to increase their off-reservation hunting, fishing, and gathering throughout the Ceded Territories, expanding their ability to practice their cultural heritage and utilize the treaty rights their ancestors reserved for them.

Now, however, climate change is affecting culturally significant plants and animals. As culturally important treaty-harvested beings respond to climate change, they may become locally or regionally extirpated, shift their ranges outside reservation and Ceded Territory boundaries, or otherwise become unavailable or unsustainable for treaty harvest. Because reservation and Ceded Territory boundaries are legally fixed in place, and treaty rights are limited in geographic scope, Ojibwe tribal members today do not enjoy the same ability to move across the landscape in response to changing environmental conditions that allowed their ancestors to survive and thrive.

The effects of climate change on treaty resources are already being felt in the Great Lakes region. In the case of wiigwaasaatig (paper birch), warming temperatures and increased periods of drought, combined with non-climate stressors such as commercial demand in the home decoration sector, have led to the implementation of tribal harvest restrictions. Some beings, such as waabooz (snowshoe hare), are responding to changes in their environment by shifting their ranges to the north and may eventually shift their ranges out of the Ceded Territories entirely. Others, such as baapaagimaak (black ash), are threatened by bakaan ingoji gaa-ondaadag which can overwinter in greater numbers as winter temperatures warm. Finally, many climate change-related factors, including more frequent intense rainstorms and warmer summer nights, have affected and will continue to affect manoomin (Figure 2). Manoomin, gifted by the Creator to the Anishinaabeg, is a being so deeply embedded in culture and spirituality that many tribal members fear a loss of identity as their ability to maintain their relationship with manoomin is lost due to the cumulative effects of climate change and changes in water quality, disease, manidoonsag (little spirits/pests and pathogens), and other stressors.

Figure 2. Manoomin (wild rice) is deeply embedded in Ojibwe culture and spirituality.
Photo credit: CO Rasmussen (GLIFWC).

The magnitude of observed and predicted change, much of which is now inevitable regardless of human action to limit greenhouse gas emissions, has prompted the tribes and GLIFWC to undertake climate adaptation planning in the Ceded Territories. Tribal communities across the United States are leading the way, finding ways to mitigate their contribution to global change and using their knowledge and adaptability to continue cultural practices and practice treaty rights despite these changes, while other parts of society are often in denial or mired in political argument, as Makoons Fred Ackley Jr. described in this story:

> “This little bird... he’d fly around and mess with everybody. And the Creator wanted all the birds to come together… Everybody heard him but that little bird. He was flying around… teasing people and not listening to the speaker. And the Creator said he wanted everybody to get their colors. All the birds… went there that day and they got their colors and the other bird, little brown bird, he was flying around. That evening, everybody was checkin’ each other out, all the… different colors. And he come flyin’ around, he said, ‘Hey! Where’d you guys get all these colored feathers? They’re beautiful!’ And they told him, well, the Creator told us to be there and you weren’t there, so… that’s what you get stuck with… little brown feathers. That’s how people are right now.”

The GLIFWC Climate Change Program—Caring for Those Who Care for Us

GLIFWC is an intertribal agency that exercises authority delegated to it by its member tribes to implement court orders and inter-jurisdictional agreements related to their off-reservation treaty rights. For over 35 years, GLIFWC has operated comprehensive conservation, ecosystem protection, conservation law enforcement, and public information programs designed to implement the tribes’ treaty rights, cooperatively manage natural resources and ecosystems within the Ceded Territories to support those rights, and to promote healthy and safe tribal communities.

GLIFWC initiated its Climate Change Program in 2014 with the goal of integrating Traditional Ecological Knowledge (TEK) and Scientific Ecological Knowledge (SEK) to provide member tribes with a more holistic and culturally appropriate approach to climate change adaptation. There is no singular definition of TEK. Also known as Traditional Knowledge and Indigenous Knowledge, TEK can be defined as the ongoing accumulation of knowledge, practice, and belief about relationships between living beings in a specific ecosystem that is acquired by Indigenous people over hundreds or thousands of years through direct contact with the environment, handed down through generations and used for life sustaining ways (National Park Service 2020). TEK is typically expressed orally, through languages, stories, songs, and laws. The term “SEK,” sometimes known as western science, is used here to reflect a body of knowledge associated with the scientific method and which also originates from a diverse set of disciplines.

In this vulnerability assessment, SEK and TEK contribute in different ways to understanding the current and future effects of climate change. SEK contributes sophisticated climate models, tools for assessing vulnerability, and a large body of published research assessing short term physiological and long-term evolutionary responses to environmental changes. TEK draws from thousands of years of observing how beings respond to climate and other changes on the landscape, and human adaptation to those changes in order to survive. TEK often reaches beyond the limits of SEK in its explanatory power as it includes interconnected knowledge about living and non-living systems and the relationships of those systems with cultural and spiritual aspects of life. To develop culturally appropriate and effective climate adaptation strategies for tribal and non-tribal communities, GLIFWC and other agencies invested in climate adaptation will benefit from the strengths of both knowledge systems.

Under the guidance of tribal leaders, elders, and harvesters, and to better understand how climate change is affecting culturally important animal and plant beings, the GLIFWC Climate Change Program has undertaken this climate change vulnerability assessment. It considers the vulnerability of 66 plant and animal beings to climate change by the mid-21st century using TEK and SEK interdependently. It has been designed to serve as a planning and educational resource for use by GLIFWC, its member tribes, and their non-tribal partners in adapting and responding to climate change in the Ceded Territories and maintaining treaty rights, treaty resources, and human/non-human reciprocal relationships for future generations.

It is important to remember that long before treaties were signed with the United States, the Anishinaabeg entered into what they refer to as the “first” or “original treaty” with the other orders of creation. This treaty acknowledges that humans are fully dependent on all the other beings for everything we need for mino-bimaadiziwin (living a good life). All beings are of great and equal importance, and humans have the responsibility to use the gifts they provide us appropriately and with respect and reciprocity, caring for those who care for us, and using our voices to speak for those who can’t speak for themselves. Though often disregarded, the Anishinaabe understanding of the treaties signed with the United States implies that federal and state management agencies should treat our non-human relatives as would the Anishinaabeg:

> “The tribes have a pre-existing relationship with all of our environment... our first treaty is our treaty with the universe, the treaty with creation. And that’s our mutual responsibility and obligations that we have to each other. And so each time we’re given one of those gifts, one of those responsibilities… with that comes the obligation to use your tobacco, offer that. So when we understand our relationship based upon all those collective knowledges, we went to the treaties, we understood our responsibility to all of our environment, and when the tribes said yes, the non-Indian can coexist in our territory, they essentially vouched for them, because all of those treaties were invoked on the spiritual construct. They had the pipes there, they used their tobacco, they had the shake tents going on, it’s all understood they invoked the spirit or a cultural perspective, and it’s even in the records, the master of life is witness to what we are doing… these people that are coming in our territory will treat the resource based upon the relationship we have with them and that’s their obligation by signing that treaty. That’s the mentality that we can begin to push forward in those areas where there is potential conflict, or when the state says we don’t want to manage the plant resources like this, or we don’t want to manage wild rice like that, or the deer herd like this… that treaty binds them to have to take into consideration our management prerogative, which is based on our cultural teachings and foundations.” *—Kekek Jason Stark*

Final note

Significant efforts were made to gather TEK for all 66 beings included in this assessment. Due to the large number of beings selected and the nature of the semi-directed interviews used to gather TEK, the amount of knowledge gathered for each being varied. Many beings were discussed at length, but there were also some about which little or no knowledge was shared; in some cases, previously published materials have been utilized to provide additional cultural knowledge for these beings.

Beings in this assessment are grouped into categories commonly used in Ojibwe culture. Plants are self-explanatory, crawlers include reptiles and amphibians, four-leggeds refers to mammals and swimmers to fish. Waawaatesi (firefly) was the only insect assessed and is included with birds in the flyer category. Cave bats and tree bats are included on the same being page, as are least, short-tailed, and long-tailed weasels. The Ojibwe names given to us were for “bat” and “weasel,” respectively, and much of the knowledge shared about these beings was general. However, cave bats, tree bats, short-tailed/least weasels, and long-tailed weasels are all listed separately in tables throughout the assessment, as their vulnerability was assessed separately.

Some knowledge holders shared information about non-human relatives, including rocks, mineral bodies, animikiig (thunderbeings), and spiritual keepers of the forest, many of which are recognized in Ojibwe culture and language as animate beings. A focus of Ojibwe culture is the interrelationship between all beings, both human and non-human relatives. These beings are viewed as sources of life and power. A great amount of respect is held for them, and they are honored through tobacco, food, and other offerings. The interconnectedness between humans and our non-human relatives is displayed in various ceremonies, oral traditions, and stories. These stories teach morals and positive behavior, which are exemplified mostly through animal spirits that are each known to hold specific roles in life. It is believed that following the teachings of these stories can lead to a positive and sustainable life for both individuals and communities. The animal spirits can also serve as spirit helpers who provide protection and are identified through dreams, visions, and spiritual leaders. Much of the knowledge shared about these beings is considered sacred and not suitable for sharing in this assessment. However, knowledge holders and tribal leaders recognize that human activity and climate change impact these non-human relatives; for example, when mining impacts the groundwater and magnetic mineral bodies that maintain Gichigami (Lake Superior) as a refuge for Anishinaabeg and other beings.

As you look through the pages of this document you will see various forms of TEK including contemporary personal accounts, oral histories, dibaajimowinan (stories), and aadizookaanag (sacred stories). Occasionally, some of this knowledge may seem incomplete. This is intentional. Not all the TEK gathered for this assessment is appropriate for sharing outside of tribal communities or for sharing in this format. Many aadizookaanag, especially those referencing Wenaboozhoo, a spirit being and Anishinaabe cultural icon, are to be told only in winter. Wenaboozhoo stories shared in this document are summaries and have been previously published elsewhere.

Climate Change Impacts on the Ceded Territories

Native peoples practicing subsistence lifeways recognize that environmental change is inevitable and have been observing and responding to environmental change in order to survive for millennia. This story tells of when native people lived through the first climate change and survived with the help of aandeg (American crow):

> "It used to be that it was always warm here. We didn't have much of the seasonal change at all, everything was always green and wonderful. But then something started changing… some of the plants were turning yellow and at night it was getting colder and colder, and they'd have to huddle together just to stay warm. And there was this bird, his name was aandeg, and he was the most beautiful bird ever, he had a beautiful beak with colors on his beak and every color of the rainbow was represented in his feathers. He was just the most beautiful bird, and he had the most beautiful song ever. And when he would sing it was to sing us to sleep and sing us awake. It was just special. He started noticing that the Anishinaabeg were suffering… and he became concerned about the Anishinaabe people. And so, he decided on his own to go to the Creator's lodge and tell the Creator what was happening in his creation… aandeg took off and he flew through the layers of the earth and through four layers of the sky and outside the Creator's lodge and he sat in a maple tree just outside the lodge… and he starts singing. He's singing a song and the Creator says, 'eh, I know you, your name is aandeg. Biindigen.' He flew into the Creator's lodge… and he said, 'Grandfather, your people are suffering, they need your help, there's a change, something is changing on the earth and it's getting cold at night and they're suffering, they have nothing to keep them warm.' The Creator took his pipe, and he filled it, and smoked it, and pondered these things. And when he was done smoking, he goes, 'I know what to do.' He said, 'Here, take this,' and he reached down and grabbed a firebrand out of the fire, he said, 'Take this to down to the people. They can use this, this is ishkode. It's fire. They can use this to keep themselves warm and warm their lodge.' So aandeg took off. He goes, 'but fly quick, don't take a lot of time, because this won't last forever, you need to get it down there before it goes out.' So aandeg started flying through the first layer of the sky, and he realized that the wind was blowing on it, shooting sparks off of it, it was burning faster and faster, so he flew harder and harder and harder and harder, and finally he just tipped over and dived as fast as he could. And as he was doing that the spray from the sparks and the flames was starting to hit him and he could feel his face tightening up and he looked at his beak and his beak was changing shape and shrinking and the longer he went, the darker it got. Pretty soon he noticed his beak was pure black and he could feel his feathers just melting… but he kept flying, and he wouldn't give up. And as he was going through the last layer of the sky and entering the realm of the earth, he wanted Anishinaabe to come quick, so he was going to sing his song that he sang to Anishinaabe since the beginning of time, and he started to sing and when he breathed in, he breathed in the flame, and he coughed, and finally he made it to a tree outside the village and he landed there and he started trying to sing, but because it scorched his throat, the only sound he could make was 'caw, caw, caw.' He dropped it and it smoldered the one last little coal, and in the leaves, it caught flame. Anishinaabe came there and took their fire from that, and to this day we honor him with the name aandeg—to change colors—because he was once colorful and now, he's cooked black, and he no longer has a beautiful voice, but just a rough caw that we hear. But if you take a feather of his and hold it up in the sunlight, twist it, you can see every color of the rainbow, the colors that used to be before he made that sacrifice." —*Niso-asin Sean Fahrlander*

Overview of this section

This section summarizes the basics of climate change and climate modeling, followed by a summary of previous (past) and projected (future) effects of climate change in the Ceded Territories. Projected changes are generally described for the mid-21st century. Throughout this section, we blend knowledge and observations made by tribal members in the Ceded Territories with information collected by scientists. Together, these knowledge systems provide a more comprehensive view that includes a cultural lens of the numerous effects of climate change on Anishinaabe people and the resources they depend on for survival.

Global Climate Change: A brief overview

Climate change is the result of increased levels of greenhouse gases, such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) in the atmosphere. A certain concentration of these gases is essential—in what is known as the greenhouse effect, greenhouse gases reflect the sun's energy back into the atmosphere, keeping the planet warm and allowing it to sustain life (Figure 3). However, as the concentration of gases in the atmosphere rises, more energy is trapped and the temperature of the earth increases. Many factors affect the earth's climate, but human activities such as burning fossil fuels, deforestation, and land use change over the past century have caused significant greenhouse gas emissions and increased the temperature of the earth.

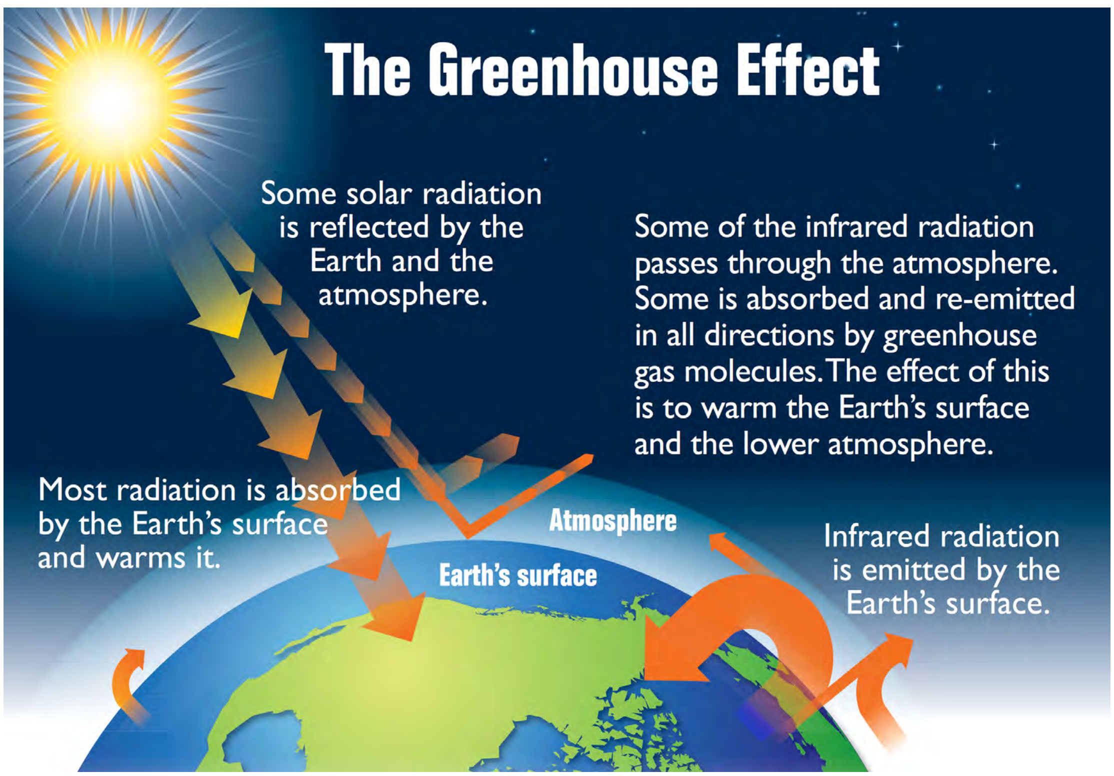


Figure 3. The greenhouse effect (U.S. Environmental Protection Agency 2016).

The atmospheric concentration of carbon dioxide has risen to levels higher than at any point in the last 800,000 years, and at an unprecedented rate (Figure 4). As a result of these increased levels of carbon dioxide and other greenhouse gases, average annual global air temperatures have increased 0.13°F per decade over the last 130 years (a total of about 2°F), and every year since 1977 has been warmer than the 20th century average (Figure 5). Temperature records continue to be broken at global, regional, and local scales. Tribal members have observed this change directly:

> "In 30 years, I've seen this change, and the weather change from when I was a little boy. And it's been getting worse the last, I'd say, 15 years." —*Makoons Fred Ackley Jr.*

In addition to increases in average temperature, there are many other projected regional effects of climate change, including:

- a longer growing season.
- more intense heat waves in the summer months.
- increased water temperature, longer duration of a stratified period, and decreased ice cover on lakes.
- increased spring and winter precipitation, and more winter precipitation falling as rain.
- increased frequency and intensity of heavy precipitation events.
- decreased surface soil moisture.

These effects are not all discussed in detail here; for more information, see the Fourth National Climate Assessment (USGCRP 2018).

Scientists recommend that warming should be limited to 1.5-2°C (2.7-3.6°F) by the end of the 21st century to prevent the most catastrophic effects of climate change and prevent millions of people from suffering heatwaves, droughts, floods, and poverty. To limit warming to 1.5°C (2.7°F), greenhouse gas emissions need to be reduced to net zero by 2050 (Rogelj et al. 2018). However, there is no sign of greenhouse gas emissions peaking in the next few years, and even if current national pledges to reduce emissions are met, a UN report estimates that climate change will cause mass extinctions and leave large parts of the planet uninhabitable by 2100 (United Nations Environment Programme 2019):

> “Now the climate change. I heard five degrees. To us, you can jump in the water at 70 degrees or 75. It’s still going to be about the same to us. But I hear worldwide, five degrees and it’s almost disaster, catastrophe. It makes things go different.” —*Carmen Butler*

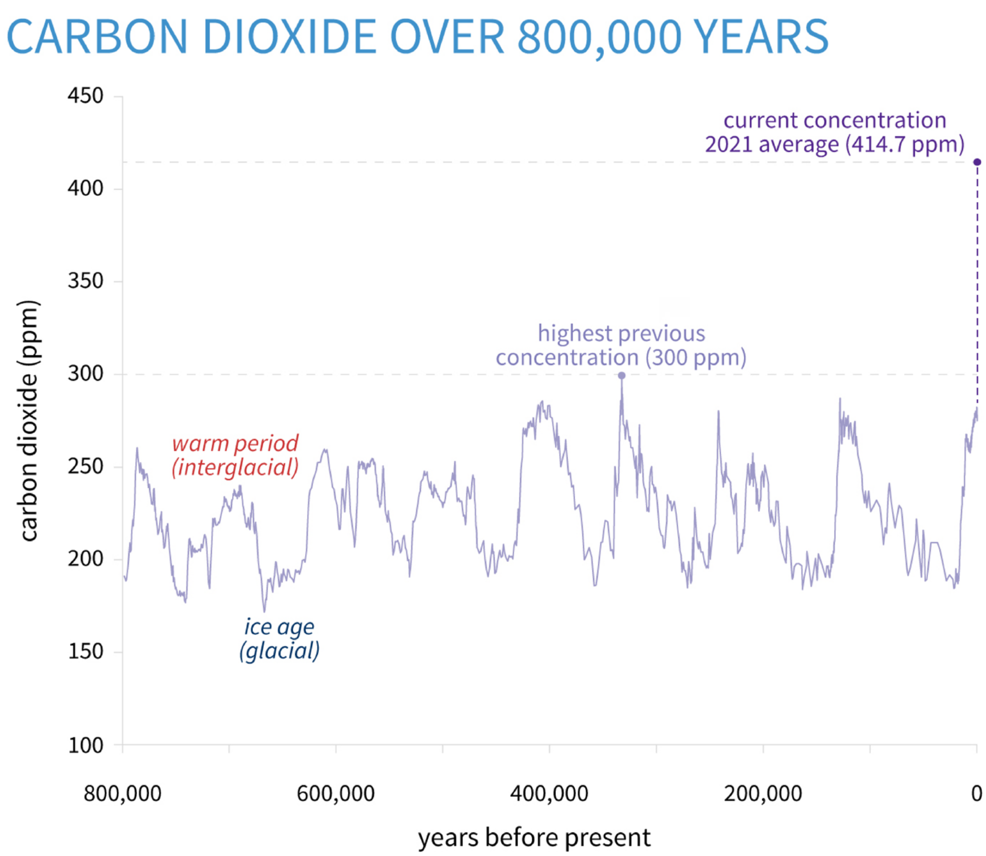


Figure 4. Global atmospheric carbon dioxide (CO_2) in parts per million (ppm) for the past 800,000 years based on ice-core data (purple line) compared to 2021 concentration (dark purple dot). The peaks and valleys in the line track ice ages (low CO_2) and warmer interglacials (higher CO_2). Throughout that time, CO_2 was never higher than 300 ppm (light purple dot, between 300,000 and 400,000 years ago). The increase over the last 60 years is 100 times faster than previous natural increases. In fact, on the geologic time scale, the increase from the end of the last ice age to the present looks virtually instantaneous. Graph by NOAA Climate.gov based on data from Lüthi, et al., 2008, via NOAA NCEI Paleoclimatology Program.

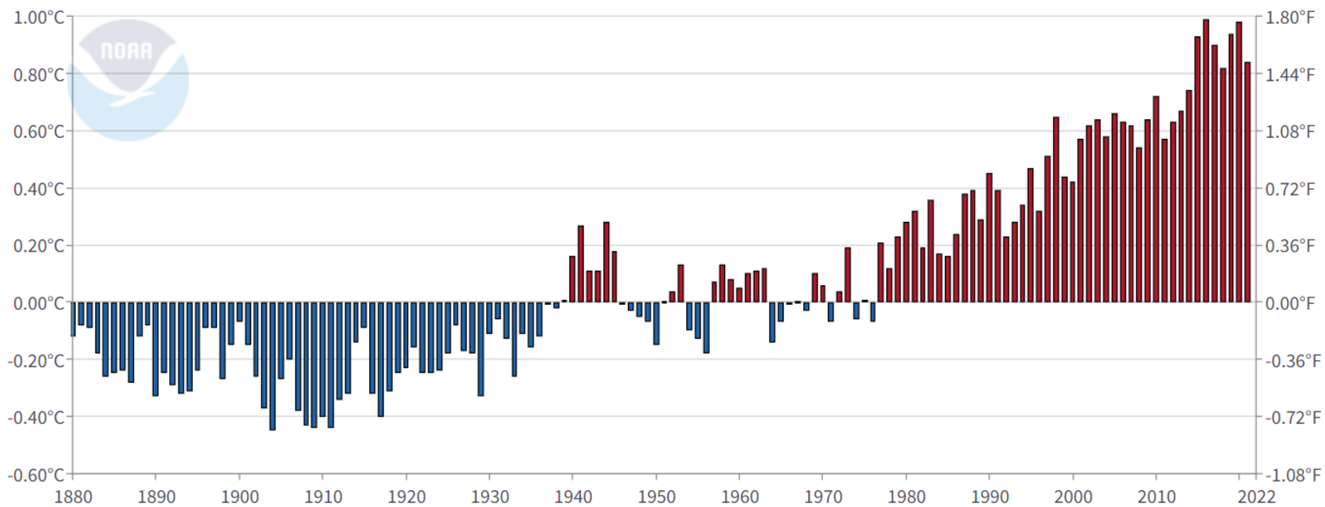


Figure 5. Average annual global temperatures since 1880 compared to the long-term average (1901-2000). The zero line represents the long-term average temperature for the planet; blue and red bars show the difference above or below average for each year. Celsius (C) values are on the left axis; Fahrenheit (F) values are on the right (NOAA National Centers for Environmental Information 2022).

Climate Modeling

To estimate future climate conditions that will result from increased atmospheric greenhouse gas concentrations, scientists use three-dimensional computer representations of the earth's climate, called General Circulation Models (GCMs). Because these models are produced at a global scale, they provide information at coarse geographical scales, roughly two to three degrees latitude and longitude, and are therefore less useful at regional scales. Downscaling takes coarse resolution GCMs and uses them to make projections at regional and local scales by incorporating what we know about global weather patterns and their relationships to local factors such as temperature, precipitation, elevation, proximity to large water bodies, and other regional factors that affect local climate. There are two methods of downscaling climate data to make the global models more relevant at a local scale. *Statistical downscaling* develops relationships between global atmospheric variables and local weather measurements and uses those relationships to generate models that are relevant at regional scales. *Dynamical downscaling* uses high-resolution regional climate models (RCMs) nested within GCMs to simulate regional conditions in much greater detail. For example, dynamically downscaled models can simulate the effects of topography, land cover, lakes, and other regional circulation patterns, such as changing levels of ice cover on the Great Lakes, which are then used to simulate variables such as lake effect snow.

The degree of future climate change depends on future global greenhouse gas emissions, which in turn will depend on the political climate, the global economy, growth and use of alternative energies, land-use decisions, and the extent of fossil fuel use. Because it is impossible to predict with certainty how these factors will play out over this century, climate modelers use simplified scenarios to compare plausible future conditions. The Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report used four scenarios known as Representative Concentration Pathways (RCPs) to simulate different levels of atmospheric greenhouse gas concentrations from the year 2000 to 2100 based on a range of climate policy outcomes, population trends, economic growth, energy consumption and sources, and land use in the next century (IPCC 2013, Figure 6). Using different RCPs allows modelers to examine the effects of different levels of greenhouse gas concentrations that result from a range of plausible future global decisions. Three of these are shown in the figure below. RCP8.5 assumes continued emissions increases, few climate change policies, and modest rates of technological change and energy intensity improvements; RCP4.5 is a stabilization scenario in which emissions peak around 2040 and then decline; RCP2.6 is a scenario that aims to limit the increase in global mean temperature to 2°C (3.6°F), and assumes participation of all nations in an effort to quickly and drastically reduce greenhouse gas emissions (Riahi et al. 2011, Thomson et al. 2011, van Vuuren et al. 2011). Currently, RCP8.5 most closely tracks worldwide emissions and is thought to be the most useful for projecting emissions out to the mid-21st century (Schwalm et al. 2020).

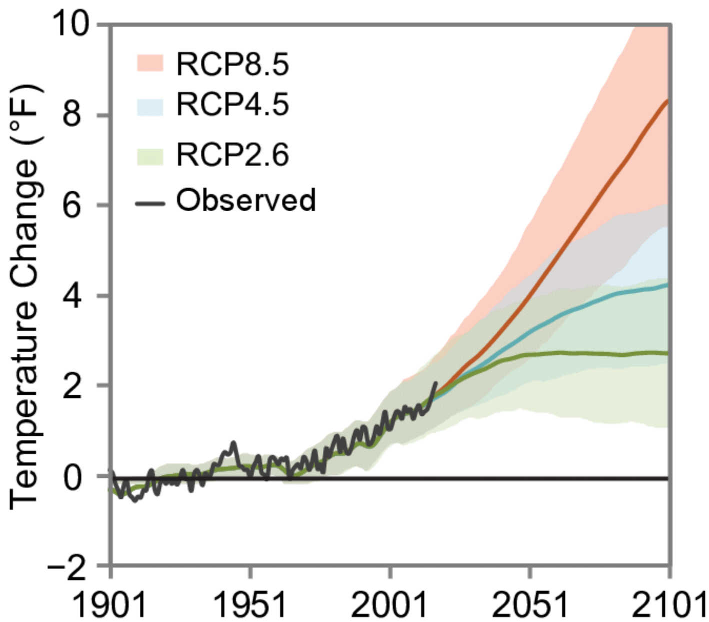


Figure 6. Multi-model simulated time series from 1900 to 2100 for the projected change in global annual mean surface temperature relative to 1901–1960 for a range of the Representative Concentration Pathways (RCPs). Observed change in temperature to the present day is also shown (USGCRP 2018).

Uncertainty

Uncertainty comes from a few sources in climate modeling. The first is emissions uncertainty, in which we can project greenhouse gas emissions over time, but actual emissions depend on a variety of factors, such as the political climate, global economy, growth and use of alternative energies, and global emissions reductions. When we look a century or more ahead, this becomes the biggest component of uncertainty. Another component of uncertainty is natural variability, including short-term factors such as volcanic eruptions, El Niño events, and tropical storms, as well as longer-term factors like natural climate variability over decades. While some of these are predictable, uncertainty still exists around the actual occurrence of these events. The final source of uncertainty is model variability or error, in which models are only as good as the science we have, the available data, and our knowledge of climate and weather patterns. Uncertainty about climate projections also increases as the models are downscaled because the process of making them more locally relevant introduces statistical uncertainty. When evaluating climate models and future projections, it is important to keep these sources of uncertainty in mind.

Climate Data Used in Assessment

Most of the figures below display projections from models using climate data dynamically downscaled under the RCP8.5 scenario for the mid-21st century. We selected dynamically downscaled data because factors included in those models such as topography, lakes, and ice cover are critical in determining the climate of the Great Lakes region. We selected RCP8.5 because for the first part of the 21st century, uncertainty in climate projections is largely driven by variation in climate models, as emissions scenarios are fairly similar (Beaumont et al. 2008, Hawkins and Sutton 2009), and because the dynamically downscaled data were available for RCP8.5. The dataset includes six global climate models (Table 1). In some of the figures below, two of the models are displayed, one projecting the least amount of change, and the other projecting the most amount of change to show the range of possible futures. Some figures below are taken from other studies; these are referenced in each figure caption.

Table 1. Six global climate models used in this assessment. Models produced using the Regional Climate Model (RCM) RegCM4 under the RCP8.5 scenario for the mid-21st century (nelson.wisc.edu/ccr/resources/dynamical-downscaling/index.php, Notaro et al. 2015a, Notaro et al. 2015b).

Global Climate Model	Abbreviation
Centre National de Recherches Meteorologiques Coupled Global Climate Model Version Five	CNRM-CM5
Model for Interdisciplinary Research on Climate Version Five	MIROC5
Institut Pierre Simon Laplace Coupled Model Version Five-Medium Resolution	IPSL-CM5-MR
Meteorological Research Institute Coupled Global Climate Model Version Three	MRI-CGCM3
Centre for Australian Weather and Climate Research, Australia GCM	ACCESS1-0
National Oceanic and Atmospheric Administration Geophysical Fluid Dynamics Laboratory model	GFDL-ESM2M

Air Temperature

Air temperature increases over the 20th century in the Great Lakes region have been larger than increases across the rest of the continental United States. The Great Lakes basin has warmed 1.6°F in annual mean temperature relative to 1901-1960, higher than the average change of 1.2°F for the rest of the contiguous United States in the same time period (Figure 7, Vose et al. 2014).

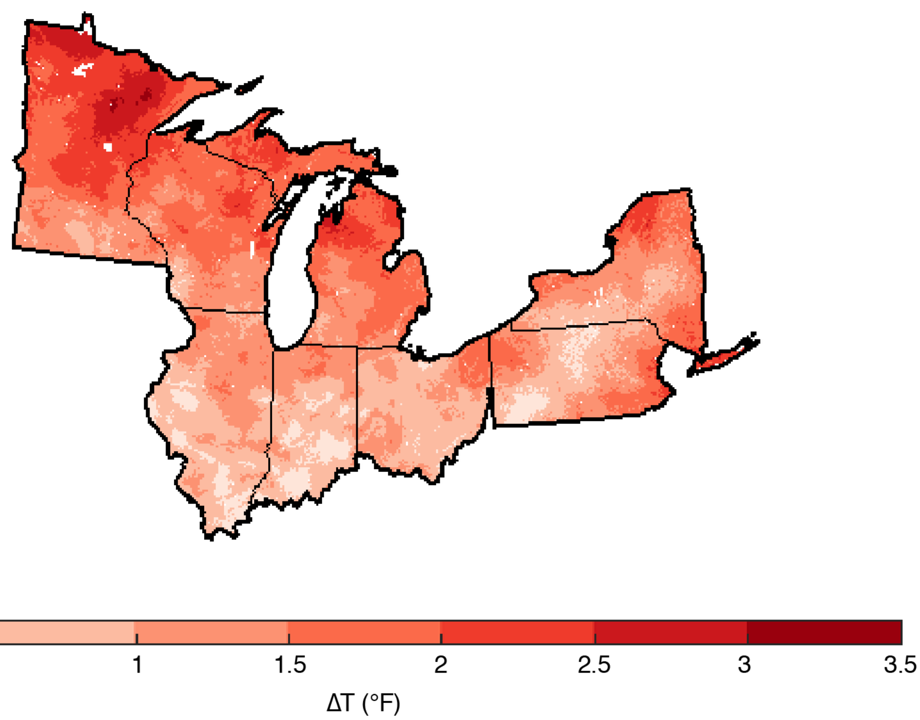


Figure 7. Observed changes in annually-averaged temperature (°F) for the U.S. states bordering the Great Lakes for present-day (1986–2016) relative to 1901–1960. Derived from the NOAA nClimDiv dataset (Vose et al. 2014). Figure source: NOAA/NCEI.

Average daytime high temperatures have increased 1.4°F (from 53.1°F to 54.5°F) in the upper Midwest. Average nighttime low temperatures have increased more than daytime temperatures: 3.1°F in the upper Midwest (from 31.1°F to 34.2°F) from 1900 to 2019 (NOAA National Centers for Environmental Information 2019):

> "When I was a kid, it was 25 below for two weeks, snow used to be 4-5 feet high, but you don't see that anymore." —*Joseph Duffy*

Increases in temperature are projected to continue. Average annual (mean) temperature across the Ceded Territories is projected to rise by 2.9°F to 5.5°F by the mid-21st century relative to the 1980-1999 average:

> "And it gets warm. It's goin' to get warmer; we know that." —*Makoons Fred Ackley Jr.*

We can expect the smallest increase in average temperature in the spring (an increase of 2.1°F to 5.4°F), and the largest increase in average temperature in the summer (an increase of 3.5°F to 6.6°F) (Figure 8).

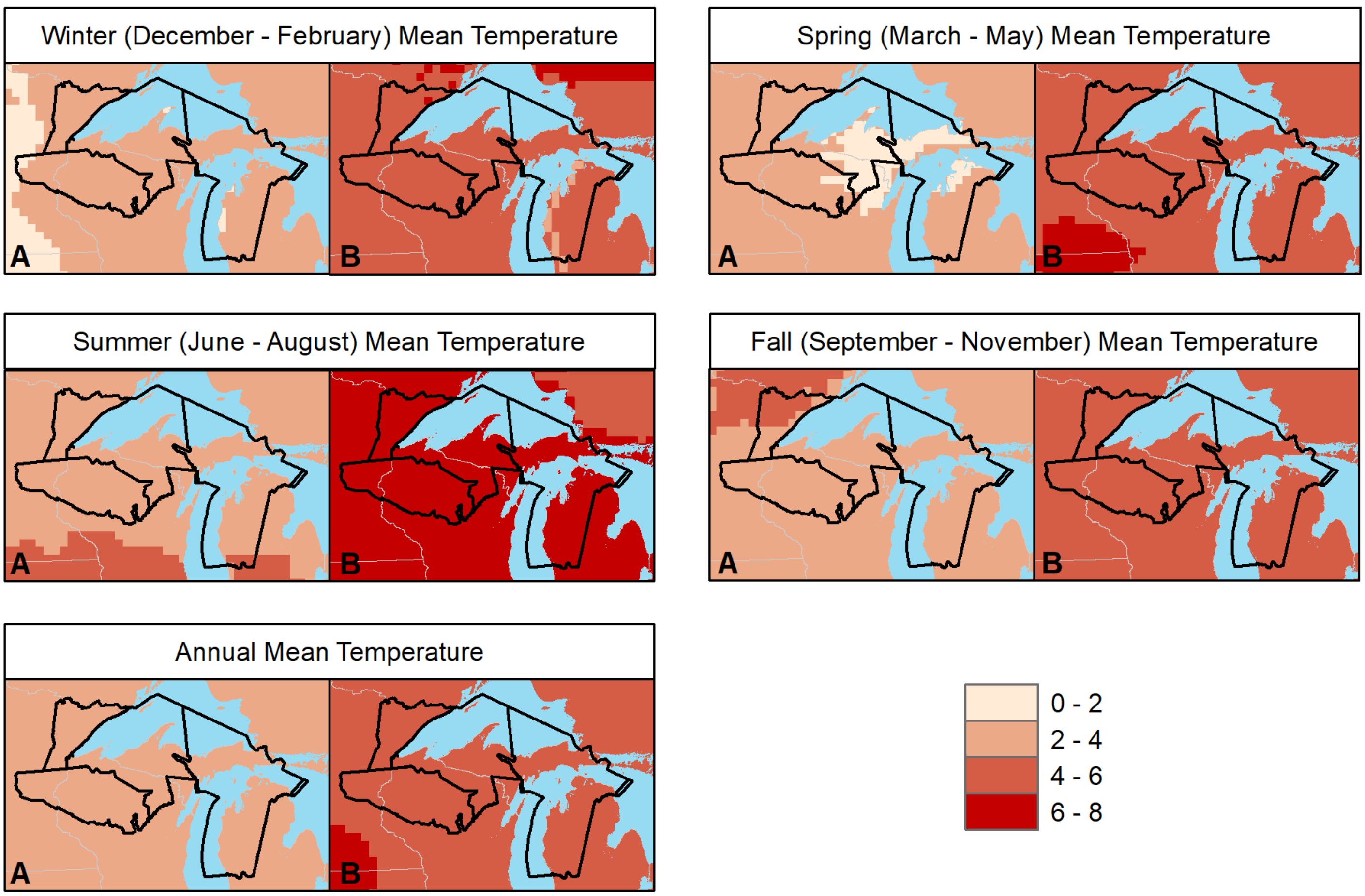


Figure 8. Increase in average temperature (°F) across the Ceded Territories by the mid-21st century relative to the 1980-1999 average. On the top are seasonal projections and on the bottom are annual projections. Models displayed are A) MRI-CGCM3 (least projected change) and B) MIROC5 (most projected change). Data from nelson.wisc.edu/ccr/resources/dynamical-downscaling/index.php.

Average minimum temperatures in the Ceded Territories are projected to rise 1.8°F to 7.5°F relative to the 1980-1999 average. The biggest increases in minimum temperatures will be in the winter months (December – February) (Figure 9). An increase in winter minimum temperatures will also mean warmer lakes with fewer days of ice and thinner ice cover (see ice cover section below).

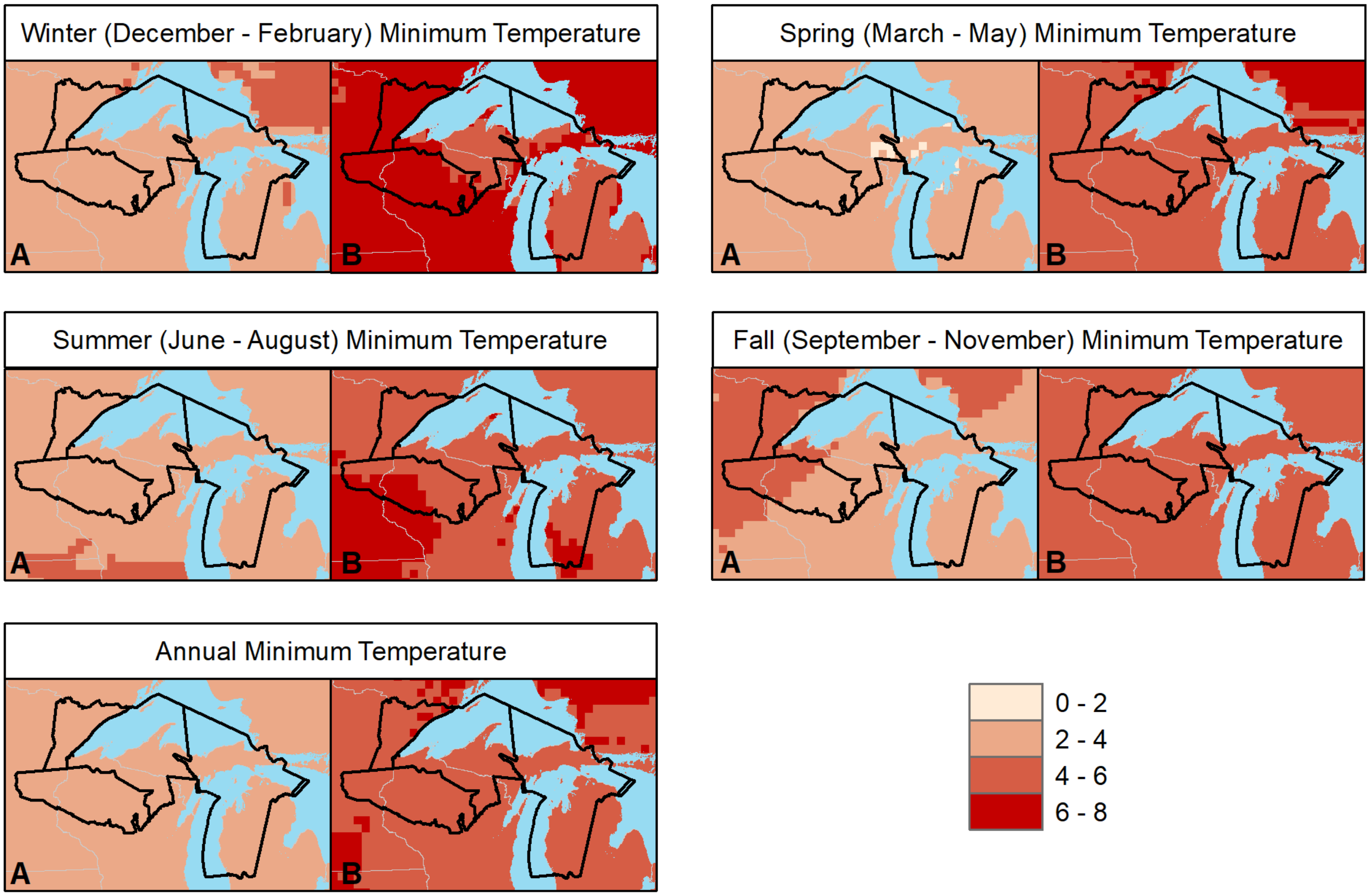


Figure 9. Increase in average minimum temperature (°F) across the Ceded Territories by the mid-21st century relative to the 1980-1999 average. On the top are seasonal projections, and on the bottom are annual projections. Models displayed are A) MRI-CGCM3 (least projected change) and B) MIROC5 (most projected change). Data from nelson.wisc.edu/ccr/resources/dynamical-downscaling/index.php.

Increases in air temperature will directly affect many beings adapted to northern climates by way of factors such as heat stress and changes in behavior. Gijigijigaaneshiinh (chickadee) has already been affected by increasing temperatures:

> "Chickadees are climate sensitive. They love the cold. And if it's not cold, they're not going to be around, they'll keep going north. Those are really interesting ones for me. In my lifetime I don't see the number of chickadees around here that you used to, in the wintertime, at all, not even close. Because when I was a kid, they were everywhere. You'd walk out in the woods and all you could hear all day long was chicka-deedeedeedee, chicka-deedeedeedee." —*Niso-asin Sean Fahrlander*

Warmer temperatures will make the Ceded Territories more inhabitable for bakaan ingoji gaa-ondaadag that may not have lived here previously:

> "[One year I] ran into opossums here! Even on the north end of Mille Lacs Lake. And it was like, 'Where did opossums come from?' You know? And I can only think that's the weather changing. Maybe not severe swings in weather we used to have, instead it's more consistent warm."
> —*Curt Kalk*

Increases in temperature will also affect plants and animal beings indirectly in a variety of ways. In the winter, more precipitation is likely to fall as rain, reducing the snowpack, which is often critical for a slow release of water in the spring and for protecting beings such as miin (blueberry) from browse by waawaashkeshi, waabooz, and other plant-eating beings. It may also lead to more crusty snow conditions, which can make travel difficult for waawaashkeshi and hunting more difficult for gookooko'oo (owl) and waabizheshi (American marten) (GLIFWC Climate Change Team 2018, Mysterud 2016). Along with heavy precipitation events, warmer temperatures may also contribute to algae blooms in lakes, such as the unprecedented blue-green algae bloom in Lake Superior in 2018 (Croll 2019).

Increasing temperatures will have cultural impacts, including on the tradition of harvesting Anishinaabe-zhiiwaagamizigan (Figures 10 and 11). Spring nights below 32°F are extremely important for tapping ziinzibaakwadwaatig (sugar maple), as freezing nights and thawing days allow ziinzibaakwadwaaboo (maple sap) to run. The timing of ziinzibaakwadwaaboo collection is becoming increasingly erratic, and in some years in which temperatures are especially warm and freeze-thaw cycles are irregular, tribal members are getting very little or even no ziinzibaakwadwaaboo at all:

> "I picked this habit up of making maple syrup in the last, say, 5 years plus, and in that time frame I have noticed that the season is becoming shorter in just that little bit of time. I don't ever remember… talking about not having a season. But new tappers of today are saying we are missing it, or we missed it, the window of opportunity seems to be shorter." —*Mark Duffy*

> "One year [my daughter] couldn't even get anything [maple sap] ... because it was too warm."
> —*Maryellen Baker*

> "The warmups have not been gradual and predictable like they had been in the past, like it would slowly start creeping up, slowly start warming up, and you just knew sugaring was right around the corner. But now, you'll get these warm spells in January sometimes where everything starts melting and outside feels like it's time to sugar. And it'll plunge back down to single negative temperatures, and it seems like in the past March was always the time we would start tapping and just in the last few years I've been tapping in February, which is odd, but at the same time too, I try to keep an eye on what's going on out there. I don't want to tap too soon either like when the trees are still frozen and hurt them. I keep a pretty close eye on those things. I've actually tapped early in February when other people said it's too early and I've gotten my largest sap runs during those times." —*Gidigaa bizhiw Jerry Jondreau*

Warmer temperatures may cause ziinzibaakwadwaaboo production to increase in the upper Midwest by the end of the 21st century, particularly in the 1854 Ceded Territory. However, ziinzibaakwadwaaboo sugar content is expected to decline as temperatures warm, resulting in lower syrup production overall in most of the Ceded Territories (Rapp et al. 2019).

Figure 10. A hand-crafted tap made from sumac, Bear Trap Creek, WI, 2022. Warmer temperatures are causing ziinzibaakwadwaaboo (maple sap) production to become more erratic. Photo credit: D White (GLIFWC).

Figure 11. Boiling down ziinzibaakwadwaaboo (maple sap) to make Anishinaabe-zhiiwaagamizigan (maple syrup). Anishinaabe-zhiiwaagamizigan production is expected to decline across the Ceded Territories due to climate change. Photo credit: CO Rasmussen (GLIFWC).

Temperature Extremes

The Ceded Territories have seen more hot days and fewer cold nights in recent years (USGCRP 2018):

> "My brother he'll call me up, you know, and he'll say, 'Holy Christ' …he's 80 years old… he says, 'Holy Christ Joe, you're having a heat wave up there.' Yeah, it's 36 degrees right now… that is warm for us. We should be 20 below zero right now in January. I can remember when I was a kid school closed for the whole week, 35-40 below zero." —*Joseph Duffy*

The number of nights with low temperatures below 0°F are projected to decrease by up to 24 days per winter by the mid-21st century, and the number of days with a high temperature above 90°F is projected to increase by up to 28 days per year by the mid-21st century relative to the 1980-1999 average (Figure 12).

High temperatures stress a variety of beings, including humans. High temperatures can negatively affect the pollination of manoomin and reduce its seed production (Hansen 2008). Mooz (moose) is another northern being stressed by high summer temperatures. Mooz struggles to regulate its internal body temperature when temperatures rise, which can result in changes in movement, poor nutrition, and increased sensitivity to parasites (Stults et al. 2016).

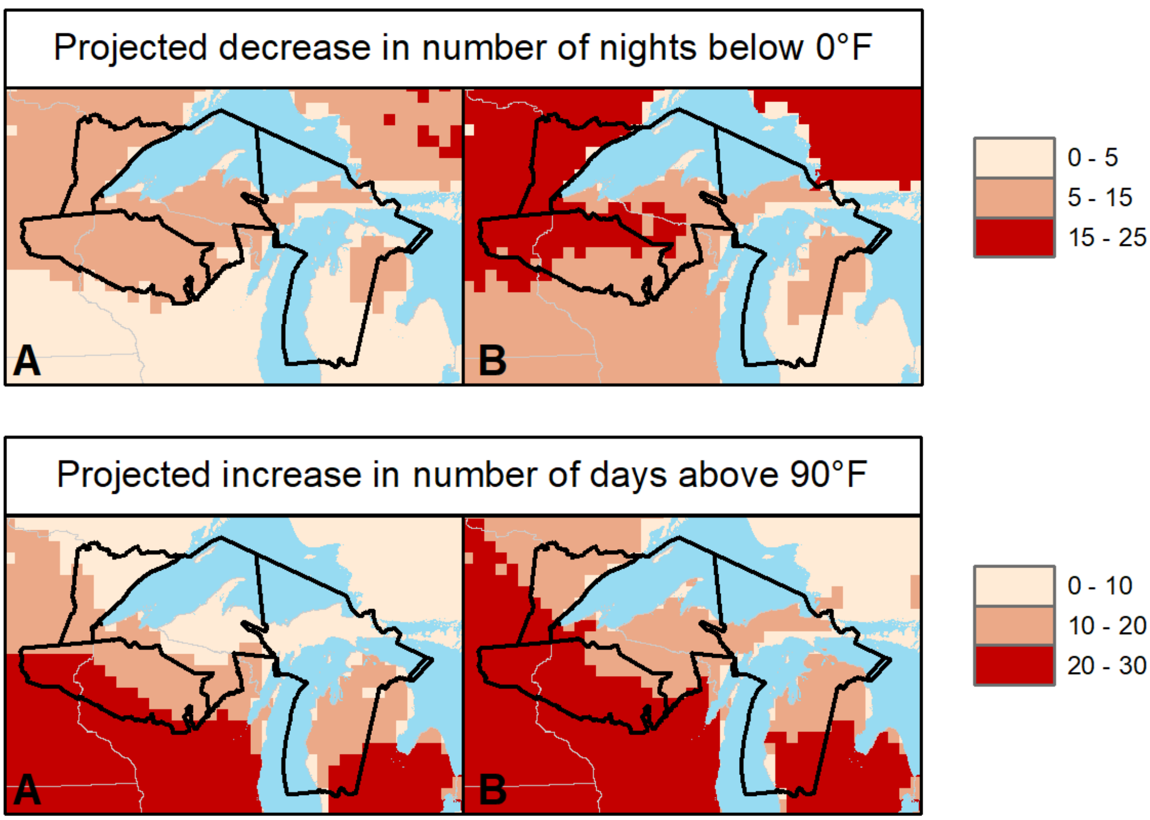


Figure 12. Projected decrease in the number of below 0°F nights and increase in the number of days above 90°F in the Ceded Territories by the mid-21st century relative to the 1980-1999 average. Models displayed are A) MRI-CGCM3 (least projected change) and B) MIROC5 (most projected change). Data from nelson.wisc.edu/ccr/resources/dynamical-downscaling/index.php.

Cold nights are important in this region for several reasons, including limiting populations of manidoonsag that eat certain plant beings. The emerald ash borer is predicted to decimate ash populations in the Midwest. Baapaagimaak is used for basket-making, among other things (Figures 13 and 14). Aagimaak (white ash) is used for snowshoes, lacrosse sticks, and other crafts. Emerald ash borer larvae are vulnerable to cold temperatures, and nights below 0°F are important to keep their populations in check. Models show that about five percent of emerald ash borer larvae should die when temperatures reach 0°F, 34 percent at -10°F, 79 percent at -20°F, and 98 percent at -30°F (Venette and Abrahamson 2010). Cold nights are also essential for building ice cover on lakes. This ice cover can slow the growth of bakaan ingoji gaa-ondaadag that may be able to outcompete native beings. For example, non-local *Phragmites* and non-local cattails can sometimes outcompete manoomin, but significant winter ice cover can help keep their populations low (Hansen 2008).

Figure 13. Mashkiiziibiing (Bad River Band of Lake Superior Tribe of Chippewa Indians) tribal member April Stone identifies growth patterns in baapaagimaak (black ash) logs cut for the traditional craft of basket-making. Baapaagimaak is threatened by the emerald ash borer. Photo credit: CO Rasmussen (GLIFWC).

Figure 14. Baapaagimaak (black ash) pack basket made by Mashkiiziibiing (Bad River Band of Lake Superior Tribe of Chippewa Indians) tribal member April Stone. Photo credit: April Stone.

Water Temperature

Globally, mean lake summer surface temperatures have increased by 0.61°F (0.34°C) per decade from 1985 to 2009 (O'Reilly et al. 2015). In Lake Superior, summer (July-September) surface waters have increased by 1.4±0.7°F (0.8±0.4°C)/decade from 1979 to 2014, more than in the other Great Lakes. In Lake Michigan and Lake Huron, summer surface waters have warmed by 0.9±0.7°F (0.5±0.4°C)/decade and 1.3±0.5°F (0.7±0.3°C)/decade, respectively (Environment and Climate Change Canada and the U.S. Environmental Protection Agency 2017, Figure 15). This rate of warming is faster than increases in regional air temperatures due to earlier stratification because of reduced ice cover (Austin and Colman 2007, 2008, Environment and Climate Change Canada and the U.S. Environmental Protection Agency 2017, Pratt et al. 2016).

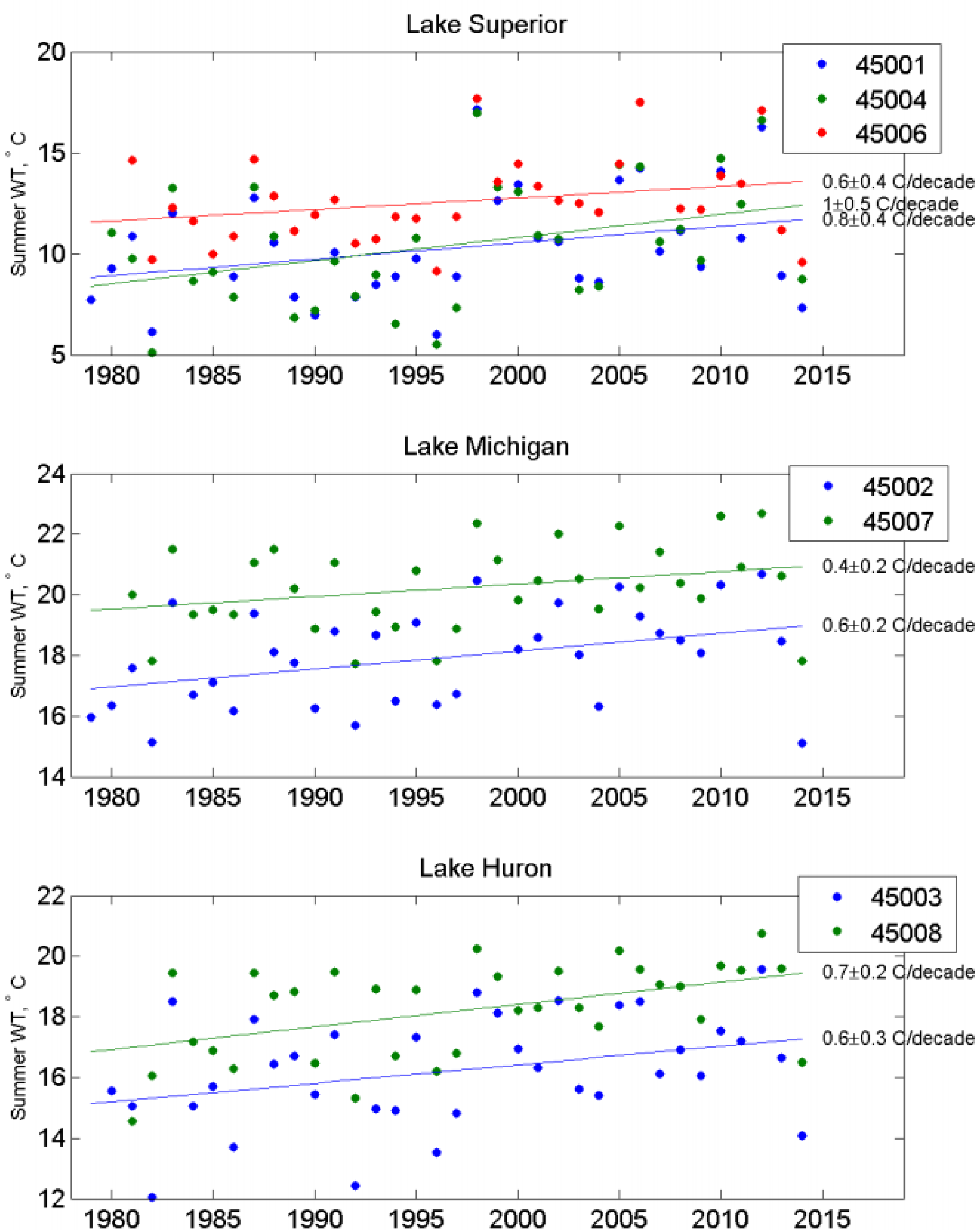


Figure 15. Summer (July-September) surface water temperature trends for Lake Superior, Lake Michigan, and Lake Huron from 1980-2015. Different colored dots represent different locations in each lake. Reproduced from Environment and Climate Change Canada and the U.S. Environmental Protection Agency 2017.

Similarly, in inland lakes throughout the Ceded Territories, water temperatures have increased, though increases have not been uniform across the region. Characteristics in each lake can alter the influence warmer air will have on water temperature throughout the year. These characteristics include fetch (distance traveled by wind across open water), wind, canopy cover (how much shade exists in the watershed), solar radiation, mixing (surface waters mixing with water at the bottom), shape, depth, and water clarity (Figure 16; O'Reilly et al. 2015; Read et al. 2014; Rose et al. 2016). In turn, the magnitude of warming in each waterbody will influence its ecology and the availability of beings for harvest by Anishinaabe people.

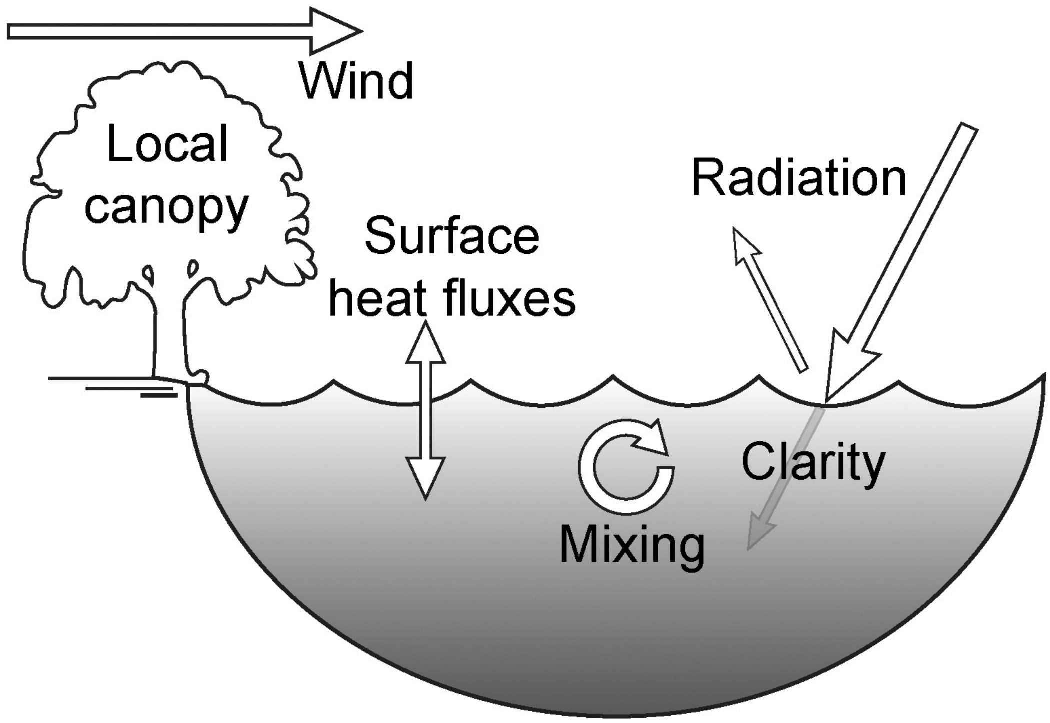


Figure 16. Characteristics about each lake can influence water temperature throughout the year. Reproduced from Read et al. 2014.

In inland lakes, changes in water temperature will depend on the characteristics of each lake. Models predict by mid-century, growing degree days above a base of 41°F (5°C) may decrease by 4% or increase by as much as 17%. By the end of the century, all models indicated an increase in growing degree days (2% - 31%). These increases in temperature and number of growing degree days are predicted to alter many fish communities in inland lakes by favoring warm-water beings (e.g., ashigan (largemouth bass)) over cool- and cold-water beings (e.g., ogaa) (Hansen et al. 2017):

> "Whitefish lay in the fall because they can't take the heat when the water starts to warm up. They're too sensitive to it. So... whitefish and tullibee are going to be the first ones to be affected by a temperature shift in your water column." —*Niso-asin Sean Fahrlander*

Great Lakes water temperatures are projected to warm, though the warming will vary across seasons. Surface water temperatures in the summer may experience increases of up to 3.6°F (2°C) and Lake Superior will experience the greatest increase in surface water temperatures (Figure 17; Environment and Climate Change Canada 2020). All of the Great Lakes will also have a longer duration of thermal stratification, stronger stability of stratification, and deeper daily mixing depths during peak thermal stratification (Lehman 2002). A study of Lake Superior found that preferred thermal habitat has been increasing for lean lake trout, Chinook salmon, and ogaa, but decreasing for Siscowet lake trout (Cline et al. 2013).

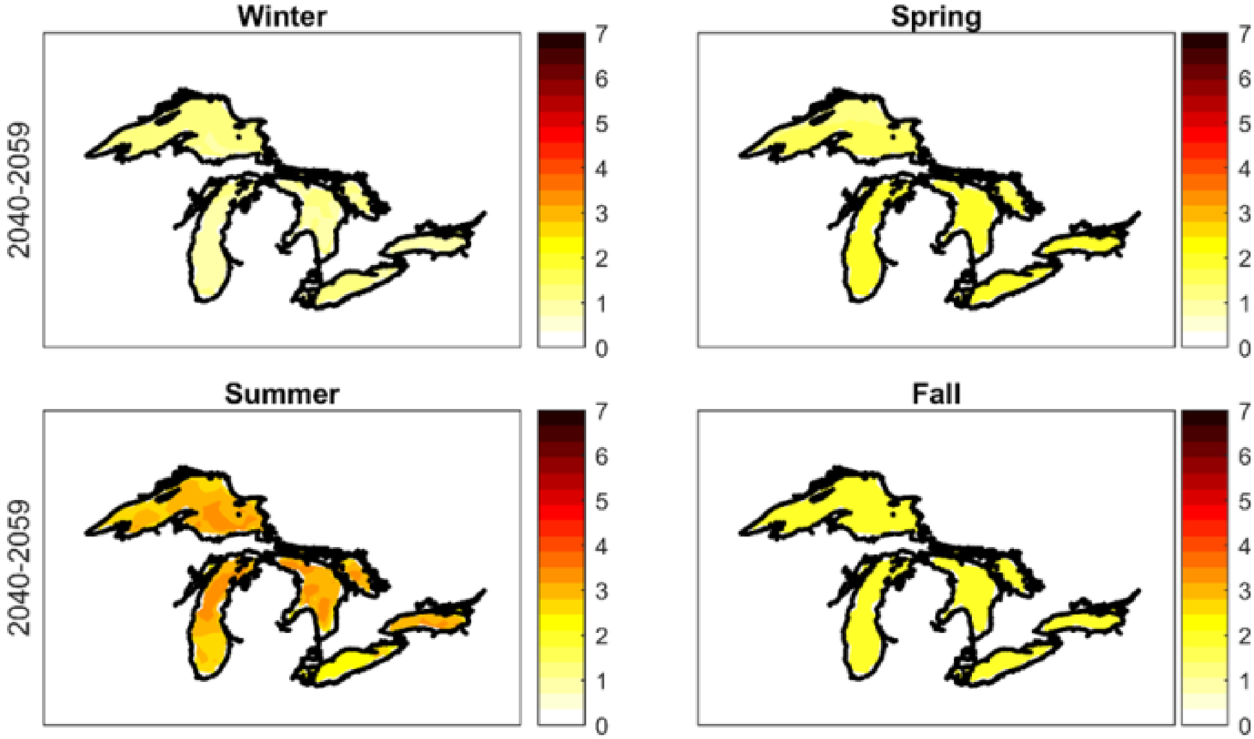


Figure 17. Preliminary results from a study using data from the Canadian Regional Climate Model Version 5 (CRCM5) under the RCP8.5 high emission scenario. The figure shows changes in lake surface temperatures (°C) between mid-century (2040-2059) and the current climate (1986-2005) (Environment and Climate Change Canada 2020).

Growing Season

The growing season, the part of the year in which conditions allow for plant growth, is expected to increase across the Ceded Territories by an average of 19 to 23 days by the mid-21st century relative to the 1980-1999 average (Figure 18). The last spring frost is projected to occur up to 17 days earlier and the first fall frost is projected to occur 5 to 20 days later by the mid-21st century relative to the 1980-1999 average (Figure 19).

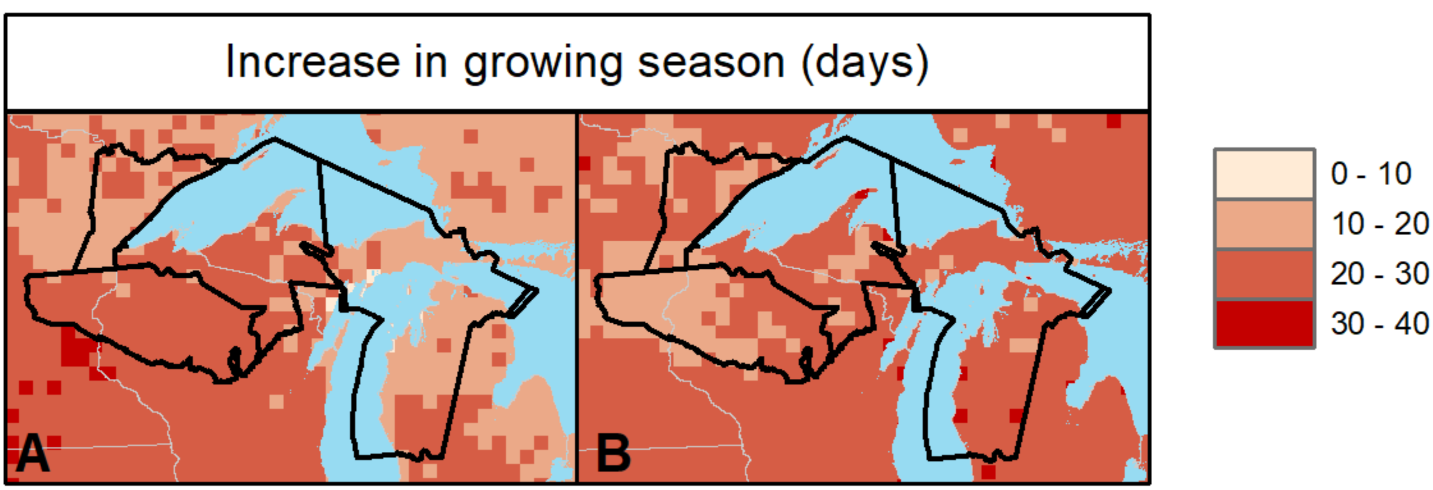


Figure 18. Projected increase in growing season length (frost-free season) in the Ceded Territories by the mid-21st century, relative to the 1980-1999 average, in days. Models displayed are A) MRI-CGCM3 (least projected change) and B) MIROC5 (most projected change). Data from nelson.wisc.edu/ccr/resources/dynamical-downscaling/index.php.

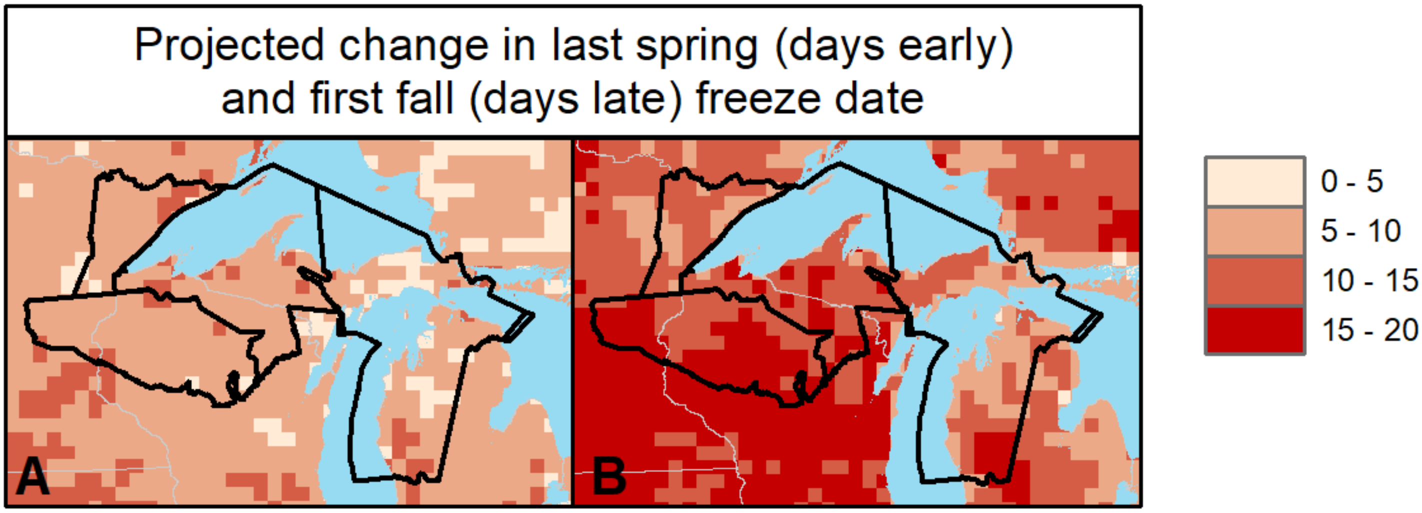


Figure 19. Projected change in date of last spring and first fall freeze, in number of days, in the Ceded Territories by the mid-21st century relative to the 1980-1999 average. A displays projected spring freeze date; B displays projected fall freeze date. Model displayed is MRI-CGCM3. Data from nelson.wisc.edu/ccr/resources/dynamical-downscaling/index.php. Note that MRI-CGCM3 was the only model available for change in spring and fall freeze date.

A longer growing season will have a variety of effects. Plants will have increased growth and additional storage of carbon dioxide for plant beings (White et al. 1999). However, it will also mean more time for manidoonsag that eat plant beings to breed and produce multiple generations, more time for diseases to impact particular beings, and more time for bakaan ingoji gaa-ondaadag to grow (Lipton et al. 2018). Late frosts that occur after an early spring may damage plant beings that have begun flowering or leafing out earlier in the year, and may also cause mismatches between pollinators and the beings they pollinate (Polgar and Primack 2011).

Ishkode (Fire)

Increased temperatures, along with the potential for drying conditions, may cause conditions conducive to wildfire to occur more frequently and earlier in the year, with the Upper Peninsula of Michigan and northern Minnesota projected to have some of the biggest increases in these conditions (Kerr et al. 2018). Increased wildfire has impacts on human health, infrastructure, and timber production. However, it also provides an opportunity to return to the relationship with ishkode that Ojibwe people have long held, which has been demonstrated to reduce the conditions that lead to uncontrolled fire, and to be helpful in the restoration of culturally important landscapes and beings.

Cultural burning of land areas to promote certain beings or habitats was a part of Ojibwe stewardship for thousands of years, until fire suppression became the focus of local, state, and federal land management agencies. Continuous fire suppression results in a buildup of fuels on the landscape and makes fires more intense when they occur. However, through utilizing Indigenous knowledges, there has been a recent push to revitalize both cultural and prescribed burns. In 2017, a 5-acre cultural burn was carried out on Stockton Island through a partnership between local tribes and the Apostle Islands National Lakeshore in northern Wisconsin. The goal of the burn was to restore pine barren habitat, increase miin production, and reconnect local Ojibwe with cultural practices:

> "They ask me how come there's no more berries. You don't let nobody burn… You got to burn berries to germinate them. You gotta burn them... the brush is outgrowing the berries... [Historically], about every five years somebody would burn it… two years from then, holy cripe, blueberries, lots of them."
> —*Joseph Duffy*

Precipitation: Rain

Precipitation is more difficult to project than temperature, because of the number of local and regional variables involved in producing precipitation. Because of this variability, climate models do not all agree whether average precipitation will increase or decrease in the future (Figure 20). What scientists are confident of is that precipitation will become more variable.

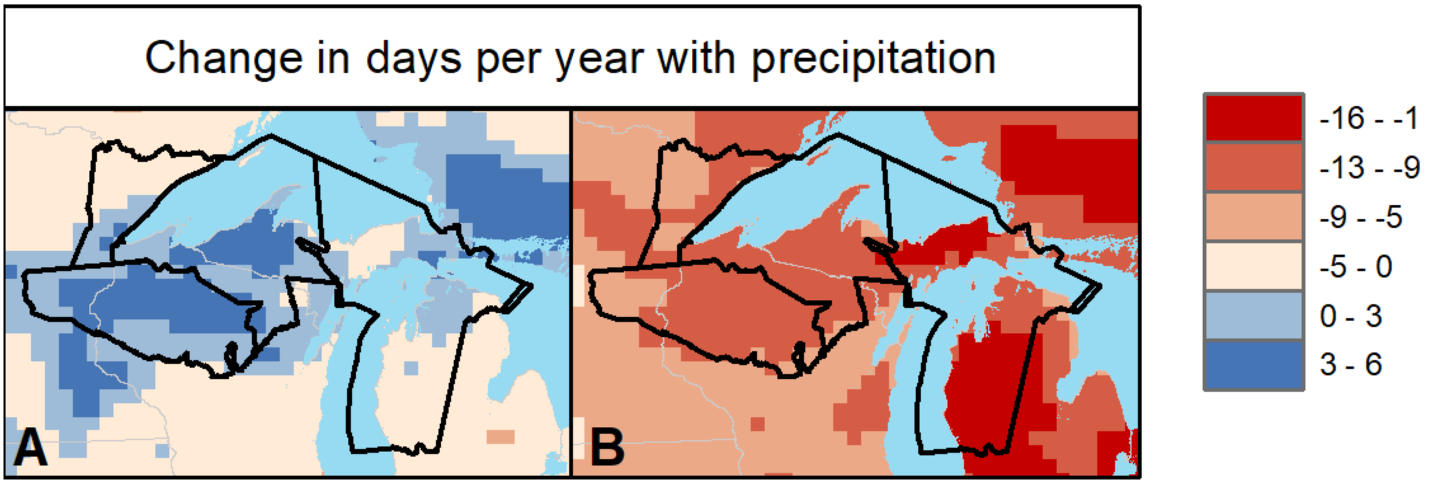


Figure 20. Projected change in the number of days per year with precipitation in any form in the Ceded Territories by the mid-21st century, relative to the 1980-1999 average. Models displayed are A) MRI-CGCM3 (least projected change) and B) ACCESS1-0 (most projected change). Data from nelson.wisc.edu/ccr/resources/dynamical-downscaling/index.php.

Heavy precipitation events have increased. The Midwest experienced a 42% increase in the amount of precipitation falling in the top 1% of heavy precipitation events (typically defined as more than one inch of rainfall within a 24-hour period) from 1901 to 2016 (Figure 21). Heavy rains can be extremely destructive. For example, in 2012, a 500-year rain event (in which a flood of that magnitude has a 1 in 500 chance of occurring in a given year) dropped 9-11 inches of rain over western Lake Superior. In July 2016, only four years later, the Bad River area received another 500-year rain event that dropped 8-10 inches of rain in an 8-hour period and caused the Bad River to rise over 27 feet (Figure 22). This event washed out roads, destroyed homes, caused power outages, and left community members stranded without access to medical care, medical supplies, food, or water. Flood damage to northern Wisconsin from the 2016 event is estimated at $35 million.

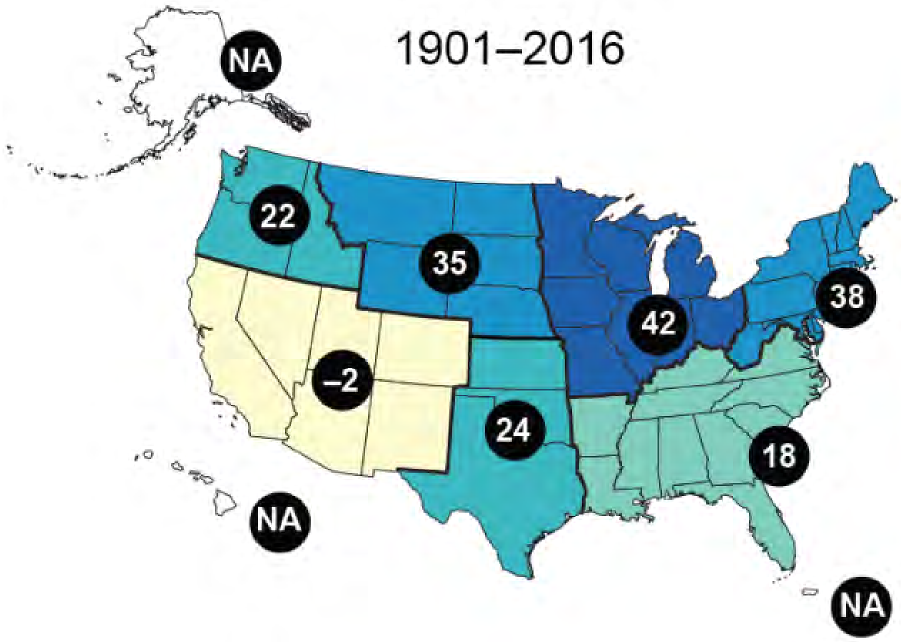


Figure 21. Observed (numbers in black circles give the percentage change) change in the amount of precipitation falling in the heaviest 1% of events (99th percentile of the distribution). The observed trend is calculated as the difference between 1901–1960 and 1986–2016. The trends are averaged over each National Climate Assessment region. Figure taken from USGCRP 2018; originally adapted from Easterling et al. 2017.

Figure 22. Flooding in the Mashkiiziibiing (Bad River Band of Lake Superior Tribe of Chippewa Indians) area after the 500-year rain event in July 2016. Photo credit: CO Rasmussen (GLIFWC).

Heavy rain events are projected to become more frequent and with more precipitation, with parts of the Ceded Territories experiencing an increase of over 40% more precipitation in the heaviest rain events by the end of the century (2070-2099) relative to the 1986-2015 average (USGCRP 2018). This means that more total precipitation is projected to fall in bigger events, with drier periods between storms (Figure 23):

> "I do think this flood we had last year [2016], I think that's going to become the norm, and [100-year floods will be happening every] 5 or 10 years." —*Maria Nevala*

These large events can cause erosion, sedimentation, flooding, and can have consequences for both plant and animal beings in the Ceded Territories. For example, sedimentation and flooding can impact manoomin, particularly in its "floating leaf" stage:

> "With all this water, if this keeps up, we get that catastrophic amount of rain, come first of June or so and the wild rice is floating leaf stage, we know we're going to have problems." —*Curt Kalk*

In this stage of development, the plants start exchanging gases with the air, and if the water levels rise too quickly, the plants can drown. This occurred in the flood of June 2012, in which many manoomin beds in the Ceded Territories, particularly in Minnesota, were destroyed. Manoomin was also affected in the 2016 event:

> "This year [2016] there wasn't any rice anywhere, they had to go look for it, because of that July storm that we had." —*Mark Duffy*

> "[The 2016 storm] knocked all the rice flat on the ground, Christ we had to go 200 miles to find some rice. Before we would just go here… every lake had rice on it. Now we're halfway to Wausau… nobody had rice… with that big rain we had, the wind knocked the shit out of the rice."
> —*Joseph Duffy*

Heavy rain events will continue to affect manoomin in every life stage, which will continue to affect traditional gathering practices and those relying on manoomin for subsistence.

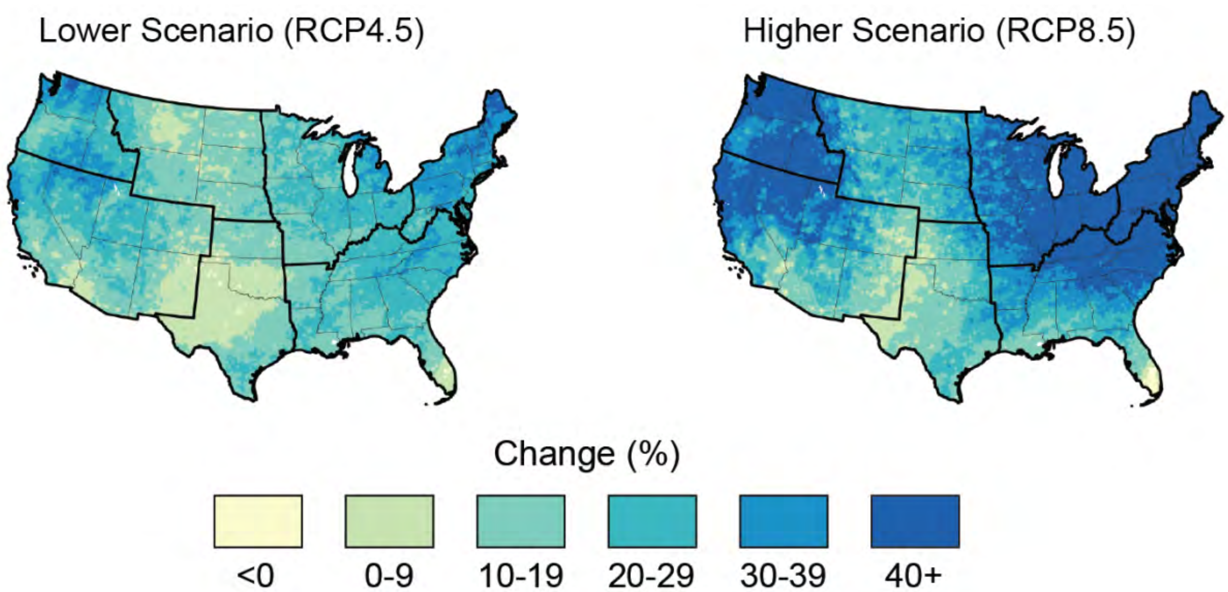


Figure 23. Projected change in the amount of precipitation falling in the heaviest 1% of events (99th percentile of the distribution). Trends are for a lower (RCP4.5, left) and a higher (RCP8.5, right) scenario for the period 2070–2099 relative to 1986–2015. Figure taken from USGCRP 2018; originally adapted from Easterling et al. 2017.

Many tribal members have noticed more variable precipitation, including more frequent rainy days in the fall. This can have consequences on many aspects of harvesting, including tasks such as drying manoomin (Figure 24):

> "It's been so wet during the last few times that the rice is laid out. I've noticed cloudy days, a lot of humidity, a lot of rain so it was just really moist in the air so the rice can't dry out on the tarps and it didn't matter how many times I would move the tarp into direct sunlight, which I would do. I would make sure I stay home and when it's gonna be sunny, I block off my driveway so no cars can come in. It didn't matter what I did, the rice still got moldy because it didn't have the time to dry. I actually had to throw out rice." —*April Stone*

Figure 24. Manoomin (wild rice) drying on a tarp after harvest. All aspects of manoomin harvesting are being affected by climate change; drying manoomin has become more difficult as increased humidity has caused it to mold. Photo credit: CO Rasmussen (GLIFWC).

Longer dry periods between heavy precipitation events will also have effects on many beings sensitive to drought:

> "Now the problem that I'm seeing with sugar maple is they're really incredibly sensitive to drought cycles... you can stress the trees. And especially if you're tapping them, they can go. You can tap them if you have one bad season of drought. But you have lower water quantities over a period of time... it really has an effect on them." —*Niso-asin Sean Fahrlander*

> "A lot of [swamps] are drying out. When you drive along over the past 30 years, a lot of these little sloughs that used to have tamarack or spruce growing in them, they're all dead now, standing there bare. Swamps are drying up. So there's an impact." —*Niso-asin Sean Fahrlander*

Changing precipitation will affect beings that depend on aquatic or moist habitats for some or all of their life cycles. These include beings such as waawaatesi (firefly), which depends on moist or aquatic habitats for egg laying and larval growth, wazhashk (muskrat), which depends on wetlands with particular water levels, ogaa, which depends on shallow (typically <2m) gravel bars for spawning in the spring, and mitigoningwiishib (wood duck), which depends on particular water depths for breeding and raising chicks.

Precipitation: Snow

The Ceded Territories have received snow later in the year, and are experiencing less snow overall:

> "People in their 50s can remember, there has never been a Thanksgiving without snow on the ground. Deer season, Thanksgiving there was always snow on the ground, that's mid-November to late November. Always snow on the ground. A little bit later we said 'Well, are you gonna have snow for deer season?' The generation of today, asked the question, 'Are we gonna have snow for Christmas?' It's a month's change in just 20-30 years." —*Mark Duffy*

> "The snow, you would literally get snowed in, you know, people would get snowed in, like worried that they wouldn't be able to get out of their door the snow just got so deep so quick, and now, I don't really have to wear my snow boots very often. It's pretty crazy how much that's changed." —*Gidigaa bizhiw Jerry Jondreau*

> "We haven't had [snow] in the last 5 years… I mean, we used to have snowstorms up to my shed." —*Joseph Duffy*

> "Another good rain, we'd lose the snowpack; it's like Earth's sleeping without a blanket." —*Mike Wiggins Jr.*

Snow depth is projected to decline due to increased temperatures, with more precipitation falling as rain instead of snow and decreased winter precipitation in general. January's snow depth is projected to be up to 10 inches below its current levels by the mid-21st century relative to the 1980-1999 average, and the number of days in a year with snowfall may decrease up to 18 days per year (Figures 25 and 26).

This decrease in snowpack may negatively affect beings such as waabizheshi, which depends on deep fluffy snow for travel and for hunting small mammals (Stone 2010). Waabooz also depends heavily on snow for camouflage. Its fall molt from brown to white appears to be closely linked to photoperiod (the amount of light in a day) instead of snow cover, and waabooz is turning white around the same time in the winter, even as the snow season starts later. This makes it highly susceptible to predation by a variety of beings (Zimova et al. 2016). Waabooz also depends on snow for food availability in the winter – a deeper snowpack allows it to reach more high-quality browse. Waabooz has already been observed to be in decline:

> "I haven't seen a rabbit in 15 years, and I shot hundreds and hundreds of them." —*Joseph Duffy*

As a decrease in snowpack continues to affect waabooz and many other beings, it will also affect the Anishinaabeg who depend on these beings:

> "[Waabooz is a] big part of a staple for food... they also used all the rabbit furs, rabbit feet and everything for our traditional beading." —*Giiwegiizhigookway Martin*

It will also change the behavior of beings such as waawaashkeshi:

> "[Now] the winters are mild enough with the exception of extreme blizzards that drop a lot of snow at once. Generally speaking, like here we are in January and the snowpack is almost gone, but the winters have been mild enough snow-wise to where deer aren't migrating." —*Mike Wiggins Jr.*

The combination of increased temperatures and precipitation falling as rain will likely cause an increased frequency of ice storms, which can stress trees and cause them to bend or break.

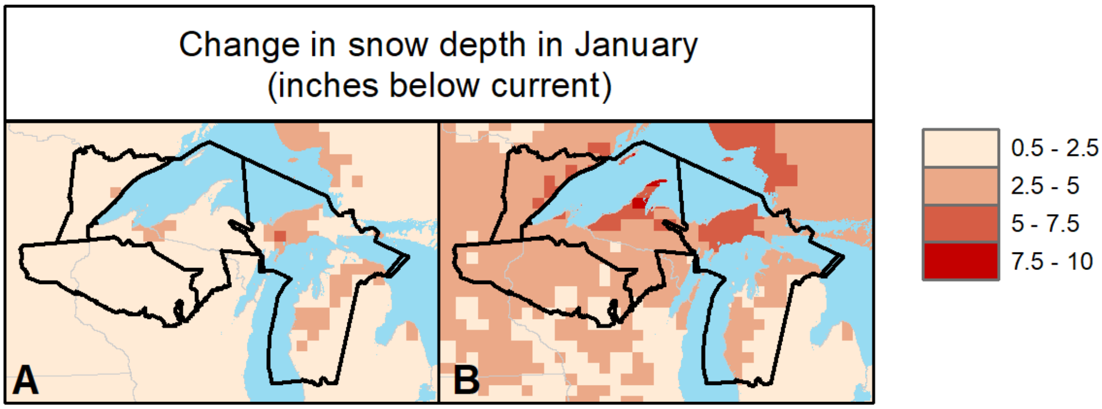


Figure 25. Change in snow depth in January in the Ceded Territories by the mid-21st century, in inches below current, relative to the 1980-1999 average. Models displayed are A) MRI-CGCM3 (least projected change) and B) ACCESS1-0 (most projected change). Data from nelson.wisc.edu/ccr/resources/dynamical-downscaling/index.php.

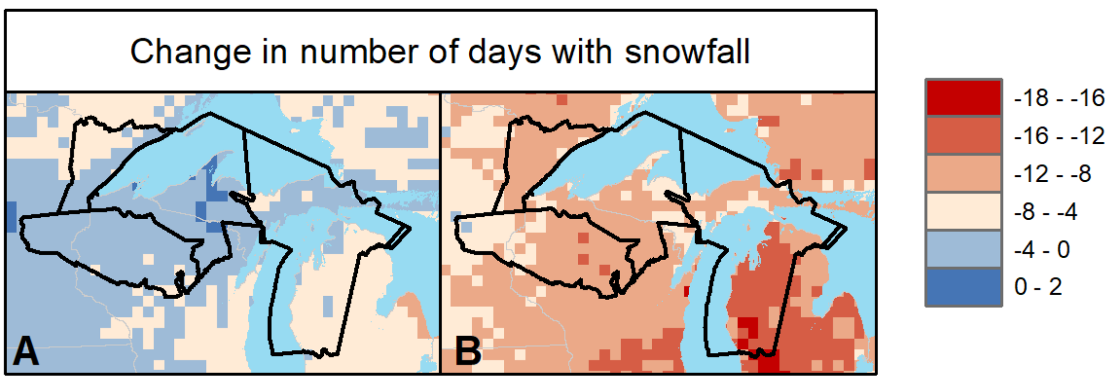


Figure 26. Change in number of days per year with snowfall in the Ceded Territories by the mid-21st century relative to the 1980-1999 average. Models displayed are A) MRI-CGCM3 (least projected change) and B) MIROC5 (most projected change). Data from nelson.wisc.edu/ccr/resources/dynamical-downscaling/index.php.

In the winter, when cold, dry air moves across big bodies of comparatively warmer water such as the Great Lakes, it absorbs moisture. When this air reaches a landmass, it drops the moisture in the form of precipitation (usually snow). This process is called lake-effect precipitation. In the Great Lakes region, lake-effect "snow belts" are found in places like the Keweenaw Peninsula of the Upper Peninsula of Michigan, which can receive more than 300 inches of snow in a winter. Lake-effect snow projections are less certain than regular snow projections. In general, lake-effect snow is projected to decline in frequency throughout the 21st century, with some lake-effect precipitation falling as rain instead. However, lake-effect precipitation around Lake Superior may *increase* into the mid-21st century, due to the warming lake and decreased ice cover (Notaro et al. 2015a).

Ice Cover

Ice cover on the Great Lakes has been decreasing. There are fluctuations from year-to-year, but since 1973 the trend has been downward. Compared to other Great Lakes, the declines on Lake Superior have been the largest. Along the Lake Superior shoreline, ice duration has been declining at a rate of approximately 2 days per year (Figure 27, Mason et al. 2016). Similarly, an analysis of ice cover in inland lakes in Minnesota, Wisconsin, and Michigan from 1917–2007 has shown that formation of ice occurred later (0.07 day/year), cumulative amount of ice has decreased (-0.17 cm/year), and ice break-up occurred earlier (-0.09 day/year) (Mishra et al. 2011). Tribal members have observed this decline directly:

> "[In Lake Superior in 2017] the whole lake… was the warmest in history… in the last 3 years we haven't had [any] ice because it takes too long in the wintertime for Lake Superior to cool back off where it makes ice… if the water's, say, 40 degrees, and it's gotta be 30 degrees to freeze… it takes maybe a month to cool it off." —*Joseph Duffy*

> "The ice has never been so thin in the last ten years that I've seen. I used to run on the resorts in Mille Lacs as a young man and you could take a 16' by 20' fish house out there. You could take an 8' by 16', 8' by 20', you could make a big ol' fish house. And drag it out there by December, by mid-December. Now you can't even get one out there throughout the year because that thing would fall right through the ice." —*Curt Kalk*

Determining the cause of this decline is difficult, as there are many factors that influence ice cover, including the randomness of weather, large climate patterns such as the El Niño Southern Oscillation and North Atlantic Oscillation, and wind speed. Over Lake Superior, average wind speeds have been increasing 5% per decade since 1980, exceeding trends in wind speed over land (Desai et al. 2009). Wind can impact the formation, amount, and movement of ice, and increasing wind speeds may lead to less ice cover overall. Therefore, climate change likely contributes to some of the observed regional declines in ice cover. Despite the downward trend, it is still possible to have winters with high levels of ice cover, because of high variability and the many factors that influence ice production.

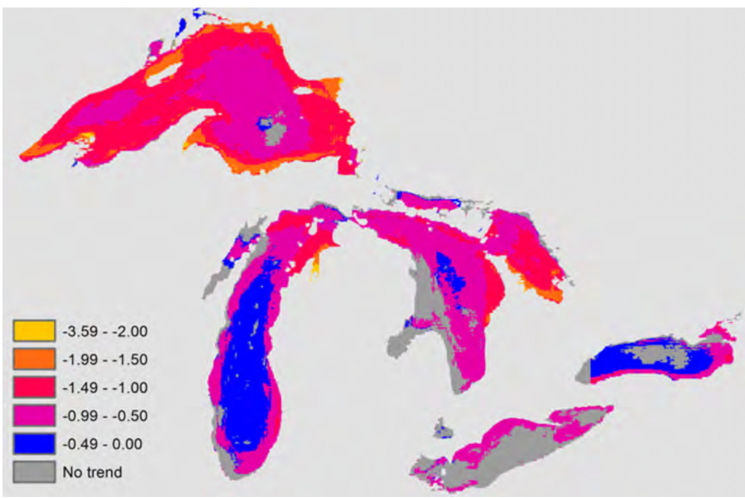


Figure 27. Seasonal ice cover duration slope (days/year) of the linear regression trend model from 1973 to 2013 (Mason et al. 2016). The warmer the color, the faster the duration of ice cover is decreasing.

It is difficult to project ice cover into the future, but if the current rate of decline continues, by the end of the 21st century, the Great Lakes can expect to see ice develop only at the northern shores, leaving most of the lakes as open water even in midwinter, with ice typically only developing during January–March (Notaro et al. 2015a).

Less ice cover on the Great Lakes can have several cascading effects. The temperatures of the Great Lakes will continue to increase as the ice-free season lengthens, affecting many aspects of aquatic life. This increase in temperature, along with increased open lake area, will lead to increased lake-effect snow in the snow belts, as more moisture is picked up in winds coming off the lakes (see “Precipitation: Snow” section above).

Many cultural activities will be significantly affected by reduced ice cover. Spearing through the ice for name (sturgeon), ginoozhe (northern pike), and maashkinoozhe (muskellunge) for food and ceremonies is a cultural activity passed down through generations (Figure 28):

> “In the last 3 years we haven’t had no ice… I used to make my living fishing on the ice in the wintertime… hard work and all that, but in the last, say, 3-5 years we never had no ice. When I say no ice, I don’t mean just Bass Island, I mean where we could go 25 miles right straight out to Outer Island [Apostle Islands National Lakeshore, northern Wisconsin]. We used to set nets out there, but in the last 5 years, nothing… The last two years, the ferry boats run all year round now.” —*Joseph Duffy*

Another cultural activity that will be affected is a traditional game called Gooniikaa-Ginebig Ataadiiwin (Snow Snake), played on ice or snow, and considered to be a rite of passage for some bands and members (Figure 29). The game is long known as having a connection to hunting. Historically, long spears were created and thrown or slid across the ice or the hard crust on the snow to kill animals that were bedded down. These long spears eventually came to be used in the game of Gooniikaa-Ginebig Ataadiiwin which is played during the time of Onaabani-Giizis in the Great Lakes region.

The month of March is known in Ojibwe as Onaabani-Giizis, or Crust-on-Snow Moon. This is the time in late winter that the days are longer and the increase in sunlight thaws the top layer of snow during the day and freezes it at night. Similar versions of the game have been played all across North America by various Indigenous groups. The Ojibwe today create wooden poles (known as snow snakes) that resemble the long spears their ancestors used and add weight to them, so they slide over the snow or ice. Today the game is mostly played among the youth and requires both skill and strength to win. Teams or individuals compete to slide the snow snakes the farthest, demonstrating the attributes of successful hunters. As the ideal winter conditions necessary for this cultural activity to occur are impacted, the survival of this traditional game is threatened along with countless other aspects of Ojibwe culture and cultural identity.

Figure 28. Utilizing a gillnet set under the ice, a Gaa-miskwaabikaang (Red Cliff Band of Lake Superior Chippewa Indians) tribal member harvests Gichigami (Lake Superior) fish near the shores of Wenaboozhoo minisan (Apostle Islands) in northern Wisconsin. Photo credit: CO Rasmussen (GLIFWC).

Figure 29. Wooden poles used in the traditional game of Gooniikaa-Ginebig Ataadiiwin (snow snake). The game is one of many traditional activities threatened by climate change as winter conditions change. Photo credit: CO Rasmussen (GLIFWC).

Summary

New reports of climate change effects continue to appear daily, and the magnitude of the changes is likely to increase. Rising temperatures and changing precipitation regimes, as well as changes in ice cover, soil moisture, lake temperature, and storm intensity and frequency will continue to affect the Ceded Territories and the beings living here. Some beings will be able to adjust, or adapt, to these changes, and others may not be able to adapt quickly enough to survive. Anishinaabeg in the Great Lakes region have depended on these beings for centuries, and continue to depend on them for spiritual, ceremonial, medicinal, subsistence, and economic needs, as well as their culture and identity.

Methods

Beings (Species) Selected for the Assessment

We selected 66 beings for the assessment based on several criteria. The first, and primary, criterion was that each being was mentioned as of concern or of interest in Traditional Ecological Knowledge (TEK) interviews conducted with GLIFWC member tribes. Beings with the highest number of mentions were selected after an initial round of interviews. Additionally, we included beings of special cultural importance, those included in the GLIFWC Preliminary Climate Change Vulnerability Assessment (Chiriboga 2015) and the GLIFWC Phenology Study, those for which GLIFWC currently issues permits, those which currently have specific and restricted harvest regulations, and those for which GLIFWC currently tracks harvest numbers across the Ceded Territories (Table 2). Beings are grouped into categories commonly used in Ojibwe culture (crawlers, flyers, four-leggeds, plants, and swimmers) (Figure 30).

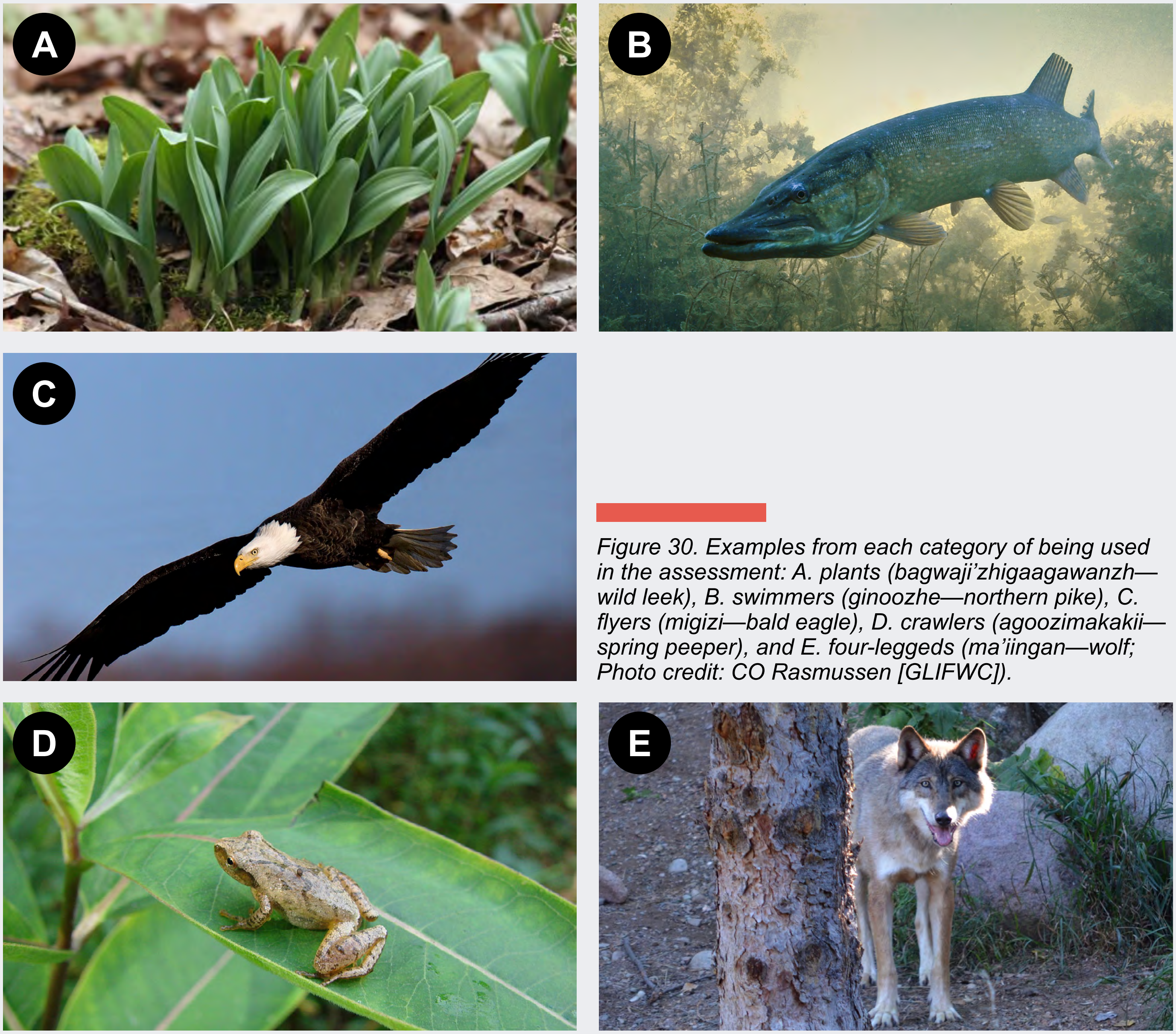


Figure 30. Examples from each category of being used in the assessment: A. plants (bagwaji'zhigaagawanzh—wild leek), B. swimmers (ginoozhe—northern pike), C. flyers (migizi—bald eagle), D. crawlers (agoozimakakii—spring peeper), and E. four-leggeds (ma'iingan—wolf; Photo credit: CO Rasmussen [GLIFWC]).

Table 2. List of beings included in vulnerability assessment, with Ojibwe (singular and plural), English, and Latin names, and by category. Beings were grouped into categories commonly used in Ojibwe culture. Note that others may choose to use other groupings. Also note that bapakwaanaajiinh (cave bats and tree bats) and zhingos (short-tailed, long-tailed, least weasel) are grouped together on a single being page but are listed separately in most tables and graphs.

Ojibwe Name (singular)	Ojibwe Name (Plural)	English name	Latin name	Category
Manoomin	No plural form exists	Northern Wild Rice	*Zizania palustris*	Plant
Mashkiigwaatig	Mashkiigwaatigoog	Tamarack	*Larix laricina*	Plant
Mashkiigobag	Mashkiigobagoon	Labrador Tea	*Ledum groenlandicum*	Plant
Ininaandag	Ininaandagoog	Balsam Fir	*Abies balsamea*	Plant
Giizhikaatig	Giizhikaatigoog	Northern White Cedar	*Thuja occidentalis*	Plant
Ziinzibaakwadwaatig	Ziinzibaakwadwaatigoog	Sugar Maple	*Acer saccharum*	Plant
Jiisens	Jiisensag	American Ginseng	*Panax quinquefolius*	Plant
Wiigwaasaatig	Wiigwaasaatigoog	Paper Birch	*Betula papyrifera*	Plant
Namepin	Namepinag	Wild Ginger	*Asarum canadense*	Plant
Baapaagimaak	Baapaagimaakoog	Black Ash	*Fraxinus nigra*	Plant
Bagwaji'zhigaagawanzh	Bagwaji'zhigaagawanzhiig	Wild Leek	*Allium tricoccum*	Plant
Aagimaak	Aagimaakoog	White Ash	*Fraxinus americana*	Plant
Gaagigebag	Gaagigebagoon	Princess Pine	*Lycopodium obscurum*	Plant
Miskojiibik	Miskojiibikwag	Bloodroot	*Sanguinaria canadensis*	Plant
Wiikenh	Wiikenyag	American Sweet Flag	*Acorus americanus*	Plant
Bagwajipin	Bagwajipiniig	Broadleaf Arrowhead	*Sagittaria latifolia*	Plant
Miin	Miinan	Blueberry	*Vaccinium angustifolium, V. myrtilloides*	Plant
Wiigobaatig	Wiigobaatigoog	American Basswood	*Tilia americana*	Plant
Wiingashk	Wiingashkoon	Sweetgrass	*Anthoxanthum hirtum*	Plant
Miskwaabiimizh	Miskwaabiimizhiig	Red-osier Dogwood	*Cornus sericea*	Plant
Ode'imin	Ode'iminan	Strawberry	*Fragaria virginiana, F. vesca*	Plant
Mashkodewashk	Mashkodewashkoon	Wild Sage	*Artemisia ludoviciana*	Plant
Anaaganabag	Anaaganabagoon	Ostrich Fern	*Matteuccia struthiopteris*	Plant
Miskomin	Miskominag	Raspberry	*Rubus idaeus*	Plant
Odoonibiins	Odoonibiinsag	Tullibee	*Coregonus artedi*	Swimmer
Adikameg	Adikamegwag	Lake Whitefish	*Coregonus clupeaformis*	Swimmer
Ogaa	Ogaawag	Walleye	*Sander vitreus*	Swimmer
Namegos	Namegosag	Lake Trout	*Salvelinus namaycush*	Swimmer
Asaawens	Asaawensag	Yellow Perch	*Perca flavescens*	Swimmer
Ginoozhe	Ginoozheg	Northern Pike	*Esox lucius*	Swimmer
Maashkinoozhe	Maashkinoozheg	Muskellunge	*Esox masquinongy*	Swimmer
Noosa'owesi	Noosa'owesiwag	Smallmouth Bass	*Micropterus dolomieu*	Swimmer
Name	Namewag	Lake Sturgeon	*Acipenser fulvescens*	Swimmer
Ashigan	Ashiganag	Largemouth Bass	*Micropterus salmoides*	Swimmer

Ojibwe Name (singular)	Ojibwe Name (Plural)	English name	Latin name	Category
Maang	Maangwag	Common Loon	*Gavia immer*	Flyer
Aagask	Aagaskoog	Sharp-tailed Grouse	*Tympanuchus phasianellus*	Flyer
Waabizii	Waabiziig	Trumpeter Swan	*Cygnus buccinator*	Flyer
Mitigoningwiishib	Mitigoningwiishibag	Wood Duck	*Aix sponsa*	Flyer
Ajijaak	Ajijaakwag	Sandhill Crane	*Grus canadensis*	Flyer
Waawaatesi	Waawaatesiwag	Firefly	*Photinus pyralis*	Flyer
Migizi	Migiziwag	Bald Eagle	*Haliaeetus leucocephalus*	Flyer
Ozhaawashkonebiisibens	Ozhaawashkonebiisibensag	Blue-winged Teal	*Spatula discors*	Flyer
Aandeg	Aandegwag	American Crow	*Corvus brachyrhynchos*	Flyer
Ininishib	Ininishibag	Mallard	*Anas platyrhynchos*	Flyer
Mizise	Miziseg	Wild Turkey	*Meleagris gallopavo*	Flyer
Gaagaagi	Gaagaagiwag	Common Raven	*Corvus corax*	Flyer
Nika	Nikag	Canada Goose	*Branta canadensis*	Flyer
Mitigwaakiing dizi mishiikenzh	Mitigwaakiing dizi mishiikenyag	Wood Turtle	*Glyptemys insculpta*	Crawler
Agoozimakakii	Agoozimakakiig	Spring Peeper	*Pseudacris crucifer*	Crawler
Miskwaadesi	Miskwaadesiwag	Painted Turtle	*Chrysemys picta*	Crawler
Mikinaak	Mikinaakwag	Snapping Turtle	*Chelydra serpentina*	Crawler
Waabooz	Waaboozoog	Snowshoe Hare	*Lepus americanus*	Four-legged
Mooz	Moozoog	Moose	*Alces americanus*	Four-legged
Waabizheshi	Waabizheshiwag	American Marten	*Martes americana*	Four-legged
Ojiig	Ojiigag	Fisher	*Pekania pennanti*	Four-legged
Bapakwaanaajiinh	Bapakwaanaajiinyag	Tree Bat and Cave Bat	Several species	Four-legged
Wazhashk	Wazhashkwag	Common Muskrat	*Ondatra zibethicus*	Four-legged
Zhingos	Zhingosag	Short- and Long-tailed Weasel; Least Weasel	Short-tailed: *Mustela erminea*; Long-tailed: *M. frenata*; Least: *M. nivalis*	Four-legged
Amik	Amikwag	American Beaver	*Castor canadensis*	Four-legged
Omashkooz	Omashkoozoog	Elk	*Cervus elaphus*	Four-legged
Waawaashkeshi	Waawaashkeshiwag	White-tailed Deer	*Odocoileus virginianus*	Four-legged
Ma'iingan	Ma'iinganag	Gray Wolf	*Canis lupus*	Four-legged
Makwa	Makwag	Black Bear	*Ursus americanus*	Four-legged
Gidagaa-bizhiw	Gidagaa-bizhiwag	Bobcat	*Lynx rufus*	Four-legged
Nigig	Nigigwag	River Otter	*Lontra canadensis*	Four-legged
Zhaangweshi	Zhaangweshiwag	American Mink	*Neovison vison*	Four-legged

Traditional Ecological Knowledge (TEK) Interviews

TEK interviews were conducted with tribal elders, harvesters, and knowledge holders from each of the 11 GLIFWC member tribes from 2016 to 2020. Interviews were conducted by the Climate Change TEK Outreach Specialist, and occasionally other GLIFWC climate change staff, with both individuals and groups.

Interview Process

Interviewees were selected by the TEK Outreach Specialist or through recommendations made by tribal leaders, staff, other tribal members, and other interview participants, based on their knowledge of various issues such as spiritual practices, Anishinaabe lifeways, and climate change (Appendix 1). Interviewees were approached following GLIFWC's Guidelines for Conducting Traditional Ecological Knowledge Interviews (Appendix 1).

The following principles were adhered to during the interview process: 1) the need to be consistent and maintain long-term contact with tribal members, 2) the need to be sensitive to Ojibwe culture, and 3) the need to be transparent with how the information would be used by GLIFWC. Informal consultation was carried out with spiritual advisors through the entire process to ensure that interviews were conducted in a culturally sensitive manner and that the information shared was understood in deeper, more abstract ways. Interviewees were gifted and passed asemaa (tobacco), and at times additional gifts were given. All interviewees were also given stipends for their time. Additional ceremonies were carried out as determined by the knowledge holders and the TEK Outreach Specialist.

We conducted cooperative qualitative semi-directed interviews, as this was determined to be the most culturally sensitive and appropriate method. A climate change-focused questionnaire, a list of beings included in the assessment, and maps of the Ceded Territories were used to prompt knowledge and memory sharing (Appendix 1). Interviewees were given the option of answering the questions on the questionnaire or speaking freely about any knowledge they were comfortable sharing. Interviews were conducted in the homes of the interviewees or other meeting locations if available. All interviews were recorded using high quality digital audio recorders and captured in Waveform Audio File Format.

Efforts focused more on the gathering of widely shared, generalized land-based knowledge, rather than specialized knowledge, which often consists of more protected information pertaining to ceremonies, healing, specific gathering locations, and other information that is not shared outside tribal communities. However, some knowledge pertaining to ceremony, subsistence, commercial harvesting, spirit beings, and other observations was shared by interviewees and was included as deemed appropriate. Because Anishinaabe lifeways are so deeply interconnected with the land, commercial harvesting and observational knowledge often had a direct connection to ceremonial knowledge.

Free, Prior, and Informed Consent

Interviews were conducted following the principle of Free, Prior, and Informed Consent (Fernández de Larrinoa et al. 2016). This allows Indigenous peoples the right to give or withhold consent to any project that may affect their territories. Any knowledge shared is owned by the individual and can be rescinded or withdrawn at any time; it is not the property of GLIFWC. Knowledge was shared for the purposes of the GLIFWC Climate Change Program and this vulnerability assessment and is not to be used for other purposes unless explicit permission is granted by the owner.

Summarizing Interviews

Interviews were transcribed by GLIFWC staff in ELAN (The Language Archive 2020), an open-source language archive software. All transcripts and audio were subsequently retained on secure servers, with access limited to the authors of the assessment. Transcripts were given to interviewees for review and revised at the interviewees' request. Sensitive knowledge was withheld from transcripts. If a knowledge holder passed during the project period, any audio files, transcriptions, or documents containing their knowledge were left untouched for a year, as is culturally appropriate.

Knowledge pertinent to effects of climate change (e.g., timing of spawning, changes in precipitation) was compiled into a summary, which included keywords, beings, and locations mentioned (Appendix 1). In cases where beings were mentioned infrequently, supplementary sources were utilized, including historical accounts and Ojibwe stories obtained from a combination of the TEK Outreach Specialist's personal knowledge, oral interviews, and books. Knowledge relevant to each being was compiled and added to each being's individual page and was considered equal in importance to the Climate Change Vulnerability Index results.

Climate Change Vulnerability Index

The vulnerability of each being was assessed using the Climate Change Vulnerability Index, Version 3.02 (CCVI; Young et al. 2016). The CCVI is a Microsoft Excel-based tool that allows users to calculate vulnerability scores based on climate models and natural history information for aquatic or terrestrial beings. We chose this method because it has been widely used in many ecosystems and with a large number of taxa, it provides a consistent and efficient way to assess the climate change vulnerability of a large number of beings, and it allowed us to incorporate primary literature as well as knowledge from interviews.

There are many ways to characterize climate change vulnerability, but the CCVI focuses on exposure, sensitivity, and adaptive capacity (Figure 31). Exposure is the amount of climate change a being is likely to experience where it lives within the assessment area — for example, amount of increased rainfall or increase in average temperature. Sensitivity is the degree to which a being is likely to be affected by climate change — for example, water levels may be too high for a particular aquatic plant to grow or summer temperatures may be too hot for a being to tolerate. Adaptive capacity is the ability of that being to cope with those changes — for example, the ability of a being to move its home range or change its diet.

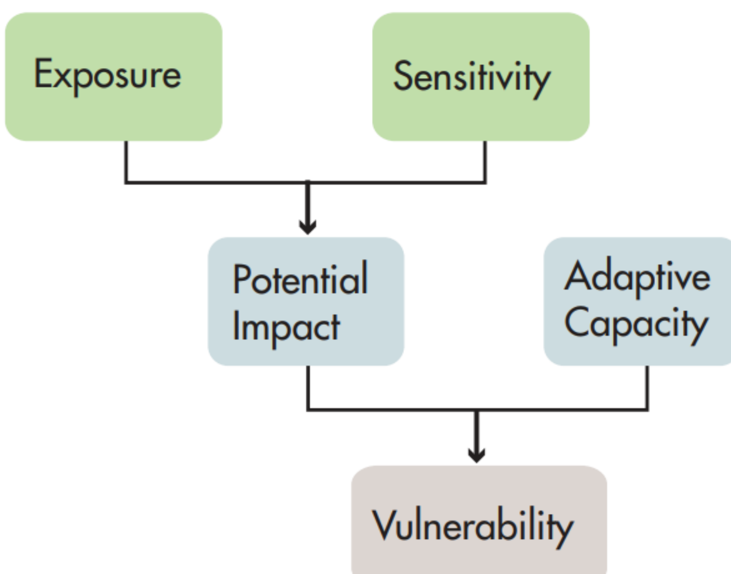


Figure 31. Relationship among the three major components of vulnerability: exposure, sensitivity, and adaptive capacity (Stein et al. 2014).

To determine vulnerability using the CCVI, an exposure score is generated using models of temperature and moisture projections for the assessment area for the mid-21st century. Sensitivity and adaptive capacity scores are generated by answering 27 questions about the being's natural history, including any existing modeling efforts, if available. The scores are then combined to create an overall vulnerability score.

Climate Data Inputs

For temperature inputs to the CCVI, we used two dynamically downscaled models from RCP8.5 – the model projecting the least amount of temperature change in the Ceded Territories by the mid-21st century (MRI-CGCM3; labeled as "best case" on each being's graph) and the model projecting the most amount of temperature change in the Ceded Territories by the mid-21st century (MIROC5; labeled as "worst case" on each being's graph). See "Climate Change Impacts on the Ceded Territories" (page 13) for an introduction to global climate data as well as more information on the data used in the assessment.

The CCVI incorporates the Hamon AET:PET moisture metric instead of precipitation, as moisture availability is more relevant to a being's ability to survive than precipitation. The Hamon moisture metric integrates temperature and precipitation through a ratio of actual evapotranspiration to potential evapotranspiration, with consideration of total daylight hours and saturated vapor pressure. For this metric, we used Climate Wizard data prepared by NatureServe for the Ceded Territories (Girvetz et al. 2009).

Assessments of Beings

The 27 questions related to indirect exposure, sensitivity, and adaptive capacity were answered initially by conducting a literature review, including reports, journal articles, and herbarium or other reputable natural history websites. All literature relevant to a particular question was recorded; at least two climate change staff reviewed the compiled literature and answered each question by consensus. All questions were checked for consistency in interpretation. For more information on scoring, see Young et al. (2016).

Reviews

After each being was scored by climate change staff, two regional specialists on each being conducted a review of the scores (Appendix 1). Reviewers scored the questions using their own knowledge or additional literature after reviewing the CCVI questions, the literature compiled, and the scores given by GLIFWC staff. Additional literature and references were incorporated into the assessment as suggested by reviewers, and original scores were adjusted at the discretion of staff based on the reviews, considering available literature, specialist knowledge, and consistent interpretation for each being.

Incorporating TEK into the CCVI

CCVI scores were also adjusted using knowledge from TEK interviews. This was done after the initial review process as interviews were still ongoing during the time of initial reviews. In order to give the TEK equal weight to the already-incorporated SEK, all knowledge from interviews which referenced any of the 27 CCVI questions about each being was extracted and compiled for consideration. If the knowledge contained information that had not previously been incorporated into the CCVI, scores were adjusted based on the number of interviewees that shared knowledge related to a particular question, again keeping in mind consistent interpretation (Table 3).

Table 3. CCVI score adjustment using knowledge from TEK interviews. Scores were adjusted according to the number of interviewees that shared knowledge regarding a particular CCVI question. Scores were adjusted depending on the direction of knowledge shared – e.g., if a being was mentioned as sensitive to increasing temperature, the score for the CCVI question on temperature would increase; if a being was mentioned as not sensitive to increasing temperature, its score would decrease. The score adjustment factor refers to the categorical responses to each CCVI question – neutral (N), somewhat increase (SI), increase (I), and greatly increase (GI). Whole number score adjustments adjusted a score up/down by the corresponding number of categories (e.g., a question with a previous response of N and a 1 score adjustment would change to SI); half score adjustments adjusted a score by adding the next category to the response (e.g., a question with a previous response of N and a 0.5 score adjustment would change to N/SI). For more information on CCVI scoring, see Young et al. (2016).

Number of mentions of a particular CCVI question for any being	Score adjustment factor
1	0.5
2	1
3	1.5
4	2
5	2.5

Calculating Vulnerability Scores

The standard CCVI output is a categorical ranking into one of five categories – less vulnerable (LV), moderately vulnerable (MV), highly vulnerable (HV), extremely vulnerable (EV), or insufficient evidence (IE). LV indicates that available evidence does not suggest abundance and/or range extent within the geographic area assessed will change substantially. MV indicates a being’s abundance and/or range extent within the geographic area assessed is likely to decrease. HV indicates a being’s abundance and/or range extent within the geographic area assessed is likely to decrease significantly. EV indicates a being’s abundance and/or range extent within the geographic area assessed is extremely likely to substantially decrease or disappear by 2050. We used these categories in each graph and calculated the raw scores to undertake quantitative analyses. Scores were calculated for both climate models, and averages as well as the range in scores were displayed on each individual being’s graph.

Results

Vulnerability Scores

Swimmers had the highest median vulnerability score and four-leggeds had the lowest median vulnerability score in the worst-case scenario. Median scores for swimmers fell into the HV ranking, median scores for crawlers and plants fell into the MV ranking, and median scores for flyers and four-leggeds fell into the LV ranking (Figure 32). Ten beings had a vulnerability score in the worst-case scenario over 16 (in the EV category) — manoomin, waabooz, odoonibiins (tullibee), mashkiigwaatig (tamarack), mooz, mashkiigobag (Labrador tea), giizhikaatig (northern white cedar), adikameg (lake whitefish), waabizheshi, and ininaandag (balsam fir). Manoomin was the most vulnerable being in the assessment. Miskomin (raspberry) and zhingos (long-tailed weasel) were the least vulnerable beings (Figure 33).

The scores of 63 beings were adjusted an average of 1.07 (±2.49) points after review — 41 scores were increased and 22 were decreased. Of the 63 adjusted, six scores were adjusted enough to change the vulnerability rankings (LV, MV, HV, EV). The scores of 17 beings were adjusted again according to information gathered in TEK interviews. The scores adjusted according to information gathered in TEK interviews were adjusted an average of 0.75 (±0.54) points. All but two of the scores increased — the scores of aandeg and ininishib (mallard) decreased with the addition of information from TEK interviews. None of the resulting vulnerability rankings were changed by including information from TEK interviews (Table 4).

For more information on each being, see individual pages in the Beings pages section on pages 66–234.

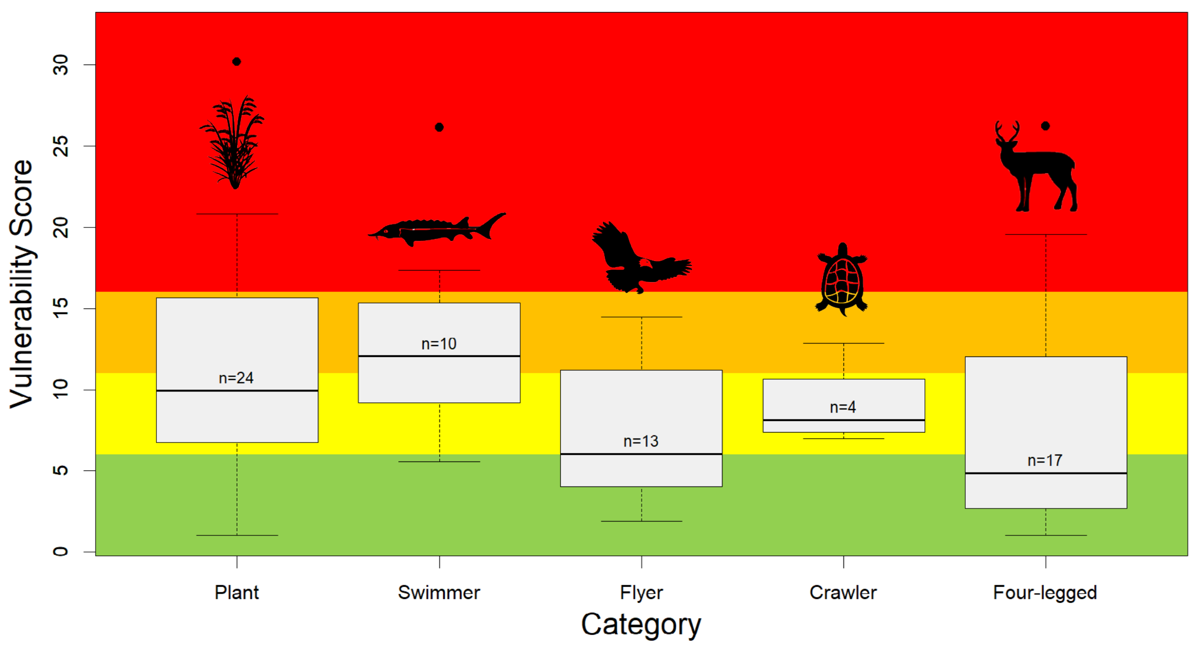


Figure 32. Average vulnerability score by category, in the worst-case scenario (MIROC5 model, RCP8.5). Two categories (four-legged and plant) contained outliers. The outlier in the four-legged category was waabooz and the outlier in the plant category was manoomin. Colors indicate overall vulnerability ranking: green = less vulnerable (LV), yellow = moderately vulnerable (MV), orange = highly vulnerable (HV), and red = extremely vulnerable (EV). LV indicates available evidence does not suggest that abundance and/or range extent within the geographic area assessed will change substantially by 2050. MV indicates abundance and/or range extent within the geographic area assessed is likely to decrease by 2050, HV indicates abundance and/or range extent within the geographic area assessed is likely to decrease significantly by 2050, and EV indicates abundance and/or range extent within the geographic area assessed is extremely likely to substantially decrease or disappear by 2050.


Ojibwe name
(best-case vulnerability score)
English name
(worst-case vulnerability score)
Plants
Manoomin
Northern Wild Rice
Mashkiigwaatig
Tamarack
Mashkiigobag
Labrador Tea
Ininaandag
Balsam Fir
Giizhikaatig
Northern White Cedar
Ziinzibaakwadwaatig
Sugar Maple
Jiisens
American Ginseng
Wiigwaasaatig
Paper Birch
Namepin
Wild Ginger
Baapaagimaak
Black Ash
Bagwaji'zhigaagawanzh
Wild Leek
Aagimaak
White Ash
Gaagigebag
Princess Pine
Miskojiibik
Bloodroot
Wiikenh
Sweet Flag
Bagwajipin
Broadleaf Arrowhead
Miin
Blueberry
Wiigobaatig
American Basswood
Wiingashk
Sweetgrass
Miskwaabiimizh
Red-osier Dogwood
Ode'imin
Strawberry
Mashkodewashk
Wild Sage
Anaaganabag
Ostrich Fern
Miskomin
Raspberry
Less Vulnerable
Moderately Vulnerable
Highly Vulnerable
Extremely Vulnerable
Swimmers
Odoonibiins
Tullibee
Adikameg
Lake Whitefish
Ogaa
Walleye
Namegos
Lake Trout
Asaawens
Yellow Perch
Ginoozhe
Northern Pike
Maashkinoozhe
Muskellunge
Noosa'owesi
Smallmouth Bass
Name
Sturgeon
Ashigan
Largemouth Bass
0
5
10
15
20
25
30
Vulnerability Score

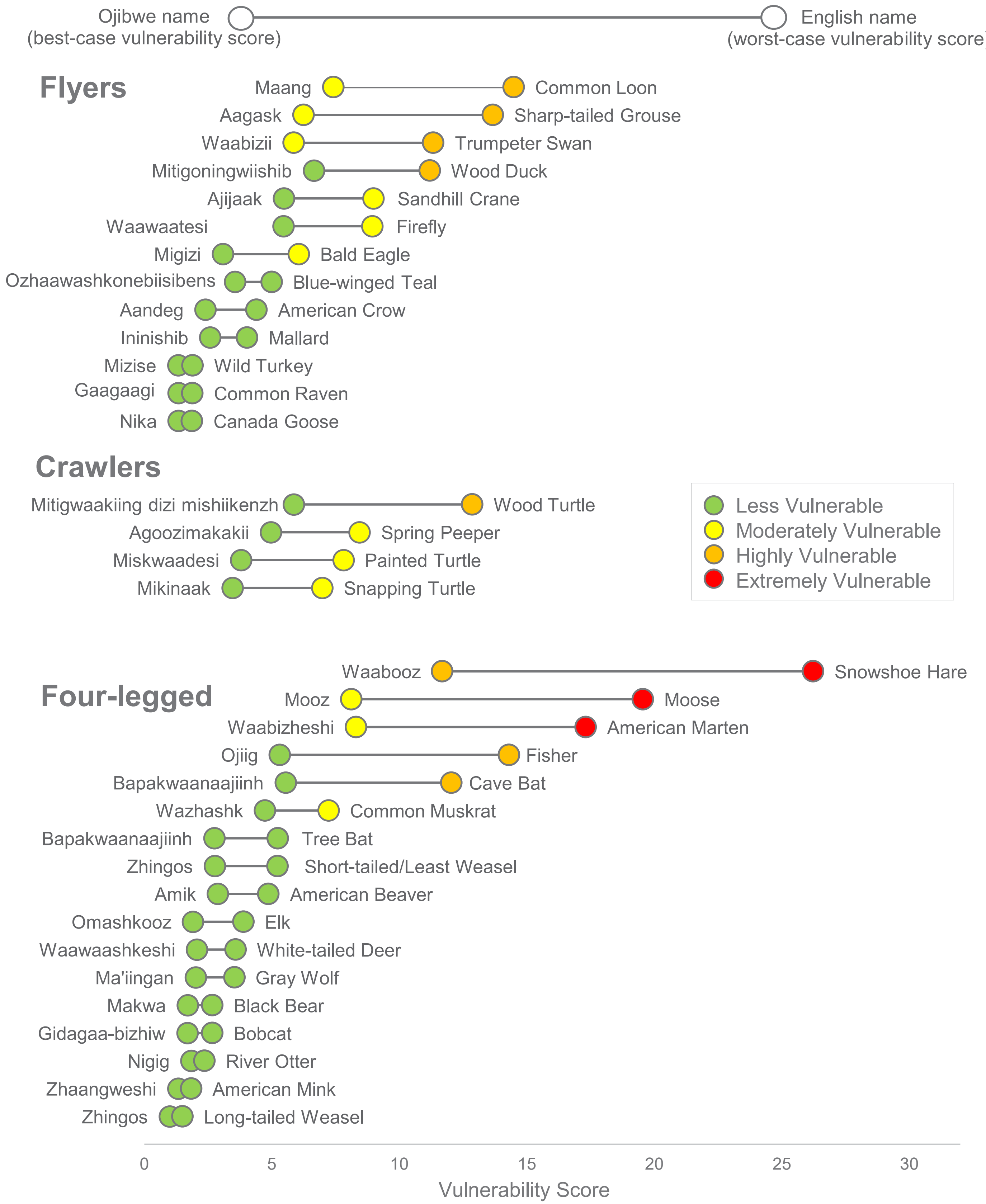


Figure 33. Vulnerability of all beings, grouped by category, in the best case (MRI-CGCM3 model, RCP8.5; dot on left side) and worst case (MIROC5 model, RCP8.5; dot on right side) scenario. Note that tree and cave bats are separated here, as are short-tailed/least weasels and long-tailed weasels. Less vulnerable indicates available evidence does not suggest abundance and/or range extent within the geographic area assessed will change substantially; moderately vulnerable indicates abundance and/or range extent within the geographic area assessed is likely to decrease; highly vulnerable indicates abundance and/or range extent within the geographic area assessed is likely to decrease significantly; and extremely vulnerable indicates abundance and/or range extent within the geographic area assessed is extremely likely to substantially decrease or disappear, all by 2050.

Table 4. Vulnerability rankings of all beings included in the assessment, grouped by category. Note that tree and cave bat are separated here, as are short-tailed/least weasel and long-tailed weasel. Best case (MRI-CGCM3 model, RCP8.5) vulnerability ranking is based on the being's average score in the best case scenario. Worst case (MIROC5 model, RCP8.5) vulnerability ranking is based on the being's average score in the worst-case scenario by mid-century.

Category	Ojibwe Name	Common Name	Best Case Vuln. Ranking	Worst Case Vuln. Rating
Plants 	Manoomin	Northern Wild Rice	HV	EV
	Mashkiigwaatig	Tamarack	MV	EV
	Mashkiigobag	Labrador Tea	MV	EV
	Ininaandag	Balsam Fir	MV	EV
	Giizhikaatig	Northern White Cedar	MV	EV
	Ziinzibaakwadwaatig	Sugar Maple	MV	HV
	Jiisens	American Ginseng	MV	HV
	Wiigwaasaatig	Paper Birch	MV	HV
	Namepin	Wild Ginger	MV	HV
	Baapaagimaak	Black Ash	MV	HV
	Bagwaji'zhigaagawanzh	Wild Leek	LV	HV
	Aagimaak	White Ash	LV	MV
	Gaagigebag	Princess Pine	LV	MV
	Miskojiibik	Bloodroot	LV	MV
	Wiikenh	Sweet Flag	LV	MV
	Bagwajipin	Broadleaf Arrowhead	LV	MV
	Miin	Blueberry	LV	MV
	Wiigobaatig	American Basswood	LV	MV
	Wiingashk	Sweetgrass	LV	MV
	Miskwaabiimizh	Red-osier Dogwood	LV	LV
	Ode'imin	Strawberry	LV	LV
	Mashkodewashk	Wild Sage	LV	LV
	Anaaganabag	Ostrich Fern	LV	LV
	Miskomin	Raspberry	LV	LV
Swimmers 	Odoonibiins	Tullibee	HV	EV
	Adikameg	Lake Whitefish	MV	EV
	Ogaa	Walleye	MV	HV
	Namegos	Lake Trout	MV	HV
	Asaawens	Yellow Perch	LV	HV
	Ginoozhe	Northern Pike	LV	HV
	Maashkinoozhe	Muskellunge	LV	MV
	Noosa'owesi	Smallmouth Bass	LV	MV
	Name	Sturgeon	LV	MV
	Ashigan	Largemouth Bass	LV	LV

Category	Ojibwe Name	Common Name	Best Case Vuln. Ranking	Worst Case Vuln. Rating
Flyers	Maang	Common Loon	MV	HV
	Aagask	Sharp-tailed Grouse	MV	HV
	Waabizii	Trumpeter Swan	MV	HV
	Mitigoningwiishib	Wood Duck	LV	HV
	Ajijaak	Sandhill Crane	LV	MV
	Waawaatesi	Firefly	LV	MV
	Migizi	Bald Eagle	LV	MV
	Ozhaawashkonebiisibens	Blue-winged Teal	LV	LV
	Aandeg	American Crow	LV	LV
	Ininishib	Mallard	LV	LV
	Mizise	Wild Turkey	LV	LV
	Gaagaagi	Common Raven	LV	LV
	Nika	Canada Goose	LV	LV
Crawlers	Mitigwaakiing dizi mishiikenzh	Wood Turtle	LV	HV
	Agoozimakakii	Spring Peeper	LV	MV
	Miskwaadesi	Painted Turtle	LV	MV
	Mikinaak	Snapping Turtle	LV	MV
Four-leggeds	Waabooz	Snowshoe Hare	HV	EV
	Mooz	Moose	MV	EV
	Waabizheshi	American Marten	MV	EV
	Ojiig	Fisher	LV	HV
	Bapakwaanaajiinh	Cave Bat	LV	HV
	Wazhashk	Common Muskrat	LV	MV
	Bapakwaanaajiinh	Tree Bat	LV	LV
	Zhingos	Short-tailed/Least Weasel	LV	LV
	Amik	American Beaver	LV	LV
	Omashkooz	Elk	LV	LV
	Waawaashkeshi	White-tailed Deer	LV	LV
	Ma'iingan	Gray Wolf	LV	LV
	Makwa	Black Bear	LV	LV
	Gidagaa-bizhiw	Bobcat	LV	LV
	Nigig	River Otter	LV	LV
	Zhaangweshi	American Mink	LV	LV
	Zhingos	Long-tailed Weasel	LV	LV

TEK Interviews

15 interviews were conducted with GLIFWC's 11 member tribes (Table 5). Knowledge shared primarily pertained to areas inside the Ceded Territories, but at times other locations were mentioned. The beings that were mentioned the most were wiigwaasaatig (20 mentions), manoomin (20), ziinzibaakwadwaatig (18), waawaashkeshi (17), makwa (14), and miin (14). Mitigwaakiing dizi mishiikenzh (wood turtle) was not directly mentioned in any of the interviews (Table 6).

Table 5. Number of interviews conducted in each of GLIFWC's 11 member tribal communities.

	Number of Interviews	Number of Total People
Bikoganoogan (St. Croix)	2	4
Waaswaaganing (Lac du Flambeau)	3	10
Odaawaa-zaaga'iganiing (Lac Courte Oreilles)	3	4
Gaa-miskwaabikaang (Red Cliff)	4	6
Zaka'aaganing (Sokaogon/Mole Lake)	1	1
Mashkiiziibiing (Bad River)	3	6
Misi-zaaga'iganiing (Mille Lacs)	3	4
Nagaajiwanaang (Fond du Lac)	2	3
Ginoozhekaaning (Bay Mills)	2	2
Gakiiwe'onaning (Keweenaw Bay)	1	1
Gete-gitigaaning (Lac Vieux Desert)	1	5

Table 6. Number of interviews (represented by dots) in which each being was mentioned. Beings are grouped by category and characterized by whether the population of the being was mentioned to be increasing, decreasing, or other (mentioned but no increase or decrease in population specified).

Being	Being mentioned as increasing ▲	Being mentioned as decreasing ▼	Being change not specified	Total mentions
Paper Birch		●●●●●●●	●●●●●●●●●●●●●	20
Northern Wild Rice	●	●●●●●●●	●●●●●●●●●●●●	20
Sugar Maple	●	●	●●●●●●●●●●●●●●●●	18
Blueberry		●●●●●●●●●	●●●●●	14
Northern White Cedar	●	●●●●●●	●●●●	11
Strawberry		●●●●●●	●●●●	10
Wild Leek	●		●●●●●●●	8
American Basswood		●●	●●●●●●	8
Raspberry		●	●●●●●●●	8
Red-osier Dogwood		●●●	●●●●	7
Ostrich Fern		●●	●●●●●	7
Black Ash		●●●	●●●	6

Being	Being mentioned as increasing ▲	Being mentioned as decreasing ▼	Being change not specified	Total mentions
Balsam Fir			●●●●●	5
Labrador Tea		●●	●●	4
White Ash		●	●●●	4
Princess Pine			●●●●	4
Broadleaf Arrowhead	●	●	●	3
Wild Sage		●	●●	3
Tamarack		●	●	2
American Ginseng			●●	2
Wild Ginger		●	●	2
Sweet Flag		●	●	2
Sweetgrass	●		●	2
Bloodroot			●	1
Walleye		●●	●●●●●●●●●	11
Yellow Perch	●	●●●●	●●●●	9
Northern Pike	●	●	●●●●●●	9
Sturgeon		●	●●●●●●●●	9
Muskellunge	●●		●●●●●	7
Lake Trout			●●●●●●	6
Tullibee		●	●●●	4
Lake Whitefish			●●●●	4
Smallmouth Bass	●●		●●	4
Largemouth Bass	●		●●	3
Bald Eagle	●●●●		●●●●●●	10
Wild Turkey	●●●●●		●●●	8
Sandhill Crane	●●●●●		●●	7
Canada Goose	●●	●	●●●	6
Trumpeter Swan	●●	●	●●	5
Firefly		●●●	●●	5
American Crow			●●●●●	5
Mallard		●●	●●●	5
Sharp-tailed Grouse	●		●	2
Wood Duck		●	●	2
Blue-winged Teal		●●		2
Common Raven			●●	2
Common Loon			●	1

Being	Being mentioned as increasing ▲	Being mentioned as decreasing ▼	Being change not specified	Total mentions
Snapping Turtle		●	●●●●●●	7
Spring Peeper			●●●●	4
Painted Turtle			●●	2
Wood Turtle				0
White-tailed Deer		●●	●●●●●●●●●●●●●●●	17
Black Bear		●●	●●●●●●●●●●●●	14
Snowshoe Hare		●	●●●●●●●●●●●	12
Moose		●●●	●●●●●●	9
American Beaver			●●●●●●●●●	9
Gray Wolf	●		●●●●●●●●	9
Common Muskrat			●●●●●●●	7
American Marten	●●●	●	●	5
Elk		●	●●●●	5
River Otter		●	●●●●	5
Fisher	●	●●	●	4
Weasel (all)	●		●●	3
Bobcat			●●●	3
American Mink	●		●	2
Cave Bat/Tree Bat			●	1

We counted the frequency of words spoken in interviews. Words were consolidated into their stem words (e.g., the word “wait” would include “waited,” “waiting,” and “waits”). Excluding stop (common) words, the “know” was the most commonly spoken word, mentioned 1984 times. There were 12 words mentioned over 500 times (“know,” “get,” “see,” “go,” “think,” “use,” “time,” “year,” “people,” “now,” “come,” and “look”) (Figure 34). We also counted the number of times beings were mentioned throughout the interviews. The three most mentioned beings were rice (190 total mentions), deer (156 total mentions), and birch (144 total mentions) (Figure 35).

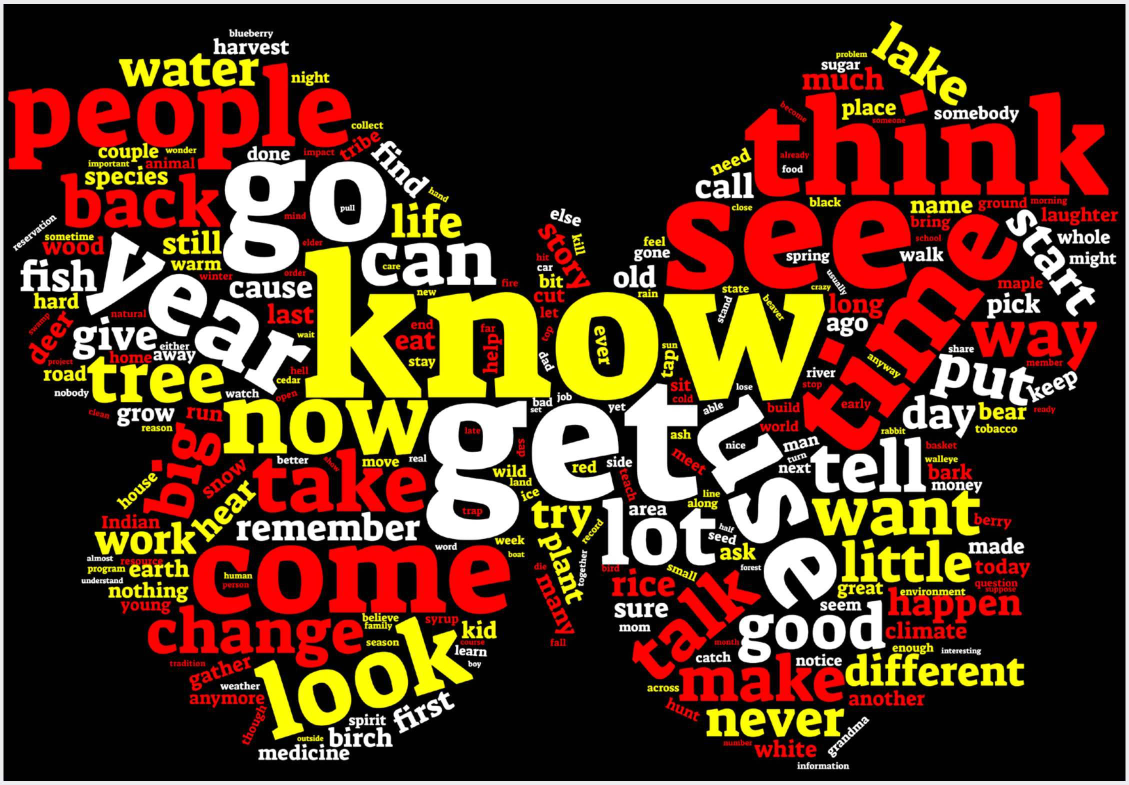


Figure 34. *Word cloud containing words used more than 40 times in interviews, excluding stop words such as “and,” “or,” and “but.” The larger the word appears, the more often it was used. Word placement and colors are random. For a list of words and their frequencies, see [Appendix 1](#).*

Interviews ranged from 1–4 hours in length and covered a variety of themes connected to climate change. Interviewees generally discussed changes in the populations of beings they frequently harvest or harvested in the past, environmental and cultural changes over time, and places with which they were familiar. Some interviews discussed a large variety of beings and others discussed a small number of beings in greater detail. Stories, teachings, and songs were shared about traditional ways of life, as well as other topics indirectly linked to climate change such as ongoing racism, memories of cultural suppression, and struggles in exercising treaty rights prior to and after their reaffirmation. Much of this knowledge has not been previously shared in a written format. Some culturally sensitive knowledge was shared, often due to the interviewee’s previous relationship with the interviewer. This knowledge was only given to the interviewer, was removed from transcripts, and does not appear in this document.

Climate change was discussed in many different contexts. Many inferred that changing weather patterns have always been detected and observed by Anishinaabe people, and recent human-caused climate change is no exception, though not all described it using the words “climate change:”

> “Climate change… some older person, a lot older than I, probably going to tell you, yeah, they seen this too. They seen it and maybe got a different word for it, but… the grandfather is going to make it to be that way, we just gotta figure out how we can handle it.” —*Tom Maulson Sr.*

Some felt that the words “climate change” were too narrow in scope to describe observed changes:

> “[The phrase ‘climate change’] makes you think… you’re looking only at like one thing. At least for me anyway because climate change is looking at how the change in the weather and the patterns of the earth have changed. What we’re seeing and what we’re gathering… that’s what I look at.”
> —*Giiwegiizhigookway Martin*

Most interviewees mentioned or alluded to the profound impact climate change will have on their culture:

> "Climate change, what I see about it, it affects our stories. It affects when we hunt, where we fish. And it has a great deal of affect [on] us." —*Carmen Butler*

A major theme discussed in interviews was environmental changes over time, whether from climate change or natural variability. Flooding was a major concern in many communities, particularly regarding impacts on manoomin:

> "I told my wife there this mornin', I said, 'You know, I watched all my life for this rain this time of year… this is the most I ever seen.' When it does rain, we get hammered pretty good." —*Makoons Fred Ackley Jr.*

Many non-human relatives were mentioned and sometimes discussed at great length during interviews. Much of this knowledge is sacred and therefore not shareable. Those mentioned included both animate and inanimate beings, such as rocks, mineral bodies, animikiig (thunderbeings), thunder snow, sun, moon, lightning, little people, giants, and spiritual keepers of the forest. One of the most frequently mentioned were animikiig, which some interviewees mentioned were decreasing, found in smaller families, or that only young animikiig are arriving without parents.

> "I've never heard of thundersnow except in the past 5 years. Where it's snowing and thundering at the same time." —*April Stone*

> "It doesn't seem like the thunderstorms are around like they used to be. We'd get these big booming things. I was told that was good for the plants. I was told that back then. It just doesn't seem like we have those like we used to. We have the rain, but we don't have the thunderstorms."
> —*Curt Kalk*

See "Climate Impacts in the Ceded Territories" section for additional climate- and weather-related observations shared in interviews.

All interviewees expressed concern about environmental degradation by humans, and for most, climate change was interconnected:

> "There's a lot of human action messing things up on earth… I always think about that, cause if all life has a spirit, what about everything that isn't getting the focus or attention by us right now, I'm always curious about what that means for the future of our actions now as humans and what we are trying to do on the landscape, like with climate change." —*April Stone*

> "But what's happening is we are just polluting the world. We are killing the mother earth. That's why things are happening like the way it is today. We're killing everything. We're killing the water. We're killing the mother Earth. We're killing everything like the ocean, animals. We contaminated everything." —*Mary Moose*

Many of these environmental changes were discussed in the context of impacts on cultural harvesting practices. One theme that came up often was making Anishinaabe-zhiiwaagamizigan (maple syrup):

> "The reason you are having a shorter season is because right now we're getting our spring a whole month ahead of time… 3 weeks to a month we're ahead… those trees are ready to go, it goes right back to the god damn atmosphere that we're warming up, the country is warming up so that tells whatever nature does, that tells them trees to start sapping or whatever." —*Joseph Duffy*

> "We actually haven't gone to the sugarbush or tapped trees in the past two years because of the weather. The weather just wasn't there, the temperatures weren't there, it didn't get cold enough at night or warm enough during the day, it was really strange weather so both years we ended up not tapping trees. That has a big impact on our life because we use syrup for all kinds of things." —*April Stone*

Declines or increases in the population of many beings were discussed (see Table 6). Beings mentioned frequently as declining were berries (sometimes talked about in general, instead of specific berries):

> "We used to have all the strawberries we wanted. We used to gather chokecherries, pin cherries, strawberries, blueberries, juneberries. Juneberries, I don't hear about them anymore. I don't hear about them. Hazelnuts. We used to have hazelnuts right out here. Last year we didn't have any. Chokecherries we used to have a whole bunch of them down these roads here… they used to be just black with chokecherries. I didn't see that many, that much last year." —*Maryellen Baker*

> "Berries, I like to pick, blackberries, juneberries, they kind of disappeared." —*Duane Poupart Sr.*

> "Strawberries… I don't see them. I haven't seen them in years. I don't know and I think it's because... The season is usually in June but it's always so cold lately that I don't see them. I haven't seen wild strawberries in, I don't even know." —*Vera Klingman*

> "The plants just aren't fruiting. And it's strange to see blueberry plants everywhere and just not get any blueberries. So we're seeing them go away too now. I don't know what causes that." —*Curt Kalk*

Many indicators were shared, describing events that were cues to know when it was time to harvest. Over half of the interviews discussed indicators of some kind, though these differed based on tribe, region, and experience. A few involved zhiiwaagamiziganike (making maple syrup). Chibinesi Jim Northrup Jr. described watching for two things to know when it's time to tap trees:

> "I have various things that I watch for. One is… when a tree is standin' there like that, it's warmed by the sun, so it melts a little collar around it… it's the little 'collar of last fall' I call it, 'cause you can see the leaves. Another is, when the crows arrive telling news." —*Chibinesi Jim Northrup Jr.*

Other tribal members look for different cues, such as the meme (pileated woodpecker):

> "You wait for sugarbush. You wait for meme… you wait for him to tell you that it's time to do sugarbush… You go stand around outside, and then when you hear that voice… when they're making that sound… it's time." —*Mary Moose*

Other indicators were shared for when to harvest wiigwaas (birch bark):

> "When the deer flies come, it's warm enough then, for the layers of bark to separate, because they've got that sap goin' up and down." —*Chibinesi Jim Northrup Jr.*

A few indicators involved fish:

> "[When] old frogs start (makes noise)… we would start to spear on the reservation." —*Tom Maulson Sr.*

> "This morning, I listened to frogs. They're singing now. I don't know if they're, I call them singing, like they're steady whistling. So then when you listen to them… you know again that… the sturgeons are spawning." —*Mary Moose*

> “As soon as the popple leaves got as big as a quarter… the suckers would come up by the thousands and thousands.” —*Joseph Duffy*

Some interviewees mentioned that certain indicators no longer correspond with their associated events:

> “But again, we used to time the way we panfished by the ants coming out of the ground. So, we knew that when the ground was heated up enough that the ants would come out from underneath, that the ground under the water that the sun was hitting was heating the bottom of the lake also. Which would trigger the panfish to spawn. And now you’re not seeing that anymore… it seems like the panfish are already done before the ants come out.” —*Curt Kalk*

Finally, one theme found in every interview was that of gratitude and respect. This included topics such as offering asemaa (tobacco) before harvesting and gratitude for the gifts provided by various beings:

> “Tobacco is our first medicine. I was always taught to put tobacco down every time you take something because of what you’re doing to that part of the world. You know it can be little bitty spots but it’s still part of the world.” —*Maryellen Baker*

> “I always use tobacco, that’s just my culture. Go fishing, I go hunting, and I use it too.” —*Leonard Sam*

> “[Maple sap is] a gift, it comes out of that tree one drop at a time, and so, it’s a gift.” —*Chibinesi Jim Northrup Jr.*

> “Everything you do, you gotta have a good heart… all the traditional things that we do, you know from sugarbush to wild rice to planting gardens to planting tobacco or whatever you’re doing... you have to have a whole heart respect for it because it’s given to us by the Creator, he’s making it possible, and all you have to do is you have to put the effort into it. So when we have our crew of… our sons and, our young bucks and young girls and we tell ‘em… you’re gonna be puttin’ tobacco down for this tree, so you can take the sap. You have to have a good mind. You know, you gotta be thankful and so if you’re mad or, you know, you’re troubled about something, don’t do it, because then that will go into that food.” —*Pat Northrup*

Discussion

Many beings of interest to GLIFWC's member tribes will be affected by climate change in the upper Midwest Ceded Territories, regardless of which emissions scenario unfolds. In the worst-case scenario, 45 of 66 beings were categorized as moderately vulnerable or higher. Many of these will decrease in abundance and/or shift their ranges by the mid-21st century. In some cases, their ranges may shift out of the Ceded Territories entirely, putting at risk relationships held with Ojibwe people for centuries. Despite being categorized as less vulnerable, the remaining beings will also be impacted by increasing temperatures, variable precipitation, extreme storms, warmer winters, and/or the arrival of bakaan ingoji gaa-ondaadag, among a growing list of climate change effects.

Swimmers were the most vulnerable category, mostly due to higher scores for questions about physiological thermal niche, manidoonsag or predators, competition, dietary versatility, and projected decreases in range and population size (Appendix 3). Scores were not similar across all swimmers, however. Cool/cold-water swimmers (e.g., ogaa, odoonibiins) had moderate to extreme vulnerability scores while warm-water swimmers such as ashigan and noosa'owesi had low to moderate scores. Cool/cold-water swimmers may be limited in the habitat they can occupy, particularly in the summer when surface temperatures are too warm and oxygen levels are too low near the bottom of a waterbody. Changes in land use after European settlement and climate change have reduced the oxy-thermal habitat of cool/cold-water fish habitat in stratified lakes in the upper Midwest in the last century (Jacobson et al. 2019). Forested areas in catchments around these lakes should receive high priority for protection to maintain cool/cold-water habitat (Jacobson et al. 2019). As for warm-water swimmers such as ashigan, research indicates that population size and range may expand in the upper Midwest as the climate changes and habitats become more favorable for these beings (Hansen et al. 2017).

Plants were almost as vulnerable as swimmers on average and made up five of the ten most vulnerable beings. Manoomin was the most vulnerable being in the assessment and is discussed in greater detail below. Plant beings had higher scores for questions about dispersal ability, dependence on other beings for dispersal, impacts of hydrology, interspecific interactions, and a documented response to climate change (Appendix 2). As plants disperse across the landscape slowly, in many cases they may be unable to respond quickly enough to the rapid pace of climate changes, and local hydrological impacts will affect them to a much larger degree than other beings. Many plants also have close relationships with other plant beings, and most have relationships with mycorrhizal fungi that will be challenged as climate change creates conditions favorable to some beings and less favorable to others. Many plant beings, particularly understory beings, are under-researched in general and in relation to climate change, with many climate change studies focusing primarily on trees (e.g., Janowiak et al. 2014). A lack of data made it more difficult to assess those understory plant beings, and therefore confidence levels for many of those beings are low. This assessment will provide a baseline for investigating climate change effects on some culturally important beings often overlooked in the scientific literature.

Four-leggeds and flyers were the least vulnerable categories on average, though scores varied widely. For both groups, but particularly for flyers, this is likely due in part to their ability to travel longer distances across the landscape to respond to changing conditions and cross barriers that can prevent the movement of other beings. Four-leggeds also scored the lowest in the questions pertaining to hydrologic changes and other disturbances, manidoonsag and predators, and genetic variation. As four-leggeds are often higher on the food chain than other beings, in general they have fewer predators and often have methods of dealing with manidoonsag (Hart 2011). However, many of the four-legged beings, such as waabooz, mooz, waabizheshi, and ojiig, are northern beings highly dependent on winter conditions and a deep snowpack. Migratory flyers also have another set of climatic conditions to contend with on their wintering grounds, which were not investigated in this assessment, and which may increase their vulnerability beyond what we have considered here.

The average vulnerability score for crawlers was moderate. Crawlers scored the highest for the questions about barriers, disturbances, and genetic variation. These beings also disperse short distances, and as small, mostly aquatic beings, are affected by many natural and manmade barriers to dispersal as well as changing hydrologic conditions. Nearshore nesting sites are susceptible to flooding during heavy rain events. There are many references to frogs and toads as “indicators” of ecosystem health, including in Great Lakes coastal wetlands, as they are documented to be sensitive to a variety of human stressors (Price et al. 2007). Climate change will continue to add to existing stressors for these beings.

Other assessments in the upper Great Lakes region found many of the same beings to be vulnerable to climate change, though there were some differences in the levels of vulnerability projected. These differences are likely due to differences in regional climate impacts, and the different interactions among living and non-living beings (e.g., earth, water, fire, and air) in each assessment area (Janowiak et al. 2014, Inter-Tribal Council of Michigan, Inc. 2016, Stults et al. 2016, Wisconsin Initiative on Climate Change Impacts [WICCI] 2017). For example, manoomin was found to be moderately vulnerable in 1854 Treaty Authority’s Vulnerability Assessment and Adaptation Plan (Stults et al. 2016). There may be a few reasons for the difference in vulnerability ratings between the two assessments – the 1854 Ceded Territory extends farther north than the 1837, 1842, or 1836 Ceded Territories. Local variance in water quality, climate impacts, genetic variation, manoomin abundance, among others, may also be different in the different, although overlapping, assessment areas.

The factors that had the most influence on the vulnerability of beings in this assessment were manidoonsag and predators, changing hydrological conditions, and an increase in disturbances. Manidoonsag and predators (called “pathogens or natural enemies” in the CCVI) were the most influential factor in the assessment, affecting the scores of 45 out of 66 beings. Warmer winter nights in particular will likely allow many manidoonsag to overwinter in higher numbers or allow new manidoonsag to move into the Ceded Territories and have increased impacts on many beings, particularly plants. Some examples of this are baapaagimaak, which will be increasingly affected by the emerald ash borer; manoomin, which can be impacted by rice worms and brown spot disease; mooz, which is affected by winter ticks; and bapakwaanaajiinh, which is affected by white nose syndrome. Other studies have confirmed that manidoonsag are moving north to new places (Bebber et al. 2013). However, because these beings have such complex, unstable relationships that are not very well understood, there is still a large amount of uncertainty in what will happen with many of these interactions as the climate changes (Dukes et al. 2009). Predators increasing in population due to climate change was an additional part of this factor; some beings favored by climate change, such as gidagaa bizhiw, are predators that have the capacity to hunt many other beings. Browsing by waawaashkeshi influenced the vulnerability of many plant beings, including giizhikaatig (Weiskopf et al. 2019). Disturbances such as extreme storm events (including flooding, wind, and wave action) influenced the vulnerability scores of 38 beings. When extreme storm events occur, sedimentation can disrupt fish spawning grounds, wind and wave action can displace eggs or larvae, and flooding can inundate the roots of plant beings and damage the homes of animals. Though wildfire is not common in most of the Ceded Territories, increases in intense fires may impact some beings in the assessment. Changing hydrologic conditions impacted the scores of 32 beings. Longer periods of drought or increased rainfall can disrupt the habitat of beings that depend on consistently moist conditions, such as baapaagimaak and waawaatesi. These changing conditions will also cause varying water levels, which will impact beings such as mitigoningwiishib and manoomin.

Shifting ranges or changes in population size and density of beings due to climate change and other factors will bring new interactions and relationships (e.g., Hansen et al. 2001; Van der Putten et al. 2010). Other new interactions will occur when beings are assisted in their migration by humans, when bakaan ingoji gaa-ondaadag expand their ranges or are introduced into new areas, or when other changing environmental conditions influence the migration of certain beings. Areas within the Ceded Territories are being promoted by mainstream media and some non-governmental organizations as “climate refuges” for humans escaping more severely impacted areas of the world. Increased human migration into the Ceded Territories will likely lead to more development, deforestation, industrial agriculture, and impacts to nibi (water) to meet the demands of more people, all of which will impact Ceded Territory beings and ecosystems. While Ojibwe people have adapted to changing relationships for millennia, the speed of these climate-related changes will affect their ability to maintain cultural relationships with beings that they have held for centuries. Some of these relationships may be lost as beings are no longer found in the Ceded Territories, and with those relationships, culture, language, and traditions surrounding those beings will be lost as well. However, there may also be new relationships forged with beings that have not previously resided in the Ceded Territories or had previously been in low abundance. There are current examples of this, in which beings brought from other countries are now commonly used by Ojibwe people. For example, common mullein and broadleaf plantain were introduced in the 18th century and are now used medicinally. These relationships will continue to change with the climate.

Most frequently mentioned beings

Manoomin was mentioned in 80% of interviews, and as the most vulnerable being in the assessment, its abundance and/or range in the Ceded Territories is likely to decrease significantly even in the best-case scenario (Figure 35). Several studies around the Great Lakes region have recently or are currently focused on manoomin, attempting to learn more about the being that is the basis of Ojibwe culture (e.g., Cozzetto et al. 2013; Matson et al. 2021). As manoomin declines or even disappears from certain places on the landscape, it will have extreme impacts on the relationship that Ojibwe people share with the land. It will likely also have negative effects on physical health (Ballinger 2018). Manoomin is deeply embedded in culture and spirituality and many tribal citizens fear a loss of identity as their ability to maintain their relationship with manoomin is lost:

> "There is no origin story for wild rice. It's elemental, it was there from the beginning… it's like the original berry. It always existed… It's its own spirit and everything flows from that." —*Niso-asin Sean Fahrlander*

> "To talk about the rice and how sacred and valuable it is to our people cannot be measured in any form of human methodology." —*Rose Polar Martin*

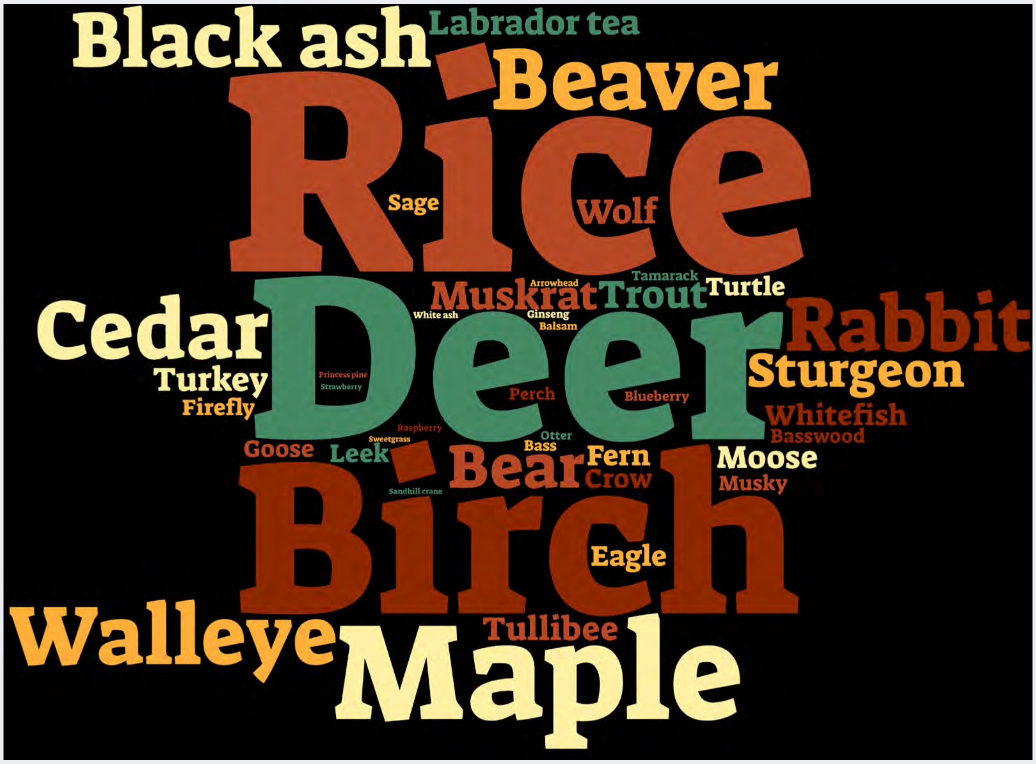


Figure 35. Word cloud containing beings in the assessment mentioned 5 or more times. The larger the name of a being, the more often it was used in TEK interviews. Word cloud is based on number of times a being was mentioned overall, throughout the interviews.

Ogaa was mentioned more than any other swimmer in the assessment. Interviewees raised concerns about ogaawag becoming smaller and less abundant over the past few generations. In addition, tribal members noticed that the timing of ice-off and spawning are becoming more variable and are no longer in sync with other seasonal cues. Other studies have also raised concerns about the declining productivity of ogaa fisheries (Embke et al. 2019, Sass et al. 2021), and more variability in the timing of ice-off and ogaa spawning that may have negative consequences for the production and survival of young ogaawag (Feiner et al. 2021, Barta et al. 2022). These changes may be occurring more frequently and quickly over larger areas because of climate change, but are also related to habitat loss, overharvest, pollution, and bakaan ingoji gaa-ondaadag (Lynch et al. 2021). As aquatic ecosystems continue to change, tribes may need to consider how to maintain their relationship with ogaa and potentially forge new relationships with other swimmers (Shultz et al. 2022).

> “When we were small, average [walleye size] was a couple pounds. Now average is probably under a pound.” —*JD Lemieux*

> “We literally could just go off and fish on the bank and catch 6, 7 walleye in 3 hours, 2 hours, whatever, and bring ‘em home and have a nice meal. Now, you’re lucky if you get 2 or 3 walleyes that are 12, 13 inches.” —*Maria Nevala*

> “So to me sugaring was the first thing. And then as the ice started breaking up in the bays and moving out, then it was time to spear… and sometimes there would be overlap in that. And then the birch run after those things. But now, depending on how cold the winter’s been, how much ice we have, all those sequences are just, I don’t know, they’re just not normal.” —*Gidigaa bizhiw Jerry Jondreau*

Wiigwaasaatig was the most mentioned plant being, along with manoomin, and was mentioned in 80% of interviews. Although models show that wiigwaasaatig in general has a fair ability to cope with climate changes in the region, many tribal members are concerned about its decline. Many tribal members reported not seeing as many wiigwaasaatig that are large enough to build wiigwaasi-jiimanan (birch bark canoes), and large trees that are spotted are usually dead. Along with large quantities of birch poles being cut for decoration, and the fact that wiigwaasaatig regeneration is not often a primary goal for land management agencies, many tribal members are concerned about the future of this being in a changing climate (Moser et al. 2015).

> “One thing that we have noticed in the last 10 years or so is that more trees are dead at their tops and so we keep driving along the road or we will look into the forest, and we will see beautiful bark but then we always have to look up to see if the top is dead or not. That’s one thing that we have noticed, it seems to be declining... I keep thinking about the birch bark canoe, how will we be able to make more in the future and even though there’s just a handful of people making them right now, how will that impact a tree growing up, a really nice tree growing up that could be used for a birch bark canoe in the future?” —*April Stone*

Waawaashkeshi was the four-legged mentioned most often in interviews, primarily because of this being’s importance as a healthy food source. Interviewees were concerned about waawaashkeshi numbers along with changes to local ecosystems, including impacts from disease, hunting pressure (human and other), and changes in waawaashkeshi food sources. Warmer temperatures were also mentioned as a concern, both in the winter in relation to yarding behavior, and in the early hunting season especially after a kill. Waawaashkeshi is generally expected to be less vulnerable to, or even favored by, climate change. If its population does increase in the Ceded Territories, it could exacerbate browse damage to many understory plants, while range expansions northward could negatively impact mooz populations (Lyons et al. 2021).

> “…because I was always told when I was a kid that you eat that waawaashkeshi because that waawaashkeshi out there eats all that different medicine out there, and he loves us so much that he gives his life for us, so we get that medicine from him. And that’s what helps sustain us.”
> —*Vern Northrup*

> "The other thing, hunting the whitetail rut when it's 60 degrees out, it's just unbelievable. I mean, it sucks bad. And then it changes the dynamic of harvesting, because the food prep side of things completely alters when you're above 50 degrees. As soon as you pull the trigger you're in clean mode, racing to get that deer out so you can get it put away because of the heat… But can you imagine if our ancestors had to deal with these conditions, I could see it being apocalyptic for a winter, because you can't store that meat, even if you smoked it, when it's 65 degrees outside, and you don't have refrigeration and freezers, I don't know how they would have done that, I really don't." —*Mike Wiggins Jr.*

Mikinaak (snapping turtle) was the most mentioned crawler. While occasionally mentioned as a food source, interviewees primarily related mikinaak to the Anishinaabe re-creation story and lunar calendar. As a being that lives in nibi, interviewees were very concerned about its sensitivity to environmental changes and predators. However, mikinaak was the least vulnerable crawler in the assessment, though there are limited data on population trends in the Ceded Territories. Some research suggests that mikinaak could benefit from warmer fall temperatures that may allow them to lay larger eggs or larger clutches of eggs in the spring (Hedrick et al. 2018).

> "Reptile and amphibian, every single one of them… is hyper sensitive…Their sensitivity to predators and where they can rest." —*Niso-asin Sean Fahrlander*

> "There are 13 sections in the shell of mishimikinaak, the snapping turtle, and that's our lunar calendar. We use a ceremonial pipe to tell the creation story. Then we use a turtle shell to tell the re-creation." —*Moka'ang Giizis-Rising Sun Joe Rose Sr.*

The most mentioned flyer was migizi (bald eagle). This being is not expected to be very vulnerable to climate change and currently has a high population in the Ceded Territories. Migizi carries messages and prayers to the Creator and is highly respected in Ojibwe culture. Eagle parts, particularly feathers, are often used in cultural practices. After the decline in the migizi population due to DDT starting in the 1940s, DDT was banned, and their populations have recovered. No interviewees expressed concern about recent or future declines in migizi.

> "Bald eagles, you know they're more plentiful today than they were when I was around. It was a rare occasion to see an eagle flying around… but they're back!" —*Lawrence Deragon Sr.*

> "I know that in the last 20 years bald eagles have come back. I saw one when I was younger, I was probably around 15 or 16, and now I see them numerous times during the summer."
> —*Cheryl Baragwanath*

The challenges of integrating TEK and SEK

TEK and SEK contributed in different ways to understanding the vulnerability of beings in the Ceded Territories. TEK shared was generally holistic in nature, looking at multiple threats to a particular being and environmental changes over time, including climate change. Much of the knowledge shared also included impacts to culture and human activities. To many tribal members, climate change is simply another instance of human degradation of the environment. TEK also contributed substantial information about relationships among beings, many of which may be affected by climate change. This deep knowledge comes from observations developed over thousands of years:

> "That's how it was long ago. They didn't have no almanac, no TV, no computer, no weatherman, or someone telling you, 'Ho get ready, it's going to be forty below tomorrow.' You know? Who told them that? Nobody. They had to observe and watch, with the connection that they had around them. Everything is connected and they're related." —*Carmen Butler*

There are some fundamental barriers to integrating TEK with SEK in this context. "Climate change vulnerability," the basis for this document, is a concept taken from SEK, and there is no direct translation in Ojibwemowin. However, knowledge about past and current climate changes is deeply embedded in TEK. The way Anishinaabeg see and describe the world in Ojibwemowin, an ancient language, is fundamentally different from the comparatively recent English terminology. Therefore, there can never be full integration of TEK within the framework used by this assessment. This is particularly true for those non-human relatives, such as rocks and mineral bodies, that are not recognized as animate beings by SEK. For these reasons, rather than attempting to fully integrate the two types of knowledge, we attempted to present them as companions and equally valuable knowledge systems. Despite these differences, both TEK and SEK will need to be relied upon to address the effects of climate change and to build and maintain relationships with beings throughout the Ceded Territories.

While we chose to share the number of times a being was mentioned in TEK interviews, this number does not correspond to each being's "importance," as all beings are of equal importance in Ojibwe culture. Due to the nature of the semi-directed interviews, not all beings were discussed in each interview, and interviewees mentioned those that came to mind, beings they wanted or were able to share knowledge about, or those which they thought may be affected by climate change or other environmental or human factors. The number of times a being was mentioned in the interviews also does not correspond to its vulnerability to climate change – three of the top 10 mentioned beings (waawaashkeshi, makwa, and ode'imin) were categorized as least vulnerable by the CCVI in both climate scenarios. While the CCVI rankings include knowledge from the interviews, they only include knowledge related to certain aspects of a being's natural history. Other, deeper or more general knowledge from interviews was not possible to incorporate into the CCVI, and therefore the CCVI rankings do not completely reflect the Ojibwe perspective on how a being will be affected by climate change.

There are limitations and benefits to using the Climate Change Vulnerability Index. The tool does not consider more than one life stage of a being. It also is not conducive to including information outside of the categories provided. Finally, even if a question receives the maximum score, each question has a limited effect on the overall score, and the overall score therefore may not entirely reflect the severity of a particular threat. For example, baapaagimaak is predicted to be decimated by the emerald ash borer throughout the Ceded Territories, but it was categorized as moderately or highly vulnerable instead of extremely vulnerable because of the limited impact on its score by considering emerald ash borer. However, the tool is extremely useful for a rapid assessment of a large group of beings and as the basis for adaptation planning. The questions answered to assess vulnerability allow us to pinpoint which facets of a being's natural history make it most vulnerable to climate change, and design adaptation actions to address these specifically.

Traditional perspectives

In addition to climate change or other environmental changes, there are other perspectives on why some beings may be declining in population. As referenced in the introduction, there are certain ceremonies and protocols that are followed to show respect for and maintain beings which volunteered to give their gifts to the Anishinaabeg in the original treaty. All beings are considered gifts, though they are typically viewed as "resources" by western culture. It is our responsibility to care for these gifts, in order for them to continue to take care of us. Some believe that not using those gifts and following the protocols in the original treaty may cause them to decline or disappear:

> "Sometimes I think that the reason why the land is declining is because we aren't using it… that's why it's falling out of use, because we aren't using it anymore." —*Jarrod Dahl*

> "Like the fish, the beaver, after you eat them, you go put them in the water. You go put your tobacco in the water with them... then you say 'come back alive'… But we don't do that anymore. Now they run out of fish. So that teaching is gone, nobody is doing it no more. Every bone that you have, and you eat, you save it in one place. You go put it in the water, so that fish come back alive. That's same thing with beaver. After you cook your beaver, you put those bones one place, then… put them in the water. You say same thing. Then that beaver starts swimming around again. It comes back alive, but you don't see it. It just comes back. So that's how, that's how they used to do it. They used to do it a long time ago. Same thing with moose, or caribou. After you finish whatever you can't use, you go put out in the woods. Clear the spot, put the cedar there, and then you put those bones there. Then you tell him to come back. Come back alive, so we never run out of food. That's how you say it, but now there's no moose around here because, I guess we all forgot the teachings." —*Mary Moose*

> "I know something's changing [a traditional medicine] because I've seen it being scarce and hard to find. Not as abundant as it used to be. Sometimes I think it's people not using it right."
> —*Maryellen Baker*

This perspective is in stark contrast to those who view animals and plants as objects to be used as we desire, and that humans can control other beings for their own use:

> "See what's happening is that the chimookomaan, the man, they think they have total control over this earth. They'd like to believe they do. And they're trying their best to be in control and they're not. They'll find out in the long run they're not. That's the way the chimookomaan thinks. Versus the Anishinaabe, goes with the flow, you know, those manidoog will provide, so one year we're low on rice. But next season you'll probably have more. It fluctuates. And then we'll talk about, oh remember the year we had no rice." —*Lee Obizaan Staples*

> "You gotta let nature take its course. You gotta trust those manidoog know what they're doing, so sometimes when you go through vulnerability stages of these particular animals, there's a reason for that, you know, maybe they need to die off and they'll be replenished later, you know what I mean? The deer are no longer available for certain animals to eat, maybe they'd been too plentiful. So I would just trust nature knows what it's doing. I wouldn't worry about it. I wouldn't do research and do some scientific experiments and start pulling my hair… We just gotta be more trusting of this world, and these manidoog, nature itself… I'd be willing to bet that if they die off one year that they'll be back later on up the road. I trust that. There are certain things that the Creator gave us to eat and I don't think we'll be without... I mean we may be low with some of that stuff in a particular year, you know, like we were given the animals to eat, like the deer and the rabbits, the fish, the wild rice, and those things that grow in the wild. And there'll be some times when they're plentiful and there'll be some times when they're not. It goes back and forth. And I wouldn't worry about it." —*Lee Obizaan Staples*

> "I think the only thing different that I think about with my grandmother… it wasn't so much about the resources as the way of life, like she would say. We're put here to live with the animals. The problem with the people that are around now, really believe in their hearts and their souls and their religion, that they're here to rule over the animals. And that's a big difference in how we're looking at it. It's upside down. Compared to what everybody else is looking at, is that they're here to rule, conquer, and control those things. And I think my attitude is the same as hers; we're here with them. We can't get the heck off the planet. And neither can they. But for some reason people think today that you're made to rule over the beasts and the animals and things like that. She just wasn't a believer in that. She didn't believe that. We're all the same, we respect that." —*Curt Kalk*

Next Steps

Vulnerability assessments are generally one of the first steps in the adaptation planning process. From this assessment, we learned which Ceded Territory beings may be most vulnerable to climate change, which will likely be less affected, and which beings may benefit. All beings are important to Ojibwe people, but the TEK interview process gave us insight into which beings tribal members are most concerned about for themselves and for future generations. Our next step will be to begin adaptation planning, using this document, among other resources, to prioritize which beings to focus on moving forward.

An adaptation plan typically identifies specific policies and actions that can be undertaken to help beings, including humans, deal with climate changes identified for a particular region. Often these actions include physical land management. While our member tribes have sovereignty over their reservations, the ability for them to act unilaterally on ceded lands and waters is limited. Instead, we will need to work with partners at every level and throughout the Ceded Territories to advocate for the beings that need our support. We recognize that other governments and agencies are also involved in adaptation planning for the Ceded Territories and tribes need to be involved with, and lead, these efforts while also planning for themselves.

To undertake our GLIFWC adaptation planning process, we anticipate drawing from multiple resources including the Tribal Adaptation Menu (TAM) and the Resist-Accept-Direct (RAD) framework. The TAM is a tool created by multiple partners, including GLIFWC, that provides a framework to integrate Indigenous and traditional knowledge, culture, language, and history into the climate adaptation planning process (Tribal Adaptation Menu Team 2019). We have been using the TAM successfully since 2019, facilitating workshops with tribes and non-tribal partners planning culturally driven adaptation projects and anticipate carrying this model forward into our GLIFWC adaptation planning. The RAD framework allows managers to plan for climate adaptation to either resist, accept, or direct changes for beings or ecosystems (Feiner et al. 2022). GLIFWC and Waaswaaganing (Lac du Flambeau Band of Lake Superior Chippewa Indians) staff have used the RAD framework to analyze fisheries management decisions and actions regarding ogaa in the Minocqua Chain of Lakes in Wisconsin and tribal goals of resisting change and maintaining ogaa populations in this ecosystem (Shultz et al. 2022).

In keeping with GLIFWC's mission to infuse Ojibwe culture into everything we do we recognize that along with research, workshops with the member tribes, and continuing interviews and discussions with tribal elders, knowledge holders, and harvesters, we also have a responsibility to respectfully seek knowledge directly from our animal and plant relatives and the manidoog so that we can best plan to care for those who care for us.

Conclusion

We currently stand at a fork in the road, in the age of the seventh fire. Climate change threatens the very existence of some beings in the Ceded Territories and therefore also threatens relationships held with these beings for thousands of years. Every aspect of Ojibwe culture related to these beings, including subsistence harvesting, spiritual relationships, ceremonies, language, and stories will be affected. This assessment is a first step in helping us determine how best to take care of these beings who take care of us. It is, however, only the start of a process. GLIFWC serves 11 distinct Ojibwe communities and helps them implement their treaty rights and co-manage natural resources over 60,000 square miles of Ceded Territory in three states. Adaptation, like language and culture, is place-based, so strategies and tactics that work for one community may not work or may not be appropriate in another.

Ojibwe people have been adapting to changes in the climate for thousands of years, which they will continue to do. Some climate-driven changes may provide new opportunities along with new challenges. Adaptation means different things to every tribe, community, and individual, and this assessment does not attempt to answer the question of how culture should adapt:

> "What defines culture? That's a big question, but do we try to keep things as they are even though the natural world doesn't want it to be the same?" —*Jarrod Dahl*

> "Thousands of years my people been livin' here like this on this land, you know? Same animals, fish, birds… plants, water. All this time, we're eating and surviving, you know? Off the Earth. And we're still doin' it today somewhat, you know… my people observing… good years, bad years, good times and bad times of the Earth. When human beings aren't too good or when they are good. All these things, it goes down into our traditional ways. So, everything you see that's still growing here, it's because we wanted it that way. That's the way God put it here, let's keep it that way." —*Makoons Fred Ackley Jr.*

Ojibwe culture focuses on the seventh generation philosophy in which all decisions are made with the thought of seven generations ahead and the long-term consequences of our actions. Climate change is no exception. The task given to us is to accept the knowledge gifted to us from our tribal communities and use it to make the world a better place for our children, grandchildren, and their grandchildren. At times, this approach may conflict with the demands of western culture, but our challenge is to see past the short term to the long-term consequences of our actions:

> "[I want to] make sure we keep things better for the next generations… we want that to go to our kids and grandkids so they can do the same thing." —*Pat Northrup*

Being Pages

The following section is composed of individual pages for each being (species) in the assessment, each containing a photo, range map, vulnerability ranking and graph, and Traditional and Scientific Ecological Knowledge related to the vulnerability of the being to climate change. The section is organized by category (plants, swimmers, flyers, crawlers, and four-leggeds), with the more vulnerable beings appearing toward the beginning of each category. The first page is an example page, which explains the information found on the subsequent pages. The word “being” is used in this document to emphasize how all other non-human life forms are considered relatives.

For complete results from the Climate Change Vulnerability Index tool for each being, see Appendices 2–6.

For references associated with a particular being or beings, please contact the author team.

Photo of being.
Unless otherwise
specified, photos
are open source.

Range map of being. Note that some may be slightly out-of-date due to a lack of recent information.

Permanent Resident: This being can be found here all year long.

Nonbreeding Resident: This being can be found here only during its nonbreeding season.

Breeding Resident: This being can be found here only during its breeding season.

Introduced: Areas of this being's current range where it has arrived due to human actions.

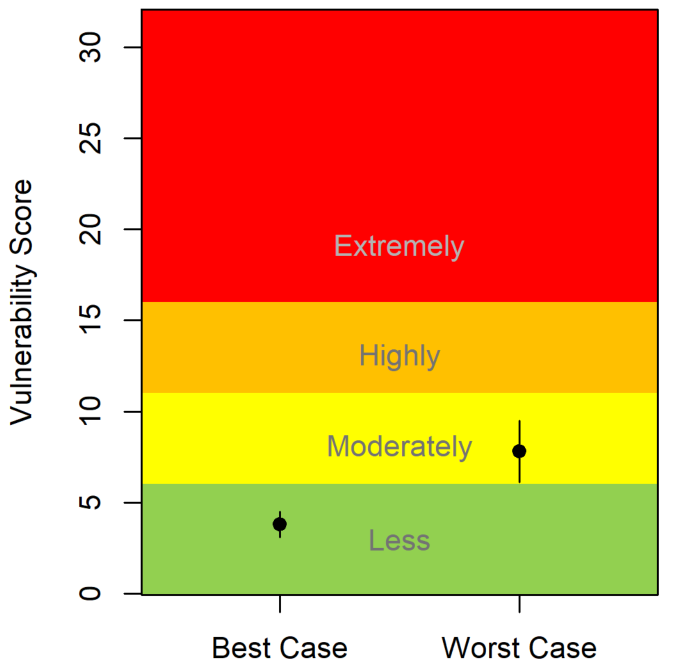
Passage Migrant: This being stops here for a short time during seasonal migration.

Range map of being.

Ojibwe name

Plural Ojibwe name / English name / *Latin name*

Vulnerability Ranking: Less, Moderately, Highly, or Extremely (a range given from the best case to worst case scenario)
(Confidence Level: Low, Moderate, or High)
Low confidence level is 9 or more un-answered questions on the CCVI tool; moderate 5-8; high 0-4.



Climate change vulnerability scores for the being on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

This box contains cultural information about each being, including traditional stories, star or clan knowledge, uses, and more. Some of this knowledge comes from interviews conducted as part of this assessment and some comes from outside sources. Sensitive cultural information about these beings is not shared.

This section contains natural history information about each being, including its preferred habitat and diet. If known, information on the status of the population in the Ceded Territories is also included here.

Below the natural history information is a summary of knowledge shared in interviews about this being. Some beings were infrequently mentioned. For those beings, a note is included that while the being was mentioned infrequently, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties.

Summary of climate threats:

The first sentence of this section reports the vulnerability score of each being as a percentile, which compares its score both to the other beings in its category (flyer, crawler, four-legged, swimmer, or plant) and also to all other beings in the assessment. A being in the 100th percentile would be the most vulnerable being in the group; a being in the 1st percentile would be the least vulnerable being in the group.

The rest of this section provides an overview of climate change impacts to each being, which summarizes the information found in the next section.

Factors that increase the vulnerability of this being to climate change:

This section lists any factors from the Climate Change Vulnerability Index tool that were scored above “neutral” for this being (either somewhat increase, increase, greatly increase, or a combination of these scores) and will therefore increase the vulnerability of the being to climate change. More vulnerable beings will have many factors listed. The legend below explains the symbols. See below for brief definitions of the rankings. For a more detailed explanation of the scoring, please see Young et al. (2016).

For a complete list of scores for each being, see Appendices 2 to 6.

References for the following pages can be provided on request.

Legend

GI	**Greatly Increase** This factor greatly increases vulnerability
I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability
I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability
SI	**Somewhat Increase** This factor somewhat increases vulnerability
N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Climate Change Vulnerability Index Definitions

Natural barriers: If this factor is listed on a being’s page (i.e., scored above neutral), there are natural features that prevent the movement or dispersal of the being, such as unsuitable habitat or large lakes.

Anthropogenic barriers: If this factor is listed on a being’s page (i.e., scored above neutral), there are human-made features that prevent the movement or dispersal of the being, such as large urban areas or dams.

Human land use changes: If this factor is listed on a being’s page (i.e., scored above neutral), human actions taken to reduce the impact of climate change, such as renewable energy projects or plantations for carbon offsets, will impact the being.

Dispersal: If this factor is listed on a being’s page (i.e., scored above neutral), the being is categorized by restricted dispersal (the ability to move across the landscape).

Historical thermal niche: If this factor is listed on a being’s page (i.e., scored above neutral), the being has experienced limited variation in temperature in the past 50 years across its range.

Physiological thermal niche: If this factor is listed on a being’s page (i.e., scored above neutral), the being is at least somewhat restricted to cool or cold environments that are vulnerable to climate change.

Historical hydrological niche: If this factor is listed on a being’s page (i.e., scored above neutral), the being has experienced limited variation in precipitation in the last 50 years.

Physiological hydrological niche: If this factor is listed on a being’s page (i.e., scored above neutral), the being is at least somewhat dependent on specific hydrologic conditions that are vulnerable to climate change.

Disturbance regime: If this factor is listed on a being's page (i.e., scored above neutral), the being will be disrupted by changing disturbances such as fires, flooding, and/or wind.

Dependence on snow or ice: If this factor is listed on a being's page (i.e., scored above neutral), the being is at least somewhat dependent on ice or snow as part of its life cycle.

Uncommon landscape features: If this factor is listed on a being's page (i.e., scored above neutral), the being is at least somewhat dependent on an uncommon landscape feature or habitat type for part or all of its life cycle.

Dependence on other species to generate habitat: If this factor is listed on a being's page (i.e., scored above neutral), the being is at least somewhat dependent on another being or small set of beings to generate or maintain its habitat.

Dietary versatility: If this factor is listed on a being's page (i.e., scored above neutral), the being is dependent on a being or a small set of beings for its diet. This factor applies only to animal beings.

Pollinator versatility: If this factor is listed on a being's page (i.e., scored above neutral), the being depends on a certain pollinator or set of pollinators for propagation. This factor applies only to plant beings.

Dependence on other species for dispersal: If this factor is listed on a being's page (i.e., scored above neutral), the being is dependent on another being or set of beings for its dispersal.

Pathogens or natural enemies: If this factor is listed on a being's page (i.e., scored above neutral), the being is likely to be affected by manidoonsag (little spirits/insect pests and pathogens) that will benefit from climate change.

Competition: If this factor is listed on a being's page (i.e., scored above neutral), the being is likely to be affected by competition from local or non-local beings that will benefit from climate change.

Interspecific interactions: If this factor is listed on a being's page (i.e., scored above neutral), the being is at least somewhat dependent on a relationship with another being or beings, such as mutualism, commensalism, or parasitism, for survival.

Genetic variation: If this factor is listed on a being's page (i.e., scored above neutral), the population of the being has low or very low genetic variation.

Bottlenecks: If this factor is listed on a being's page (i.e., scored above neutral), the being's population has gone through a bottleneck (a point where there were a small number of individuals remaining) in some point in the being's recent evolutionary history.

Reproductive system: If this factor is listed on a being's page (i.e., scored above neutral), the being has a reproductive system that infers limited genetic variation in its population. This factor applies only to plant beings and is only scored if genetic data are not available.

Phenological response: If this factor is listed on a being's page (i.e., scored above neutral), the being has not yet responded to changing seasonal temperature or precipitation dynamics.

Documented response to climate change: If this factor is listed on a being's page (i.e., scored above neutral), the being has already experienced a decline in population due to climate change.

Future change in range size: If this factor is listed on a being's page (i.e., scored above neutral), some or all of the being's projected future range disappears from the assessment area, based on available models.

Overlap of future and current range: If this factor is listed on a being's page (i.e., scored above neutral), a being's projected future range has limited overlap with its current range, based on available models.

Occurrence of protected areas in future range: If this factor is listed on a being's page (i.e., scored above neutral), the amount of the projected future range of the being that is considered "protected" is low.

Plants

Plants provide habitat, food, and medicine for human and non-human beings. Plant beings are in the second order of creation:

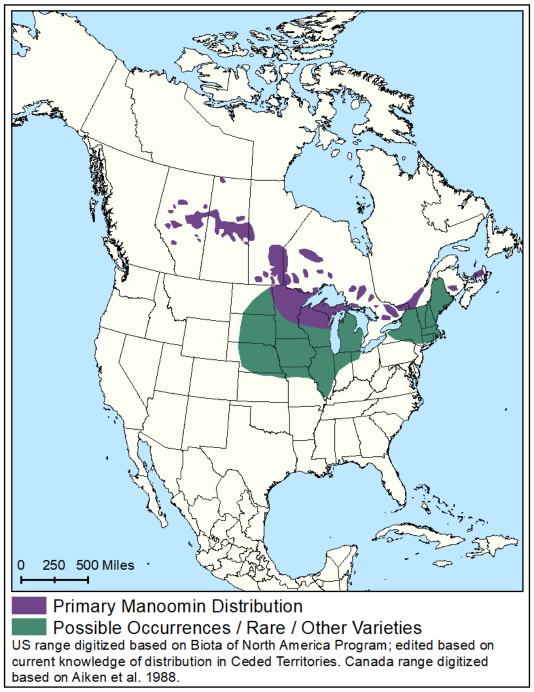
> "And that was all of the plant beings. All those beings of the second order. The fruits and vegetables, the grasses, the trees, and everything of the green world." —*Moka'ang Giizis-Rising Sun Joe Rose Sr.*

For complete results from the Climate Change Vulnerability Index, see Appendix 2. For references associated with a particular being or beings, please contact the author team.

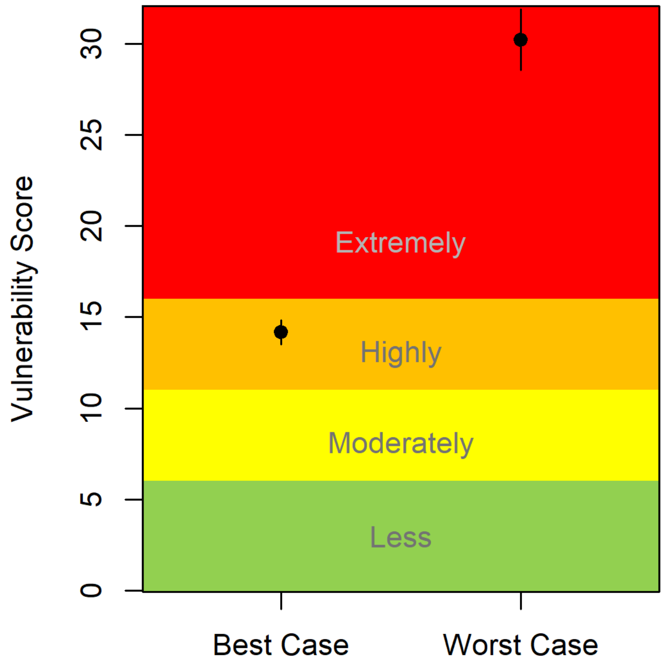
Manoomin

No plural form of manoomin exists / Northern wild rice / *Zizania palustris*

Highly - Extremely Vulnerable
(Confidence Level: Moderate)



Range map of manoomin.



Climate change vulnerability scores for manoomin on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

To the Ojibwe, manoomin is considered a special gift from the Creator which ties them to this plant both spiritually and culturally. One story tells of Wenaboozhoo worrying about what the Anishinaabe people would eat during long hard winter months. Many winters went by where little food was available and the Anishinaabe people were suffering. Wenaboozhoo wanted to help them, so he went into the woods to fast for four days. He dreamed of dancing with others in a river. The Ojibwe dancers with them wore elaborate headdresses with the feathers waving back and forth. When he woke up, he remembered the dream and saw tassels waving above the water. As he went closer, he realized that long seeds were hanging from the tassels. He gathered some of the seeds and brought them with him to continue his fast. When he fell back asleep, he had another dream of gathering the seed and eating it. He returned to his village to share his dream with the people. Together, they harvested enough manoomin to get them through the long winter.

Manoomin typically grows in lakes, streams, and rivers, in shallow water (1-3 feet) in places with soft, organic sediment. It requires flowing water and grows best in waters with low levels of sulfide. It is an annual plant that grows from seed each spring. Its life stages include a submergent stage, in which the plant is developing under the water, a floating leaf stage, in which one or two leaves float on the surface of the water, and an emergent stage, in which the plant grows out of the water. It then develops flowers and seeds that ripen in late summer/early fall.

Manoomin is found across the Ceded Territories, mostly concentrated in northern Minnesota and northern Wisconsin. Manoomin varies substantially in abundance from year to year, depending on factors including weather, water and/or nutrient levels, and presence of manidoonsag (little spirits – a word used to describe insects and pathogens), though not all of these factors are well understood. Many tribes have long-standing manoomin restoration programs, both on- and off-reservation, reflecting their concern and care for this being.

Particular effort has been made within GLIFWC to gather Traditional Ecological Knowledge specific to manoomin. The following are a few of the major themes mentioned across interviews.

Concern was expressed by many tribal members regarding the decrease and overall health of manoomin in many areas throughout the Ceded Territories. In Waaswaaganing (Lac du Flambeau), manoomin was once plentiful, but after the installation of a dam, it is now mostly just present on the rivers. Some feel it is being destroyed in areas such as Clam Lake (Burnett County, Wisconsin), but efforts on the lake are underway to remove carp and restore manoomin. Brown spot infestation has been seen in several areas since at least 2003.

Many stories were shared about poor harvest years or other harvesting issues. Several Mashkiiziibiing (Bad River) members related that they experienced multiple issues with their harvest from 2014 to 2016. Among other concerns, the air was too humid during the period the manoomin was laid out to dry, which caused manoomin to mold and resulted in a partial loss of their harvest. A Gaa-miskwaabikaang (Red Cliff) tribal member expressed concern over being forced to travel at least 200 miles from the reservation during the 2016 harvest season after severe storms earlier in the year heavily impacted manoomin beds closer to the reservation.

Much of the knowledge shared about when or how to harvest manoomin has the potential to be impacted by climate change. For example, it was said that if the mitigomizhiig (white oaks) are hanging with mitigominan (acorns), it will be an unusually productive year for manoomin. Additionally, the gathering period is only about two weeks long during what is known to the Anishinaabeg as Manoominike-giizis (Rice-making Moon). Climate change may cause these seasons to shift and disrupt these relationships that have been held for centuries, threatening the practice of harvesting manoomin.

Most interviewees felt that manoomin is vulnerable to climate change due to changes in water level, stronger and more frequent storm events, pollution, and many other factors. Overall, manoomin harvesters would like to see it be more plentiful on the landscape and are strong advocates of restoration.

Summary of climate threats:

Manoomin was the most vulnerable being in this assessment and has already begun to respond to climate-related effects across the Ceded Territories. It is sensitive to many different potential climate effects in each stage of its life cycle. It is also sensitive to many anthropogenic changes. Factors that affected the vulnerability of manoomin include natural barriers; human land use changes; limited dispersal as well as thermal and hydrological niche; sensitivity to disturbance; dependence on snow and ice; dependence on uncommon landscape features; sensitivity to pathogens, predators, and competition; and limited genetic variation.

Factors that increase the vulnerability of manoomin to climate change:

SI Natural barriers: Upland habitat and Lake Superior form natural barriers to manoomin.

SI Human land use changes: Land use changes resulting from human responses to climate change vary, but warmer temperatures may cause increased boat traffic, which often disturbs manoomin. Hydroelectric dams, installed as renewable energy sources, would likely negatively affect manoomin through artificial controls of water levels. Altered land use in response to climate change and an increase in tourism in the Ceded Territories would also negatively affect manoomin.

I Dispersal: Manoomin is capable of dispersing downstream when moving water transports seeds, but not upstream or across unsuitable upland habitat. Its seeds are heavy, without wings, and generally fall into the water near the plant. Many manoomin beds are the result of human seeding because the plant's natural dispersal is so limited.

I

Physiological thermal niche: It is likely that warmer temperatures will decrease seed production. Following milder winters, spring germination rates appear to be lower. Manoomin is also found near the central or southern end of its range in the Ceded Territories, and therefore warming temperatures may negatively affect this being.

I

Physiological hydrological niche: Manoomin is sensitive to changes in water level. It is well adapted to annual fluctuations in water levels; however, changes in precipitation that cause multiple years of low or high water are likely to prevent it from growing in a given location. Inter-annual fluctuations can also affect manoomin – high water during the floating leaf stage can drown or uproot the plant.

SI/I

Disturbance regime: Manoomin does depend on some level of disturbance (such as fluctuations in annual water level), but major disturbance events can be detrimental. A 2012 flood destroyed entire manoomin beds, and a 2016 flood also negatively affected the manoomin crop for the year. Hail, heavy rain, and wind can damage plants directly. Severe storms can also damage dikes and dam infrastructure, affecting manoomin beds.

I

Dependence on snow or ice: Ice cover on waterbodies in the winter provides low oxygen conditions that help the seed emerge from dormancy in the spring. Thickness and duration of ice cover also has an influence on aquatic plant competition – thicker and longer-lasting ice will prevent perennial and/or non-local beings from outcompeting this annual plant.

N/SI

Uncommon landscape features: Manoomin depends on a particular type of wetland which is not common in the Ceded Territories – wetlands with water depths of 1-3 feet; soft, organic sediment; and slow-moving water.

SI/I

Pathogens or natural enemies: Warm, humid nights (with dewpoints above 70°F) support diseases such as brown spot disease. These conditions have already and will continue to increase in the Ceded Territories. Brown spot disease causes lesions on manoomin leaves that can reduce seed production by up to 90%. Common carp can also disturb sediments and reduce aquatic vegetation, including manoomin. “Rice worms,” a moth larva, bore into manoomin stems and also cause a large decrease in seed production. Warmer winter conditions are likely to allow these “worms” to overwinter in higher numbers. Nikag (Canada geese) and waabiziig (Trumpeter swans), both of which have expanded their ranges and populations in the Ceded Territories substantially in recent years, have been known to decrease or even decimate manoomin populations on some water bodies in the Ceded Territories.

SI

Competition: Many native and non-local aquatic plants have the potential to outcompete manoomin, including pondweeds, water lilies, hybrid cattail, flowering rush, and *Phragmites*.

N/SI

Genetic variation: Research is limited but suggests that genetic interchange between populations may be lower than historical levels, because of locations that can no longer support manoomin.

I

Documented response to climate change: GLIFWC data show a reduction in abundance that is consistent with climate effects such as flooding and disease outbreaks.

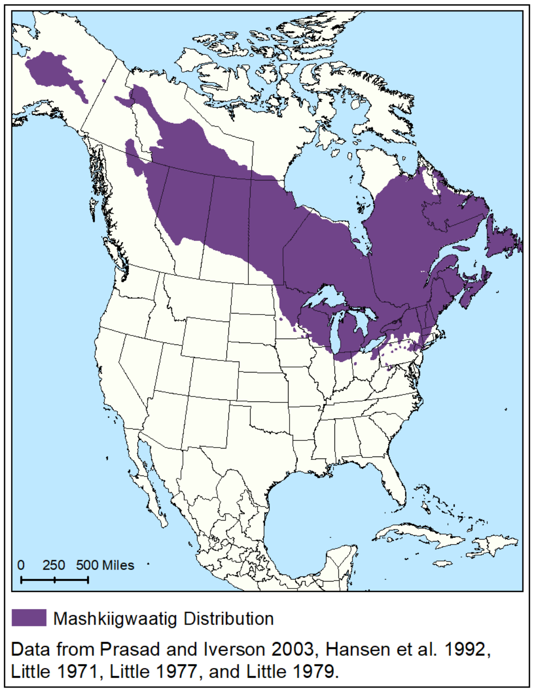
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

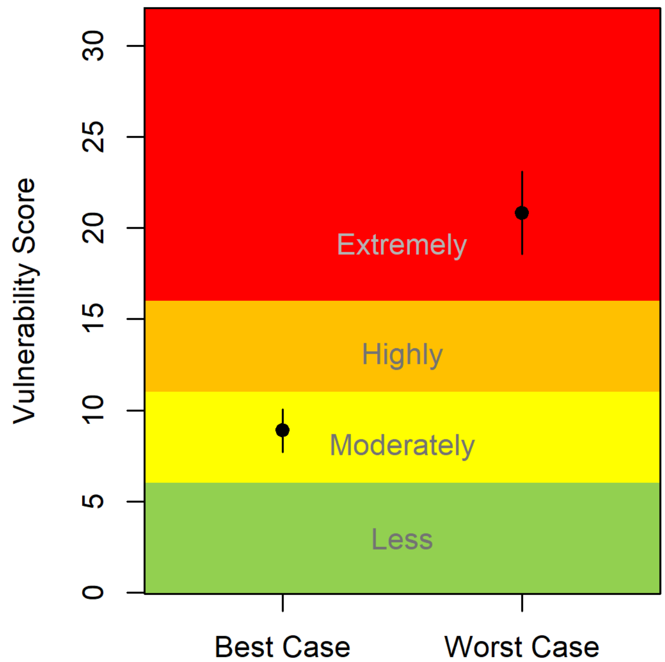
Mashkiigwaatig

Mashkiigwaatigoog (plural) / Tamarack / *Larix laricina*

Moderately - Extremely Vulnerable
(Confidence Level: High)



Range map of mashkiigwaatig.



Climate change vulnerability scores for mashkiigwaatig on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Mashkiigwaatig is the only conifer in the Ceded Territories known to lose its needles in the winter. A story from the White Earth region of Minnesota tells of how gijigijigaaneshiinh (chickadee) was unable to fly south for the winter and was very cold, so he asked mashkiigwaatig for help. Mashkiigwaatig was proud of his beautiful needles and would not lower his branches to protect gijigijigaaneshiinh. Wenaboozhoo overheard mashkiigwaatig refuse to help his little relative and put mashkiigwaatig to sleep, causing him to lose all his needles. Gaawaandag (white spruce) lowered his branches and protected the little bird through the winter and mashkiigwaatig had to regrow his needles in the spring.

Ojibwe people have multiple uses for mashkiigwaatig. Roots are used to make various items such as woven bags. Various parts of the tree are also used as medicines to treat burns, anemia, urinary passage inflammation, chronic bronchitis, and other ailments.

Mashkiigwaatig is found in open and forested bogs and swamps. It is also found along streams, lakes, and sometimes in upland sites, particularly in the northern parts of its range. Seedlings are usually thought to require full sunlight but recent studies have observed their ability to establish under some level of shade. Mashkiigwaatig is found across the Ceded Territories.

Mashkiigwaatig is one of the beings for which little Traditional Ecological Knowledge was shared by interviewees; however, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. According to an interviewee from Misi-zaaga'iganiing (Mille Lacs), mashkiigwaatig is a “really sensitive tree” and is the “first thing to die off in a swamp.” An interviewee from

Waaswaaganing (Lac du Flambeau) observed that he had seen “three beautiful brook trout stream systems disappear” because of amik (beaver) building dams, causing the water level to rise, which “drowns out all the cedars and everything else in there – black spruce or tamarack.”

Summary of climate threats:

Mashkiigwaatig was in the 96th percentile relative to both other plants and other beings in the vulnerability assessment. Mashkiigwaatig is a northern being at the southern end of its range in the Ceded Territories and is likely to be impacted by increasing temperatures. Changing hydrology will affect mashkiigwaatig and may also impact sphagnum moss, which mashkiigwaatig depends on. Disturbances such as windstorms and ishkode (fire) and a reduced snowpack will also negatively impact this being. There are a few manidoonsag (insects) that may thrive in a warmer climate and have severe impacts on mashkiigwaatig. Overall, mashkiigwaatig is expected to respond negatively to climate change.

Factors that increase the vulnerability of mashkiigwaatig to climate change:

N/SI Natural barriers: Upland habitats may be barriers for this being.

SI Anthropogenic barriers: Agriculture, urban areas, roads, logged areas can all be barriers for mashkiigwaatig, depending on location.

I Dispersal: Seeds of mashkiigwaatig are dispersed by wind and red squirrels. Most seeds fall within two tree heights (or around 200 feet), but some travel farther.

I Physiological thermal niche: Mashkiigwaatig is near the southern end of its range in the Ceded Territories. It is found in cooler habitats and is likely to be affected by increasing temperatures.

SI/I Physiological hydrological niche: Mashkiigwaatig prefers wet soils but cannot tolerate high water levels. It is quite susceptible to changes in hydrology and is likely to be affected by summer droughts.

SI/I Disturbance regime: Flooding can cause mortality of mashkiigwaatig. Increased winter and spring precipitation, along with severe storm events, can drown seeds and seedlings or kill established stands of mature trees. Large wind events can also impact these shallow-rooted beings. Mashkiigwaatig is also easily killed by ishkode.

SI Dependence on snow or ice: Reduced snowpack can result in frost damage to mashkiigwaatig roots.

SI Dependence on other species to generate habitat: Mashkiigwaatig is dependent on sphagnum moss for habitat. Sphagnum moss controls the chemistry of the bogs in which it is found, contributes substantial biomass to the accumulating peat, and is responsible for much of the waterlogging of the soils.

I Pathogens or natural enemies: Mashkiigwaatig is susceptible to a variety of manidoonsag, including the tamarack sawfly, the larch casebearer, and the eastern larch beetle. At peak population cycles, the sawfly can cause extensive mortality of mashkiigwaatig by eating the leaves. Eastern larch beetle has historically had minimal impact on mashkiigwaatig, but longer growing seasons have allowed beetle populations to expand rapidly in recent years, causing widespread mortality of mashkiigwaatig. Warmer winter temperatures will also cause increased survival of manidoonsag, and potentially more impacts on mashkiigwaatig.

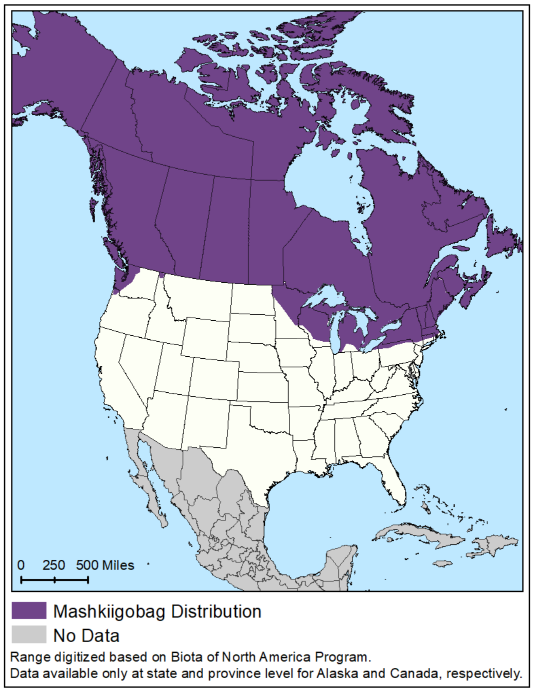
Legend

GI **Greatly Increase** This factor greatly increases vulnerability	**I/GI** **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I** **Increase** This factor increases vulnerability
SI/I **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI** **Somewhat Increase** This factor somewhat increases vulnerability	**N/SI** **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

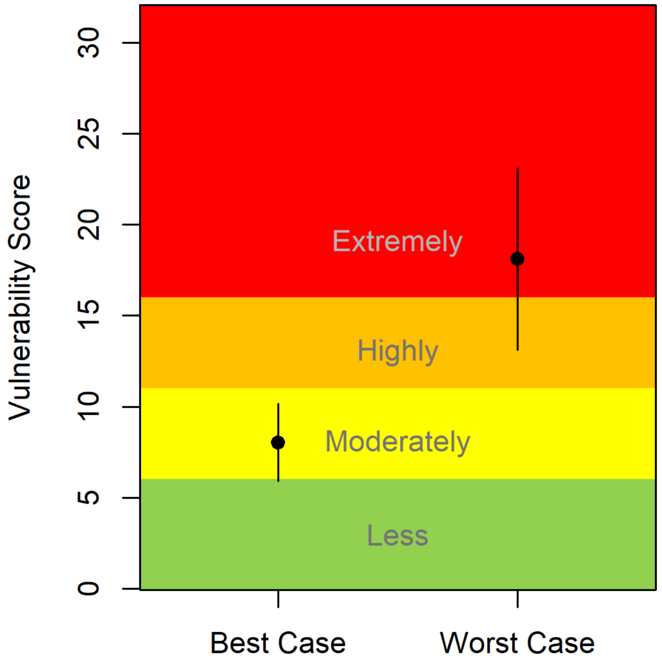
Mashkiigobag

Mashkiigobagoon (plural) / Labrador tea / *Rhododendron groenlandicum*

Moderately - Extremely Vulnerable
(Confidence Level: Moderate)



Range map of mashkiigobag.



Climate change vulnerability scores for mashkiigobag on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Mashkiigobag, also commonly referred to as “swamp tea” by the Ojibwe, is frequently used as both a medicine and a beverage and is often flavored with Anishinaabe-zhiiwaagamizigan (maple syrup). Some harvesters gather leaves for use in the springtime before the plant flowers, while others gather them year-round. The leaves are steeped to make a tea that can be consumed as a tonic, though extended boiling may cause the release of harmful alkaloids. Mashkiigobag is also known to treat a wide range of health problems such as asthma, sore throats, cold symptoms, fevers, kidney problems, jaundice, poison ivy, and more.

Mashkiigobag grows predominantly in bogs and conifer swamps, but can also be found in drier conifer forests, on shaded bluffs, along lakeshores, and in rock crevices. Mashkiigobag is found across the Ceded Territories but is at the southern end of its range.

Despite the frequent use of mashkiigobag, this being was mentioned infrequently in Traditional Ecological Knowledge interviews. However, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. An elder in Nagaajiwanaang (Fond du Lac) shared that he often gathered mashkiigobag from the swamp behind his house throughout the year, especially when someone in his home became sick. A harvester in Zaka'aaganing (Mole Lake) expressed concern over a decrease in mashkiigobag. He recalled gathering this being when he was young in the 1940’s with his grandma, who dried the leaves of mashkiigobag to make a tea to which she would add Anishinaabe-zhiiwaagamizigan as a sweetener.

Another elder from Misi-zaaga'iganiing (Mille Lacs) also expressed concern over the decrease in mashkiigobag as he has seen “less and less” of it over the years. He mentioned that it is really sensitive and needs shelter from mashkiigwaatig (tamarack) and zesegaandag (black spruce) so that it doesn’t dry out. It is also considered an indicator plant and when it is decreasing, it means that something is changing in the wetland. He has observed that many of these swamps containing mashkiigobag are already drying out and the plants in them are dying.

Summary of climate threats:

Mashkiigobag was in the 92nd percentile relative to other plants and in the 93rd percentile relative to other beings in the vulnerability assessment. Mashkiigobag thrives in cold wetland habitats that tend to be nutrient-and oxygen-poor. Warmer conditions will cause wetland habitats favored by this being to lose water due to evaporation, and may cause soils to dry. This can expose wetland soils to oxygen, increase decomposition and nutrient availability, and make these regularly cold wetlands more suitable for other beings. Mashkiigobag is also dependent on snow for moisture, has limited dispersal, and is limited in its ability to move across the landscape. It depends heavily on sphagnum moss which is also likely to be susceptible to dry and/or warm conditions.

Factors that increase the vulnerability of mashkiigobag to climate change:

SI — Natural barriers: Upland habitat is a barrier to mashkiigobag.

N/SI — Anthropogenic barriers: Agriculture, urban areas, and logged areas are all barriers to mashkiigobag. Runoff with road salt in it may affect the chemistry of wetlands where mashkiigobag grows.

SI/I — Dispersal: Mashkiigobag produces a lot of seeds, which are small and easily transported by wind or water but are short-lived in the seedbank and need to find suitable habitat soon after arrival at a new site. This makes dispersal quite limited.

I — Physiological thermal niche: Mashkiigobag is found in cool or cold environments. As air temperatures warm, increased evaporation may cause soils to dry. This will cause the wetland peat soils to be exposed to oxygen and decompose more rapidly, and more nutrients will become available, limiting mashkiigobag habitat.

I — Physiological hydrological niche: Worldwide, mashkiigobag is found in places with a variety of moisture levels, but in the Ceded Territories, it is generally found in bogs and conifer swamps, which are vulnerable to dry and/or variable conditions.

N/SI — Dependence on snow or ice: This being is only found in places with snowpack in winter, and changes in snowpack duration can have an impact on the phenology of shrubs like mashkiigobag (such as the timing of flowering).

SI/I — Dependence on other species to generate habitat: Mashkiigobag is associated with bogs and sphagnum moss. Sphagnum moss creates the right conditions for growth of mashkiigobag, including controlling the pH and moisture levels and creating a substrate for mashkiigobag to grow on. Tribal members also mentioned the dependence on mashkiigwaatig and zesegaandag for cover.

N/SI — Competition: Other bakaan ingoji-gaa ondaadag (non-local beings), such as narrow-leaved cattails, may have an increasing advantage over mashkiigobag.

N/SI — Interspecific interactions: Mashkiigobag is often associated with ericoid mycorrhizae. It is possible that climate change could affect this interaction.

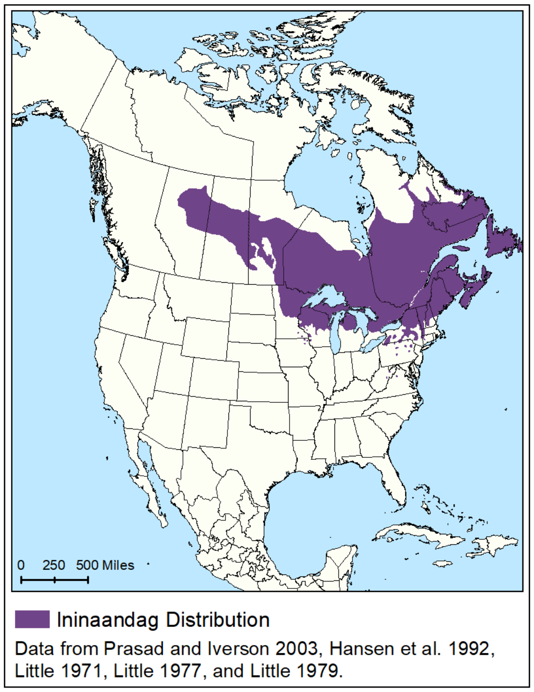
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

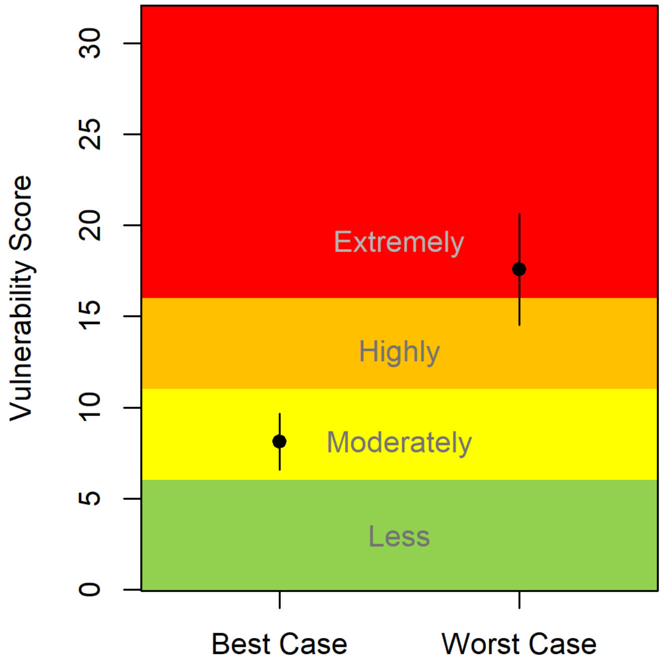
Ininaandag

Ininaandagoog (plural) / Balsam fir / *Abies balsamea*

Moderately - Extremely Vulnerable
(Confidence Level: Moderate)



Range map of ininaandag.



Climate change vulnerability scores for ininaandag on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Ininaandag is also commonly known as “zhingob” in many areas, which refers to the bough of an evergreen tree. Many harvesters cut ininaandag boughs to sell for wreaths during the holiday season, but there are many other traditional uses of ininaandag. One use mentioned by a Nagaajiwanaang (Fond du Lac) member was to dip a branch in boiling maple sap to prevent it from boiling over. In a compilation of interviews called "Balsam Fir and Burns," an elder from the Leelenau Peninsula of Michigan recognizes the tree as “nimisse’.” Nimisse’ in the Ojibwe language means “elder sister,” who is said to have the highest concern for her family and relatives. It is said that when walking in the woods, the fragrance of nimisse’ indicates the tree is giving up prayers for those that cannot pray, as related in this story told by Keewaydinoquay: “There was a man who had several little children, and they were starving. He went out on the lake fishing. When he caught a big fish, the biggest he had ever seen, he was deeply grateful, but if he stopped to give thanks, he might lose this important fish and his little children would go hungry yet another day. So as he worked to bring in the fish, he called out “nimisse’” and the balsam fir made his thanksgiving for him.”

Ininaandag is found in a variety of upland and lowland communities, including northern upland forests and swamps, where it often grows with giizhikaatig (northern white cedar). It is typically found growing interspersed with other beings. It prefers mesic to wet sites. Ininaandag is found across the Ceded Territories.

Ininaandag is one being for which little Traditional Ecological Knowledge was shared by interviewees, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. A tribal member from Nagaajiwanaang observed that ininaandag was doing well, while others in the Mashkiiziibiing (Bad River) area mentioned that ininaandag in their area was rare and harvesters had to travel to obtain it. Ininaandag is a traditional medicine used to treat numerous ailments including sores, sore eyes, colds and other respiratory ailments, and joint pain. It is also used as a wash in sweats and on the hair. Some shared that it is sometimes used during pregnancy to aid in providing strength, though other sources warn against use during pregnancy and while breastfeeding. The resin from the tree, obtained by chopping a hole in the trunk so that the resin can accumulate and harden, is also valued. When boiled down, the resin can be used as a topical application to heal wounds. There are also a few Ojibwe place names of lakes and rivers in the Lake Superior and Lake Michigan region that carry the ininaandag name.

Summary of climate threats:

Ininaandag was in the 83rd percentile relative to other plants and in the 85th percentile relative to other beings in the assessment. Ininaandag is a boreal being, adapted to cold temperatures and dependent on high soil moisture. It can be affected by disturbances, such as wind throw and ishkode (fire), and heavily affected by manidoonsag (insects) such as spruce budworm. Its genetic diversity is low, and models project a reduction in suitable habitat in the Ceded Territories by mid-century. This being is likely to respond negatively to climate change.

Factors that increase the vulnerability of ininaandag to climate change:

SI/I Dispersal: Ininaandag produces a high number of seeds, which drop in the fall, winter, and spring. The seeds are wind- and animal-dispersed, though generally do not travel far.

I Physiological thermal niche: Ininaandag is a boreal being, restricted to cool, moist regions and inhabiting microsites toward the cooler end of the spectrum. Increasing temperatures are likely to affect this being.

SI/I Physiological hydrological niche: Ininaandag requires abundant soil moisture, and drought stress is likely to affect this being. Research shows that short dry periods may not affect ininaandag, but longer droughts in combination with increased temperatures will affect growth.

SI Disturbance regime: Major wind events can cause blowdown of ininaandag, particularly in wet habitats in which roots are often shallow. It is also easily killed by ishkode.

SI/I Pathogens or natural enemies: Spruce budworm is the major threat to ininaandag. Spruce budworm populations are cyclical, but higher winter temperatures will lead to increased spruce budworm survival and therefore more serious impacts on ininaandag. Previous epidemics of this being have caused tree mortality across large areas and lasting impacts on surviving trees. Other manidoonsag that can have an impact on this being are the balsam fir bark beetle, balsam wooly adelgid, and hemlock looper. Ininaandag is not heavily browsed by waawaashkeshi (white-tailed deer) but is a major winter food source for mooz (moose).

SI Genetic variation: Ininaandag reportedly has low genetic diversity compared to other similar beings. This may make it difficult to adapt to rapid change.

SI Future change in range size: Climate Change Atlas models show a 41% projected decline in abundance of ininaandag in the Ceded Territories by the end of the century.

Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	**I/GI**	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I**	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI**	**Somewhat Increase** This factor somewhat increases vulnerability	**N/SI**	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Giizhikaatig

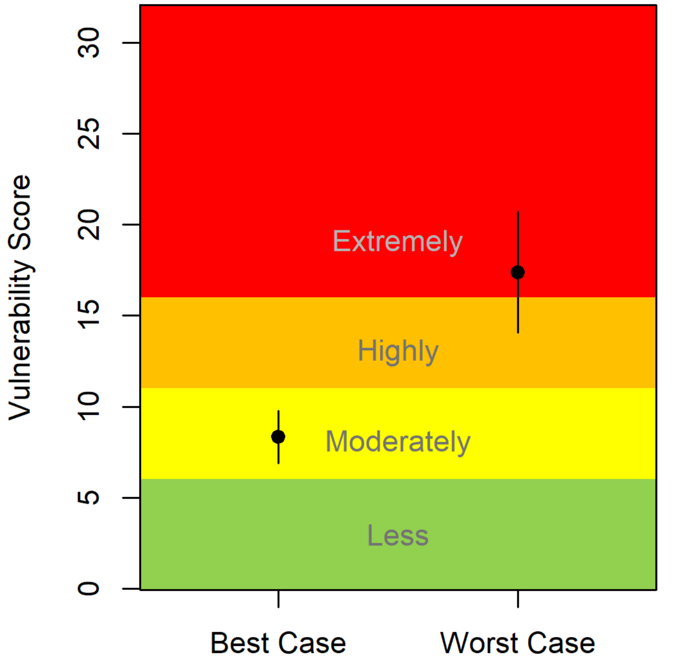
Giizhikaatigoog (plural) / Northern white cedar / *Thuja occidentalis*

Moderately - Extremely Vulnerable
(Confidence Level: Moderate)

Giizhikaatig Distribution

Data from Prasad and Iverson 2003, Hansen et al. 1992, Little 1971, Little 1977, and Little 1979.

Range map of giizhikaatig.



Climate change vulnerability scores for giizhikaatig on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Giizhik (cedar) is known as one of the four main medicines used by the Ojibwe people in a variety of ways. Many Ojibwe elders have shared that the giizhikaatig (cedar tree) was, and still is, seen as a gift to the Ojibwe people to help with various ailments, physically, emotionally, mentally, and spiritually. It is said that mewinzha (long ago), the two-leggeds (humans) were suffering greatly, despite the good way they were trying to live. The Creator saw this and took pity on them. He went to the Nokomis (Grandmother) giizhikaatig and asked if she could walk with the two-leggeds and provide them with medicine when they need to be protected or are ill and hurting. The giizhikaatig agreed and because of that, this being is heavily honored. One way the Ojibwe use giizhik is by ingesting it, which many believe causes the spirit of giizhik to live inside of them.

Giizhik is used in various ways, including burning twigs in ceremonies to purify spaces, hanging twigs for protection, in tea for ailments such as respiratory infections, making manoomin (wild rice) knockers, and making ribs for wiigwaasi-jiimaanan (birch bark canoes).

Giizhikaatig is found in uplands and lowlands, in a wide variety of moisture conditions. Upland habitats in which this being grows typically consist of dry, calcareous soils, such as limestone cliffs and boulder fields, old fields, and seepage areas. Its primary habitat, lowland sites, consist of swamps, riverbanks, and lakeshores. It prefers neutral or basic soils and is abundant in rich swamps with a strong flow of mineral-rich water, in which it often forms pure, dense stands. It is not found in the center of bogs but can be found on the edges where nutrients are more abundant. Giizhikaatig is found across the Ceded Territories but is at the southwestern end of its range.

Giizhikaatig was mentioned in almost half of the Traditional Ecological Knowledge interviews. Most interviewees mentioned that decreases in giizhikaatig have made it harder to find in recent years. An elder in Odaawaa-zaaga'iganiing (Lac Courte Oreilles) stated that the decrease in her area has impacted her cultural way of life. She now travels far to obtain it and is concerned about depleting it in other locations. She also correlates a decrease in waawaashkeshi (deer) in that area with the decline in giizhikaatig, as it is a medicine for waawaashkeshiwag and they have also been traveling elsewhere to find it. Interviewees in Mashkiiziibiing (Bad River) stated that the decrease in giizhikaatig is largely attributed to years of logging and expressed concern over some small stands of giizhikaatig turning to a rust color which they fear is caused by a fungus. A spiritual leader in the Bikoganoogan (St. Croix) community noted that giizhikaatig being harder to find has led to changes in various ceremonies. However, one interviewee in Gete-gitigaaning (Lac Vieux Desert) noted a major increase in giizhikaatig and felt that it is thriving in the Lac Vieux Desert area.

Summary of climate threats:

Giizhikaatig was in the 88th percentile relative to other plants and in the 91st percentile relative to other beings in the vulnerability assessment. Giizhikaatig is limited in its dispersal ability, and many barriers to dispersal exist. It is limited to cool and snowy environments with particular hydrologic requirements that are likely to be disrupted as the climate changes. It is highly susceptible to deer browse, particularly in the winter. Models show a reduction in suitable habitat by mid-century.

Factors that increase the vulnerability of giizhikaatig to climate change:

N/SI	Natural barriers: Unsuitable habitat can be a barrier to giizhikaatig dispersal.
N/SI	Anthropogenic barriers: Agriculture and urban areas are barriers to giizhikaatig dispersal.
I	Dispersal: Giizhikaatig seeds have fairly limited dispersal and are typically dispersed by wind up to 150 – 200 feet from the parent tree.
SI/I	Physiological thermal niche: Giizhikaatig is primarily restricted to cool environments and may not tolerate warmer temperatures.
I	Physiological hydrological niche: Giizhikaatig (in its lowland habitats) is tightly linked to particular hydrologic conditions, in which the soils are saturated for most of the growing season. Changing and variable conditions can lead giizhikaatig to be susceptible to drought and/or flooding.
SI	Dependence on snow or ice: Giizhikaatig may respond positively to snow cover. Its range overlaps areas that receive snow, which may protect giizhikaatig from deer browse.
I	Pathogens or natural enemies: Giizhikaatig is a preferred food of waawaashkeshi (white-tailed deer), particularly in the winter. The threat of waawaashkeshi browse is expected to increase as the climate warms.
N/SI	Documented response to climate change: In more than one tribal community, giizhikaatig was mentioned as decreasing due to climate change.

Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

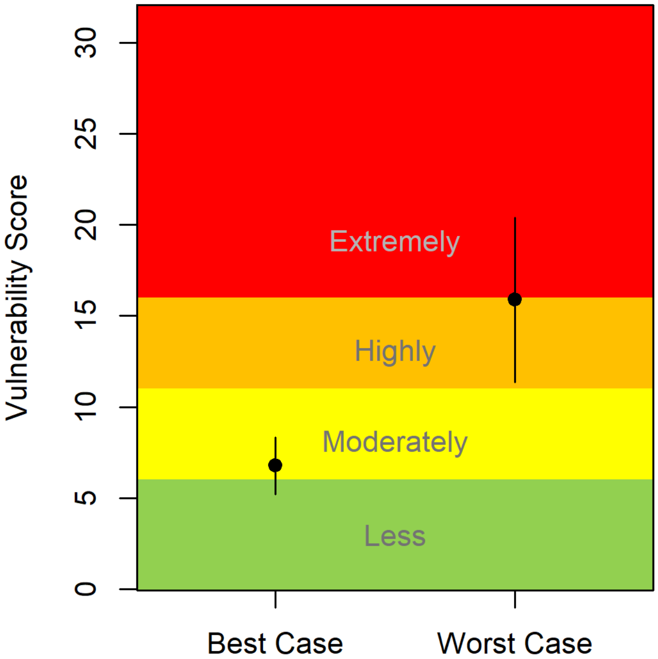
Ziinzibaakwadwaatig

Ziinzibaakwadwaatigoog (plural) / Sugar maple / *Acer saccharum*

Moderately - Highly Vulnerable

(Confidence Level: High)

Range map of ziinzibaakwadwaatig.



Climate change vulnerability scores for ziinzibaakwadwaatig on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Mewinzha (a long time ago) there were long periods of darkness and cold which caused the Anishinaabeg to suffer for days without food, and as a result, they began getting sick. Ziinzibaakwadwaatig saw this and decided to help them. He told them if they broke part of his branches, Anishinaabe-zhiiwaagamizigan (maple syrup) would come out. The Anishinaabeg did this and used the Anishinaabe-zhiiwaagamizigan to sustain themselves. But after some time, they became greedy and took too much, since very little effort was needed to obtain it. Wenaboozhoo saw this and told ziinzibaakwadwaatig that in order to respect and appreciate the ziinzibaakwadwaatig, the Anishinaabeg needed to be forced to work for it. Wenaboozhoo then added a large amount of water to the ziinzibaakwadwaatig, causing the Anishinaabeg to spend much more time processing the ziinzibaakwadwaaboo (maple sap) for it to become Anishinaabe-zhiiwaagamizigan and ziinzibaakwad (maple sugar). From then on, they have always needed to work hard for it and have therefore developed a greater appreciation for ziinzibaakwadwaatig.

Other important teachings came from the gathering of ziinzibaakwadwaaboo. There was a time that an entire village set up camp in the iskigamizigan (sugarbush) for the season, as they had done every year. While there, one brother was instructed to take care of his younger brother and be certain to watch over him so that he didn't wander off. The older brother watched the younger one for a while but then became distracted and the little brother wandered off. The entire village began searching for the little brother but couldn't find him anywhere. Since that time, every year during sugaring season meme (pileated woodpecker) can be heard saying "shiime," which refers to little brother in Ojibwe and reminds us to take good care of our children and watch over them.

Ziinzibaakwadwaatigoog are still tapped every year. The ziinzibaakwadwaaboo is not only used for Anishinaabe-zhiiwaagamizigan and Anishinaabe-ziinzibaakwad, but also as medicine. The inner bark of the ziinzibaakwadwaatig is used as a cough syrup or expectorant and poles that come from various ininaatigoog (maple trees) and maananoons (ironwood) are used to construct ceremonial lodges.

In the Ojibwe lunar calendar, the name of a moon references important natural and cultural events that occur during that time, although the name of a moon may vary by location, especially latitude. Throughout most of the Ceded Territories, April is known as Iskigamizige-giizis, which means sap boiling moon.

Ziinzibaakwadwaatig grows in rich, mesic forests as well as drier, upland forests. It can grow in a variety of soils but does best in well-drained loams. It is very shade-tolerant and can persist underneath a dense forest canopy, where it can respond quickly to canopy openings. It can grow in pure ziinzibaakwadwaatig stands or mixed with other hardwood beings. Ziinzibaakwadwaatig is found across the Ceded Territories at the northwestern edge of its range. The presence and importance of ziinzibaakwadwaatig in the Ceded Territories is evident in Traditional Ecological Knowledge (TEK) of Ojibwe place names. For example, Ziinzibaakwado-minis (Sugar Maple Island), also referred to as Iskigamizige-minis (Sap Boiling Island), is known today as Rocky Island and is one of the Wenaboozhoo Minisan (Apostle Islands) in northern Wisconsin on Lake Superior.

Ziinzibaakwadwaatig was mentioned in several interviews, with many elders and harvesters sharing memories, stories, and other knowledge about this being. A family in Nagaajiwanaang (Fond du Lac) expressed their beliefs that since thousands of generations have depended on ziinzibaakwadwaatig for food, it is tied to the Anishinaabeg as a people. It is considered to be a medicine, in which one drop comes out of the tree at a time, and a necessary part of the diet in order to live healthily. One elder of the family stated that the iskigamizigan is more than a location, it is a state of mind.

Several interviewees noted recent changes in the timing or quality of the ziinzibaakwadwaaboo run. A group of harvesters in Mashkiiziibiing (Bad River) shared that they tapped 80 to 100 trees every year for many years, except from 2014 to 2016, because during those years it didn't get cold enough at night or warm enough during the day for the ziinzibaakwadwaaboo to run. Not being able to tap for a few years in a row had a big impact on their lives. They also mentioned that if there is rain prior to tapping, the quality of the ziinzibaakwadwaaboo is affected. In Gaa-miskwaabikaang (Red Cliff), a family of harvesters said they normally tap 100 to 150 trees. They recalled getting about two gallons of Anishinaabe-zhiiwaagamizigan a day when the seasons were good and the run going for about two weeks, and that their window of tapping was shorter from about 2014 to 2018. An elder harvester in Ginoozhekaaning (Bay Mills) mentioned that they often have to boil the ziinzibaakwadwaaboo longer than before, which they think is due to a decrease in the sugar content. Although April is known as Iskamizige-giizis, some harvesters mentioned tapping ziinzibaakwadwaatigoog as early as February, particularly in recent years. One Misi-zaaga'iganiing (Mille Lacs) harvester recalled hearing the sounds of the ice breaking up on the lakes while they were tapping. Recently, however, they are done tapping well before ice break-up.

Interviewees also noted changes related to the ziinzibaakwadwaatig tree. An elder harvester from Nagaajiwanaang is concerned about ziinzibaakwadwaatigoog dying off. A group of knowledge holders in Waaswaaganing (Lac du Flambeau) stated that they are noticing an increase in the ziinzibaakwadwaatig population but a decrease in their size. An elder in Odaawaa-zaaga'iganiing (Lac Courte Oreilles) shared concerns over disturbance in the earth and climate change causing problems with both wiinizik (yellow birch) and ziinzibaakwadwaatig. He shared that both are very sensitive to changes, especially drought, which causes the trees to be stressed during tapping. However, he believes that a loss of zhiishigimewanzh (red maple) will occur before a loss of ziinzibaakwadwaatig.

A variety of indicators of when to start or stop tapping were shared from different locations. A group of knowledge holders in Mashkiiziibiing starts tapping when little flocks of tiny finches show up in the iskigamizigan and snow rings around the base of the trees get wider. They also said seeing snow mosquitos indicates that it will be an early run. They know to stop harvesting when little white moths come out, which indicates that there are only a few days left of the season. A Gaa-miskwaabikaang family pulls their taps once the sun comes out and causes the leaves on the ziinzibaakwadwaatig to start popping. The ziinzibaakwadwaaboo will start to turn black once the leaves emerge. An elder in Nagaajiwanaang said he knows when it's time to tap when a ring of melted snow appears around the ziinzibaakwadwaatig and when aandegwag (crows) arrive announcing that it's time. The family from Nagaajiwanaang also shared that when they see migiziwag (eagles) flying over during the iskigamizigan season, they know that they're going to the Creator's lodge to tell him the Anishinaabeg are using the gift of ziinzibaakwadwaatig.

Summary of climate threats:

Ziinzibaakwadwaatig was in the 79th percentile relative to other plants and in the 84th percentile relative to other beings in the vulnerability assessment. Ziinzibaakwadwaatig is likely to be affected by increasing temperatures, drought stress, heavy precipitation events, and unseasonal freeze/thaw events. It depends on a winter snowpack for insulation and is affected by several insect beings that are likely to have better overwinter survival. Waawaashkeshi (white-tailed deer) and mooseg gaa-biimaabiigiziwaad (non-local earthworms) are also expected to negatively impact regeneration of this being. Despite these threats, ziinzibaakwadwaatig is described as highly adaptable and the latest models show it is expected to gain suitable habitat in the assessment area, particularly in the 1854 Ceded Territory. Ziinzibaakwadwaaboo production and sugar content are also tied to climate variables. Ziinzibaakwadwaaboo production may increase in the Ceded Territories, particularly in the 1854 Ceded Territory, although sap sugar content is expected to decline, which is expected to lead to lower Anishinaabe-zhiiwaagamizigan production overall. Increasingly variable weather conditions may have the biggest impacts on maple sugaring in the Ceded Territories.

Factors that increase the vulnerability of ziinzibaakwadwaatig to climate change:

N/SI Anthropogenic barriers: Ziinzibaakwadwaatig is not very tolerant of compacted soil, air pollution, and road salt. These factors may make it more difficult for ziinzibaakwadwaatig to disperse in the Ceded Territories.

SI Dispersal: Ziinzibaakwadwaatig seed dispersal is somewhat limited, although the wind can carry the samaras several hundred meters. Animals such as agongosag (chipmunks), waawaabiganoojiinyag (mice), and amikowaabigozhiishag (voles) sometimes disperse the seeds as well, though they typically consume the samara instead of merely transporting it.

SI/I Physiological thermal niche: Ziinzibaakwadwaatig is restricted to areas with cool climates; increasing temperatures will affect this being. Additionally, extreme fluctuations in temperature, such as hotter and drier summers, will negatively impact pockets of ziinzibaakwadwaatig on the landscape. Early freeze/thaw events in the spring or later freeze/thaw events in the fall will also affect this being, with a major impact on the collection of ziinzibaakwadwaaboo in the spring.

SI Physiological hydrological niche: Drought stress is likely to affect ziinzibaakwadwaatig, particularly during drier periods between rain events. One harvester mentioned that a tree can handle one year of drought stress, but multiple years will start to really impact the trees.

SI Disturbance regime: Heavy rains and flooding can impact ziinzibaakwadwaatig roots. Additionally, ziinzibaakwadwaatig is susceptible to wind damage and ice storms. Any increases in fire will affect this being – even light fires can damage its bark, and heavy fires can destroy entire stands.

SI/I Dependence on snow or ice: Snow removal experiments have shown that ziinzibaakwadwaatig is affected by decreased snowpack in the winter, particularly in the northern part of its range. Snow insulates and protects its roots from frost damage, to which this being is particularly vulnerable.

N/SI — Pathogens or natural enemies: Ziinzibaakwadwaatig is susceptible to a variety of manidoonsag (insects). Defoliators such as the spongy moth, forest tent caterpillar, and the Asian longhorned beetle are some of the primary threats. Increasing temperatures will lead to better over-winter survival of these beings. Various pathogenic and canker fungi also attack ziinzibaakwadwaatig, which may or may not increase in prevalence. Most notably, waawaashkeshi populations are expected to be higher in a warmer climate, and this is likely to mean more serious impacts on regeneration of ziinzibaakwadwaatig and other tree beings.

SI — Competition: Mooseg gaa-biimaabiigiziwaad (non-local earthworms) are a serious threat to ziinzibaakwadwaatig. Some models show that these mooseg gaa-biimaabiigiziwaad will have invaded 90% of the terrestrial habitats in less than a century. Mooseg gaa-biimaabiigiziwaad reduce litter, alter nutrients and water cycling, increase drought susceptibility, and decrease regeneration for ziinzibaakwadwaatig.

N/SI — Interspecific interactions: According to TEK, you will not find ziinzibaakwadwaatig in the forest without wiigobaatig (American basswood).

Legend

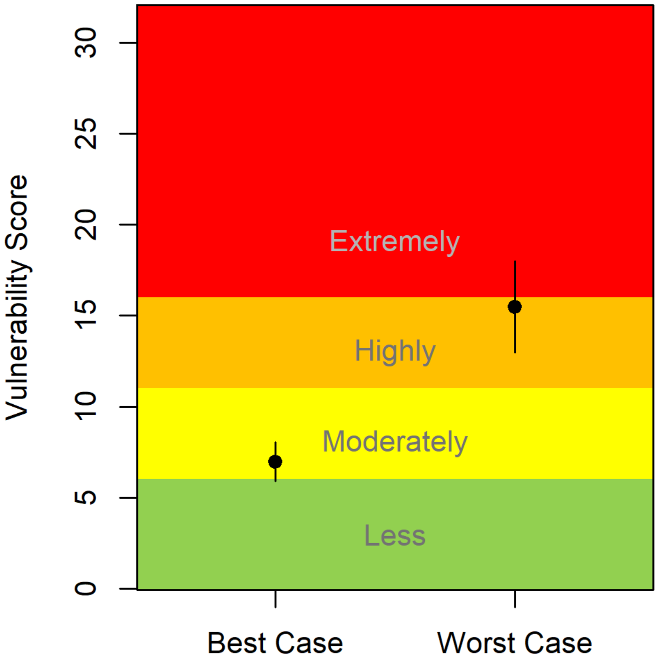
GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Jiisens

Jiisensag (plural) / American ginseng / *Panax quinquefolius*

Moderately - Highly Vulnerable
(Confidence Level: Low)

Range map of jiisens.



Climate change vulnerability scores for jiisens on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Jiisens is a plant used by the Ojibwe but one that has been known to be exploited by other cultures for its medicinal value. Therefore, knowledge shared about this being is generally limited and not shared outside tribal communities. However, it is known that the root was only gathered before the red berries were mature.

Jiisens prefers rich, shady, moist, undisturbed deciduous woods, with canopy beings such as ziinzibaakwadwaatig (sugar maple) and wiigobaatig (American basswood), but it can also be found in mixed forests, and in either drier or wetter sites. It occurs most commonly on slopes or ravines and can be found in many soil types.

Jiisens is widespread but scarce in the region and is more prevalent in the southern parts of the Ceded Territories. Jiisens was once abundant but is now threatened by human harvest for commercial sale, logging, and to a lesser extent, habitat loss and degradation. It is slow-growing and takes five to eight years to mature, which makes it particularly sensitive to disturbance. Jiisens is listed as a being of special concern in Minnesota.

Jiisens is one being for which little Traditional Ecological Knowledge was shared by interviewees, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. A tribal member of Waaswaaganing (Lac du Flambeau) mentioned looking for jiisens but not finding it because of logging disturbance. A Misi-zaaga'iganiing (Mille Lacs) tribal member said he knew of cases in which people dug up waaboozojiibik (wild sarsaparilla) simply because they confused it with jiisens.

Summary of climate threats:

Jiisens was in the 75th percentile relative to other plants and in the 82nd percentile relative to other beings in the assessment. Jiisens is sensitive to many kinds of forest disturbance and has a limited ability to disperse. It is also a target for several wildlife beings and quite sought after for human harvest. These factors make jiisens particularly vulnerable to climate change.

Factors that increase the vulnerability of jiisens to climate change:

SI — Natural barriers: Lake Superior is a natural barrier to the north. Wetlands and inland lakes also limit jiisens movement in the Ceded Territories.

SI — Anthropogenic barriers: Agriculture, urban and developed areas, and logging can all be barriers to jiisens movement.

I/GI — Dispersal: Jiisens is a poor disperser, as seeds are dispersed primarily by gravity. Small mammals such as mice and chipmunks destroy the seed rather than disperse it. Deer and turkeys feed on fruits and digested fruits are likely not viable. Thrushes may consume the fruits and disperse viable jiisens seeds, which does provide a mechanism for dispersing farther than gravity will allow.

SI — Disturbance regime: Jiisens grows best in undisturbed intact forests, and any disturbances that fragment the forest or impact understory vegetation will negatively impact this being. Some of these disturbances include heavy storms, fire, blowdowns, and bakaan ingoji gaa-ondaadag (non-local beings). A massive decline in ash canopy cover due to emerald ash borer may also disrupt jiisens habitat.

SI/I — Pathogens and natural enemies: Deer browse is a major threat to jiisens populations, and is likely to increase as deer are favored by climate change. In addition, invertebrates eat many parts of the jiisens plant, small mammals cause root damage, and miziseg (wild turkeys) eat jiisens fruits and can uproot entire plants by scratching. Mooseg gaa-biimaabiigiziwaad (earthworms) are likely to cause a decrease in suitable jiisens habitat. Jiisens can also be affected by a variety of fungal infections, as well as nematodes and slugs, all of which can be problems in cultivated jiisens that can potentially spread to wild populations.

SI/I — Competition: Multiple bakaan ingoji gaa-ondaadag (non-local beings) such as honeysuckle, buckthorn, multiflora rose, barberry, and garlic mustard have reduced populations in some areas of southwest Wisconsin through competition and changes in soil structure, organic matter, and nutrient levels. This threat is likely to grow as the prevalence of bakaan ingoji gaa-ondaadag increases with warmer temperatures.

Legend

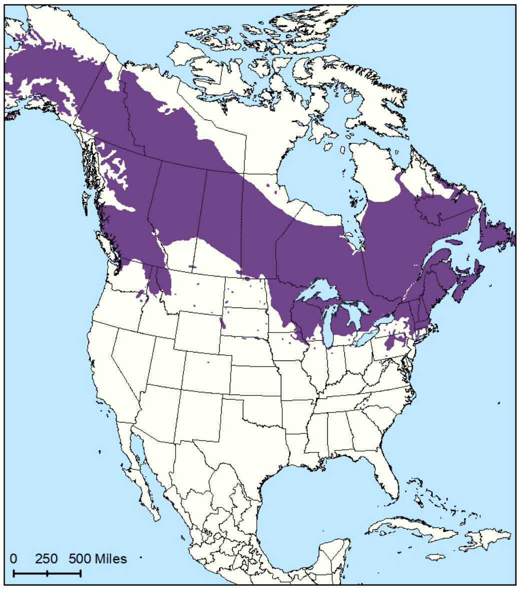
GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Wiigwaasaatig

Wiigwaasaatigoog (plural) / Paper birch / *Betula papyrifera*

Moderately – Highly Vulnerable

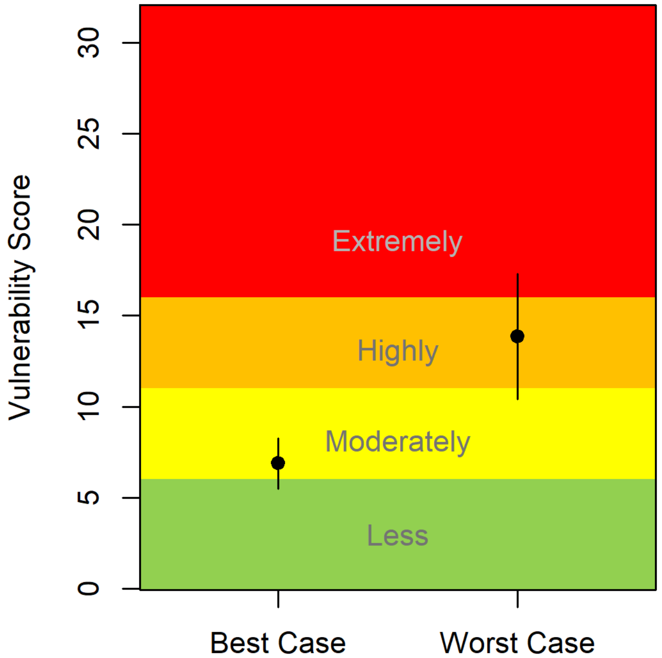
(Confidence Level: High)



Wiigwaasaatig Distribution

Data from Prasad and Iverson 2003, Hansen et al. 1992, Little 1971, Little 1977, and Little 1979.

Range map of wiigwaasaatig.



Climate change vulnerability scores for wiigwaasaatig on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Wiigwaasaatig (also called wiigwaas) has countless uses: building materials, crafting materials, boat-making materials, food, and medicines. And just as wiigwaasaatig has many uses, there are many stories about this being. One of these comes from a Misi-zaaga'iganiing (Mille Lacs) band member:

“So there’s the birch tree... Wenaboozhoo punished ‘em for making noise while he's trying to take a nap, waiting for his dinner to cook and he switched ‘em up and it left black marks on ‘em. And that didn't work and he got up and they were still squeakin’, so he climbed up a tree, had some grease from this moose that he had and he was trying to put it in the crack there where it was squeakin’, and he slipped, ‘cause, you know, paper birch is really loose like that, he slipped, and got caught up by his hand like that, he was hung up there, along come these wolves, and he was telling ‘em, 'No, don't, don't worry about me, I'm fine, go on brothers, go on.' They come and they see this big moose, and they fall on that moose and they eat it all up, most of it up, just little pieces of meat clinging to it, he's still stuck, kinda waving in the wind a little bit. That gets done and he's going, 'Well there must be enough left on them bones and stuff, I'll find something to eat.' Pretty soon, here come all them birds, one bird after another landed on that moose and started pecking away at a little bit of meat and gristle, and whatever fat was left on it, 'Ah, taya, go on out of here, go on,' and they wouldn't go, they just kept eating away, and finally, the wind pushed him he slipped out of there, fell, boom! Landed on the ground, he got up and the birds are still eatin’ away. He tried to chase ‘em out and they flew up but as soon as he'd go past they'd fly back down and were eating. He finally remembered he could do great and wonderful magic and he took his hands and slap! Slapped his hands together like that. And all them birds, the reverberation kind of knocked ‘em all silly, stunned ‘em all, they all just dropped where they were. And Wenaboozhoo goes, ‘I'll teach you for stealing the last of my food, and he took that first bird, foom! Threw it at that birch bark tree, and smack, it hit it and fell over. He took another one, smack! He spent about a half hour just pitching the birds at the birch trees, just pelting ‘em with it. So today, when you go and peel a birch bark, when you open it up, on the outside are the switch marks, and on the inside are shapes of birds, all the birds that Wenaboozhoo bounced off that tree. And they're still there. So culturally that's how it fits. But it was also one of the admonishments, he goes, ‘It's too easy for Indian people so forever they'll have to search for an unblemished piece of birch bark to make what they need. That's why they'll know and honor the birch tree.’ Because, you think about it, when you make a water-tight container, any mark, any blemish, on that bark is a spot where it could potentially end up leaking. So you have all these marks and they all kind of fit together.”

Wiigwaasaatig can grow on almost any soil type and on any topographic feature, from steep rocky outcrops to the borders of swamps and bogs. It grows best in cool, moist sites in well-drained soil but can survive in poor quality sites. It can be found mixed with other hardwoods in dry northern forests or form pure stands, particularly in areas recently disturbed by fire or logging. Pure stands are often succeeded by other plant beings after one generation.

Wiigwaasaatig is found across the Ceded Territories at the southern end of its range. The number of wiigwaasaatigoog has decreased by 49% on forest land in the Ceded Territories since 1980, and bark supply has declined 45.5%. Overharvesting of young birch for birch poles for the interior design and decoration industry is a serious threat to this being. In response, GLIFWC and several tribes have limited birch pole harvest to ceremonial use only. Additionally, forests are generally not managed to promote wiigwaasaatig, and suppression of cultural, prescribed, and wildland ishkode (fire) has reduced the disturbance regime that once helped to create conditions for this being to germinate.

Many tribal members talked about wiigwaasaatig during interviews, and all were very concerned about the visible decline seen in parts of the Ceded Territories. Some mentioned having difficulty finding large trees for use in building wiigwaasi-jiimanan (birch bark canoes) while others were concerned about improper harvest timing and techniques. An interviewee from Mashkiiziibiing (Bad River) talked about commercial demand for birch poles, saying that “I don’t know why they would be taking it in that kind of commercial quantities…” An elder from Zaka'aaganing (Sokaogon/Mole Lake) discussed climate change impacts on wiigwaasike (the process of harvesting birch bark), stating that he used to be out harvesting after 11 am but recently had to go “real early in the morning…’cause round about 11:00 now, it gets so hot from the sun rays that one side of that birch tree will stick…” Another concern of tribal members was the phenological mismatch of traditional indicators, such as the emergence of deer flies indicating warm enough temperatures for harvesting summer wiigwaasaatig bark.

Summary of climate threats:

Wiigwaasaatig was in the 71st percentile relative to other plants in the vulnerability assessment and in the 78th percentile relative to other beings in the assessment. Wiigwaasaatig is a northern being, adapted to cold temperatures and snow. It is susceptible to drought and manidoonsag (insects) as well as deer herbivory. It is also easily outcompeted with time. Wiigwaasaatig has already declined in its recent history for a variety of reasons. These factors make it particularly vulnerable.

Factors that increase the vulnerability of wiigwaasaatig to climate change:

SI Dispersal: Wiigwaasaatig produces tiny seeds that are typically dispersed by the wind over a distance of 30-60 m. Some seeds fall on the snow in the winter and are blown longer distances.

SI/I Physiological thermal niche: Wiigwaasaatig is a northern being, adapted to cold temperatures, and is at the southern end of its range in the Ceded Territories. Projected temperatures for mid-century may be beyond its physiological limits in some portions of the Ceded Territories. Wiigwaasaatig seldom grows in areas where average July temperatures exceed 70°F.

SI/I

Physiological hydrological niche: Wiigwaasaatig grows in areas with a variety of precipitation levels, but wiigwaasaatig seedlings and mature trees are both susceptible to drought, particularly on dry or poor-quality sites.

N/SI

Dependence on snow or ice: Though no direct dependence on snow has been documented, wiigwaasaatig only grows in regions that receive snow in the winter. There is likely a connection between snow and wiigwaasaatig, and a decreased snowpack may affect this being.

SI/I

Pathogens or natural enemies: Wiigwaasaatig is affected by manidoonsag such as bronze birch borer and other defoliators which impact weakened trees. This threat is likely to grow as temperatures increase, which will help winter survival of these manidoonsag. Waawaashkeshi (white-tailed deer) herbivory can also have a significant impact on this being. Overharvest of young birch (birch poles) by humans is currently a major threat to this being, though it is unclear how climate change will affect this.

SI

Competition: Wiigwaasaatig is outcompeted by more shade-tolerant beings after one generation. *Rubus* spp. can outcompete wiigwaasaatig seedlings in areas that have been clear cut, and these beings may be favored by climate change.

SI

Documented response to climate change: At least four tribal communities across the Ceded Territories mentioned a decline in wiigwaasaatig likely due in part to climate change.

Legend

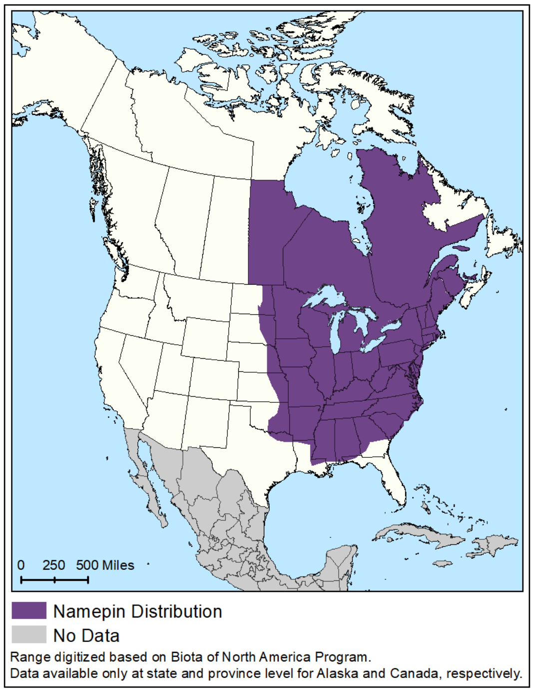
GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Namepin

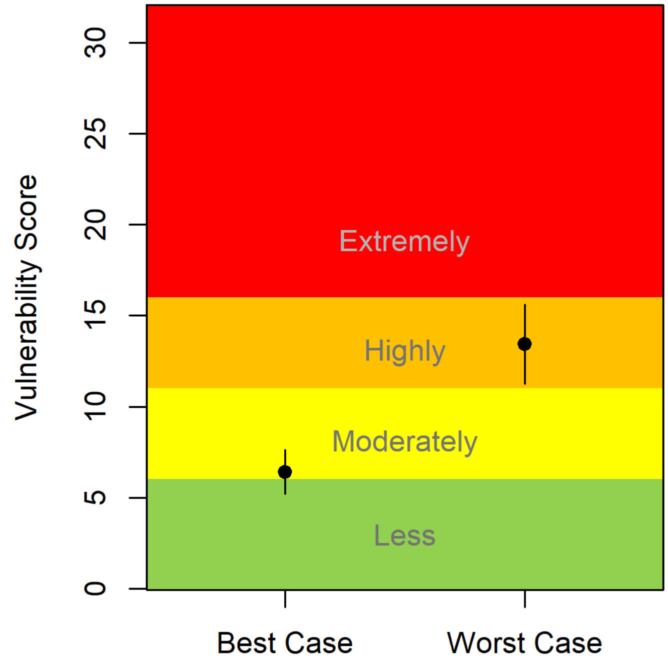
Namepinag (plural) / Wild ginger / *Asarum canadense*

Moderately - Highly Vulnerable

(Confidence Level: Moderate)



Range map of namepin.



Climate change vulnerability scores for namepin on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Namepin is gathered in ziigwan (springtime) and is considered to be very important and useful among the Ojibwe people. As a medicine, it is known to aid in digestion, provide strength when combined with other plants, stimulate the appetite, calm the stomach, ease childbirth when used with extreme caution, and dress wounds. Historically, it was also used to treat whooping cough. However, this plant being can cause skin irritation in some people.

Namepin grows in moist, rich, deciduous forests. Namepin is found across the Ceded Territories and in the eastern half of the United States.

Namepin (also known as sturgeon potato) was mentioned infrequently in interviews. However, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. During a group interview at Odaawaa-zaaga'iganiing (Lac Courte Oreilles), a knowledge holder shared that namepin can often be found growing near miskojiibik (bloodroot). There is a traditional story that explains the reason for this, but the knowledge holder could not share the story during the time of the interview.

Some knowledge holders have shared that the name (sturgeon) is believed to watch over this plant being. Historically, in the Rainy River First Nation community in Ontario when the name population was high, fishermen would use namepin to keep name away from their boats when fishing to prevent the large name from tipping their boats over.

Summary of climate threats:

Namepin was in the 63rd percentile relative to other plants and in the 74th percentile relative to other beings in the vulnerability assessment. This being has limited dispersal ability on its own and is dependent on enigoosag (ants) for its primary form of dispersal. There are also several barriers to its dispersal. This being prefers a moderate amount of moisture and can be negatively affected by wetter or drier periods. Additionally, there are many bakaan ingoji gaa-ondaadag (non-local beings) that may outcompete namepin in the forest understory.

Factors that increase the vulnerability of namepin to climate change:

SI	Anthropogenic barriers: Agriculture, urban areas, roads, and logging can all be barriers to namepin.
I/GI	Dispersal: Namepin disperses primarily by rhizome. Its seeds are spread by enigoonsag, but they are not carried far – typically only a few feet. This being has very limited dispersal ability.
N/SI	Physiological hydrological niche: Namepin prefers mesic (moist) conditions, and may be affected by periods of drying, particularly in the summer.
SI	Disturbance regime: Increases in fire or flooding could negatively affect namepin, which prefers well-drained soils. Failing culverts on forest roads are known to have flooded out areas of namepin.
SI	Dependence on other species for dispersal: Namepin has a small appendage (called an elaiosome) attached to its seed that attracts enigoonsag, which carry the seeds into their burrows to eat the elaiosome, thereby dispersing the seed as well as protecting it from other beings that might want to eat the seed. Namepin is primarily dependent on enigoonsag for dispersal farther than their rhizomes allow.
N/SI	Pathogens or natural enemies: Snails and slugs eat namepin leaves. Mooseg gaa-biimaabiigiziwaad (earthworms) in the soil can also decrease nitrogen availability and make growing conditions difficult for this being.
SI	Competition: There are several bakaan ingoji gaa-ondaadag that may be able to outcompete namepin – for example, garlic mustard, buckthorn, and barberry.

Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Baapaagimaak

Baapaagimaakoog (plural) / Black ash / *Fraxinus nigra*

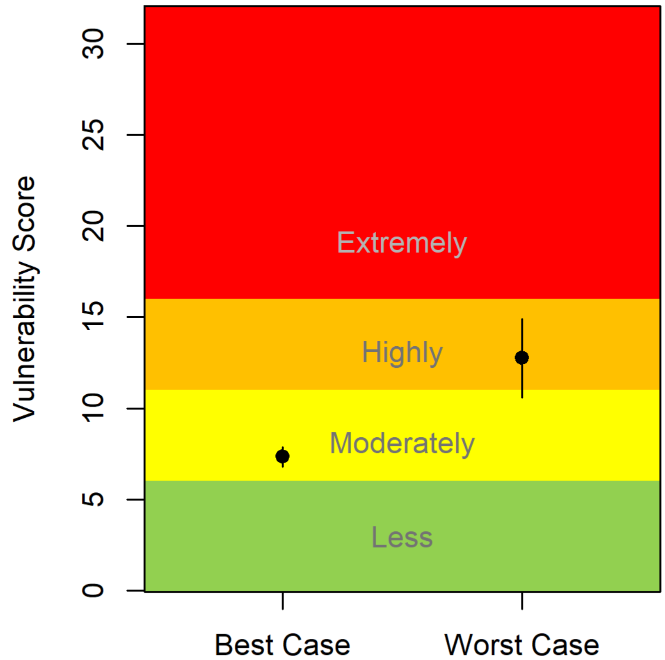
Moderately - Highly Vulnerable

(Confidence Level: Moderate)

Baapaagimaak Distribution

Data from Prasad and Iverson 2003, Hansen et al. 1992, Little 1971, Little 1977, and Little 1979.

Range map of baapaagimaak.



Climate change vulnerability scores for baapaagimaak on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Baapaagimaak is extremely important to the Ojibwe people and has been used in a variety of ways, most commonly to make various types of makakoon (baskets). The making of makakoon from baapaagimaak is a cultural practice that has been carried down through many generations. A baapaagimaak log is collected from a swamp and peeled, and a small cut is made in one end of the log. The log is pounded with the blunt end of an ax, or more commonly today with a special type of hammer, which causes the log to separate along the annual tree rings, creating splints of wood. The splints are then coiled into a bundle and submerged in water in preparation for weaving into makakoon. An infusion made from the inner bark is also used to treat eye sores and other ailments.

Baapaagimaak grows in wet habitats, such as swamps, bogs, along streams, or other seasonally flooded areas. It can tolerate stagnant water but prefers slow moving water. It often occupies pure stands, with little regeneration of other beings in the understory. In upland habitats, it can be found mixed with wiigobaatig (basswood), azaadi (quaking aspen), gaawaandag (white spruce), or maples. Baapaagimaak saplings are moderately tolerant of shade. Baapaagimaak is common across the Ceded Territories.

Baapaagimaak was mentioned in many Traditional Ecological Knowledge interviews. All who were interviewed expressed concerns over a decrease in baapaagimaakoog and interviewees felt that emerald ash borer significantly contributes to the decrease. One tribal member in Nagaajiwanaang (Fond du Lac) stated that some of the emerald ash borers were brought in on wooden pallets. One Mashkiiziibiing (Bad River) tribal member has been weaving makakoon from baapaagimaakoog since the late 1990's. Since that time, she has harvested two to three trees per year out of the same swamp in Odanah. She shared concerns about the swamps drying out and the baapaagimaakoog slowly dying. This makes it difficult to carry on her gift of making makakoon. She also has a difficult time finding the baapaagimaakoog that are ideal for the traditional craft. Even though the swamps are drying out she has also experienced higher levels of humidity which has caused mold to form on the splints.

Summary of climate threats:

Baapaagimaak was in the 67th percentile relative to other plants and in the 76th percentile relative to other beings in the vulnerability assessment. Baapaagimaak is dependent on fairly narrow habitat requirements and limited by dispersal. It also is likely to be impacted in a significant way by the emerald ash borer, which is in parts of the Ceded Territories already and expected to expand its range.

Factors that increase the vulnerability of baapaagimaak to climate change:

SI/I — Dispersal: Baapaagimaak seeds are dispersed by the wind but are fairly large and heavy. They can travel up to 330 feet from the parent tree. In the winter the seeds may be transported across the snow, though most of the seeds fall well before snow is on the ground.

I/GI — Physiological hydrological niche: Baapaagimaak is dependent on particular hydrological conditions to survive. It has a shallow root system and grows in places with high soil moisture, including standing water or moving water. Drought will have a serious negative impact on this being.

N/SI — Disturbance regime: Baapaagimaak has shallow roots that make it susceptible to windthrow in large storm events.

I — Pathogens or natural enemies: Emerald ash borer is likely to decimate baapaagimaak populations in the Midwest. Even healthy individuals are known to die within 3-4 years after an infestation of the beetles, which are currently found in the Lower Peninsula of Michigan, a few scattered sites in the Upper Peninsula, the southern two-thirds of Wisconsin (with a few scattered sites in the northern part of the state), and eastern Minnesota. All ash beings are susceptible, although some studies suggest baapaagimaak may experience the highest mortality.

N/SI — Competition from other beings: Baapaagimaak is not highly vulnerable to competition from other beings unless coupled with the decline of baapaagimaak from emerald ash borer. At that point, baapaagimaak swamps may be susceptible to bakaan ingoji gaa-ondaadag (non-local beings).

Legend

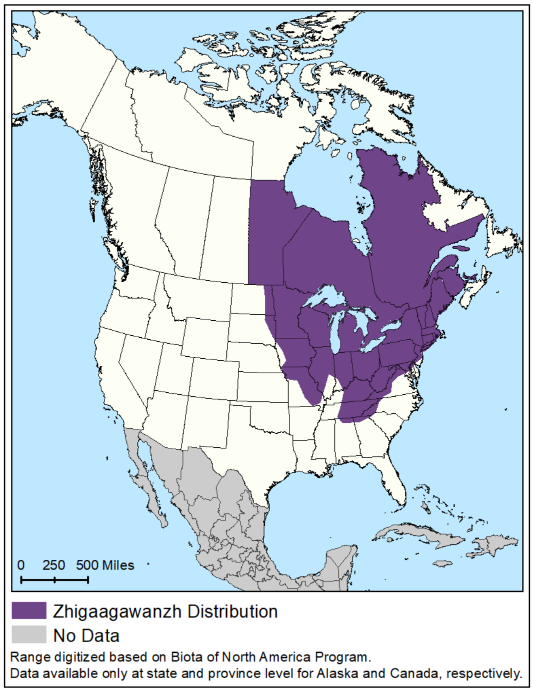
GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Bagwaji'zhigaagawanzh

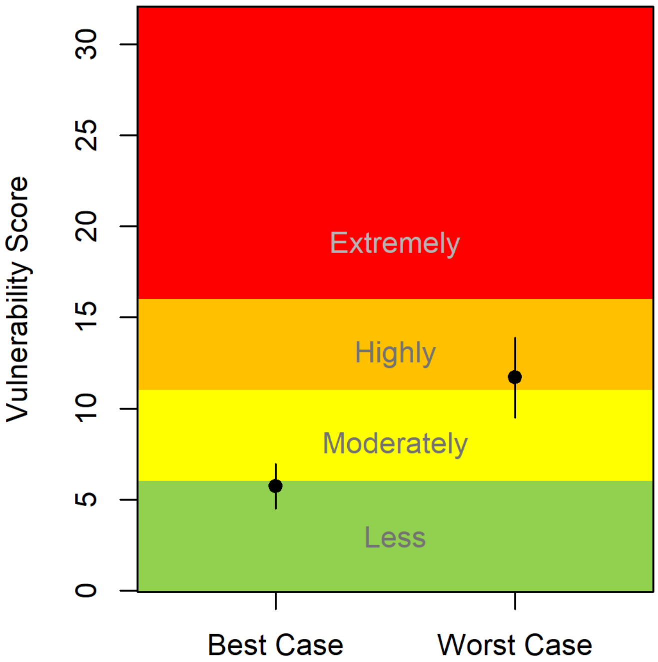
Bagwaji'zhigaagawanzhiig (plural) / Wild leek / *Allium tricoccum*

Less - Highly Vulnerable

(Confidence Level: Moderate)



Range map of bagwaji'zhigaagawanzh.



Climate change vulnerability scores for bagwaji'zhigaagawanzh on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Bagwaji'zhigaagawanzh, the wild leek or "ramp", is also known as bagwaji'zhigaagawinzh in the Leech Lake Minnesota area. Bagwaji'zhigaagawanzh shares part of its name with its cousin zhigaagawanzh, the wild onion (*Allium cernuum)*. Parts of the Ojibwe name connect to the Traditional Ecological Knowledge (TEK) about who bagwaji'zhigaagawanzh is. Bagwaji is understood to mean "wild," while zhigaag refers to our strong-smelling four-legged relative, the skunk. Those who have gathered bagwaji'zhigaagawanzhiig often mention that their strong zhigaag-like smell is strongest during the time of harvest.

A few bagwaji'zhigaagawanzh-related stories are known by the Ojibwe, each with several versions. One refers to a man who had a fight with his wife. She left, and he followed her footsteps, which stopped in a large marsh filled with bagwaji'zhigaagawanzhiig. This area is currently known as Chicago, Illinois. Many Ojibwe, along with others, believe the name for Chicago came from the word zhigaag because of the strong skunk-smelling plants of the once-present marshes.

Bagwaji'zhigaagawanzh prefers rich, mesic soils in hardwood forests. It is most commonly found in sugar maple, basswood, and birch forests and often grows near other wildflowers such as bellwort, bloodroot, ginseng, trout lily, and trillium. Bagwaji'zhigaagawanzh can usually only be found in specific areas such as forest depressions, along streamside bluffs, or in moist, marshy, forested areas.

Bagwaji'zhigaagawanzh is found across the Ceded Territories and across much of eastern North America. It is susceptible to overharvest – one study found that harvesting rates of 5-15% may lead to a population decline. Bagwaji'zhigaagawanzh is slow to reproduce.

Bagwaji'zhigaagawanzh is one of the first beings to come up in the spring. It is considered to be a spring tonic and provides a boost in vitamins and minerals, which are not as readily available throughout the winter. Parts of bagwaji'zhigaagawanzh are known to be dried and stored while bulbs and leaves can be eaten raw, such as in salads. They are also used in soups and other cooked dishes. The root is known to be a powerful medicine used to cause vomiting, which can also be extremely dangerous.

During TEK interviews, some recalled that in the past, bagwaji'zhigaagawanzhiig were more prevalent south of the Ojibwe Ceded Territories. During a group interview held in Waaswaaganing (Lac du Flambeau), tribal members believed that bagwaji'zhigaagawanzhiig weren't found anywhere on the reservation many years ago. A majority of the elders interviewed noticed more interest in harvesting bagwaji'zhigaagawanzhiig among their children and grandchildren, due to increased availability and popularity as a traditional food. Interviewees from Mashkiiziibiing (Bad River), which is known for its highly significant wetlands, referenced gathering them annually near the southern edge of the reservation.

Summary of climate threats:

Bagwaji'zhigaagawanzh was in the 58th percentile relative to other plants and in the 65th percentile relative to other beings in the vulnerability assessment. Bagwaji'zhigaagawanzh depends on moist soil, minimal disturbance, and little competition, all of which may be affected by climate change. Its low genetic diversity and limited dispersal ability also make it particularly vulnerable.

Factors that increase the vulnerability of bagwaji'zhigaagawanzh to climate change:

- **N/SI** Natural barriers: Large waterways, open areas, and any other landcover which fragments suitable rich woods act as barriers to bagwaji'zhigaagawanzh.
- **SI** Anthropogenic barriers: Agriculture, urban areas, major roads, and logged areas with complete canopy removal can be barriers to bagwaji'zhigaagawanzh.
- **I** Dispersal: Bagwaji'zhigaagawanzh has limited dispersal abilities. It is primarily dispersed by gravity, with most seeds falling on the ground, though occasionally the seeds are carried farther by waawaabiganoojiinyag (deer mice).
- **N/SI** Physiological hydrological niche: Changes in soil moisture may stress bagwaji'zhigaagawanzh, which has shallow roots and relies on moist soils.
- **N/SI** Disturbance regime: Bagwaji'zhigaagawanzh thrives in areas with minimal disturbance and grows in areas with full canopy cover. Increases in disturbances such as extreme storms, soil erosion, windstorms, or any other disturbances affecting the canopy cover may affect bagwaji'zhigaagawanzh.
- **SI** Competition: Mooseg gaa-biimaabiigiziwaad (earthworms) compact soil, which can make it unsuitable for bagwaji'zhigaagawanzh. The dominance of sedges associated with mooseg gaa-biimaabiigiziwaad can also negatively impact its habitat. Other non-local forest beings favored by climate change, such as honeysuckle or garlic mustard, also have the potential to disrupt its habitat.
- **SI** Genetic variation: Bagwaji'zhigaagawanzh genetic diversity is low, particularly at the northern edge of its range. Reproduction is vegetative or relies on self-fertilization, neither of which favors genetic diversity. This may hinder its ability to respond to changing conditions.

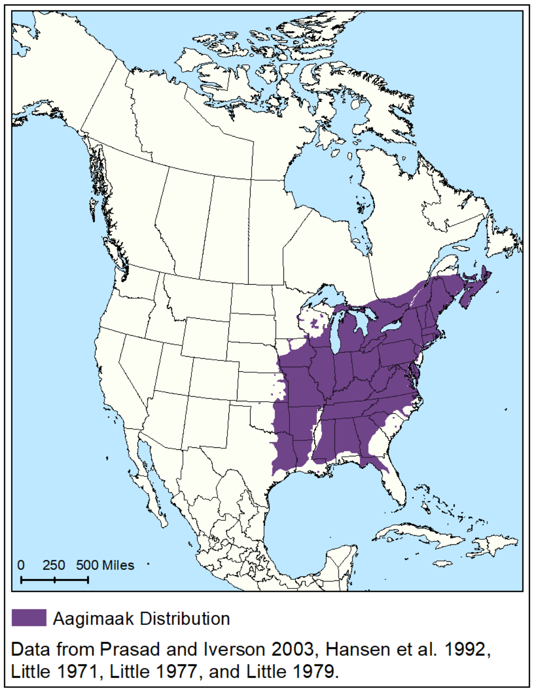
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	**I/GI** — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I** — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI** — **Somewhat Increase** This factor somewhat increases vulnerability	**N/SI** — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

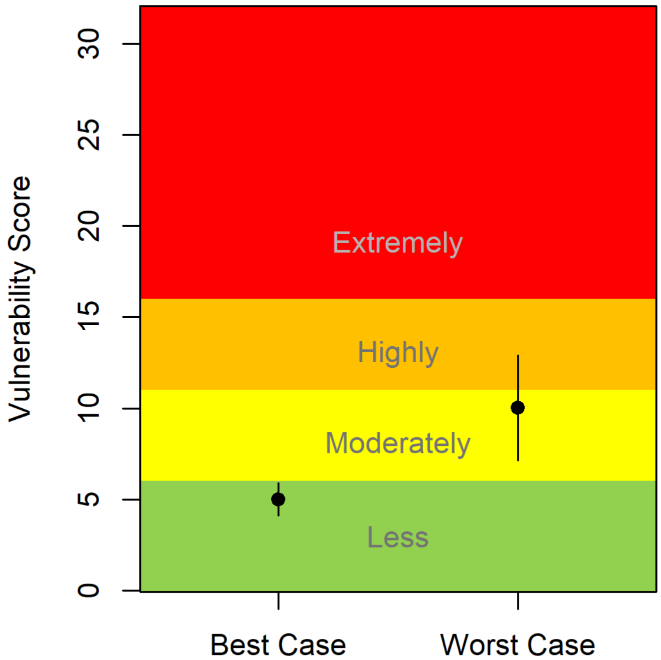
Aagimaak

Aagimaakoog (plural) / White ash / *Fraxinus americana*

Less - Moderately Vulnerable
(Confidence Level: Moderate)



Range map of aagimaak.



Climate change vulnerability scores for aagimaak on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Aagimaak is extremely important to the Ojibwe people and has been used in a variety of ways for generations. Most significantly, it was used to make mitigoon (sticks) for baaga'adowewin (lacrosse), one of the oldest games played on this continent. According to a traditional Ojibwe story, baaga'adowewin was first played by the four leggeds and the birds. It was then played by numerous groups of Indigenous people, including the Ojibwe, for social, political, and ceremonial purposes before other races began to play it. The traditional mitigoon of baaga'adowewin are still made today by boiling or steaming sections of an aagimaak log and bending one end into a round hoop for the pocket of the mitig.

Aagimaak is also sometimes referred to as spear timber because it was traditionally used to make fish spears. Aagimaak wood is also steamed or boiled to bend into snowshoe frames and less commonly today, into sleds. Historically when asemaa (traditional tobacco) was scarce, the tips of aagimaak twigs were used as a substitution and gathered when they were in a berry-like stage of growth. Aagimaak bark is also prepared as a medicine for various ailments such as respiratory infections.

Aagimaak grows in moist soils in upland forests, and on slopes along streams. It typically grows among other beings, such as white pine, oak, maple, birch, and hemlock, and not in pure stands. Seedlings can grow in full shade, but mature trees need more sun to persist. It does not typically grow in swamps like green ash or baapaagimaak (black ash). Aagimaak is found across the Ceded Territories but is not extremely common.

Aagimaak was mentioned in at least ten TEK interviews at nine of the GLIFWC member tribal communities. Nearly all expressed concern over a decrease in aagimaakoog, and many of the interviewees felt that emerald ash borer is contributing to the decrease. A harvester in Misi-zaaga'iganiing (Mille Lacs) expressed strong concern about the stands of aagimaakoog near a wastewater treatment plant in McGregor, Minnesota. He noticed them dying over the years and now they are all dead. An interviewee in Odaawaa-zaaga'iganiing (Lac Courte Oreilles) said they are becoming harder to find, but when he was young in the 1950’s and 1960’s they could be found everywhere.

Despite an observed decrease in aagimaakoog, this being still holds a lot of cultural importance. An elder in Waaswaaganing (Lac du Flambeau) stated that there is great value in just one log of aagimaak. Similarly, during a group interview in Odaawaa-zaaga'iganiing, a knowledge holder said that aagimaakoog are “everything for us” (referring to the Anishinaabeg).

Interviewees in Odaawaa-zaaga'iganiing mentioned that in addition to snowshoes and other uses mentioned above, aagimaak is also used for pipe stems and any kind of woodwork that is bent, as the wood is denser than baapaagimaak. One ideal spot remains in Odaawaa-zaaga'iganiing where aagimaak is still gathered to make traditional pipe stems. When aagimaak isn’t used, other beings such as baakwaanaatig (sumac) are substituted. It was shared by interviewees in both Nagaajiwanaang (Fond du Lac) and Gakiiwe'onaning (Keweenaw Bay) that there are sometimes workshops held focused on teaching others how to make traditional baaga’adowewin mitigoon from aagimaak.

Summary of climate threats:

Aagimaak was in the 54th percentile relative to other plants and in the 59th percentile relative to other beings in the vulnerability assessment. Aagimaak is expected to be devastated by emerald ash borer as it expands its range. Otherwise, this being is not expected to be highly vulnerable to many climate change impacts except for extreme drought.

Factors that increase the vulnerability of aagimaak to climate change:

- **SI** — Dispersal: The seeds of aagimaak are dispersed by the wind but are large and heavy. They can travel up to 460 feet from the parent tree.
- **N/SI** — Physiological hydrological niche: In general, aagimaak can tolerate a variety of soil moisture levels. However, severe droughts (if not offset by increases in winter and spring precipitation) can cause significant damage to this shallow-rooted being, although this may differ regionally. It is tolerant of temporary flooding, but significant flooding could affect this being as well.
- **N/SI** — Disturbance regime: Any increases in fire frequency, distribution, or severity will likely affect aagimaak. It does not survive fire well, and fire wounds can also increase susceptibility to manidoonsag (insects) and diseases.
- **I** — Pathogens or natural enemies: Emerald ash borer is likely to decimate ash populations in the Midwest. Even healthy individuals have been known to die within 3-4 years after an infestation of the beetles, which are currently found in the Lower Peninsula of Michigan, a few scattered sites in the Upper Peninsula, the southern two-thirds of Wisconsin (with a few scattered sites in the northern part of the state), and eastern Minnesota.

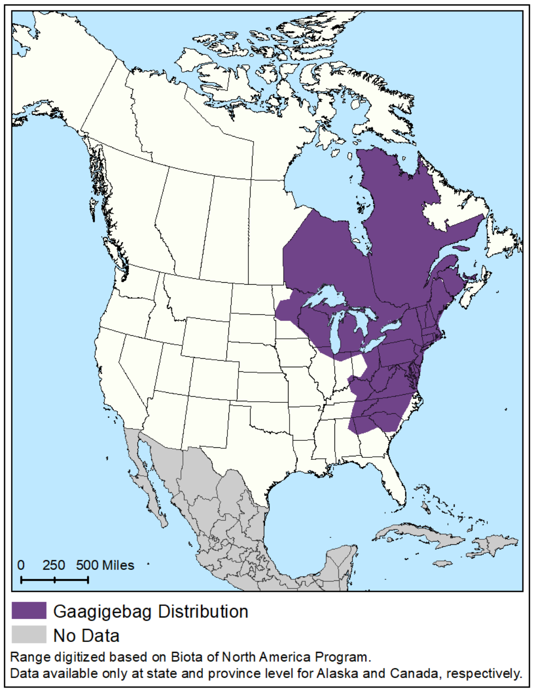
Legend

GI	Greatly Increase	This factor greatly increases vulnerability
I/GI	Increase/Greatly Increase	This factor may increase or greatly increase vulnerability
I	Increase	This factor increases vulnerability
SI/I	Somewhat Increase/Increase	This factor may somewhat increase or increase vulnerability
SI	Somewhat Increase	This factor somewhat increases vulnerability
N/SI	Neutral/Somewhat Increase	This factor may not increase or may somewhat increase vulnerability

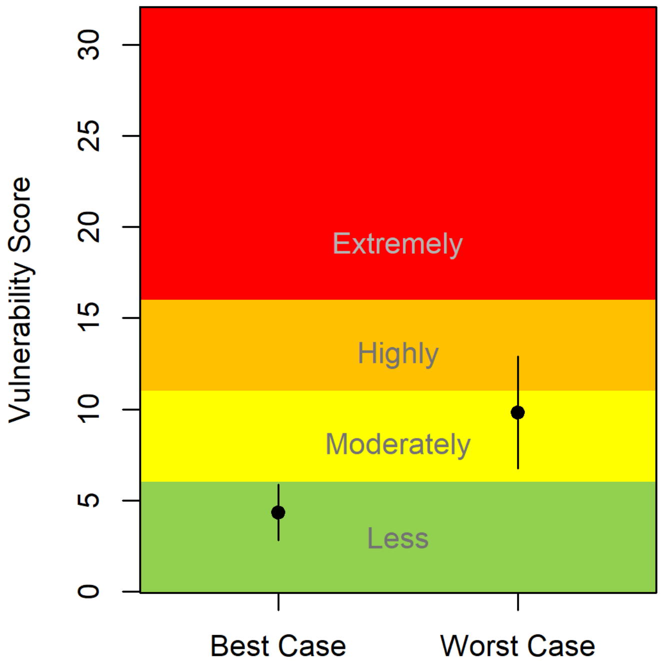
Gaagigebag

Gaagigebagoon (plural) / Princess pine / *Lycopodium obscurum*

Less - Moderately Vulnerable
(Confidence Level: Low)



Range map of gaagigebag.



Climate change vulnerability scores for gaagigebag on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

"Gaagigebag" means "everlasting leaf." Gaagigebag (sometimes also called ground pine) is used in combination with other plant beings as a diuretic and a treatment for rheumatism. When used by deer hunters in various ways, gaagigebag contributes to a successful hunt by serving as what some describe as a good luck charm. The spores are used medicinally, and their high oil content creates a flash of light when thrown onto hot rocks such as in a sweat lodge or in fires.

Gaagigebag is found in moist aspen-birch and other rich hardwood forests across the Ceded Territories. It grows best in the understory of older forests but can also grow in younger or more open forests or along the edges of bogs. It is shade tolerant and requires a forest canopy to thrive. Gaagigebag reproduces through both spores and rhizomes.

Gaagigebag is a being for which little Traditional Ecological Knowledge was shared by interviewees, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. A tribal member from Gaa-miskwaabikaang (Red Cliff) mentioned he used to pick and sell gaagigebag. He recalled being 14 years old in the 1950's and his family rarely having any money. They turned to the gathering of ground pines, which included both gaagaagiwanzh (hemlock) and gaagigebag. At that time, they were in high demand and could be sold for four to five dollars a day. They sold them by the pound, and he recalled soaking gaagigebag in the creek for about three days to add weight and earn an extra 60 to 70 cents.

Summary of climate threats:

Gaagigebag was in the 50th percentile relative to other plants and in the 54th percentile relative to other beings in the assessment. Gaagigebag is susceptible to overexploitation from harvesting. Major disturbances that result in a loss of canopy cover as well as changes in soil moisture will negatively impact this being.

Factors that increase the vulnerability of gaagigebag to climate change:

- **SI** — Anthropogenic barriers: Roads, agriculture, logged areas, and urban areas may all be barriers that cause habitat fragmentation and limit the range of gaagigebag.
- **SI/I** — Dispersal: Gaagigebag disperses primarily by rhizome. Propagation by spores requires specific conditions. Reported dispersal distances vary, but are typically less than 100 m.
- **SI** — Physiological thermal niche: Gaagigebag requires a forest canopy and therefore cooler environments; this being will be vulnerable to increasing temperatures.
- **N/SI** — Physiological hydrological niche: Long periods of drought can negatively affect gaagigebag. It is also dependent on moist soils, and canopy removal or changes in soil moisture will likely decrease habitat.
- **N/SI** — Disturbance regime: Canopy removal, including any damage from manidoonsag (insects), would affect gaagigebag. Increases in fire would decrease habitat in the short term.
- **N/SI** — Dependence on other species to generate habitat: Gaagigebag is dependent on conifer cover or past coverage by conifers to promote acidic soils and podzolization (the formation of podzol soils preferred by this being).

Legend

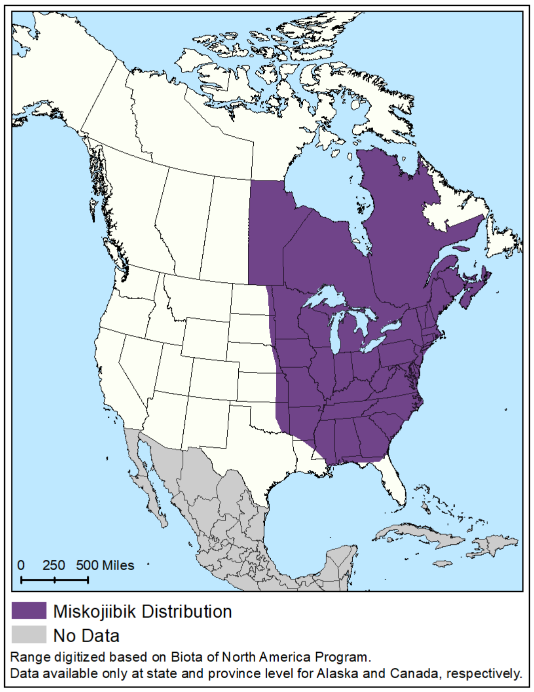
GI — **Greatly Increase**: This factor greatly increases vulnerability	**I/GI** — **Increase/Greatly Increase**: This factor may increase or greatly increase vulnerability	**I** — **Increase**: This factor increases vulnerability
SI/I — **Somewhat Increase/Increase**: This factor may somewhat increase or increase vulnerability	**SI** — **Somewhat Increase**: This factor somewhat increases vulnerability	**N/SI** — **Neutral/Somewhat Increase**: This factor may not increase or may somewhat increase vulnerability

Miskojiibik

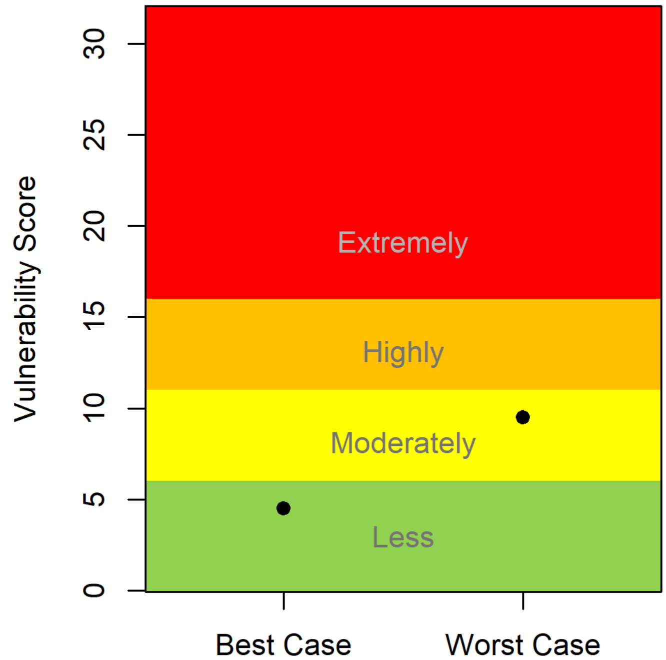
Miskojiibikwag (plural) / Bloodroot / *Sanguinaria canadensis*

Less - Moderately Vulnerable

(Confidence Level: Low)



Range map of miskojiibik.



Climate change vulnerability scores for miskojiibik on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Miskojiibik has many uses, some of which are no longer commonly known. The stem of this being contains an orange-red liquid which is a natural dye used to paint the face for certain ceremonies, such as the medicine lodge ceremony. Miskojiibik is also known to be a traditional remedy for sore throat, blood disorders, fevers, and certain skin conditions including warts. Years ago, it was also used in treating diphtheria and tuberculosis.

It is important to note that high doses of miskojiibik are toxic, especially the root, which contains opium-like alkaloids that can cause nausea and vomiting and can be fatal. Knowledge holders heavily advise against medicinal use of this being during pregnancy and when lactating.

Miskojiibik grows in moist, rich, deciduous forests. Miskojiibik is found across the Ceded Territories and across eastern North America.

Miskojiibik was mentioned infrequently in interviews; however, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. In one interview in Odaawaa-zaaga'iganiing (Lac Courte Oreilles), an elder who has gathered a lot of medicines through the years shared that miskojiibik is known as a partner plant of namepin (wild ginger) and those two plant beings are frequently found near each other.

Summary of climate threats:

Miskojiibik was in the 46th percentile relative to other plants and in the 53rd percentile relative to other beings in the vulnerability assessment. This being has very limited dispersal ability and is dependent on enigoonsag (ants) for its primary form of dispersal. There are many bakaan ingoji gaa-ondaadag (non-local beings), including mooseg gaa-biimaabiigiziwaad (earthworms), that may impact or outcompete miskojiibik in the forest understory as well. Overall, however, this being is tolerant of a variety of conditions and may not be highly impacted by climate change.

Factors that increase the vulnerability of miskojiibik to climate change:

SI — Anthropogenic barriers: Agriculture, urban areas, roads, and logging can all be barriers to miskojiibik.

I — Dispersal: Miskojiibik reproduces vegetatively and by seed. Its seeds are spread by enigoonsag; though they typically only carry the seeds a few feet, they have been observed carrying seeds up to 39 feet. This dependence on enigoonsag limits the dispersal ability of miskojiibik.

SI — Dependence on other species for dispersal: Miskojiibik is dependent on a number of enigoonsag beings for dispersal. The enigoonsag carry the seeds into their burrows to eat the elaiosome (a food-rich appendage attached to the seed), thereby dispersing the seed as well as protecting it from other beings that might want to eat the seed.

SI — Competition: Mooseg gaa-biimaabiigiziwaad can consume the duff layer that miskojiibik uses, reducing its population. Other bakaan ingoji gaa-ondaadag that grow in the forest understory may also affect this being.

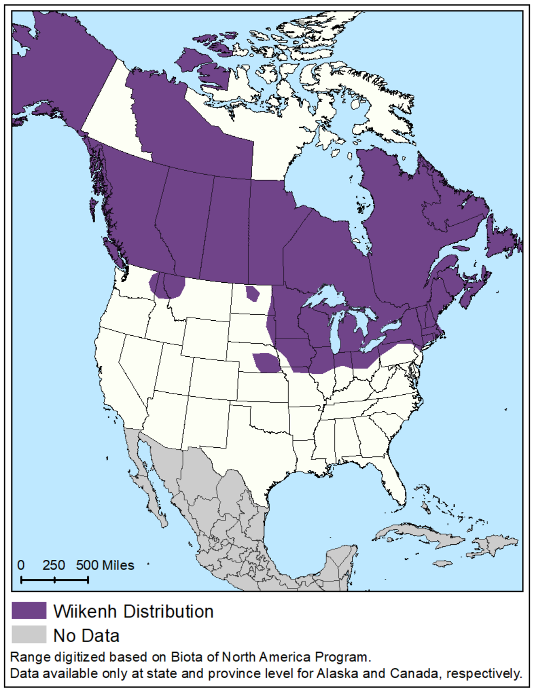
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

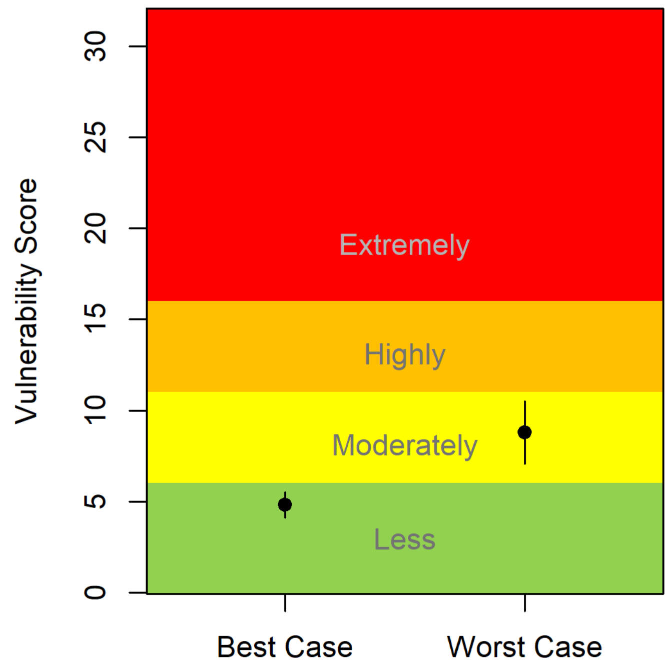
Wiikenh

Wiikenyag (plural) / American sweet flag / *Acorus americanus*

Less - Moderately Vulnerable
(Confidence Level: Low)



Range map of wiikenh.



Climate change vulnerability scores for wiikenh on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Wiikenh, referred to as bitterroot by some Ojibwe, is commonly used as a medicine and is known to be high in potassium. This being is referred to as a cure-all because it can treat a wide range of ailments, mostly minor health issues. Various parts of the plant are used, though primarily the roots, to treat illnesses such as sore throats, coughs, colds, toothaches, and cramps. The entire plant can also be used as bait for fishing and is rubbed onto fish nets along with other medicines.

Due to its many uses, wiikenh is often carried along with tobacco and other main medicines, most commonly among pow wow singers who use it to prevent a sore throat while singing.

Wiikenh grows along shorelines, stream banks, in marshes and wet meadows. It typically grows in quiet, shallow water (less than a foot deep) and is often found with sedges and cattails, all of which are subject to disturbance by large motorboat wakes. Wiikenh is found across the Ceded Territories but is often very local in distribution.

Wiikenh was mentioned infrequently in interviews. However, all beings are of equal importance to Ojibwe people based on their cultural beliefs in the original treaties with all of creation. One tribal elder from Waaswaaganing (Lac du Flambeau) shared that he used to harvest wiikenh but thinks its population is decreasing and it is now harder to find. An elder from Odaawaa-zaaga'iganiing (Lac Courte Oreilles) said that wiikenh is a difficult one to gather because it requires getting into the water and down to the strong roots. She rarely hears of anyone gathering wiikenh anymore, even though so many people use it often.

Summary of climate threats:

Wiikenh was in the 42nd percentile relative to other plants and in the 50th percentile relative to other beings in the vulnerability assessment. Wiikenh is a wetland being, and climate change impacts to wetlands are likely to impact wiikenh as well. This includes drought, flooding, and increasing numbers of bakaan ingoji gaa-ondaadag (non-local beings). Barriers to dispersal, in addition to the limited seed dispersal, make it difficult for wiikenh to relocate during times of changing conditions.

Factors that increase the vulnerability of wiikenh to climate change:

- **SI** Natural barriers: Upland habitat is a barrier to wiikenh.
- **SI** Anthropogenic barriers: Agriculture, urban areas, logged areas, and areas with high motorboat use are all barriers to wiikenh. Runoff with road salt in it may affect the chemistry of wetlands where wiikenh grows.
- **N/SI** Dispersal: Dispersal can be limited; seeds are too large and heavy to be dispersed by the wind. Both rhizomes and seeds are dispersed by water.
- **SI** Physiological hydrological niche: Wiikenh appears to be fairly drought tolerant, but drier conditions will impact wetland habitat that relies on consistent moisture and the beings that live there.
- **N/SI** Disturbance regime: Flooding may affect wiikenh habitat, as it prefers to grow in a foot of water or less. Repeated periods of drought are also likely to decrease wetland habitat and impact wiikenh.
- **SI** Competition: There are many other bakaan ingoji gaa-ondaadag that may compete with native wiikenh, including European sweet flag (*Acorus calamus*), cattail, Phragmites, flowering rush, and purple loosestrife.

Legend

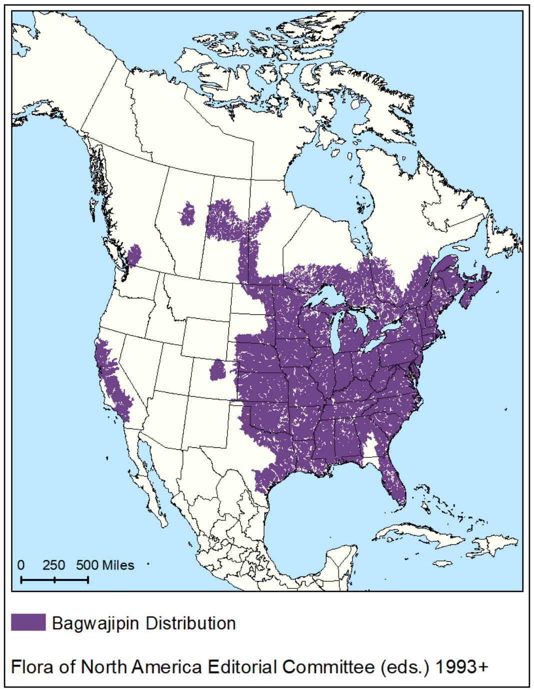
GI — **Greatly Increase**: This factor greatly increases vulnerability	**I/GI** — **Increase/Greatly Increase**: This factor may increase or greatly increase vulnerability	**I** — **Increase**: This factor increases vulnerability
SI/I — **Somewhat Increase/Increase**: This factor may somewhat increase or increase vulnerability	**SI** — **Somewhat Increase**: This factor somewhat increases vulnerability	**N/SI** — **Neutral/Somewhat Increase**: This factor may not increase or may somewhat increase vulnerability

Bagwajipin

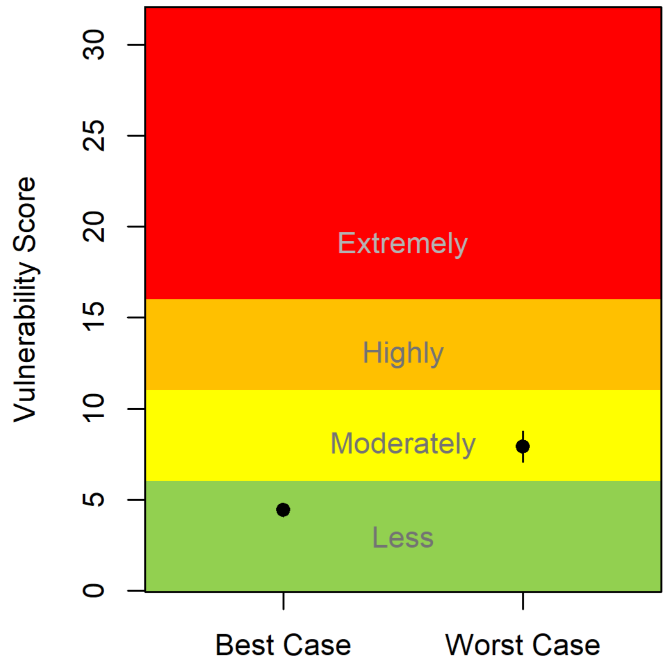
Bagwajipiniig (plural) / Broadleaf arrowhead / *Sagittaria latifolia*

Less - Moderately Vulnerable

(Confidence Level: Moderate)



Range map of bagwajipin.



Climate change vulnerability scores for bagwajipin on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Bagwajipin produces starchy tubers (like potatoes) used for food and often stored for winter use. When prepared as an infusion, the root is used to help with indigestion. A story from the *Oshkaabewis Native Journal* by an elder of the Misi-zaaga'iganiing (Mille Lacs) band describes natives gathering bagwajipin years ago: “After the middle of the summer, the women would travel in a group. They go to the Mississippi River. It was there that the wild potatoes were. Perhaps they slept there while gathering the potatoes. When they get them, they peel some of the potatoes and dry them. They roast some in the coals while they are engaged in picking the potatoes. They get them from the wet places; they got the potatoes from the wet places. The old lady also used to say that the children accompanying them are not to hit each other with the potatoes. No one should be hit by wild potatoes. She used to say that if someone is hit by wild potatoes, he won't live a year. If an Indian is hit by wild potatoes, he dies. That's what the old lady used to say.”

Bagwajipin is an emergent aquatic plant being which prefers marshes, swamps, bogs, ditches, or the shallows of ponds, lakes, or stream edges. It is often found growing near bur-reed, pickerel weed, and bulrushes. It is also sometimes known as waabiziipin, Indian potato or duck potato, named for the edible tuber that the plant forms in the late summer and fall. Bagwajipin is widespread and found across the Ceded Territories.

Bagwajipin is one being for which little Traditional Ecological Knowledge was shared by interviewees, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. An interviewee from Waaswaaganing (Lac du Flambeau) mentioned that bagwajipin can grow rather aggressively and, along with other beings, grew up in an area that was previously a manoomin (wild rice) bed.

It was also observed to be very prevalent in Rice Creek, northeast of Waaswaaganing. Interviewees in Gete-gitigaaning (Lac Vieux Desert) mentioned that bagwajipin is not seen too often anymore but that it used to be a main staple of the diet for the Ojibwe in that area. They recalled stringing up the tubers to dry them and to use throughout the entire year. Amik (beaver) and wazhashk (muskrat) are known to gather the bagwajipin and store them in a cache which is where the Ojibwe sometimes gather them.

Summary of climate threats:

Bagwajipin was in the 33rd percentile relative to other plants and in the 43rd percentile relative to other beings in the assessment. Bagwajipin is limited by natural and anthropogenic barriers such as upland habitat and developed areas, can be sensitive to changing water levels, and can also be affected by competition from bakaan ingoji gaa-ondaadag. It disperses readily and due to its habitat is not highly affected by predation.

Factors that increase the vulnerability of bagwajipin to climate change:

SI Natural barriers: Upland habitat is a barrier for this being, as most reproduction is vegetative.

N/SI Anthropogenic barriers: Agriculture, urban areas, roads, and logged areas are all barriers for bagwajipin, depending on the location. Road salt from roads may also alter water and soil chemistry and therefore the composition of wetland beings such as bagwajipin.

SI Dispersal: Bagwajipin is a good to moderate disperser in water, by way of corms (tubers) that detach and float to new sites. Seeds, which bagwajipin uses to disperse across upland habitats to new suitable wetland habitats, are small and easily transported, though most reproduction is vegetative.

SI Physiological hydrological niche: Drier conditions may reduce the amount of suitable wetland habitat for bagwajipin. Bagwajipin may be somewhat vulnerable to water level changes.

SI Competition: Bagwajipin can be outcompeted by non-local beings such as cattail (*Typha* spp.) and *Phragmites*.

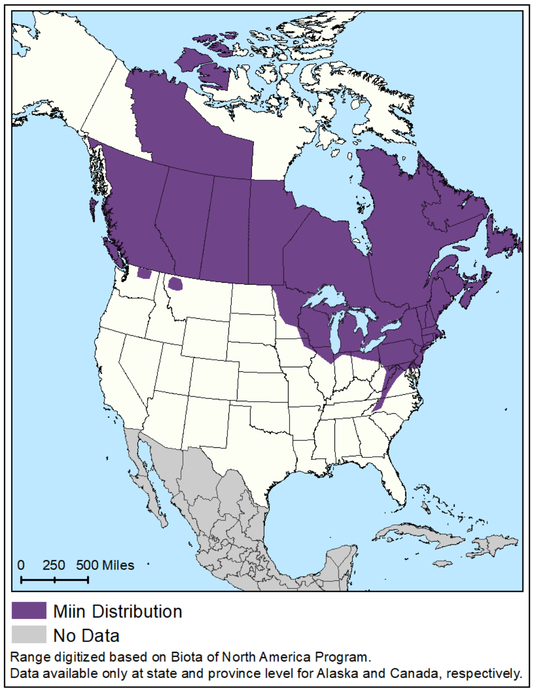
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	**I/GI** — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I** — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI** — **Somewhat Increase** This factor somewhat increases vulnerability	**N/SI** — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

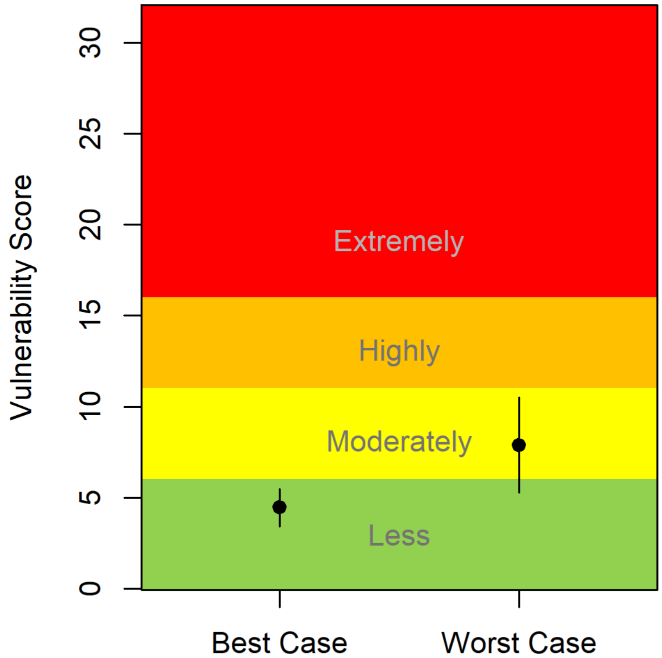
Miin

Miinan (plural) / Blueberry / *Vaccinium angustifolium and Vaccinium myrtilloides*

Less - Moderately Vulnerable
(Confidence Level: Moderate)



Range map of miin.



Climate change vulnerability scores for miin on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Miinan are one of the most important foods of the Ojibwe people and are said to have dropped out of the sky when they were sent by the Creator to relieve children's hunger during the time of famine. At the blossom end of the miin, the five-pointed star-shaped calyx serves as a reminder of this traditional Ojibwe story of origin and is why miinan are sometimes referred to as "star berries."

For many generations, miin habitats in the Great Lakes region were actively managed by the Anishinaabeg. Every few years after picking was done for the season and the plants had completed their photosynthate storage, the Anishinaabeg would set fire to the miin patches to stimulate their production. This would usually result in an increased abundance approximately two to five years after the fire. Beginning in the early 1900's, however, the federal government implemented policies focused on wildfire suppression, and the Anishinaabeg were fined if caught using fire as a management tool. Unfortunately, these policies not only contributed to an increase in wildfires, but also a significant decrease in miin production and devastating cultural, social, and economic impacts to the Anishinaabeg peoples' way of life and connection to miinan.

Miinan were commonly dried and stored to aid in survival of the Anishinaabeg people through all seasons, especially the long and harsh winters. They were eaten both fresh and dried. When drying, they were placed in the sun on top of rolls of birch bark, which allowed the miinan to cure like raisins and made them sweeter as they dried. Once dried, they were often mixed with other foods such as venison and soups. Medicinally, an infusion of leaves was used to purify the blood and the burning of dried flowers helped those struggling with mental health problems.

Miinan are still commonly picked, and their plants used medicinally, but major decreases in their populations and in berry size has caused concern. Recent efforts to return to the use of fire as both a management and a cultural tool have shown success in increasing populations once again.

Miini-baashkiminasigani-biitoosijigani-bakwezhigan (blueberry pie) is known to be the longest word in the Ojibwe language.

Miin is a northern being found across the Ceded Territories. It is found in the understory of a variety of forest communities. It can grow in areas with dry, acidic soils and plenty of sunlight, such as sand barrens or rocky outcrops. It can also grow in upland forests, often in association with pines, oaks, paper birch or aspen, or in swamps and sphagnum bogs, often with black spruce and tamarack. It relies on disturbances such as clearing or burning that create sunny openings. *Vaccinium angustifolium* (lowbush blueberry) is more commonly found in drier habitats and *V. myrtilloides* (velvetleaf blueberry) is more commonly found in wet habitats.

Miinan were mentioned in more than half of the Traditional Ecological Knowledge interviews, with all interviewees expressing strong concern about a decrease in their populations. An elder in Odaawaa-zaaga'iganiing (Lac Courte Oreilles) shared memories about gathering them while growing up and burning the plants after picking. She expressed the need to bring back the practice of burns for miin production. An interviewee in Waaswaaganing (Lac du Flambeau) recalled doing a lot of controlled burns for miinan in the Powell Marsh area in northern Wisconsin but is now worried about a significant decrease in them. In areas that haven't been burned, the plants are still there but aren't producing.

An elder in Gaa-miskwaabikaang (Red Cliff) recalled that in the 1960's, most community members would spend a few weeks camping and picking berries on Wenaboozhoo Minisan (Apostle Islands) when the miinan were ripe. In addition to keeping and preserving the berries, they sold them to local restaurants and grocery stores. Each family typically picked two to three 16-quart crates of berries a day. After picking, ferns were added to the crates and the miinan were stored under a tree to keep them fresh for a few days. Berries were picked up twice a week by boat, and they sold 20 to 30 crates of berries a week for about $6 each. Sometimes people buying berries brought food for the berry pickers. Most often, the miinan would ripen in the Moquah barrens first, then ten days to two weeks later they would ripen on Wenaboozhoo Minisan. The interviewee mentioned that this was due to the islands being consistently colder than the barrens.

When the Gaa-miskwaabikaang elder was asked why there are fewer miinan now, he said it's because they have to be burned in order for them to germinate, and no one is allowed to burn for them anymore. He stated that about every five years someone should burn which will result in a better miin crop two years after the burn. He recalled picking with an elder when he was young on Ironwood (also known as Hardwood) Island. They would camp along the lake and walk about a mile into the miin patch in the middle of the island. They always left their kettles there at the end of the season and no one ever bothered them. He recalled that the 1970's was the last time anyone went out to pick those miinan. He also expressed concern that kids don't pick miinan anymore and that they have lost the tradition. Years back they had to be picked in order for people to survive but now it's done for exercise or pleasure.

Summary of climate threats:

Miin was in the 33rd percentile relative to other plants and in the 46th percentile relative to other beings in the vulnerability assessment. Miin is fairly tolerant of a wide range of temperatures and precipitation levels and grows in a wide variety of habitats. A reduction in snow cover may cause damage to the plants and altered precipitation patterns or increased temperatures may affect miin growth if the changes are extreme. Otherwise, this being is not likely to be particularly vulnerable to climate change. It thrives on disturbance, so increases in most disturbances, particularly fires, will only benefit miin. However, based on information from interviews, localized changes in the population or timing of miin will continue to occur.

Factors that increase the vulnerability of miin to climate change:

SI Anthropogenic barriers: Development can threaten habitat, particularly in combination with fire suppression, which prevents the habitat of miin from being maintained.

N/SI Dispersal: Most of the dispersers of miin (territorial birds, small mammals) travel small distances. However, seeds can also be dispersed by songbirds, which travel longer distances.

N/SI Physiological thermal niche: Miin is a northern being limited to cool environments and may be somewhat impacted by increasing temperatures. Warm winter or spring temperatures could trigger plants to bloom out of season, and unseasonably hot summers can result in smaller, softer fruits.

N/SI Physiological hydrological niche: Some beings may be dependent on a consistent source of water and would be affected by drying or variable conditions. Severe drought may limit fruit production and/or result in shorter, thinner plant stems.

SI Dependence on snow or ice: Blueberry benefits from a snowpack in the winter to provide protection from cold and browsing by a variety of beings.

SI Documented response to climate change: At least three tribal communities have reported a decline in miin likely due to climate change.

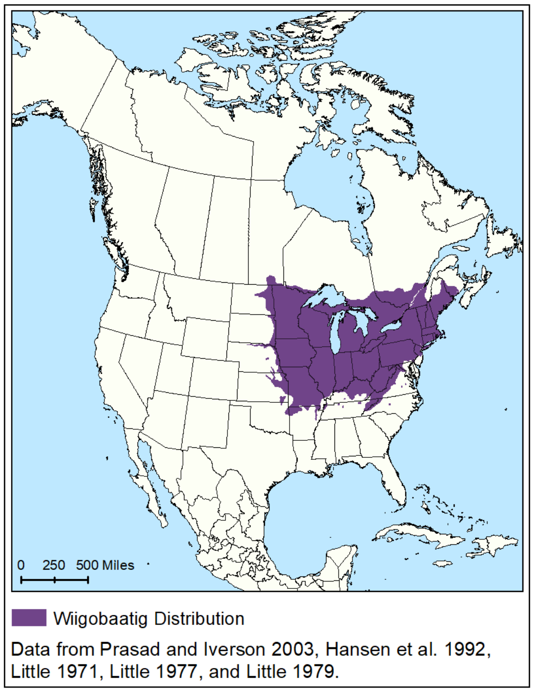
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

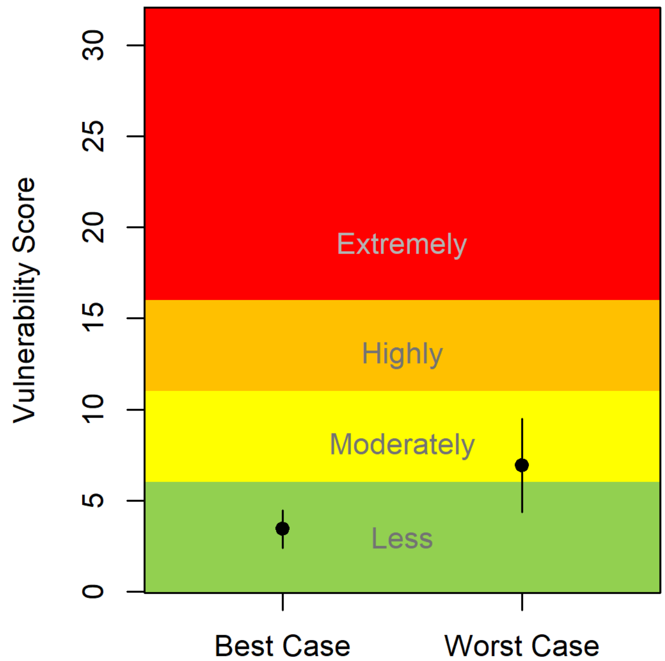
Wiigobaatig

Wiigobaatigoog (plural) / American basswood / *Tilia americana*

Less - Moderately Vulnerable
(Confidence Level: Moderate)



Range map of wiigobaatig.



Climate change vulnerability scores for wiigobaatig on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Wiigoobaatig is culturally important to the Ojibwe and has historically been used in a variety of ways, many of which are still practiced today. Hollowed out wiigobaatig logs were traditionally used as vats to store ziinzibaakwadwaaboo (maple sap) until it was ready to be boiled. Although climate change has had an impact on timing, strips of bark from wiigobaatig are gathered May through July when the bark is loose, with June being the most ideal time. Once the bark is stripped and peeled away from the outer edge, the inner fiber is stripped and used to create cordage for countless uses including tying lodge poles, sewing baskets, making mats, and less commonly, fish nets. When not in use, the cordage is wound into rolls and kept in coils that are then later prepped for use by boiling or soaking which makes them pliable. The flowers of wiigobaatig are dried for use in teas. The twigs and leaves are also commonly gathered. Various parts of wiigobaatig are used to treat burns, lung issues, dysentery, and other ailments.

Wiigobaatig is a shade tolerant being found in rich uplands in mixed deciduous forests. It is typically found with ziinzibaakwadwaatig (sugar maple) and wiigwaasaatig (paper birch). It grows best in mesic sites and is also found in even wetter areas. In general, it grows in a wide variety of sites. Wiigobaatig is found across the Ceded Territories where it is at the northern end of its range. There are a few Ojibwe place names within the Ceded Territory that refer to wiigoobaatig. Wiigobii-minis (Basswood Island) is one of the Wenaboozhoo Minisan (Apostle Islands) in northern Wisconsin. South of Ginoozhekaaning in Lake Huron lies Wiigobii-minis (Bois Blanc Island). Both Wiigobimizh-zaaga’igan (Basswood Lake) and Wiigobimizh-ziibi (Basswood River) are located in northwest Wisconsin.

Although wiigobaatig was mentioned in nearly half of the Traditional Ecological Knowledge interviews carried out, not a lot of information was shared about this being. An elder in Waaswaaganing (Lac du Flambeau) shared concerns about the decrease in them over the years and how they often die after they are stripped of their bark. Knowledge holders in Nagaajiwanaang (Fond du Lac) thought the wiigobaatig population was either stable or decreasing. One interviewee also explained how he talked to the trees before gathering anything from them to ask for their permission and explain what was needed and for what purpose. An elder in Ginoozhekaaning (Bay Mills) who has harvested a lot of different foods and medicines throughout her life noticed that there are not many wiigobaatigoog in that area anymore.

An interviewee in Odaawaa-zaaga’iganiing (Lac Courte Oreilles) shared that the inner bark peeled from the tree is referred to as wiigoob when in the form of twine or rope. She stated that it can be used on anything that can be sewed, such as birchbark, baskets, and canoes. During the interview she brought out a small bundle of wiigoob from Historyland in Odaawaa-zaaga'iganiing that she had been keeping for many years and said she had never been able to get hers to be as clean and smooth as that one. She also recalled a member of Misi-zaaga'iganiing (Mille Lacs) who was known for making dolls from wiigob.

Summary of climate threats:

Wiigobaatig was in the 29th percentile relative to other plants and in the 40th percentile relative to other beings in the vulnerability assessment. Wiigobaatig is limited by dispersal of its heavy seeds, browsed heavily by waawaashkeshi (white-tailed deer), and may be susceptible to manidoonsag (insects). It also lives in habitats likely to be affected by mooseg gaa-biimaabiigiziwaad (earthworms), which may fare better in a warmer climate. In general, however, it is found at the northern end of its range, tolerant of some disturbance and moisture regimes, and will not be heavily affected by climate change.

Factors that increase the vulnerability of wiigobaatig to climate change:

I — Dispersal: Wiigobaatig seeds are heavy and are typically dispersed one or two tree lengths by gravity. They are not carried long distances by the wind, although they are sometimes dispersed longer distances by animals.

N/SI — Disturbance regime: Wiigobaatig is easily damaged by fire, and any increases in fire will likely have a negative effect on this being. Wiigobaatig is fairly tolerant of flooding.

SI — Pathogens or natural enemies: Wiigobaatig is a preferred browse species for waawaashkeshi, whose populations are expected to increase and who have been known to eliminate wiigobaatig entirely from some stands. There are also a few defoliating manidoonsag that affect wiigobaatig, such as the basswood leafroller and basswood thrip, that may increase in prevalence.

SI — Competition: Mooseg gaa-biimaabiigiziwaad are a threat to wiigobaatig. Some models show that these non-local beings will have invaded 90% of the terrestrial habitats (and ziinzibaakwadwaatig/ wiigobaatig habitats in particular) in less than a century. Mooseg gaa-biimaabiigiziwaad reduce litter, alter nutrients and water cycling, increase drought susceptibility and decrease regeneration.

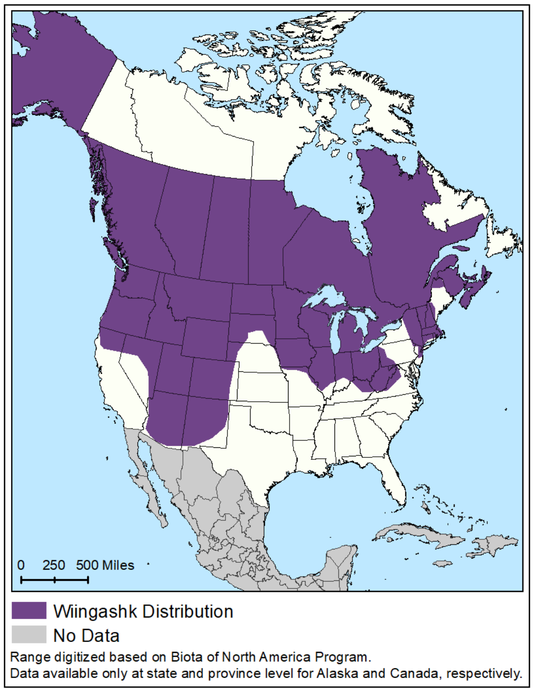
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	**I/GI** — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I** — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI** — **Somewhat Increase** This factor somewhat increases vulnerability	**N/SI** — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

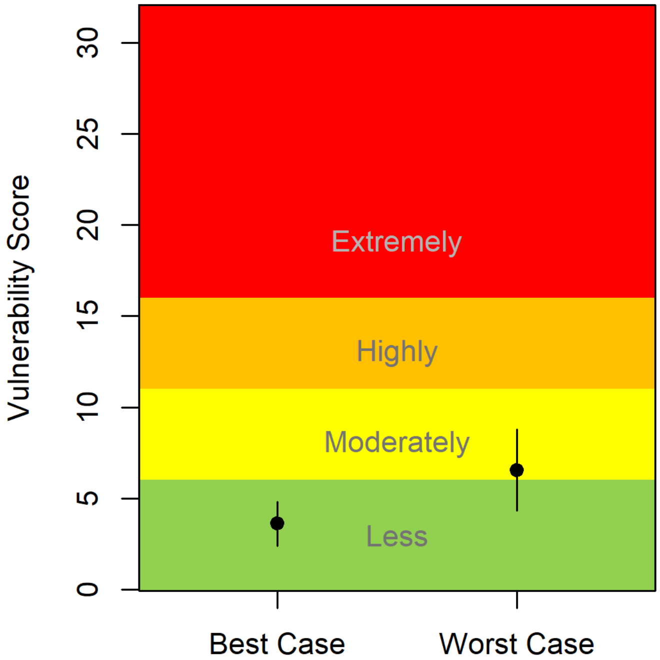
Wiingashk

Wiingashkoon (plural) / Sweetgrass / *Anthoxanthum hirtum*

Less - Moderately Vulnerable
(Confidence Level: Low)



Range map of wiingashk.



Climate change vulnerability scores for wiingashk on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Wiingashk is highly important to the Anishinaabeg and considered to be one of the four main medicines, along with mashkodewashk (sage), giizhik (cedar), and asemaa (tobacco). Wiingashk represents the hair of mother earth and is commonly braided, with the three sections symbolizing the mind, body, and spirit of all beings. When braided together, each is stronger both physically as well as spiritually. From an Anishinaabeg holistic perspective, one cannot exist without the other and all three are deeply interrelated.

Wiingashk is most often used medicinally, in ceremonies, and in crafts such as basketry. When burned, the sweet scent of wiingashk is easily recognized. Historically some men wore two wiingashk okaadenigan (braids) around their neck, fastened together in the back, with the okaadenigan falling down in the front. There are various ideas about why they were worn, including for protection, as an ornament, and to have them easily accessible if and when needed.

Wiingashk grows in moist ground at the edges of forests, marshes, sedge meadows, bogs, wet prairies, and lakeshores. It is usually found among other grasses and shrubs.

Wiingashk is found across the Ceded Territories and has an extensive range in North America. It is sensitive to overharvest for personal and commercial use as well as overgrazing. Its populations may currently be in decline, but not a lot is known about the population of this being.

Many communities believe this being has a connection with fire, though few studies have been done regarding the benefits or impacts to wiingashk from fire. Knowledge holders have shared that wiingashk is less common than it used to be and feel that fire might aid in increasing the population. Fire researchers have found an increased likelihood of it sprouting after above-ground portions of the plant are burned. Spring burns increase its success rate, as moisture levels are higher; fall burns are more likely to negatively impact the basal buds when moisture levels are lower and dried foliage burns.

Despite the cultural importance of wiingashk, it was mentioned infrequently during interviews with knowledge holders. However, all beings are important to the Ojibwe people based on cultural beliefs in the original treaties with all of creation. One elder in Odaawaa-zaaga'iganiing (Lac Courte Oreilles) shared that she didn't hear much about it while growing up but would see it used and stated there has been an increase in the population there.

Summary of climate threats:

Wiingashk was in the 25th percentile relative to other plants and in the 38th percentile relative to other beings in the vulnerability assessment. Wiingashk lives in moist areas and may be affected by altered precipitation or changes in local hydrology. It also can be outcompeted by other more aggressive or non-local beings, has a limited dispersal ability, and may have limited genetic diversity. However, transplanting can overcome dispersal barriers, as it grows aggressively by rhizome. Additionally, this being is not likely to be affected by increasing temperatures and is fairly tolerant of disturbance. Overall, wiingashk is likely to be resilient to climate change.

Factors that increase the vulnerability of wiingashk to climate change:

- **SI** — Dispersal: Wiingashk spreads using rhizomes as well as seeds. Its rhizomes are fairly aggressive but it has a limited ability to disperse across unsuitable habitat.
- **N/SI** — Physiological hydrological niche: Wiingashk primarily inhabits wet areas that may be vulnerable to droughts, flooding, or otherwise variable conditions.
- **N/SI** — Competition: Wiingashk can be outcompeted by taller, shade-producing beings, such as reed canary grass or *Phragmites*, particularly on drier, nutrient-rich sites where those other beings may be favored.
- **SI/I** — Reproductive system: Genetic variation may be limited in this being, because wiingashk reproduces primarily by rhizome and reproduction via seeds is limited.

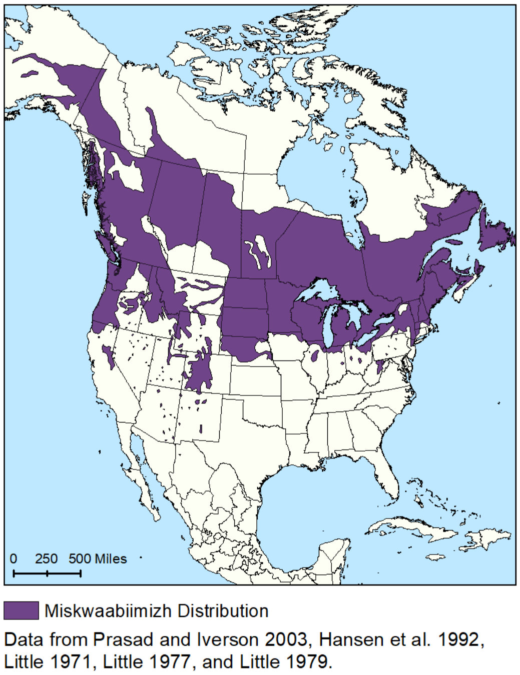
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	**I/GI** — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I** — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI** — **Somewhat Increase** This factor somewhat increases vulnerability	**N/SI** — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

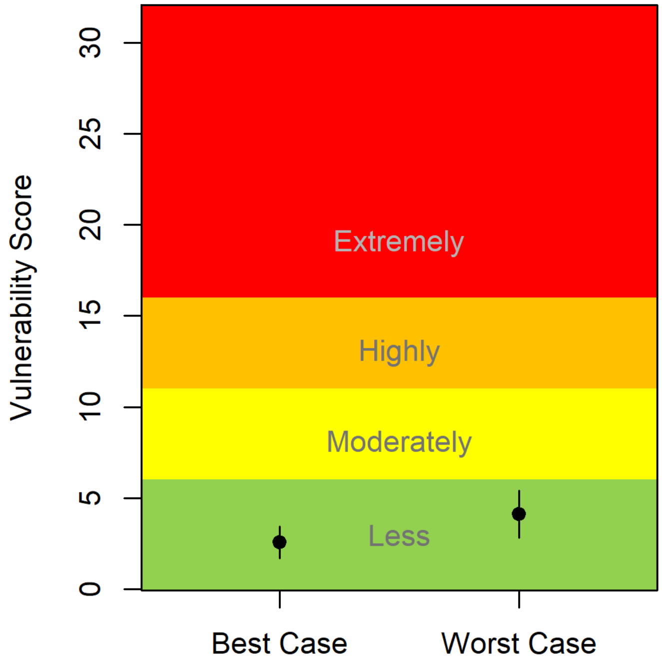
Miskwaabiimizh

Miskwaabiimizhiig (plural) / Red-osier dogwood / *Cornus sericea*

Less Vulnerable
(Confidence Level: High)



Range map of miskwaabiimizh.



Climate change vulnerability scores for miskwaabiimizh on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Miskwaabiimizh, sometimes called miskaawabi'mik, refers to the vibrant red color of the bark and twigs. Miskwaabiimizh has been used by the Anishinaabeg in many ways including medicines, food, crafts, and the making of kinikinik (traditional tobacco), one of the most important gifts to the Anishinaabeg. Kinikinik is made by combining leaves from different plants such as apaakozigan (bearberry), wiinisiibag (wintergreen), ode'imin (strawberry), and miinan (blueberry), along with the inner bark of miskwaabiimizh. In order to obtain the inner bark, the twigs are peeled to expose the inner layer which is then also peeled or scraped off and dried for use.

The bark has also been used to treat diarrhea and rashes caused by poison ivy, and in the making of red, yellow, and black dyes when mixed with other plants and minerals. The roots are used in the making of a wash used to treat sore eyes. The berries of miskwaabiimizh were also gathered and eaten fresh or dried and cooked into other foods. However, the berries are no longer often used.

Today this being is mostly gathered for kinikinik and for crafts such as baskets and dream catchers which are believed to have been first made and used by the Ojibwe. It is said that the dream catchers originated with Asabikeshiinhkwe (which means "woman who makes nets;" also referred to as Spider Woman). She was believed to have looked over and protected the Ojibwe, especially the infants. Eventually, there were so many Ojibwe everywhere, it became impossible for her to watch over them all. She began using miskwaabiimizh to make hoops and weave sinew onto them to form a web. These were then gifted to the children and used to protect them, especially while they slept. They are still commonly used and are often found hanging on the top of a child's dikinaagan (cradleboard) or above the heads of beds. Some say the web catches bad dreams at night and releases them in the day. Others say the bad dreams are caught by the web, but the good ones pass through a hole that is left in the center. It is also common for a small bead or beads to be seen near the center of the web, representing Asabikeshiinhkwe or the asabikeshiinh (spider).

Miskwaabiimizh is a woody shrub with reddish bark and twigs that is known in English as red osier dogwood or red willow. It is found along the edges of lakes, streams, ponds, and in wetlands. It grows best in rich, moist, poorly drained soils with high levels of nutrients, and prefers wetland margins where soils are saturated in the spring and may dry up by late summer, though it tolerates a wide range of soil conditions. Miskwaabiimizh is common across the Ceded Territories and has a wide range in North America.

Miskwaabiimizh was mentioned in about a quarter of the TEK interviews. All who were interviewed mentioned a decrease over the last fifty years or so, making it harder to find. One harvester in Nagaajiwanaang (Fond du Lac) noted a relationship between ishkode (fire) and miskwaabiimizh, stating that miskwaabiimizh seems to regenerate well after low intensity fires rather than moderate or severe fires, and it seems to sprout only one week after low severity fires. Most interviewees also mentioned miskwaabiimizh being used to make kinikinik. One interviewee in Gaa-miskwaabikaang (Red Cliff) also stated that York Island, one of the Wenaboozhoo Minisan (Apostle Islands) on Lake Superior, was originally called Miskwaabiimizhiikaag, Red Willow Island.

Summary of climate threats:

Miskwaabiimizh was in the 21st percentile relative to other plants and in the 25th percentile relative to other beings in the vulnerability assessment. Miskwaabiimizh is widespread and tolerates a variety of conditions. It may be somewhat affected by drought and increased deer browse, but otherwise miskwaabiimizh is not likely to be very vulnerable to changing conditions. However, based on information from interviews, localized changes in the population or timing of miskwaabiimizh will continue to occur.

Factors that increase the vulnerability of miskwaabiimizh to climate change:

SI	Dispersal: Miskwaabiimizh has been known to be dispersed by birds and mammals up to 700 feet, but is still limited by its dispersal ability.
N/SI	Physiological hydrological niche: Miskwaabiimizh is not particularly drought tolerant and requires soils that are saturated for at least part of the growing season. Dry conditions may affect this being.
N/SI	Pathogens or natural enemies: Miskwaabiimizh is browsed heavily by waawaashkeshi (white-tailed deer), which are expected to increase as climate change continues. Other beings, such as manidoo-waabooz (cottontail) and amik (beaver), also browse miskwaabiimizh to a lesser extent.

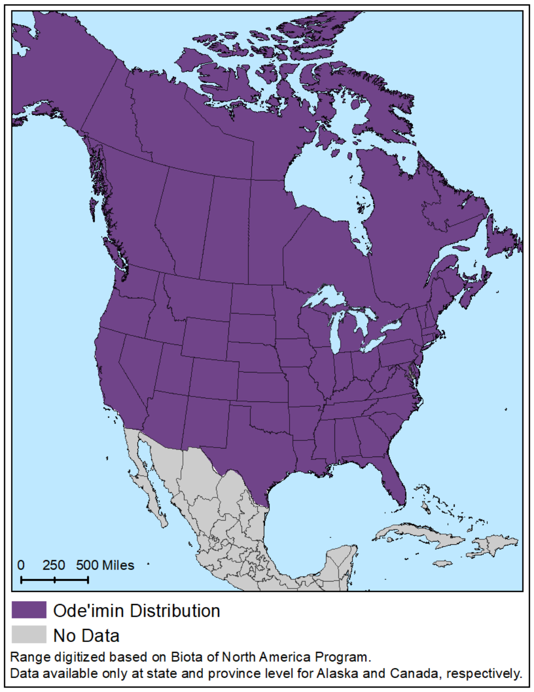
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

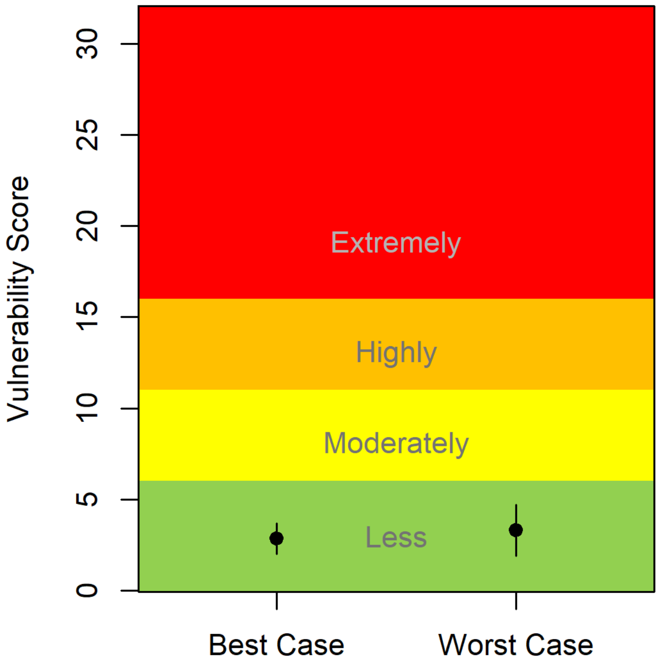
Ode’imin

Ode’iminan (plural) / Strawberry / *Fragaria virginiana and Fragaria vesca*

Less Vulnerable
(Confidence Level: Moderate)



Range map of ode’imin.



Climate change vulnerability scores for ode’imin on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

In the Ojibwe lunar calendar, the name of a month references important natural and cultural events that occur during that time, such as the gathering of food. Ode’imini-giizis, also known as the Strawberry Moon, falls around the month of June which is when strawberries are usually ready to be picked. According to many knowledge holders, it is the first wild fruit of the season to ripen. The entire plant being is known to be of use and of high importance. The root is beneficial in curing stomach problems and the leaves are known to stimulate appetite.

Ode’imin is considered one of the most important medicinal and ceremonial plants. Its fruit is sometimes referred to as the heart-shaped berry, with “ode” meaning heart and “min” referring to berry. In Ojibwe culture, when young females experience their coming of age (referred to as their first moon), they participate in a berry fast for the first year after their first moon. During this time they are to refrain from eating wild berries, especially ode’iminan. Once the year is up the fast is broken when an ode’imin is fed to them during a ceremony. The fruit is often incorporated into various other ceremonies and is considered a luxury.

Ode’imin occupies a wide variety of habitats, moisture gradients, and soils. In the Great Lakes, it is commonly found in forested habitats as well as sunny, drier areas such as meadows and fields. Ode’imin is found across the Ceded Territories and has a large range in North America.

Ode’iminan were mentioned in approximately half of the interviews with knowledge holders. All who mentioned ode’iminan expressed a concern over a decrease in their population and some mentioned a decrease in the size of the berries as well. During two separate interviews in Waaswaaganing (Lac du Flambeau), elders expressed rarely seeing ode'iminan anymore, and when they do, it is mostly just blossoms in the ziigwan (springtime) but rarely fruit in the summer. Those interviewed in Mashkiiziibiing (Bad River), Nagaajiwanaang (Fond du Lac), and Ginoozhekaaning (Bay Mills) stated the plants aren't doing as well anymore and expressed concern over smaller berries. A group of knowledge holders in Gete-gitigaaning (Lac Vieux Desert) shared that the growing season of the berries isn't as long as it was years ago. An elder in Gaa-miskwaabikaang (Red Cliff) shared memories of everyone picking ode'iminan when he was a child, which isn't so anymore.

During an interview in Odaawaa-zaaga'iganiing (Lac Courte Oreilles), an elder stated that the leaves, stems, and roots are all considered to be medicine for the heart. She often eats the entire plant and shared that her grandma used to make tea with the entire plant as well. At that time, they had an entire field of them where they lived near Signor in the southwest portion of Odaawaa-zaaga'iganiing. She attributed their decrease to the lack of prescribed burning. Ode'iminan are known to be adapted to surviving low to moderate intensity fires but are not fire dependent. The plants can endure fires and are able to re-sprout after one has occurred.

Summary of climate threats:

Ode'imin was in the 17th percentile relative to other plants and in the 22nd percentile relative to other beings in the vulnerability assessment. It can grow in many habitats and has good dispersal ability, a broad distribution, and many pollinators. It is unlikely to be affected by changes in precipitation, flooding, or droughts, and is overall unlikely to be affected by climate change. However, based on information from interviews, localized changes in the population or timing of ode'imin will continue to occur.

Factors that increase the vulnerability of ode'imin to climate change:

N/SI Anthropogenic barriers: Development can be a barrier to ode'imin.

SI/I Documented response to climate change: At least five different tribal communities mentioned that ode'imin was declining in their regions likely due to climate change or a climate change-related factor.

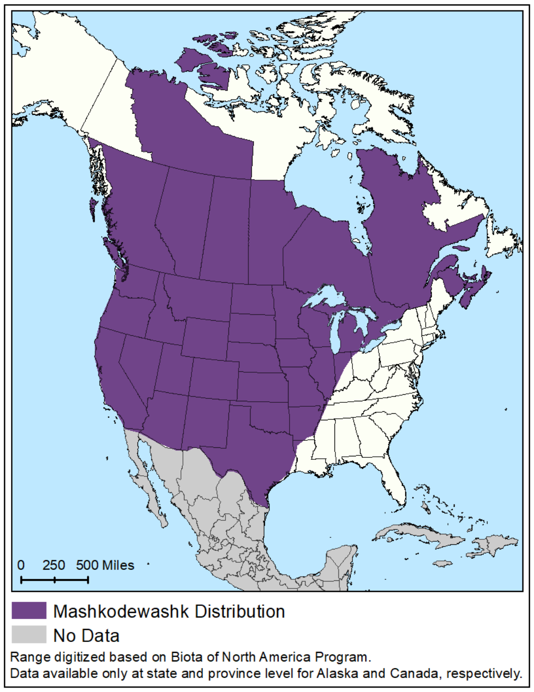
Legend

GI **Greatly Increase** This factor greatly increases vulnerability	**I/GI** **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I** **Increase** This factor increases vulnerability
SI/I **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI** **Somewhat Increase** This factor somewhat increases vulnerability	**N/SI** **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

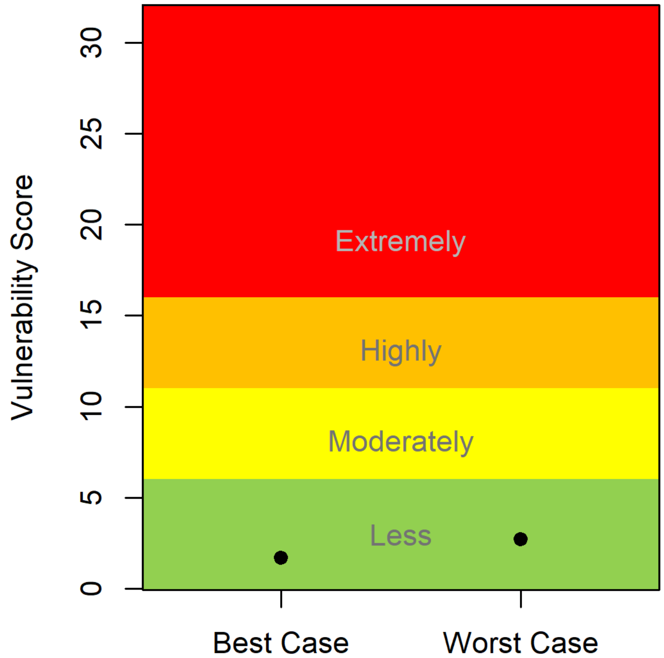
Mashkodewashk

Mashkodewashkoon (plural) / Wild sage / *Artemisia ludoviciana*

Less Vulnerable
(Confidence Level: Low)



Range map of mashkodewashk.



Climate change vulnerability scores for mashkodewashk on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Mashkodewashk is highly important to the Anishinaabeg and considered to be one of the four main medicines, along with wiingashk (sweetgrass), giizhik (cedar), and asemaa (tobacco). Of these four medicines, asemaa and mashkodewashk are the most commonly used. Nearly every ceremony performed by the Ojibwe includes smudging with mashkodewashk at the beginning and periodically throughout the ceremony. The smoke from the burning of mashkodewashk is used in many ways: to clean or purify a space, people, and sacred items; to lift the mind of troubled thoughts; and to remove negative energy. The root is also used to prepare a medicine that can be used as an anti-convulsive and the leaves can be used in a tea for relieving stomachaches. It is often gathered, made into bundles, dried, and then shared with others in a community.

Mashkodewashk grows in dry habitats, such as prairies or disturbed sites such as alongside railroads and roadsides. It prefers sunny places with hardpan clay, rocky material, or sand. Mashkodewashk is found in scattered dry and prairie sites across the Ceded Territories, though it is much more common in the Great Plains region and western US.

Even though mashkodewashk is used often, it was mentioned infrequently in interviews. However, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. An elder in Nagaajiwanaang (Fond du Lac) talked about how often it is used but that he rarely sees it in their communities. He also shared that high intensity wildfires are likely to negatively impact mashkodewashk but periodic prescribed fires may aid in reducing heat intensity when wildfires do occur, increasing the survival rate of maskodewashk after a fire.

An elder from Odaawaa-zaaga'iganiing (Lac Courte Oreilles) stated that she had seen a significant decrease in mashkodewashk during the last 35 years around Webster, Wisconsin. She thinks that maybe it's not being gathered properly, and people are pulling it out by the roots rather than breaking it off on the stem lower to the ground. She emphasized that anyone who harvests mashkodewashk should first learn about how to do so sustainably.

Summary of climate threats:

Mashkodewashk was in the 13th percentile relative to other plants and in the 16th percentile relative to other beings in the vulnerability assessment. This being is not likely to be highly vulnerable to climate change as it prefers warmer and drier conditions that are likely to continue. Wetter conditions may not favor this being, and it is possible other beings may have an advantage if wetter conditions persist. Its dispersal method is also somewhat limiting, though it has an enormous range in North America. However, based on information from interviews, localized changes in the population or timing of mashkodewashk will continue to occur.

Factors that increase the vulnerability of mashkodewashk to climate change:

SI Dispersal: Mashkodewashk primarily reproduces vegetatively by rhizome, so dispersal is quite limited. However, its tiny seeds are sometimes dispersed farther by wind or water.

Legend

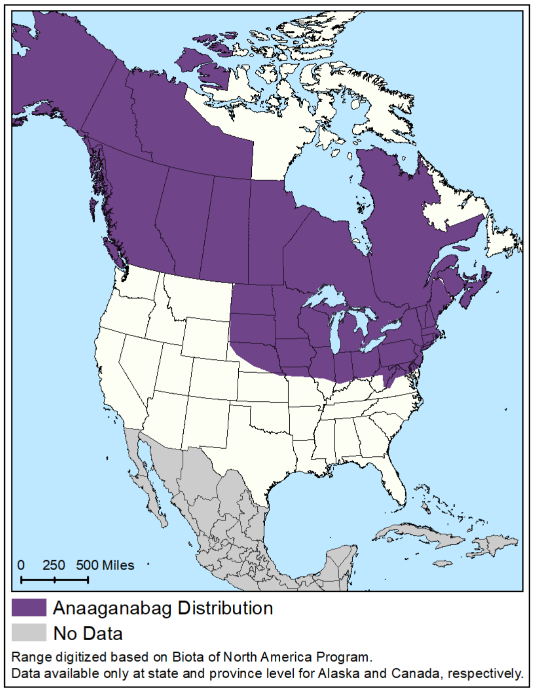
GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Anaaganabag

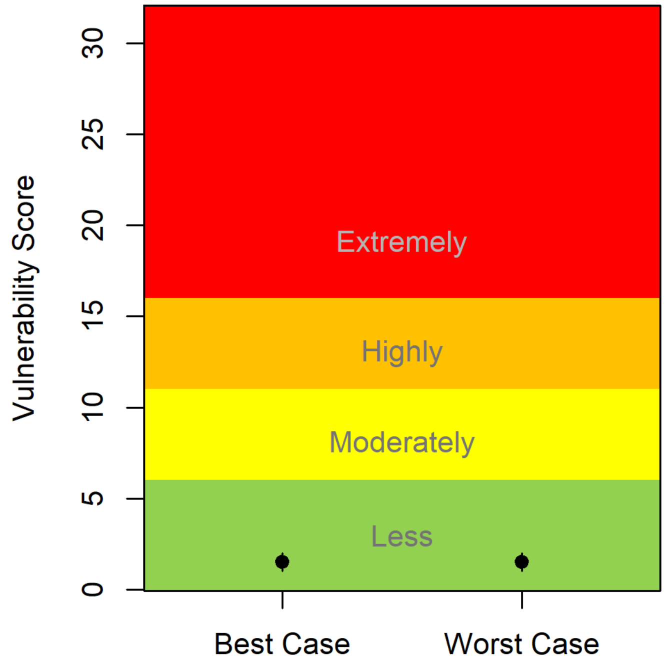
Anaaganabagoon (plural) / Ostrich fern / *Matteuccia struthiopteris*

Less Vulnerable

(Confidence Level: Low)



Range map of anaaganabag.



Climate change vulnerability scores for anaaganabag on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Anaaganabag is also sometimes referred to as a gichianiibish or anaganak in certain Anishinaabeg communities. However, it is more commonly called waawaagin, wegaagin, or other similar variations. In English, they are commonly known as fiddlehead ferns, which can be confusing as many ferns form fiddleheads (tightly curled shoots) as their first stage of growth in ziigwan (springtime).

Anaaganabag is a favorite food source in the springtime and can be used as a medicine for various health conditions and as an aid in childbirth. This plant being provides vitamins and micronutrients and is most often prepared in soups or steamed. It is recommended that any harvester ensures the correct fern is being gathered and in a sustainable way. Only two or three of the young shoots should be picked from each clump, leaving the others to mature and the population to thrive. Most importantly, not all ferns that produce fiddleheads are edible, and some can be toxic.

Anaaganabag is found along river and streambanks, and near seeps and springs. However, it can also be found in rich, moist soils, typically in deciduous or mixed forests with at least partial canopy cover. It forms large colonies that spread by rhizome. Anaaganabag is found across the Ceded Territories, and in most north-temperate and boreal regions of the world.

Anaaganabagoon were mentioned in nearly half of the interviews. Of these, half of the knowledge holders noted an increase and the other half expressed concern about a decrease in the anaaganabag population. An elder in Waaswaaganing (Lac du Flambeau) stated that he can no longer find them near Big Lake. Harvesters attributed these changes to climate change and other related impacts.

During two separate interviews in Odaawaa-zaaga'iganiing (Lac Courte Oreilles), participants stated that anaaganabagoon used to be abundant but are now harder to find, particularly near the powwow grounds. It was also noted that they would be ready to harvest at different times in different neighborhoods, historically first in Signor and later in New Post. Participants also mentioned that anaaganabagoon are used in a ceremony. They are known to be a sign of a healthy forest, and any changes in the anaaganabagoon would indicate some type of impacts to the forest understory.

An elder in Gaa-miskwaabikaang (Red Cliff) shared memories of adding anaaganabagoon to crates of freshly picked berries. Stored under a tree, the anaaganabagoon kept the berries fresh for several days prior to sale. He also recalled eating anaaganabagoon in salads and said growing up he primarily ate them instead of other greens – he hadn't even tried lettuce until the 1970's when he was in his 30's.

Summary of climate threats:

Anaaganabag was in the 8th percentile relative to other plants and in the 4th percentile relative to other beings in the vulnerability assessment. Anaaganabag requires consistent moisture in the soil and may be affected by drier or variable conditions that would disrupt moist soil conditions. Other than soil moisture changes, this being is unlikely to be very vulnerable to climate change in the Ceded Territories in general. However, based on information from interviews, localized changes in the population or timing of anaaganabag will continue to occur.

Factors that increase the vulnerability of anaaganabag to climate change:

N/SI Physiological hydrological niche: Anaaganabag grows in deep, rich, humus-laden, consistently moist soils. These areas may be affected by drying and/or variable conditions. Dry conditions may cause leaf scorch in ferns, particularly in anaaganabag.

Legend

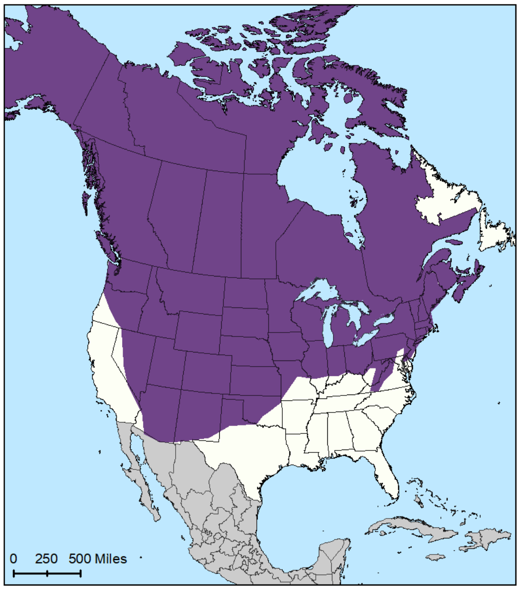
GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Miskomin

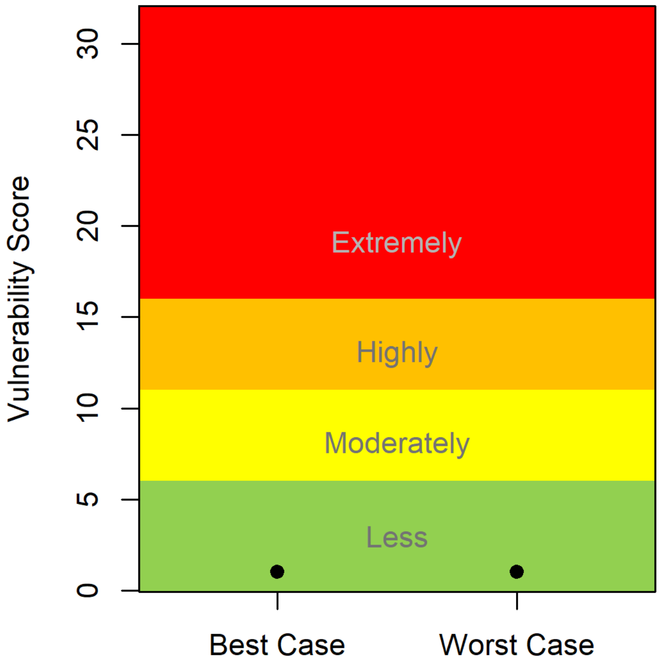
Miskominag (plural) / Raspberry / *Rubus idaeus*

Less Vulnerable

(Confidence Level: Moderate)



Range map of miskomin.



Climate change vulnerability scores for miskomin on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Miskomin is a widely used plant being. Besides being known as one of the first foods to the Ojibwe, the plant is also used as a medicine. The root can be used to treat measles, dysentery, and stomach pains, as well as made into the form of an eye wash. Tea made from the leaves is also known to diminish symptoms related to pre-menstrual syndrome and offer different benefits during pregnancy if used properly. According to an elder of Misi-zaaga'iganiing (Mille Lacs), “People are supposed to live on the Earth from the time they're babies until the time they can't chew the raspberry no more, and raspberries are the softest substance that you can chew. You put a raspberry in your mouth, and it just melts. It just melts right away, but if you can't chew it, that's it. Time for you to go back.”

Miskomin is found in a wide variety of sites, including along the edges of swamps and bogs, in the understory of deciduous and mixed forests, and in openings in the forest canopy including natural clearings and disturbed areas. It is especially common after disturbances such as ishkode (fire), windthrow, or timber harvest. Miskomin is found across the Ceded Territories and has a wide range in North America. The abundance of miskominag in the Ceded Territories in the past is evident in Traditional Ecological Knowledge of Ojibwe place names. Miskominikaani-minis (Island of Plenty of Raspberries) is also known today as Raspberry Island, which is one of the Wenaboozhoo Minisan (Apostle Islands) in northern Wisconsin.

Miskomin was mentioned in several interviews in different contexts. Members from at least three tribes (Gete-gitigaaning, Gaa-miskwaabikaang, Waaswaaganing (Lac Vieux Desert, Red Cliff, and Lac du Flambeau, respectively) observed decreases in miskomin for various reasons. Tribal members from other communities also mentioned a decrease of berries in general.

Summary of climate threats:

Along with zhingos (long-tailed weasel), miskomin was the least vulnerable being in the vulnerability assessment. Miskomin is an adaptable being that grows in many habitats and thrives after disturbance. Its seeds are dispersed widely by birds and mammals and seeds can remain viable for over 100 years. It is unlikely to be sensitive to climate change. However, based on information from interviews, localized changes in the population or timing of miskomin will continue to occur.

Apart from historical hydrological niche (see miskomin in Appendix 2), there were no additional factors that increase the vulnerability of miskomin to climate change.

Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	**I/GI** — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I** — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI** — **Somewhat Increase** This factor somewhat increases vulnerability	**N/SI** — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Swimmers

Swimmers are those beings in the animal world who swim under the surface of the water. Swimmers are in the third order of creation:

> "Great Spirit decided to create everything in the third order and that would be the animal world. All those that swam under the surface of the water, those that stood in the forest on four legs, those that flew through the air like migizi, the eagle, geese, and others." —*Moka'ang Giizis-Rising Sun Joe Rose Sr.*

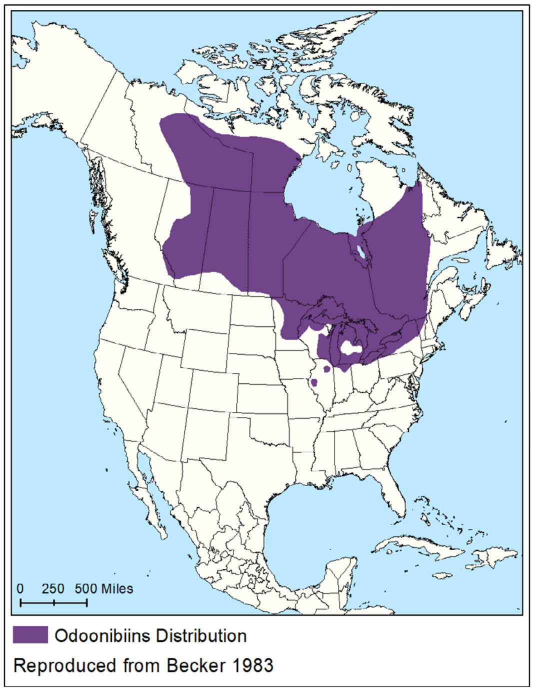
For complete results from the Climate Change Vulnerability Index, see Appendix 3. For references associated with a particular being or beings, please contact the author team.

Odoonibiins

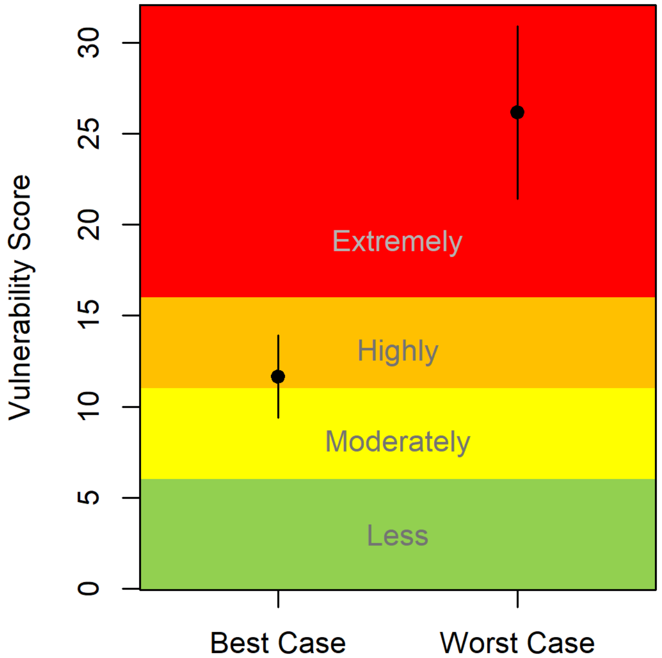
Odoonibiinsag (plural) / Tullibee / *Coregonus artedi*

Highly – Extremely Vulnerable

(Confidence Level: Moderate)



Range map of odoonibiins.



Climate change vulnerability scores for odoonibiins on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

The Fish Clan (which includes odoonibiins) is part of the Ojibwe clan system and those who belong to it are known to be sky watchers that hold knowledge of all that is in the sky, such as the sun, stars, and moon, as well as knowledge about the connections between the earth and the sky. However, members of other clans also sometimes hold that same knowledge today.

During Traditional Ecological Knowledge interviews carried out with tribal members, it was noted that various English common names for odoonibiins are used in the different communities, including tullibee, cisco, chub, and most commonly, herring and lake herring.

Odoonibiins lives in rivers and deep lakes (including Lake Superior, Lake Michigan, and rarely Lake Huron) in the Ceded Territories and has been harvested by the Anishinaabeg since time immemorial. Odoonibiins spawns at night in late fall (late November – early December), when the water temperature reaches 42.8 – 39.2 °F, typically in 10 – 90 feet of water. Eggs hatch in late April – early May, with the optimal temperature range for development being 35.6 – 46.4 °F. Fry occupy shallow areas in protected bays until they are a month old. The location of juvenile odoonibiins remains a mystery, but adult odoonibiinsag are found at water depth of 0 – 40 feet in inland waterbodies and at greater depths (75 – 200 feet) in Lake Superior.

The population of odoonibiins is unknown in most water bodies in the Ceded Territories. In the well-studied Mille Lacs Lake, the population of odoonibiins tends to be variable with peaks in abundance occurring every 4-6 years. For example, the number of odoonibiinsag captured in a standardized gill survey was over 50 per net in 2009, declined to less than 10 per net in 2014, and increased to over 80 per net in 2015. In Lake Superior, the odoonibiins population has been steadily declining, from approximately 900 fish per hectare in 1984 to less than 50 fish per hectare in 2011. A decline in the odoonibiins population might indicate abiotic conditions have changed because this being prefers cold, oligotrophic (low nutrients), and well-oxygenated water.

Although no traditional stories were shared about odoonibiins, its importance was stressed in several interviews with tribal members, primarily from those in Misi-zaaga'iganiing (Mille Lacs) and Gaa-miskwaabikaang (Red Cliff). Interviewees were also concerned about effects climate change may have on this being.

It was mentioned that as bottom feeders, they are one of the first giigoonh (fish) beings to be affected by changes in water temperature and clarity. They are also known to be hypersensitive to low oxygen levels and algae blooms, which are seen as contributing factors to sudden fish kills. This was seen during a particularly warm year in Lake Winnie (Winnibigoshish) when large numbers of odoonibiinsag were observed dead on the shoreline. This has also been observed in Lake Mille Lacs, though it has not happened as frequently after 2013. These fish kills are known to happen when the air temperature reaches about 95 °F and oxygen levels drop.

It was also expressed that in Mille Lacs Lake, recent odoonibiinsag numbers are lower, but the existing individuals are larger in size. Odoonibiinsag used to average about 12” in length but are now commonly seen around 19”. This has been raising concerns about preparation practices of these giigoonh. Years ago, they were hung in a smoker but the increase in size has caused them to fall off the hangers as they heat up. They are now more commonly laid flat on racks.

It was said that the odoonibiinsag start to run two weeks before it freezes and stop once the lake freezes. Many years ago, in the Gaa-miskwaabikaang area the “herring season” would start a few weeks before Thanksgiving. At that time about 15 boats were fishing for odoonibiinsag, and at the end of the day each boat would have 8 to 10 tons of fish. The men would bring the odoonibiinsag onto the dock and into a nearby “herring shed,” which still exists today. The women would pack the catch by placing the odoonibiinsag bellies down and putting salt around them. After the season was over, they would repack them and discard most of the salt before shipping hundreds of kegs full of them by rail to major distribution centers in Chicago, Illinois, and Minneapolis/St. Paul, Minnesota. At times they were sent to satellite towns around those areas as well as exported through Sault Ste. Marie, Michigan.

Summary of climate threats:

Odoonibiins was the most vulnerable swimmer and in the 97th percentile relative to other beings in the vulnerability assessment. Factors that increased odoonibiins vulnerability to climate change included natural barriers (temperature and low oxygen barriers), anthropogenic barriers (dams), dispersal (limited larval mobility), physiological thermal niche (cool water beings), hydrological niche (lower rainfall), disturbance (heat waves, heavy rainfall), ice cover (influence prey production), dietary versatility (restricted to small prey items), pathogens (parasites and viruses), competition (bakaan ingoji gaa-ondaadag (non-local beings)), documented response to climate change (reduce abundance), modeled response to climate change (20-70% loss in habitat), and change in future range (contraction at the southern edge of the Ceded Territories).

Odoonibiinsag are transferred into selected waters throughout the Ceded Territories (i.e., fish populations are supported by human intervention). In the short term, this strategy may resist the effects of climate change by reintroducing this being into water bodies. In the long term, reintroducing odoonibiins has the potential to increase vulnerability scores for several factors in the Climate Change Vulnerability Index. These factors include dispersal and movement, physiological thermal niche, sensitivity to pathogens and natural enemies, sensitivity to competition, interspecific interactions, measured genetic diversity, and phenological response to climate change. Collectively, these factors may increase the overall vulnerability scores for odoonibiins in waterbodies where reintroductions occur.

Factors that increase the vulnerability of odoonibiins to climate change:

I/GI — Natural barriers: In inland lakes, odoonibiins will encounter temperature (too high) and oxygen (too low) barriers as the climate changes. Dispersal to a more suitable water body will be impeded by these barriers as well as by the land that separates these water bodies. However, in Lake Superior, odoonibiins will likely be able to find cool, well-oxygenated habitats because of the large size and depth of this lake.

SI — Anthropogenic barriers: Dams and roadways can inhibit fish passage. Anthropogenic eutrophication (e.g., runoff from agricultural fields) can result in low oxygen zones in lakes creating unsuitable habitat for odoonibiins. With longer stratification, periods and warmer water predicted in the future, these low oxygen zones might persist for longer periods and limit dispersal into cooler water in the summer.

N/SI — Dispersal: Adult odoonibiins can disperse long distances. On the other hand, larvae have limited mobility, are susceptible to changes in current, and may not be able to move to optimal thermal habitats.

GI — Physiological thermal niche: Odoonibiins is almost completely restricted to relatively cool water environments that may lost or reduced in the Ceded Territories as a result of climate change. Specifically, for larval fish, lethal temperature ranges from <32.5 – 79.2 °F, with optimal temperature range between 35.6 – 46.4 °F. For adults, upper avoidance temperature is 68 °F, with a preferred temperature of 45 – 50 °F.

SI/I — Disturbance regime: Disturbance will vary regionally and by lake, but extreme storms and heat waves are predicted to occur more frequently and in greater intensity in the future. Extreme rain events could lead to sedimentation of spawning sites. Heavy winds associated with extreme storms can negatively affect recently hatched and drifting larvae. Heat waves can reduce the amount of thermal refuge for larval and adult life stages.

SI — Dependence on snow or ice: Ice cover might provide refuge for larval odoonibiins. In Lake Superior, a lack of ice cover might cause a shortage of prey availability.

N/SI — Dietary versatility: The odoonibiins diet is flexible (zooplankton and aquatic insects), but if these prey items become scarce in the odoonibiins habitat, growth and abundance could be negatively affected. Odoonibiins small gape-size (i.e., small mouth) limits the size of prey it can consume.

N/SI — Pathogens or natural enemies: Hemorrhagic septicemia virus (VHSV) might become more prevalent in certain water bodies. Parasitic copepods might also increase in abundance with warmer water temperatures.

SI — Competition: The introduction of bakaan ingoji gaa-ondaadag (non-local beings) can negatively affect odoonibiins populations. Specifically, rainbow smelt consume larval odoonibiins, which can reduce or eliminate recruitment. The introduction of Asian carp and an increase in alewife might increase competition for food. Odoonibiins might have difficulty consuming spiny water flea. Overall, bakaan ingoji gaa-ondaadag will likely be predators and competitors of odoonibiins and some of these non-natives (e.g., Asian carp) might be able to successfully invade more ecosystems as the climate changes.

I — Documented response to climate change: A contraction in odoonibiins distribution and a decline in abundance have been observed in recent years. For example, in Minnesota, the odoonibiins population has declined by approximately 60% in the last 30 years.

SI/I Future change in range size: By mid-century, the number of lakes that support viable odoonibiins habitat is predicted to decrease by 20-75%.

N/SI Overlap of future and current range: The range of odoonibiins is projected to contract, particularly along the southern border of the Ceded Territories.

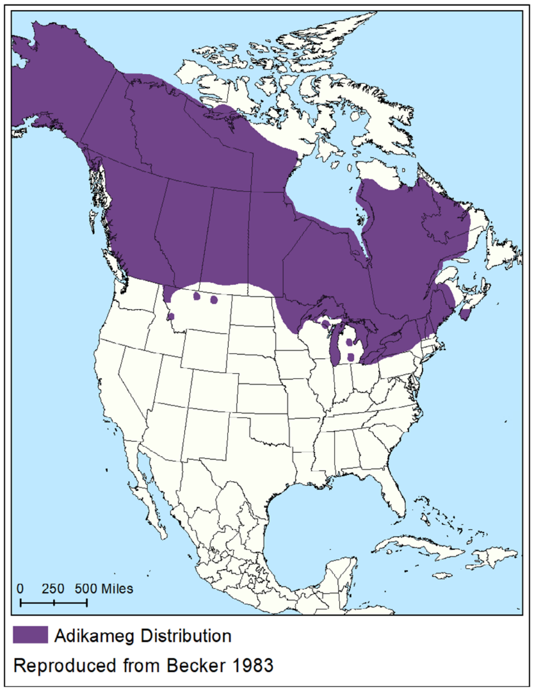
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

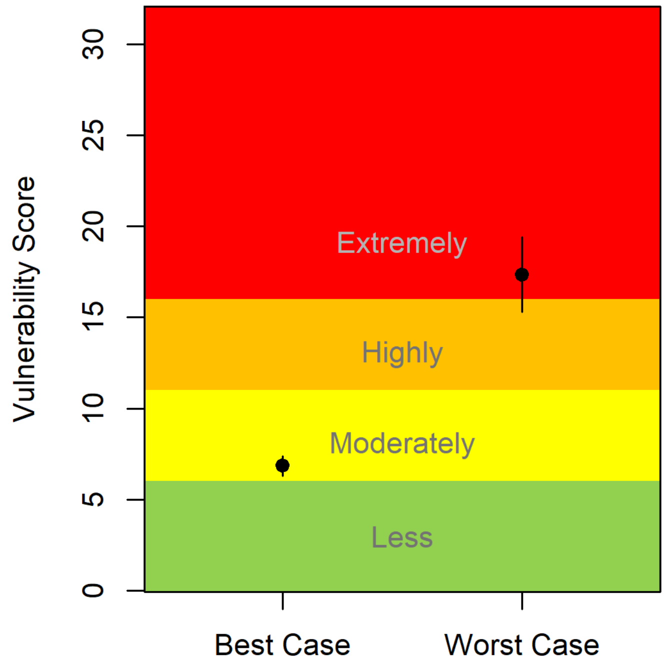
Adikameg

Adikamegwag (plural) / Lake whitefish / *Coregonus clupeaformis*

Moderately – Extremely Vulnerable
(Confidence Level: Moderate)



Range map of adikameg.



Climate change vulnerability scores for adikameg on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

The Fish Clan (which includes adikameg) is part of the Ojibwe clan system and those who belong to it are known to be sky watchers that hold knowledge of all that is in the sky, such as the sun, stars, and moon, as well as knowledge about the connections between the earth and the sky. Members of other clans also sometimes hold that same knowledge today.

The Ojibwe follow a lunar calendar (the Thirteen Moons) and the various months directly correlate with weather or harvesting time of certain beings. Gashkadino-giizis (Freezing Over Moon) is also referred to by some Ojibwe as Adikomemi-giizis (Whitefish Moon). This is around November when adikamegwag are known to spawn. The importance and presence of adikameg in the Ceded Territories is also evident in various Ojibwe place names including Adikameg-baapi-neyaashi (Laughing Whitefish Point), Adikamegong-wiikwedong (Plenty of Whitefish Bay), Adikamegong-ziibi (Whitefish-Bay River), and Adikamegosi-zaaga'igan (Whitefish Lake).

Adikameg is found in some inland lakes and rivers throughout the Ceded Territories but is most abundant in Lake Superior. Adikamegwag are important to Anishinaabe commercial fishers and are also harvested by individuals and families for subsistence. Adikamegwag spawn in the fall (late October – mid November) over gravel and small stones at a water depth of 6.5 - 59 feet, when the water temperature is approximately 40-43°F. Eggs hatch the following year in March or early April, and larvae consume plankton over inshore reefs. Juvenile adikamegwag disperse to shallow protected bays (the littoral zone) in the first year and begin to feed on amphipods (pontoporeia), the mainstay of their diet as juveniles and adults. Little is known about where juvenile adikamegwag can be found once they disperse from shallow bays. Adult adikamegwag are typically found in deeper water (median of ~90 feet) and reach maturity in 7-9 years. While pontoporeia makes up a significant portion of their diet, adults will also consume mollusks (e.g., pelecypods), invertebrates (e.g., Diptera larvae and pupae), and occasionally giigoonh (fish (e.g., sticklebacks)).

Adikameg populations declined in the mid-1900s due to overfishing and the introduction of sea lamprey into Lake Superior. Commercial yield of adikameg has increased since the 1960s in Lake Superior, which can be partially attributed to suppression of sea lamprey populations. In recent years, commercial yield and kilograms of giigoonh per kilometer of net has decreased but is still within acceptable levels of 65-136 kg per km. Overall, the population of adikameg in Lake Superior appears to be declining but is within an acceptable range, while in inland water bodies there is little information on adikameg populations.

Adikameg is known as one of the first foods, which have helped to sustain the Anishinaabeg of the Great Lakes region since time immemorial. Adikameg is most often smoked and is known as “candied fish” by many elders. Adikameg is also commonly used in soups, stews, and “fish pies.” Occasionally, a dish is made with smoked adikameg powder and fresh blueberries.

Although adikameg was mentioned infrequently in interviews, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. Interviewees from Odaawaa-zaaga'iganiing (Lac Courte Oreilles) mentioned that adikameg is a bottom feeder and extremely sensitive to changes in water temperature, particularly to warming. Along with odoonibiins (tullibee), it is among the first fish to be affected by changes in water temperature and clarity. Interviewees also shared that adikamegwag are known to run twice a year, in the late spring and early fall when the lower waters are cooler. Fall is also when they lay their eggs. Interviewees were concerned that adikameg is hypersensitive to algae blooms, which have the potential to cause large fish kills. One interviewee recalled a fish kill in Lake Winnie (Winnibigoshish) one year where many adikamegwag and odoonibiinsag were found scattered along the shore. They believe it was a warm year and the rise in water temperatures contributed to their deaths.

Summary of climate threats:

Adikameg was in the 80th percentile relative to other swimmers and in the 85th percentile relative to other beings in the vulnerability assessment. Factors that increased the vulnerability of adikameg to climate change include: natural barriers (e.g., low-oxygen zones), thermal niche (loss of coolwater habitat, more variable weather during fall spawning), hydrological niche (e.g., droughts), disturbance regime (extreme weather may affect egg survival), dependence on ice (less ice cover can reduce egg survival), uncommon landscape features (adults are restricted to specific spawning reefs), sensitivity to natural enemies (mortality associated with sea lamprey attacks may increase), competition (exotic mussels consume prey resources), and low genetic variation.

Factors that increase the vulnerability of adikameg to climate change:

N/SI <u>Natural barriers</u>: Low-oxygen barriers near the lake bottom might inhibit movements in inland water bodies but are less likely to be an issue in Lake Superior.

SI/I <u>Physiological thermal niche</u>: More variable water temperature in the fall and spring may negatively impact spawning and egg survival, particularly in inland waterbodies. Warmer surface waters could also limit available habitat for adikameg, particularly in the summer for inland water bodies. Thermal habitat in Lake Superior will increase as the climate changes. Adikameg is of the few swimmers to lay its eggs in the fall because of sensitivity to warmer waters.

SI <u>Disturbance regime</u>: The frequency and intensity of storms are predicted to increase as the climate changes. High winds and an increase in wave action associated with these storms in the fall and winter have the potential to cause physical and potentially fatal trauma to eggs, thereby limiting recruitment of future year classes.

SI

<u>Dependence on snow or ice</u>: Ice can reduce wind and wave action associated with storms, often resulting in higher recruitment. A decrease in ice cover might cause higher mortality of eggs in fall and winter.

SI

<u>Uncommon landscape features</u>: Adikamegwag form discreet stocks and adults are restricted to specific reefs for spawning.

I

<u>Pathogens or natural enemies</u>: White sucker mortality rates increase when sea lamprey feed on them at elevated temperatures. Similarly, adikamegwag attacked by sea lamprey might experience higher mortality rates as water temperature increases in the future. In addition, rainbow smelt prey heavily upon adikameg eggs, but it is unclear if this being will consume more eggs as the climate changes.

SI

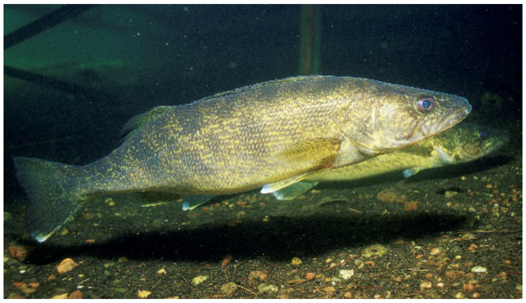
<u>Competition</u>: Zebra and quagga mussels compete with adikameg for food. For example, in Lake Michigan, diporeaia, the main food source for adikameg, decreased after zebra mussels were introduced. Zebra and quagga mussels are predicted to be favored by climate change.

SI

<u>Genetic variation</u>: Adikameg has low genetic variation in the Ceded Territories relative to populations in other regions.

Legend

GI **Greatly Increase** This factor greatly increases vulnerability	I/GI **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I **Increase** This factor increases vulnerability
SI/I **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI **Somewhat Increase** This factor somewhat increases vulnerability	N/SI **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

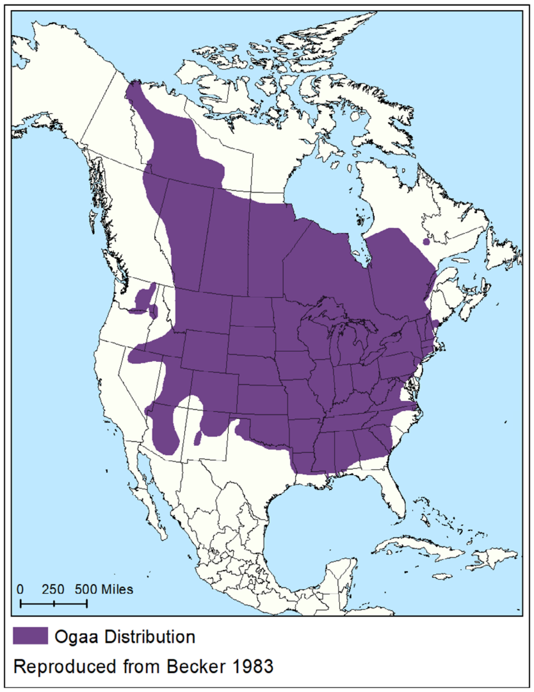


Ogaa

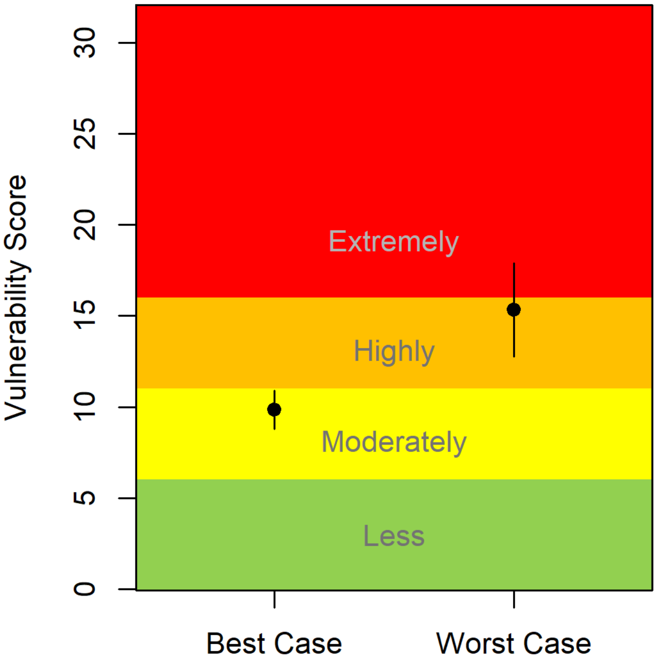
Ogaawag (plural) / Walleye / *Sander vitreus*

Moderately - Highly Vulnerable

(Confidence level: High)



Range map of ogaa.



Climate change vulnerability scores for ogaa on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Like many of the swimmers, ogaa is highly respected in Ojibwe culture. Ogaa is featured prominently in many traditional stories and personal memories which illustrates how Ojibwe people have depended on fishing as a means of survival. In a historical interview from 1992, Misi-zaaga'iganiing (Mille Lacs) tribal member Doug Sam emphasized how his people have relied on ogaa and other swimmers for their subsistence needs:

> "We used to go out here [Misi-zaaga'iganiing]… used to have big barrels full of salted fish to last all winter... and early spring there you go put a little tepee out there and get a golden northern or a walleye. That was your meal. You didn't get a whole bunch. You just got what you needed for... it was a good life."

A tribal member from Gaa-miskwaabikaang (Red Cliff) remembered her mother from Mashkiiziibiing (Bad River) describing how the frogs would make noise to indicate the start of the ogaa season. Traditional stories of ogaa also depict its interconnectedness with other beings and the night sky. One story tells of a time when Wenaboozhoo was unable to cross the great river. He asked ogaa for his help and in return he promised to paint on ogaa so that it would be remembered where ogaa comes from. Ogaa agreed so Wenaboozhoo got on the back of ogaa who carried him across to the other side of the great river. As promised once they arrived Wenaboozhoo reached into the sky to grab stars and used them to paint on the skin of ogaa. The beautiful markings that ogaa now has are to serve as a reminder that ogaa comes from the stars.

Ogaa spearing was the focus of protests by non-Indians during the “Walleye Wars” of the late 1980s. Those opposed to tribal members spearing ogaa held protests at boat landings on Ceded Territory lakes objecting to tribal treaty harvest.

These protests, which sometimes turned violent, came after the landmark decision in *Lac Courte Oreilles v. Wisconsin*, which reaffirmed the Ojibwe people’s treaty-reserved rights to hunt, fish, and gather off-reservation in those portions of the Ceded Territories located in Wisconsin. To this day, tribal members still continue to be harassed and occasionally shot at or physically assaulted, for practicing their lifeways and exercising their treaty rights to spear ogaa.

The Fish Clan (which includes ogaa) is part of the Ojibwe clan system and those who belong to it are known to be sky watchers that hold knowledge of all that is in the sky, such as the sun, stars, and moon, connecting the earth to the sky. However, members of other clans also sometimes hold that same knowledge today.

Ogaa is found in many lakes and rivers throughout the Ceded Territories and is commonly harvested by tribal members and recreational anglers. Ogaa gains a competitive advantage over other beings in turbid or stained, low-light waterbodies with limited plant growth. It typically spawns at night in early spring, shortly after ice-out over shallow (<6 feet) gravel and/or cobble bars. Young ogaawag commonly move offshore into the pelagic zone after gaining the ability to swim. Juvenile and adult ogaawag tend to use deeper, darker water during the day and move into the nearshore environment (littoral zone) at night to feed. Various place names in the Ojibwe language demonstrate the presence and importance of ogaa throughout the Ceded Territories. Examples are Ogaans- ziibi (Little Walleye River), Ogaakaagaang-ziibii (Full of Walleyed Pike River), and Ogaans-wiikwedong (Little Walleye Bay).

The ogaa population has declined in many waterbodies throughout the Ceded Territories in recent years. For example, ogaa in Lac Vieux Desert Lake has declined from a high of ~3 adult fish/acre in 1998 to approximately 0.5 fish/acre in 2016, an amount quite low relative to other Ceded Territory lakes (average 2.5 fish/acre). Similarly, ogaa in Mille Lacs Lake declined by approximately 90,000 pounds per year between 1998 (biomass ~2.5 million pounds) and 2016 (biomass ~0.89 million pounds). Ogaa stocks are predicted to decline in many other lakes throughout the Ceded Territories.

Tribal members frequently mentioned ogaa during interviews and shared that they are seeing a decrease in the population in most of the lakes where ogaa are present. Current pollution and the potential for future contamination have been consistently mentioned as concerns. One tribal member from Misi-zaaga'iganiing voiced concern about the change in color of some ogaa, noting that some are darker grey and, during processing, the meat won’t separate from the skin and tends to shrink to one-third of the size. Another consistent observation and concern noted during interviews is that cooler ogaa-dominated lakes are getting warmer.

Summary of climate threats:

Ogaa was in the 90th percentile relative to other swimmers and in the 87th percentile relative to other beings in the vulnerability assessment. Factors that increased the vulnerability of ogaa to climate change include: natural and anthropogenic barriers (e.g., connectivity of inland lakes, dams), thermal niche (loss of coolwater habitat), hydrological niche (e.g., droughts), disturbance regime (more intense floods), dietary versatility (availability of specific prey items), sensitivity to competition (ogaa competes with bass species), sensitivity to pathogens (i.e., more susceptible to infections and parasites) and documented (e.g., decline in abundance) and predicted response (e.g., range contraction) to climate change.

Ogaawag are stocked in waters throughout the Ceded Territories (i.e., fish populations are supported by human intervention/aquaculture). In the short term, this strategy may resist the effects of climate change by maintaining artificially high population levels. In the long term, stocking ogaa has the potential to increase vulnerability scores for several factors in the Climate Change Vulnerability Index. These factors include dispersal and movement, physiological thermal niche, dietary versatility, sensitivity to pathogens and natural enemies, sensitivity to competition, interspecific interactions, measured genetic diversity, and phenological response to climate change. Collectively, these factors may increase the overall vulnerability scores for ogaa in stocked waterbodies.

Factors that increase the vulnerability of ogaa to climate change:

SI — Natural barriers: Limited connectivity of inland lakes will reduce the ability of ogaa to move to suitable habitat as the climate changes. Moreover, migration routes such as shallow waterways have the potential to warm faster than lakes, creating a barrier for this coolwater being. Conversely, an increase in frequency and intensity of extreme weather and precipitation events has the potential to create new migration routes between waterbodies. Natural barriers are likely to impede ogaa dispersal as the climate changes, but some dispersal will still occur through river systems.

N/SI — Anthropogenic barriers: Barriers such as dams and road crossings can impede movements of ogaa in rivers and are likely to impede ogaa dispersal to a limited extent as the climate changes. Ogaa in lakes are less affected by this factor as few anthropogenic barriers exist in lakes.

SI — Physiological thermal niche: Thermal niche for ogaa, a coolwater being, depends on the life stage. For eggs, the optimum temperature is 48-59°F, with high mortality occurring when temperatures remain below 42°F or above 66°F for extended periods. Optimal temperature for growth of fry (young fish capable of feeding themselves) is 59°F, and no growth occurs at temperatures below 50°F or above 68°F (upper lethal temperature is 70°F; lower lethal temperature is 42°F). Optimal temperature for growth of juvenile ogaa (young fish that have developed scales and working fins) is approximately 70-77°F, with no growth occurring at temperatures below 54°F or above 84°F. For adult fish (capable of reproducing), optimum temperature is approximately 64-72°F with performance decreasing at 79°F and lethal temperatures at 84-93°F (lower lethal limit is not defined). Water temperature is predicted to increase as the climate changes, potentially reducing thermal habitat for ogaa by 10-40% and resulting in negative consequences for growth and survival of this being.

N/SI — Disturbance regime: An increase in the intensity and frequency of extreme precipitation events might decrease ogaa recruitment in some lakes and rivers.

N/SI — Dietary versatility: Ogaa diet is flexible across life stages, but due to its small mouth (i.e., gape limitation), newly hatched ogaa typically consume zooplankton. It is possible that this prey item might not be available as the climate changes, thereby limiting food for this life stage.

SI — Competition: Ogaa's sensitivity to competition depends on the fish community in the individual waterbody. Ogaa is likely to experience more competition in lakes and rivers containing ashigan (largemouth bass) and noosa'owesi (small mouth bass), a situation likely to be exacerbated as the climate changes because these beings perform better at elevated temperatures.

SI — Documented response to climate change: Distribution and abundance of ogaa has been declining in recent decades and has been correlated with environmental conditions associated with climate change (e.g., growing degree days, water clarity).

I — Modeled future range: The number of lakes that support naturally reproducing stocks of ogaa is predicted to decrease by 65% in Wisconsin. A similar decline will likely occur in lakes throughout the Ceded Territories.

SI

Overlap of future and current range: It is predicted that only 35% of the lakes that currently support naturally reproducing stocks of ogaa will do so by 2050.

I

Occurrence of protected areas in future range: Less than 5% of ogaa habitat in the Ceded Territories is predicted to be in a protected area by 2050.

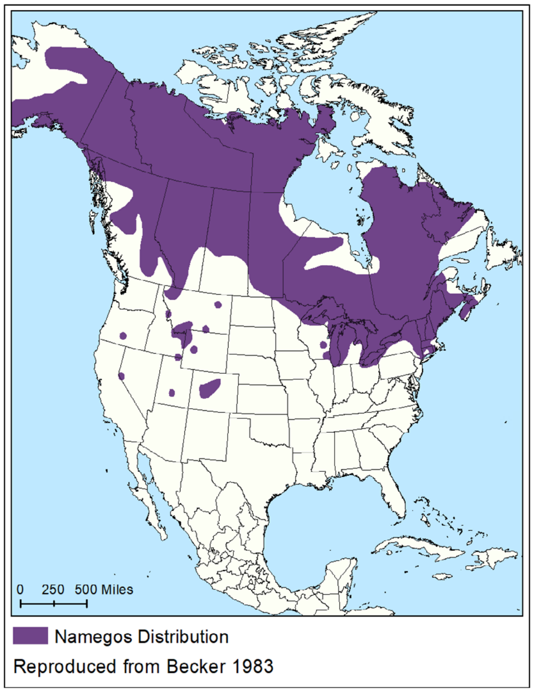
Legend

GI	**Greatly Increase**	This factor greatly increases vulnerability
I/GI	**Increase/Greatly Increase**	This factor may increase or greatly increase vulnerability
I	**Increase**	This factor increases vulnerability
SI/I	**Somewhat Increase/Increase**	This factor may somewhat increase or increase vulnerability
SI	**Somewhat Increase**	This factor somewhat increases vulnerability
N/SI	**Neutral/Somewhat Increase**	This factor may not increase or may somewhat increase vulnerability

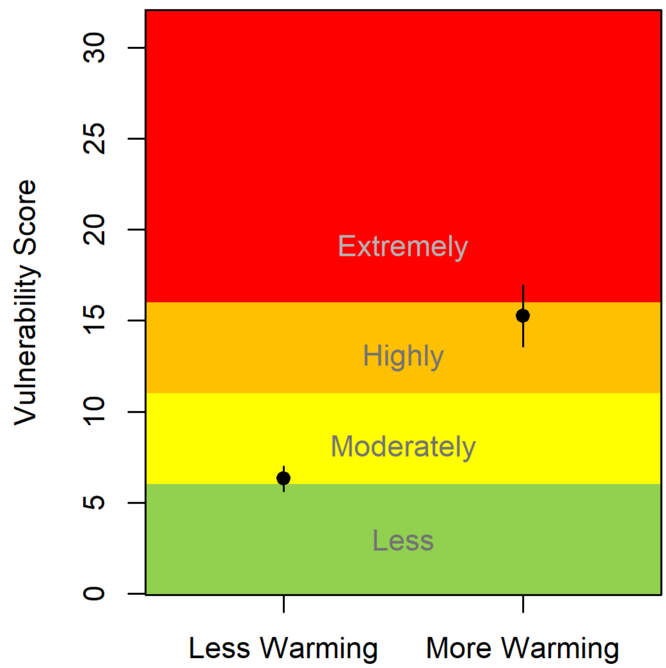
Namegos

Namegosag (plural) / Lake trout / *Salvelinus namaycush*

Moderately – Extremely Vulnerable
(Confidence Level: Moderate)



Range map of namegos.



Climate change vulnerability scores for namegos on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each warming scenario.

General Description:

Namegos is known as a culturally significant being to the Ojibwe people. The Fish Clan (which includes namegos) is part of the Ojibwe clan system and those who belong to it are known to be sky watchers that hold knowledge of all that is in the sky, such as the sun, stars, and moon, connecting the earth to the sky. However, members of other clans also sometimes hold that same knowledge today.

Namegos is found in Lake Superior and some deep inland lakes throughout the Ceded Territories, often preferring clear, cold, infertile waterbodies. It is harvested by Anishinaabe people and is considered a highly prized sportfish among recreational anglers. Namegos spawns in the fall (mid-October to December; 46-51.9°F) at water depths of inches to 90 feet over low-sediment rocky bars. Young namegosag feed primarily on opossum shrimp (mysis), but also consume insects and small fish. As namegos grows larger, fish (e.g., ciscos and smelt) become an important part of its diet.

The namegos population collapsed in the early to mid-1900s and was effectively extirpated from the Great Lakes except for Lake Superior. Predation by non-native sea lamprey further reduced populations in the mid-1900s. Stocking programs as well as sea lamprey control have aided recovery of most spawning populations of namegos in Lake Superior, but some populations have declined. For example, in management unit WI-2 (North of Ashland, WI), relative abundance nearly doubled from 0.69 adult fish per kilometer of net in 1980 to 1.16 fish per kilometer of net in 2015. Conversely, in management unit MI-2 (Northeast of the Michigan/Wisconsin border), relative abundance has declined from approximately 1.83 fish per kilometer of net in 1980 to 0.64 fish per kilometer of net in 2015. Namegos rarely occurs in inland waterbodies, but the two well-known inland namegos lakes, Black Oak and Trout Lake (Vilas County, Wisconsin), have experienced declines or no recruitment in recent years. This has spurred management agencies to initiate stocking in both of these lakes. Overall, most namegos populations appear to be stable or increasing in Lake Superior but declining in inland Ceded Territory lakes.

Namegos was mentioned infrequently in interviews, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. A few tribal members mentioned specific place names related to namegos, some connecting to a story from a specific area, and some relating to the presence of namegos in a specific waterbody. One example is Gaa-namegosikaang (place of namegos), which is also known as Chicagon Lake (Iron County, Michigan).

Summary of climate threats:

Namegos was in the 70th percentile relative to other swimmers in the vulnerability assessment and in the 79th percentile relative to other beings in the assessment. The following factors increased its vulnerability to climate change: natural and anthropogenic barriers (e.g., low oxygen zones, effluent), thermal niche (loss of coolwater habitat), hydrological niche (less precipitation), disturbance regime (wind and waves can damage eggs), restriction to uncommon landscapes (spawns on shallow, rocky bars), sensitivity to natural enemies (susceptible to sea lamprey attacks), competition (noosa'owesi [smallmouth bass] might outcompete namegos for food), and a loss of genetic variation.

Namegosag are stocked in waters throughout the Ceded Territories (i.e., fish populations are supported by human intervention/aquaculture). In the short term, this strategy may resist the effects of climate change by maintaining artificially high population levels. In the long term, stocking namegos has the potential to increase vulnerability scores for several factors in the Climate Change Vulnerability Index. These factors include dispersal and movement, physiological thermal niche, dietary versatility, sensitivity to pathogens and natural enemies, sensitivity to competition, interspecific interactions, measured genetic diversity, and phenological response to climate change. Collectively, these factors may increase the overall vulnerability scores for namegos in stocked waterbodies.

Factors that increase the vulnerability of namegos to climate change:

N/SI <u>Natural barriers</u>: Low dissolved oxygen concentrations may limit dispersal/vertical movements in inland waterbodies but might not be barrier to dispersal in Lake Superior.

N/SI <u>Anthropogenic barriers</u>: Changes in the watershed (e.g., effluent from septic systems) can result in eutrophication and low-oxygen zones. These zones might act as barriers to dispersal.

SI <u>Physiological thermal niche</u>: Lean and siscowet namegos are considered coldwater fish with a preferred temperature of 50°F and 39.2°F, respectively. As water temperature increases, both types of namegos are expected to seek deeper, cooler habitats. Most recent analyses indicate lean namegosag have experienced an increase in preferred thermal habitat of 6 days, while siscowet namegosag have experienced a loss in preferred thermal habitat of 3 days.

SI <u>Disturbance regime</u>: The intensity and frequency of severe weather is predicted to increase in the future. Wind and wave action associated with severe weather might damage or displace eggs on relatively shallow reefs.

SI <u>Uncommon landscape features</u>: Namegos is restricted to spawning on shallow rocky bars that have little silt. Loss of these spawning reefs could negatively affect reproduction and recruitment.

I <u>Pathogens or natural enemies</u>: The introduction of sea lamprey into the Great Lakes resulted in a decrease in namegos populations. White sucker mortality rates increase when sea lamprey feed on them at elevated temperatures. Similarly, namegosag that are hosts to sea lamprey might experience higher mortality rates as water temperature increases in the future.

SI Competition: Introduced Pacific salmon and steelhead, and noosa'owesi compete for food resources with namegos. Noosa'owesi, a warmwater being, is predicted to be favored under future environmental conditions.

SI Genetic variation: A substantial loss of genetic diversity occurred when many populations of namegos were extirpated or severely depressed in the mid-1900s.

Legend

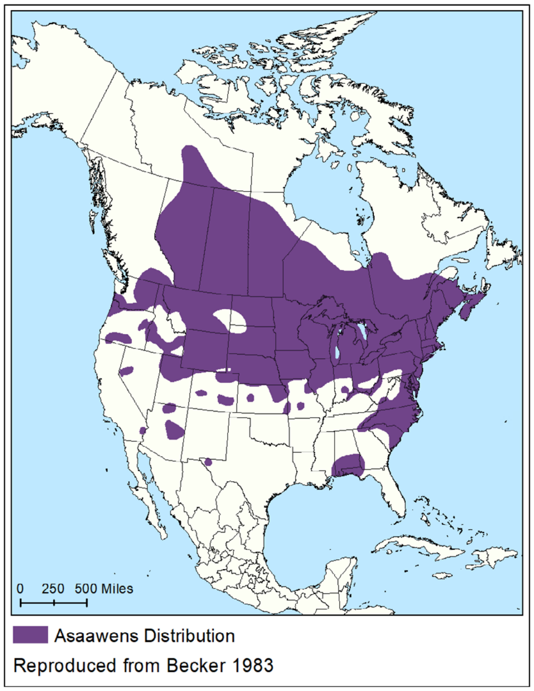
GI **Greatly Increase** This factor greatly increases vulnerability	I/GI **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I **Increase** This factor increases vulnerability
SI/I **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI **Somewhat Increase** This factor somewhat increases vulnerability	N/SI **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Asaawens

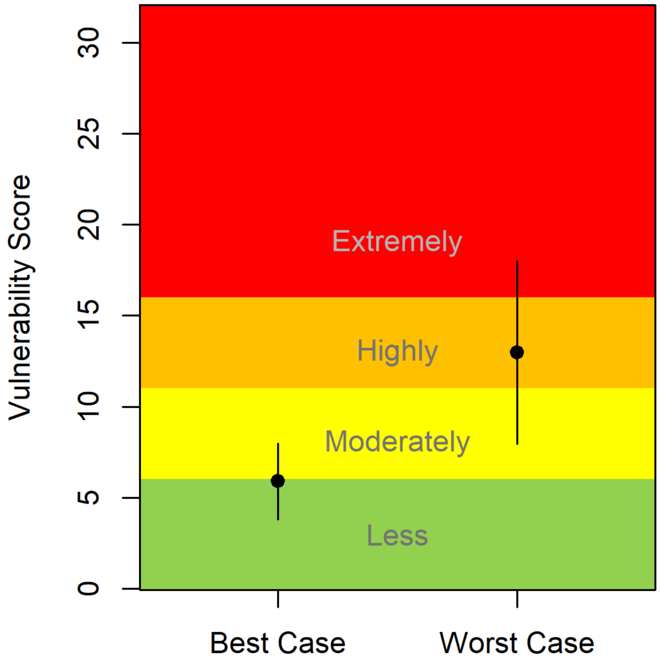
Asaawensag (plural) / Yellow perch / *Perca flavescens*

Less – Highly Vulnerable

(Confidence Level: High)



Range map of asaawens.



Climate change vulnerability scores for asaawens on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

The Fish Clan (which includes asaawens) is part of the Ojibwe clan system and those who belong to it are known to be sky watchers that hold knowledge of all that is in the sky, such as the sun, stars, and moon, connecting the earth to the sky. However, members of other clans also sometimes hold that same knowledge today. Some elders have shared that asaawens used to be referred to as “ozaawaa,” which means “it is yellow.”

Asaawens is found in many lakes and rivers throughout the Ceded Territories and is commonly harvested by tribal members. Asaawensag typically spawn at night in early spring (44 – 66°F), shortly after ogaawag (walleye) finish spawning, though Mashkiiziibiing (Bad River) tribal members reported in an interview in 2017 that they are now seeing both beings spawning at the same time. Females deposit their eggs on aquatic vegetation or structure (e.g., woody debris) in shallow (2-10 feet) slow-moving or static water and provide no parental care. Larval asaawensag commonly move into the upper 3 – 4 feet of the water column for 3 to 4 weeks. When fish reach an inch in length, they descend from the upper layers of the lake to the bottom. Young asaawensag are found in shallow, vegetated habitats and larger, older fish are in deep, open water environments. Initially, young fish feed on copepods and cladocera, and transition to large invertebrates (e.g., diptera) as they grow larger. Adult asaawensag will feed on fish and invertebrates.

The asaawens population has declined in some water bodies throughout the Ceded Territories in recent years, which could limit the amount of food available for apex predators (e.g., ogaa). Monitoring asaawens populations in inland water bodies rarely occurs, with the exception of a long-term dataset for Mille Lacs Lake. Gill nets have been set in this lake in the fall to assess relative abundance of small, forage fish, and large fish (sampled from 1986 to 2017). Young asaawensag (age-0, age-1, and age-2) have gone through boom-and-bust cycles every 3-4 years from 2010 to 2017. Overall, the population of young asaawensag appears to be neither increasing nor decreasing over time. Similarly, adult asaawensag have gone through similar cycles every 3-4 years from 1983 to 2017, with a high of over 150 fish/net in 1998 to a low of approximately 25 fish/net in 2013. Since 2013, less than 50 adult asaawensag have been captured per net and large pulses of adult asaawensag are occurring less frequently. In Wisconsin waters, the average and maximum length of asaawens has decreased over time (1944-2012) likely due to harvest regulations and changes in environmental conditions. Overall, more monitoring of asaawens populations is needed to understand if climate change is influencing the population of this being in the Ceded Territories.

Asaawens is one of the beings for which little Traditional Ecological Knowledge was shared during interviews; however, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. Tribal members did share concern over the size and catch numbers of asaawens. A decline in asaawens was discussed during interviews at Zaka'aaganing (Mole Lake), Misi-zaaga'iganiing (Mille Lacs), and Gaa-miskwaabikaang (Red Cliff). A concern over a decrease in their size was noted during an interview with an elder in Ginoozhekaaning (Bay Mills). A tribal member from Mashkiiziibiing recalled jumbo runs of asaawens in the past but doesn't see that happening anymore. She felt that noosa'owesi (smallmouth bass) sport fishing regulations in Wisconsin could be contributing to increased bass numbers and an increase in predation on asaawens and ogaa eggs by juvenile noosa'owesi. She also shared that her 90-year-old grandma was still fishing and had concerns over seeing white perch, a bakaan ingoji gaa-ondaadag (non-local being) which she had never seen before.

Summary of climate threats:

Asaawens was in the 60th percentile relative to other swimmers and in the 71st percentile relative to other beings in the vulnerability assessment. Factors that increased the vulnerability of asaawens to climate change include: anthropogenic barriers (e.g., connectivity of inland lakes, dams), thermal niche (loss of coolwater habitat), hydrological niche (e.g., droughts), disturbance regime (droughts), dependence on snow or ice (influence water temperature and spawning), dietary versatility (zooplankton main food for recently hatched asaawens), sensitivity to competition (asaawens competes with bass species), sensitivity to pathogens (i.e., more susceptible to infections and parasites), genetic variation (low relative to other beings), and phenological response (early end to winter might create a mismatch).

Asaawensag are stocked in waters throughout the Ceded Territories (i.e., fish populations are supported by human intervention/aquaculture). In the short term, this strategy may resist the effects of climate change by maintaining artificially high population levels. In the long term, stocking asaawens has the potential to increase vulnerability scores for several factors in the Climate Change Vulnerability Index. These factors include dispersal and movement, physiological thermal niche, dietary versatility, sensitivity to pathogens and natural enemies, sensitivity to competition, interspecific interactions, measured genetic diversity, and phenological response to climate change. Collectively, these factors may increase the overall vulnerability scores for asaawens in stocked waterbodies.

Factors that increase the vulnerability of asaawens to climate change:

N/SI Anthropogenic barriers: High and low head dams are barriers to dispersal.

SI Physiological thermal niche: Asaawens is somewhat restricted to relatively cool environments that might be lost or reduced in the Ceded Territories as the climate changes. Specifically, avoidance, preferred, lethal, and optimum temperatures have been defined for asaawens across a range of life stages, acclimation temperatures, and seasons. Below are the reported optimum temperatures for each life stage: spawning 46.5 – 53.5°F, incubation 50 – 70°F, young of the year 84.2°F, juvenile 68 – 74°F, and adult 63.5 – 68°F.

SI

<u>Physiological hydrological niche</u>: Asaawensag deposit their eggs in vegetated wetland habitats. More frequent and extreme precipitation events or a lack of precipitation might reduce wetland habitat needed for spawning.

N/SI

<u>Disturbance regime</u>: Severe droughts can reduce shallow water habitats used by several life stages (spawning/eggs, juveniles).

N/SI

<u>Dependence on snow or ice</u>: The amount of snow and ice can influence water temperatures and lake levels in the spring. This, in turn, can influence the timing of spawning for asaawens and hatching of prey items (e.g., zooplankton/insect). Climate change might alter the amount of snow and ice each year, which could influence the timing of spawning and hatching of asaawens and its prey.

N/SI

<u>Dietary versatility</u>: Newly hatched asaawensag consume only zooplankton, which can be an issue in water bodies where this prey item is scarce (some oligotrophic lakes and water bodies with zebra and quagga mussels). Juvenile and adult asaawensag consume a variety of invertebrates and older fish consume both invertebrates and fish.

N/SI

<u>Pathogens or natural enemies</u>: An increase in abundance of ashigan (largemouth bass) might negatively affect asaawens populations. Pathogens exist but pathogen responses to climate change are unknown as well as how asaawens will respond to those pathogens.

N/SI

<u>Competition</u>: Climate change might favor warm water beings (e.g., ashigan) that could compete with asaawens for food. In Lake Superior, warm water might favor alewife (a bakaan ingoji gaa-ondaadag), which can negatively affect asaawens recruitment.

SI

<u>Genetic variation</u>: Genetic variation is reported to be low for asaawens relative to other beings in the Ceded Territories, which might limit its ability to respond to changes in the climate.

SI

<u>Phenological response</u>: Asaawens spawning did not fully adjust when winter ended early, increasing the possibility of a mismatch between food resources for recently hatched fish.

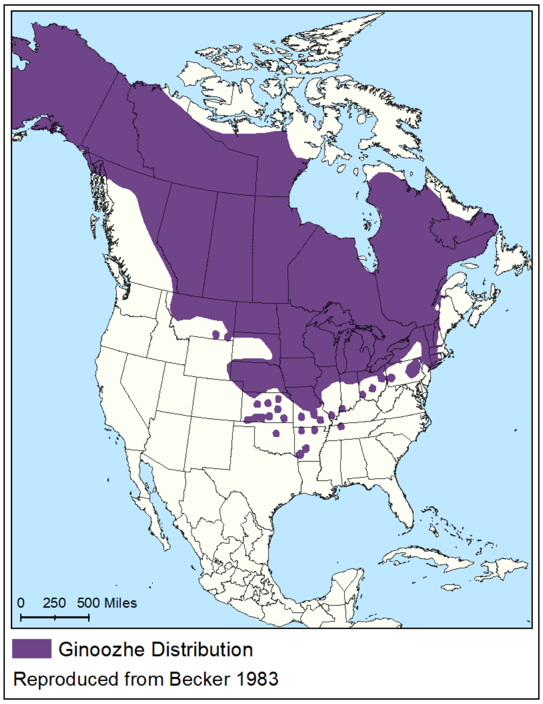
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

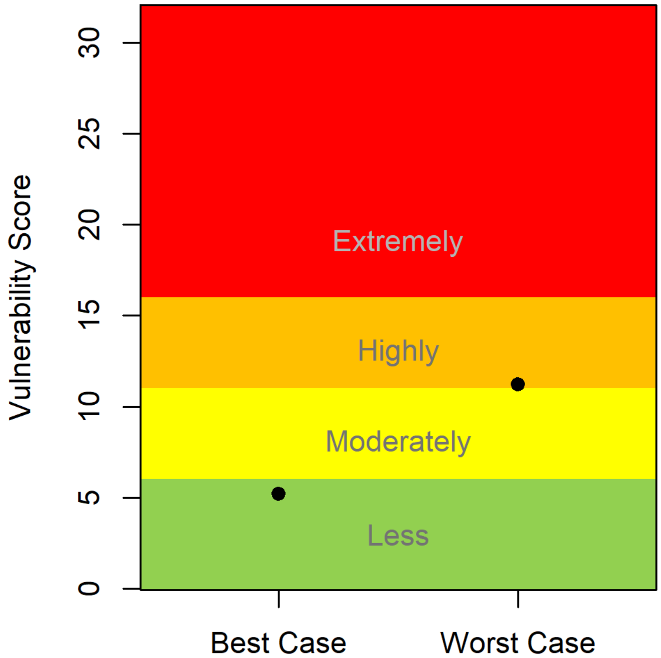
Ginoozhe

Ginoozheg (plural) / Northern pike / *Esox lucius*

Less - Highly Vulnerable
(Confidence Level: Moderate)



Range map of ginoozhe.



Vulnerability of ginoozhe on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score. No error bars exist for this being because there was no variability in its scores.

General Description:

Ginoozhe is not as commonly harvested as other fish beings such as ogaa (walleye). The Fish Clan (which includes namegos) is part of the Ojibwe clan system and those who belong to it are known to be sky watchers that hold knowledge of all that is in the sky, such as the sun, stars, and moon, connecting the earth to the sky. Members of other clans also sometimes hold that same knowledge today.

Tribal members of Lac du Flambeau have been carving fish decoys for generations, some of which are carved into a ginoozhe. The Ojibwe name for the Bay Mills Indian Community is Ginoozhekaaning, which refers to the place of the pike. Ginoozhe is also the main subject of many Anishinaabe dibaajimowinan (stories) told around the Great Lakes as well as other areas such as the Lac La Croix First Nation of Ontario, Canada, where the creation of ginoozhe is said to have occurred near the reserve at Pictured Rocks.

Ginoozhe lives in lakes and rivers throughout the Ceded Territories and is harvested by Anishinaabe and state anglers. Ginoozhe spawns over flooded vegetation (e.g., wetlands) in early spring, shortly after ice-out. Young ginoozheg avoid predators by seeking shelter in vegetated habitat. Adult ginoozheg prefer similar habitats so they can ambush prey from cover. The population of ginoozhe is unknown in most waterbodies in the Ceded Territories, but it is believed to be stable. In the well-studied Mille Lacs Lake, the population of ginoozhe, on average, has increased by approximately 12,500 fish per year between 1993 and 2006.

Ginoozhe was mentioned infrequently in interviews, however, all beings are of equal importance to the Ojibwe people based on the cultural belief in the original treaties with all of creation. Some tribal members mentioned ginoozhe in the context of climate change during their interviews. One member from Bikoganoogan (St. Croix) indicated that food web interactions might be altered as the climate changes, with a specific reference to the timing of ginoozhe spawning influencing other beings. A Misi-zaaga'iganiing (Mille Lacs) band member indicated that ginoozhe populations have increased in Mille Lacs Lake, but this increase may not be directly related to climate change. There was also concern expressed about ginoozheg containing carcinogens and mercury.

Summary of climate threats:

Ginoozhe was in the 50th percentile relative to other swimmers and in the 62nd percentile relative to other beings in the assessment. The following factors increased its vulnerability to climate change: natural and anthropogenic barriers (e.g., connectivity of inland lakes, roads), hydrological niche (e.g., droughts), thermal niche (loss of coolwater habitat), and sensitivity to pathogens (i.e., more susceptible to infections and parasites).

Ginoozheg are stocked in waters throughout the Ceded Territories (i.e., fish populations are supported by human intervention/aquaculture). In the short term, this strategy may resist the effects of climate change by maintaining artificially high population levels. In the long term, stocking ginoozhe has the potential to increase vulnerability scores for several factors in the Climate Change Vulnerability Index. These factors include dispersal and movement, physiological thermal niche, dietary versatility, sensitivity to pathogens and natural enemies, sensitivity to competition, interspecific interactions, measured genetic diversity, and phenological response to climate change. Collectively, these factors may increase the overall vulnerability scores for ginoozhe in stocked waterbodies.

Factors that increase the vulnerability of ginoozhe to climate change:

SI Natural barriers: Limited connectivity of inland lakes will limit the ability of ginoozhe to move to suitable habitat as the climate changes. Moreover, migration routes such as shallow waterways have the potential to warm faster than lakes, thereby creating a barrier for this coolwater being. Conversely, an increase in frequency and intensity of extreme weather and precipitation events has the potential to create new migration routes between waterbodies. Collectively, natural barriers are likely to impede dispersal as the climate changes to a limited extent.

SI Anthropogenic barriers: Barriers such as dams and road crossings can impede movements of ginoozhe in lakes and rivers. These are likely to impede dispersal as the climate changes to a limited extent.

SI Physiological thermal niche: Thermal niche for ginoozhe, a coolwater being, depends on the life stage. For eggs, the optimum temperature has not been defined, but mortality occurs when water temperature drops below 41°F or exceeds 60.8°F. For fry (young fish capable of feeding themselves), optimal temperature for growth and survival is 69.8-78.8°F, with higher mortality occurring at temperatures less than 42.4°F. Upper lethal temperature is not defined for this life stage. Optimal temperature for growth of juvenile ginoozhe (young fish that have developed scales and working fins) is approximately 66.2-69.8°F, with growth ceasing at 82.4°F (lethal limits are not defined). For adult fish (capable of reproducing), optimum temperature is approximately 66.2°F with lethal temperatures between 84.2-86°F (lower lethal limit is not defined). Water temperature is predicted to increase as the climate changes and potentially reduce thermal habitat for ginoozhe by 10-40%. This would have negative consequences for growth and survival of this being.

SI Physiological hydrological niche: Water drawdown or retention can negatively influence wetlands, an important habitat for adult (needed for reproduction) and juvenile ginoozhe in the Ceded Territories.

SI Disturbance regime: More variable precipitation patterns (droughts, floods) might negatively impact wetlands, a key habitat for this being.

SI

Sensitivity to pathogens: Ginoozhe bioaccumulates environmental toxins and is a host to many known parasites (e.g., fungi, protozoa, worms, leaches, mollusks, and crustacea) and pathogens (e.g. lymphosarcoma and esocid herpesvirus-1). As the climate warms, coolwater beings might be crowded into smaller spaces that might increase parasite and pathogen transmission. Warm water temperatures might also force fish and their parasites and pathogens to migrate northwards, thereby acting as a vector for transmission to fish in the receiving waterbody. Extreme weather and elevated water temperature might increase stress in fish, making them more susceptible to pathogens because of reduced immune function. Overall, pathogen and parasite abundance, distribution, and effectiveness will likely increase as the climate changes.

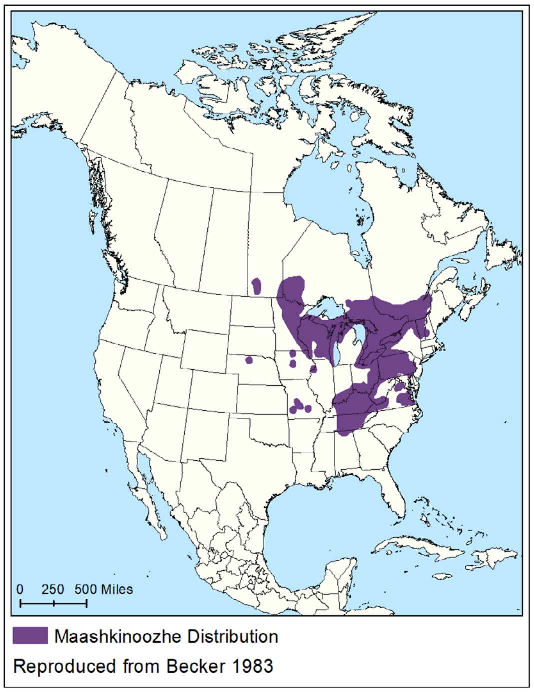
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

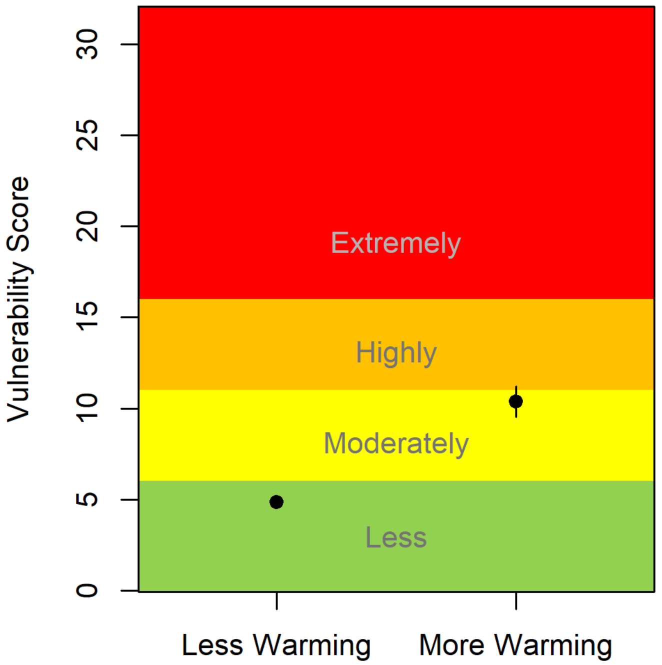
Maashkinoozhe

Maashkinoozheg (plural) / Muskellunge / *Esox masquinongy*

Less - Moderately Vulnerable
(Confidence Level: Moderate)



Range map of maashkinoozhe.



Climate change vulnerability scores for maashkinoozhe on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each warming scenario.

General Description:

The Fish Clan (which includes maashkinoozhe) is part of the Ojibwe clan system and those who belong to it are known to be sky watchers that hold knowledge of all that is in the sky, such as the sun, stars, and moon, connecting the earth to the sky. However, members of other clans also sometimes hold the same knowledge today.

In the Ojibwe language, maashkinoozhe refers to “ugly pike,” which speaks to some of the similar physical features of the maashkinoozhe and a ginoozhe (northern pike). There are various traditional teachings and stories that refer to their connection to each other.

One such story explains an argument between maashkinoozhe and ginoozhe in which they were making fun of each other for their appearances. A zhaangweshi (mink) was going back and forth between the two telling the other what was being said. Eventually they killed each other and the zhaangweshi gathered up all parts of the fish, including their eggs, for a meal. While the fish was cooking, zhaangweshi ate a large amount of eggs before taking a nap. While napping, humans came and took all the cooked fish along with the eggs, replacing the eggs with rocks. Upon waking, zhaangweshi rolled over to eat the last of the eggs but instead broke his teeth when biting down on rocks. This story also speaks to why zhaangweshi appears to have sharp, jagged, broken teeth.

Maashkinoozhe live in lakes and rivers throughout the Ceded Territories and are harvested by Anishinaabe and state anglers. Maashkinoozhe spawn over heavily vegetated shallow (<6 feet) areas (e.g., wetlands) in the spring, returning to the same area every year. Young maashkinoozhe seek shelter in vegetated habitat to avoid predators and to ambush their prey (small fish and invertebrates). Similarly, adult maashkinoozhe prefer similar habitats and clear water so they can ambush prey from cover.

Maashkinoozhe populations have been relatively stable/declining in water bodies in the Ceded Territories, with stocking programs supporting many of these populations. In Big Arbor Vitae Lake (Vilas County, Wisconsin), maashkinoozhe population has declined from a high of 0.59 fish/acre in 2006 to 0.32 fish/acre in 2017, a decrease of 0.02 fish/year. In Kentuck Lake (Vilas and Forest Counties, Wisconsin), the maashkinoozhe population has been relatively stable from 1999 (0.57 fish/acre) to 2017 (0.5 fish/acre), with a small decrease of approximately 0.005 fish per year.

Maashkinoozhe was mentioned in at least eight interviews by tribal members from Bikoganoogan (St. Croix), Waaswaaganing (Lac du Flambeau), Odaawaa-zaaga'iganiing (Lac Courte Oreilles), Misi-zaaga'iganiing (Mille Lacs), Mashkiiziibiing (Bad River), Nagaajiwanaang (Fond du Lac), and Ginoozhekaaning (Bay Mills).

In Odaawaa-zaaga'iganiing, it was said that the higher levels of mercury and other carcinogens in maashkinoozhe is believed to be due to their higher position in the food chain, which was mentioned as a strong concern. Several interviewees suggested, however, that other fish lower on the food chain are more likely to be impacted by changes in water clarity before maashkinoozhe.

The information provided in Waaswaaganing spoke to the same concern; specifically, maashkinoozhe and ogaa (walleye) are no longer present in Haskell Lake, which is believed to be a direct result of contamination. In both Ginoozhekaaning and Nagaajiwanaang, maashkinoozhe is not known to be present, except in the St. Louis River (Nagaajiwanaang).

Increases in population were noted during interviews held in Mashkiiziibiing, Misi-zaaga'iganiing, and Bikoganoogan. Specifically, the upper area of the Bad River is known to have a higher population. The increases in both Misi-zaaga'iganiing and Bone Lake of Bikoganoogan are directly attributed to the stocking of maashkinoozhe. In Misi-zaaga'iganiing, a tribal member expressed that he strongly disagreed with stocking maashkinoozhe along with concerns about tribal members not being able to harvest them.

It was also shared during the interviews that the maashkinoozhe is known to spawn under the ice approximately one month before ginoozhe, but climate change appears to be slightly shifting the timing. When both beings are harvested under the ice, wooden decoys, spears, or nets are commonly used.

Summary of climate threats:

Relative to other swimmers in this vulnerability assessment, maashkinoozhe was in the 40th percentile. Relative to all other beings, maashkinoozhe was in the 60th percentile. Factors that increased maashkinoozhe vulnerability to climate change include natural and anthropogenic barriers (e.g., connectivity of inland lakes, roads), thermal niche (loss of coolwater habitat), hydrological niche (e.g., water drawdown), disturbance regime (e.g., droughts), and sensitivity to pathogens (i.e., more susceptible to infections and parasites).

Maashkinoozheg are stocked in waters throughout the Ceded Territories (i.e., fish populations are supported by human intervention/aquaculture). In the short term, this strategy may resist the effects of climate change by maintaining artificially high population levels. In the long term, stocking maashkinoozhe has the potential to increase vulnerability scores for several factors in the Climate Change Vulnerability Index. These factors include dispersal and movement, physiological thermal niche, dietary versatility, sensitivity to pathogens and natural enemies, sensitivity to competition, interspecific interactions, measured genetic diversity, and phenological response to climate change. Collectively, these factors may increase the overall vulnerability scores for maashkinoozhe in stocked waterbodies.

Factors that increase the vulnerability of maashkinoozhe to climate change:

SI — Natural barriers: Limited connectivity of inland lakes will limit the ability of maashkinoozhe to move to suitable habitat as the climate changes. Moreover, migration routes such as shallow waterways have the potential to warm faster than lakes, thereby creating a barrier for this coolwater being. Conversely, an increase in frequency and intensity of extreme weather and precipitation events has the potential to create new migration routes between waterbodies. Collectively, natural barriers are likely to impede dispersal as the climate changes to a limited extent.

SI — Anthropogenic barriers: Barriers such as dams and road crossings can impede movements of maashkinoozhe in rivers and are likely to impede maashkinoozhe dispersal to a limited extent as the climate changes. Maashkinoozhe are less impacted by anthropogenic barriers in lakes because few exist.

SI — Physiological thermal niche: Thermal niche for maashkinoozhe, a coolwater being, depends on the life stage. For eggs and fry (young fish capable of feeding themselves), the optimum temperature has not been defined, but temperature usually ranges between 46.4-66.2 °F. For fry, critical thermal maximum was 83.8 °F for fish acclimated to 44.6 °F. Both life stages are sensitive to fluctuations in water temperature. Optimal temperature for growth of juvenile maashkinoozhe (young fish that have developed scales and working fins) has not been defined, but the upper lethal limit is approximately 90.1-91.9 °F for fish acclimated to 77-86 °F. Adult fish (capable of reproducing) select a median temperature of 72.5 °F and typically occupy areas between 68-77 °F. Water temperature is predicted to increase as the climate changes and potentially reduce thermal habitat for maashkinoozhe by 10-40%. This would have negative consequences for growth and survival of this being.

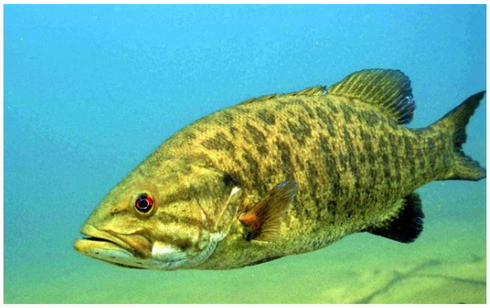
SI — Physiological hydrological niche: Water drawdown or retention can negatively influence wetlands in the Ceded Territories, an important habitat for adult (needed for reproduction) and juvenile maashkinoozhe.

SI — Disturbance regime: More variable precipitation patterns (droughts, floods) might negatively impact wetlands, a key habitat for this being.

N/SI — Sensitivity to pathogens: Disease and pathogens (e.g., piscirickettsia (musky pox) and viral hemorrhagic septicaemia (VHS)) may become more prevalent in maashkinoozhe as water temperature increases because this coolwater being may be forced into smaller thermal habitats, which can increase disease transmission and elevate stress.

Legend

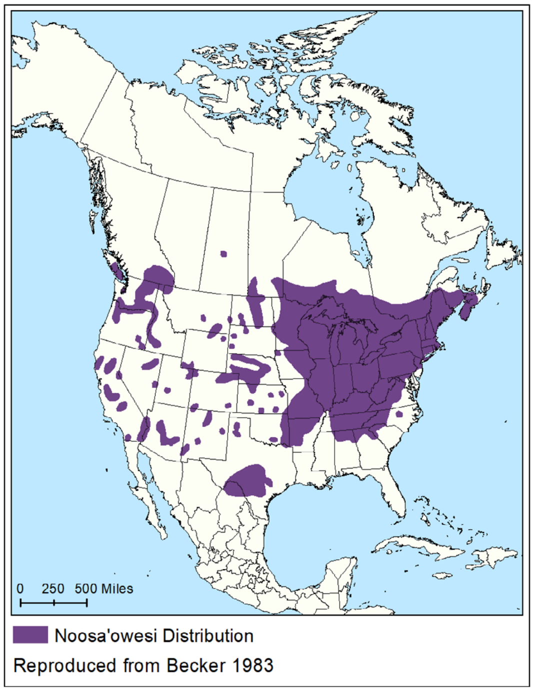
GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability



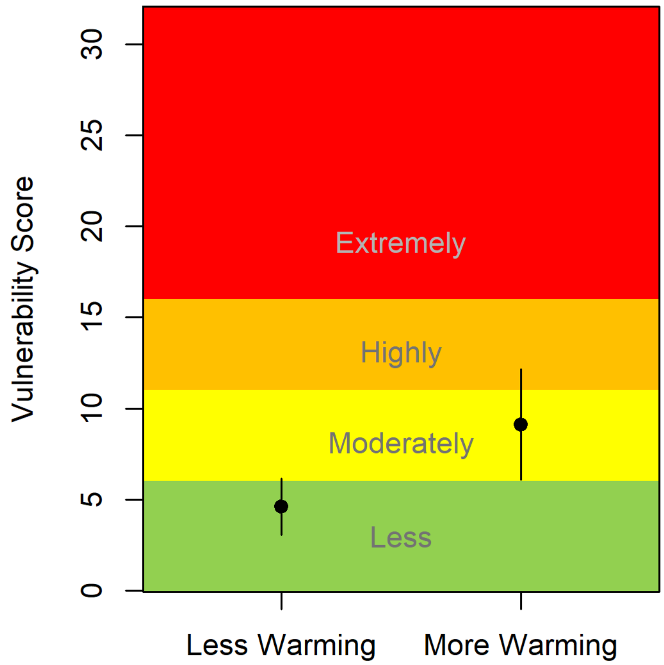
Noosa’owesi

Noosa’owesiwag (plural) / Smallmouth bass / *Micropterus dolomieu*

Less – Moderately Vulnerable
(Confidence Level: High)



Range map of noosa’owesi.



Climate change vulnerability scores for noosa’owesi on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each warming scenario.

General Description:

The Fish Clan (which includes noosa’owesi) is part of the Ojibwe clan system and those who belong to it are known to be sky watchers that hold knowledge of all that is in the sky, such as the sun, stars, and moon, connecting the earth to the sky. However, members of other clans also sometimes hold that same knowledge today.

Noosa’owesi is found in many lakes and rivers throughout the Ceded Territories, often preferring clear, large waterbodies. They are occasionally harvested by Anishinaabeg and are highly prized by many anglers. Noosa’owesiwag spawn in the spring, when water temperature reaches approximately 62-64°F and male noosa’owesiwag guard the developing young for two to four weeks. Juvenile and adult noosa’owesiwag typically use nearshore areas (the littoral zone) and almost exclusively inhabit the upper layer of the water column (the epilimnion). Young noosa’owesiwag feed on insects and small fish. As noosa’owesiwag grow larger, ashaageshiinyag (crayfish) become an important part of their diet.

The noosa’owesi population has increased in many water bodies throughout the Ceded Territories in recent years. For example, relative abundance of noosa’owesi in Lac Vieux Desert Lake has increased by 0.42 fish per mile of shoreline per year, from a low of 0 fish per mile of shoreline in 2000 to a high of 6.7 fish per mile of shoreline in 2016. Similarly, in Mille Lacs Lake, noosa’owesi has increased by 0.04 fish per year, from a low of 0 fish per net in 1983 to 1.3 fish per net in 2017. Population growth is projected to continue as the climate changes because habitat conditions (e.g., warmer water) will tend to favor this being.

Noosa’owesi is one of the beings for which little Traditional Ecological Knowledge was shared during interviews; however, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. Those who did speak of this being were concerned about the increase in population in various waterbodies and the impacts on other fish beings within the Ceded Territories related to warming water temperatures. A Mashkiiziibiing (Bad River) member expressed concerns related to state regulations in Wisconsin designed to promote larger noosa’owesi populations and a perceived increase in bass predation on ogaa (walleye) and asaawens (perch) eggs, fry and juveniles. An interviewee from Misi-zaaga'iganiing (Mille Lacs) expressed a concern over a large increase in green bass which he described as a cross between a sunfish and a bass. During an interview in Bikoganoogan (St. Croix) in late 2015, concern was expressed regarding an increase in water temperatures which is causing walleye-driven lakes to become more dominated by bass.

Summary of climate threats:

Noosa’owesi was in the 30th percentile relative to other swimmers in the vulnerability assessment and in the 51st percentile relative to other beings in the assessment. Factors that increased its vulnerability to climate change include: natural and anthropogenic barriers (e.g., connectivity of inland lakes, dams, oxygen/ temperature barriers), hydrological niche (e.g., droughts and floods), disturbance regime (more intense floods may interrupt parental care), uncommon landscape features (e.g., nesting habitat may become limiting), sensitivity to pathogens (i.e., more effective pathogens, greater abundance) and competition (e.g., changes in habitat will likely favor ashigan (largemouth bass) over noosa’owesi).

Noosa’owesiwag are stocked in waters throughout the Ceded Territories (i.e., fish populations are supported by human intervention/aquaculture). In the short term, this strategy may resist the effects of climate change by maintaining artificially high population levels. In the long term, stocking noosa’owesi has the potential to increase vulnerability scores for several factors in the Climate Change Vulnerability Index. These factors include dispersal and movement, physiological thermal niche, dietary versatility, sensitivity to pathogens and natural enemies, sensitivity to competition, interspecific interactions, measured genetic diversity, and phenological response to climate change. Collectively, these factors may increase the overall vulnerability scores for noosa’owesi in stocked waterbodies.

Factors that increase the vulnerability of noosa’owesi to climate change:

N/SI — Natural barriers: Elevated water temperature reduces the amount of dissolved oxygen, which could become a barrier to dispersal for noosa’owesi if oxygen concentrations drop below approximately 1 ppm.

SI — Anthropogenic barriers: Dams and road crossings have the potential to limit migration in river systems. Specific examples of impacted waterways include the Wisconsin, Wolf, Tomahawk, Flambeau, and Peshtigo rivers.

N/SI — Physiological hydrological niche: High flow in rivers/streams in May and June can negatively influence survival of eggs, fry, and juvenile noosa’owesiwag. Extreme precipitation events associated with climate change have the potential to increase flow in rivers and streams in the Ceded Territories.

SI — Disturbance regime: An increase in extreme weather (e.g., floods, cold snaps) in the spring might increase nest abandonment of the brood-guarding male.

N/SI — Uncommon landscape features: Nesting habitat (e.g., shallow, hard substrate, gravel) might become limiting as environmental conditions change, specifically, more aquatic plant and/or algal growth and lower levels of dissolved oxygen.

SI

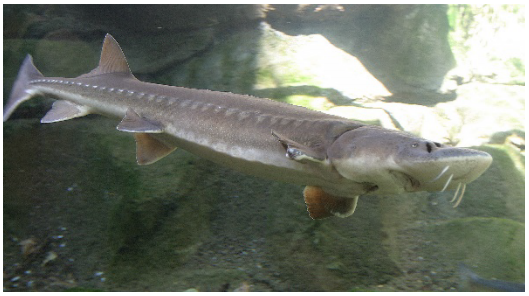
<u>Pathogens or natural enemies</u>: Noosa'owesiwag host a wide range of pathogens (e.g., viral hemorrhagic septicemia) and parasites (e.g., trematodes). Some of these pathogens and parasites might perform better or might be in greater abundance as environmental conditions change, although there has been little research on how noosa'owesi will respond to elevated pathogen or parasite loads.

N/SI

<u>Competition</u>: Altered environmental conditions (e.g., elevated water temperature, increase in aquatic vegetation) will likely favor ashigan over noosa'owesi.

Legend

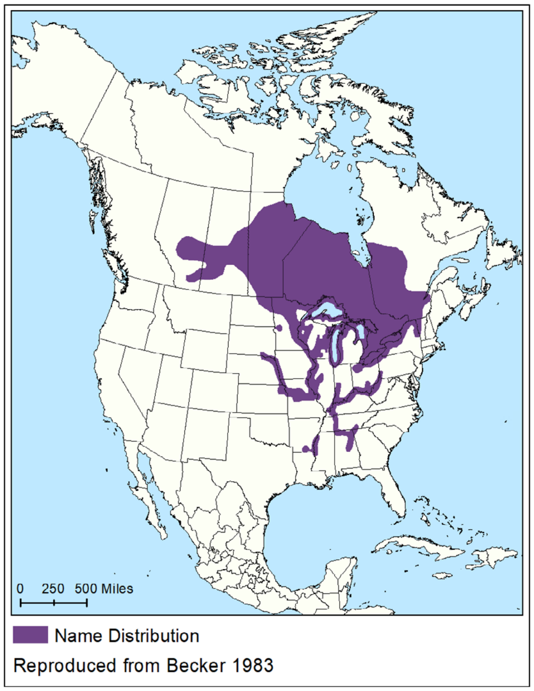
GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability



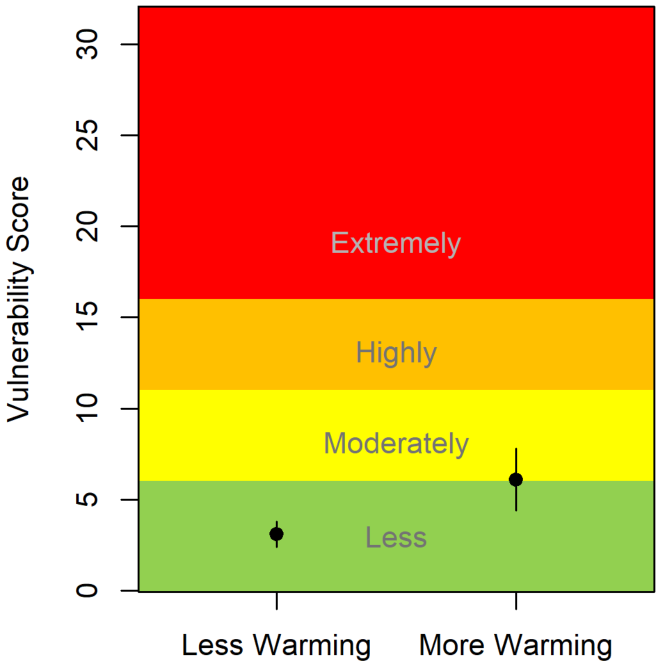
Name

Namewag (plural) / Lake sturgeon / *Acipenser fulvescens*

Less – Moderately Vulnerable
(Confidence Level: Moderate)



Range map of name.



Climate change vulnerability scores for name on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each warming scenario.

General Description:

The Fish Clan (which includes name) is part of the Ojibwe clan system and those who belong to it are known to be sky watchers that hold knowledge of all that is in the sky, such as the sun, stars, and moon, connecting the earth to the sky. However, members of other clans also sometimes hold that same knowledge today.

Name is an ancient fish that swam in the waters when dinosaurs roamed the earth and the only mammals in existence were small rodents. Namewag are culturally significant to the Ojibwe people in many ways. When plentiful, they are a significant part of a diet that incorporates what are known as traditional or first foods.

There are only a few Ojibwe people remaining who continue to utilize the skeleton of the name to tell traditional stories and share traditional teachings. When the stories are told, each piece of cartilage represents a different part of the story and the teachings therefore take many nights to tell. The story of baaga'adowewin (traditional lacrosse) references a name and parts of the name were used in crafting the lacrosse sticks and ball. Name otoliths (ear bones) have also been used for ceremonial purposes.

An elder from Lac La Croix, Ontario, Canada shared numerous stories and teachings during his lifetime. One of them in particular carried specific instructions that explained why we should never eat namewag with a red stripe on their belly. He also relayed that the name run is an indicator for when spring feasts and ceremonies, including spring fasting, should be conducted.

For generations, native people have been sharing stories that relay how amazing namewag are and speak to their ability to travel long distances and communicate through sound. For years, people have reported sounds and vibrations (name "thunder") coming from bodies of water in which there is a high population of name. Recent research in Wisconsin using underwater hydrophones has confirmed that namewag emit these sounds and vibrations before or during spawning.

Namewag live in a few large lakes and rivers throughout the Ceded Territories and are harvested by Anishinaabe and state anglers. Namewag are long-lived (lifespans estimated to be 80-100 years), late-maturing beings (males >12 years old, females >24 years old) that spawn in the spring over rough, clean substrate in shallow areas (<6 feet) with moderate to swift currents. Young namewag (<1 yr) are infrequently observed in large schools over shallow sand or cobble substrate, feeding on primarily crustaceans and invertebrates. After one year of age, juvenile and adult name occupy highly productive waters with abundant food resources that are typically less than 30 feet deep.

The Ceded Territories contain a mix of extirpated (Montreal River), recovering (Ontonagon and St. Louis Rivers), and remnant self-sustaining (Bad and Sturgeon Rivers) populations. Recent annual spawning run population estimates for the Bad River range between 617-1317 adults and Sturgeon River at 350-400 adults. Restoration efforts for name include stocking, harvest restrictions, and spawning habitat improvement to rehabilitate stocks. Overall, anecdotal evidence suggest name populations are recovering in the Ceded Territories, but additional monitoring is required. Name is listed as threatened in Michigan and as a species of special concern in Minnesota.

Name was mentioned very little in interviews, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. One Misi-zaaga'iganiing (Mille Lacs) member shared that there are namewag in Mille Lacs Lake, and described spearing a name years ago, before other agencies acknowledged that there were namewag present in the lake.

Summary of climate threats:

Based on the Climate Change Vulnerability Index (CCVI) score, name was the least vulnerable swimmer in the assessment, though less is known about this being than the other swimmers. Relative to other beings in the vulnerability assessment, name was in the 35th percentile. Factors that increased the vulnerability of name to climate change include: anthropogenic barriers (e.g., dams, flow alters feeding and spawning habitat), disturbance regime (variable precipitation can alter flow and affect recruitment), uncommon landscape features (e.g., spawning site fidelity), and limited (<5%) protected refugia.

Namewag are stocked in waters throughout the Ceded Territories (i.e., fish populations are supported by human intervention/aquaculture). In the short term, this strategy may resist the effects of climate change by maintaining artificially high population levels. In the long term, stocking name has the potential to increase vulnerability scores for several factors in the CCVI. These factors include dispersal and movement, physiological thermal niche, dietary versatility, sensitivity to pathogens and natural enemies, sensitivity to competition, interspecific interactions, measured genetic diversity, and phenological response to climate change. Collectively, these factors may increase the overall vulnerability scores for name in stocked waterbodies.

Factors that increase the vulnerability of name to climate change:

SI Anthropogenic barriers: Dams can impede migration to spawning sites resulting in no reproduction (females either reabsorb their eggs) or reduced survival of eggs. Moreover, variable flow rates caused by dams can decrease the quality of feeding and spawning habitat.

N/SI Disturbance regime: Namewag require moderate to swift flow rates over spawning grounds in the spring for egg development and dispersal. Highly variable flow rates due to changes in precipitation patterns could negatively impact recruitment.

SI

Uncommon landscape features: Adult namewag return to the same spawning locations in the spring. Alterations to these waterways (e.g., floods/droughts) could alter spawning habitat and the fish's ability to migrate to these areas.

N/SI

Competition: Name might experience an increase in mortality if sea lamprey perform better or are more abundant under future climatic conditions.

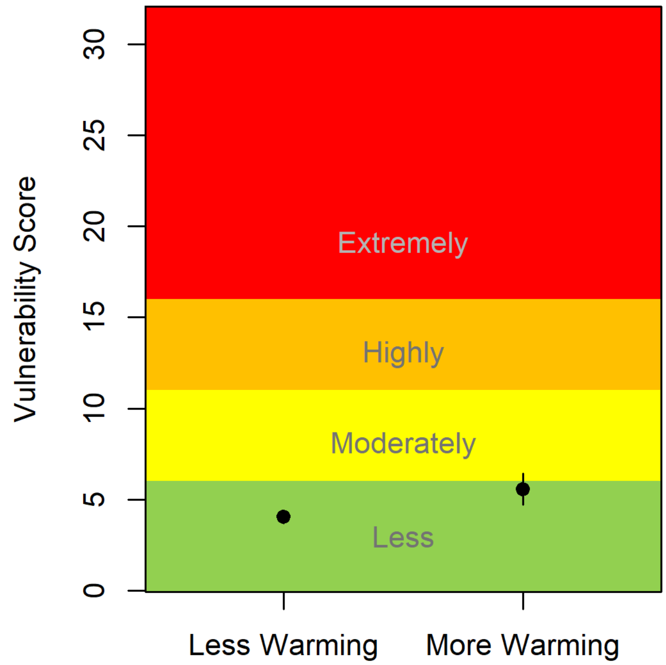
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

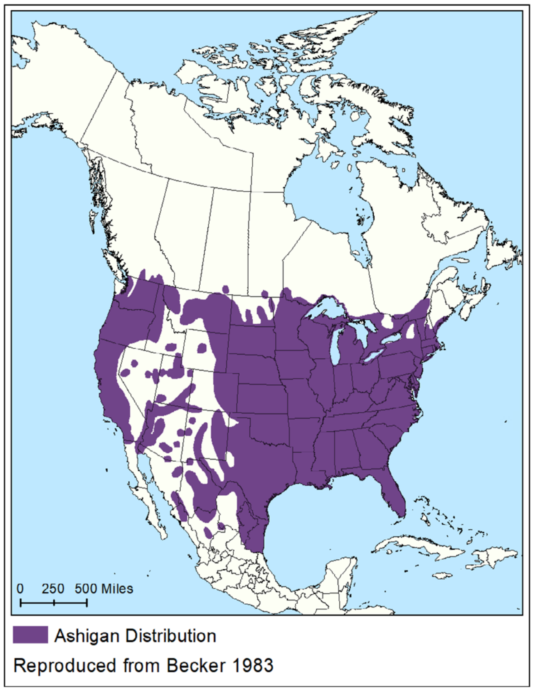
Ashigan

Ashiganag (plural) / Largemouth bass / *Micropterus salmoides*

Less Vulnerable
(Confidence Level: High)



Climate change vulnerability scores for ashigan on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each warming scenario.



Range map of ashigan.

General Description:

The Fish Clan (which includes ashigan) is part of the Ojibwe clan system and those who belong to it are known to be sky watchers that hold knowledge of all that is in the sky, such as the sun, stars, and moon, connecting the earth to the sky. However, members of other clans also sometimes hold that same knowledge today.

The historical presence of bass in the Ceded Territories is shown in various Ojibwe place names mentioning this being. For example, “Ashiganikaaning-wiikwed” refers to a bay with abundant bass and “ashiganikaaning-zaaga’igan” refers to a lake with abundant bass. “Ashiganikaan-zaaga’igan” simply refers to bass lake. According to the *Ojibwe People’s Dictionary*, the name ashigan may also be locally used for other fish beings, including rock bass and crappie, especially in northwest Ontario.

Ashigan is found in many lakes and rivers throughout the Ceded Territories, often preferring clear, large waterbodies. They are occasionally harvested by Anishinaabeg and are highly prized by many anglers. Ashiganag spawn in the spring, when water temperature reaches approximately 59-63°F and male ashiganag guard the developing young for up to five weeks. Juvenile and adult ashiganag typically use nearshore areas (the littoral zone), preferring clear water with aquatic plants. Young ashigan feed on insects and small fish. As ashigan grows larger, its diet shifts to include ashaageshiinyag (crayfish plural), large giigoonyag (fish plural), and omakakiig (frogs plural).

The ashigan population has increased in many water bodies throughout the Ceded Territories in recent years. For example, relative abundance of ashigan in Lac Vieux Desert Lake (Vilas County, Wisconsin and Gogebic

County, Michigan) has increased by 0.48 fish per mile of shoreline per year, from a low of 0.161 fish per mile of shoreline in 2000 to a high of 3.2 fish per mile of shoreline in 2016. Population growth is projected to continue as the climate changes because habitat conditions (e.g., warmer water) will tend to favor this being.

Ashigan is one of the beings for which little Traditional Ecological Knowledge was shared during interviews; however, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. Tribal members from Mashkiiziibiing (Bad River) and Nagaajiwanaang (Fond du Lac) were concerned with increases in ashigan and noosa'owesi (smallmouth bass) populations in inland lakes, both on- and off-reservation, and the resulting impacts on other fish beings. A tribal member from Nagaajiwanaang said, “I think there’s a lot more largemouth bass in our lakes here, which is good, but they’re a big predator so if you’re seeing a lot more of them, you’re seeing a lot less of other fish or a certain size of other fish.” An interviewee from Misi-zaaga'iganiing (Mille Lacs) expressed a concern over a large increase in green bass which he described as a cross between a sunfish and a bass. During an interview in Bikoganoogan (St. Croix) in late 2015, concern was expressed regarding an increase in water temperatures which is causing walleye-driven lakes to become more dominated by bass.

Summary of climate threats:

Ashigan was in the 20th percentile relative to other swimmers and in the 37th percentile relative to other beings in the vulnerability assessment. Factors that increased its vulnerability to climate change include disturbance regime (extreme weather during spawning), sensitivity to pathogens (i.e., more susceptible to infections and parasites when exposed to warmer water), and limited (<5%) protected refugia.

Ashiganag are stocked in waters throughout the Ceded Territories (i.e., fish populations are supported by human intervention/aquaculture). In the short term, this strategy may resist the effects of climate change by maintaining artificially high population levels. In the long term, stocking ashigan has the potential to increase vulnerability scores for several factors in the Climate Change Vulnerability Index. These factors include dispersal and movement, physiological thermal niche, dietary versatility, sensitivity to pathogens and natural enemies, sensitivity to competition, interspecific interactions, measured genetic diversity, and phenological response to climate change. Collectively, these factors may increase the overall vulnerability scores for ashigan in stocked waterbodies.

Factors that increase the vulnerability of ashigan to climate change:

N/SI <u>Disturbance regime</u>: Extreme changes in temperature (cold fronts), wind and wave action, and droughts have the potential to cause nest abandonment by the brood-guarding male.

SI <u>Pathogens or natural enemies</u>: Tapeworms, parasitic worms, viral hemorrhagic septicemia, largemouth bass virus (LMBV) are some of the common pathogens and parasites found in ashigan. Juvenile and adult ashigan infected with LMBV experience higher mortality rates at elevated water temperatures. As the climate changes, elevated water temperatures will likely result in higher mortality rates for fish infected with LMBV.

I <u>Occurrence of protected areas in future range</u>: Less than 5% of the modeled future distribution in the Ceded Territories is encompassed by one or more protected areas.

Legend

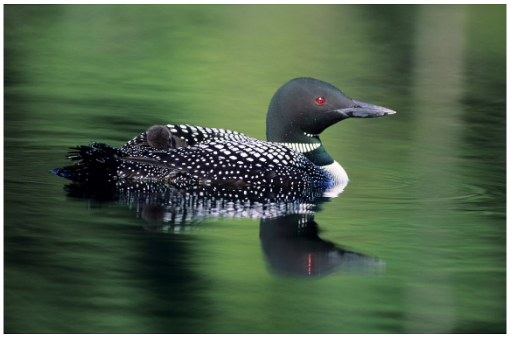
GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Flyers

Flyers are those beings in the animal world who fly through the air. Flyers are in the third order of creation:

> "Great Spirit decided to create everything in the third order and that would be the animal world. All those that swam under the surface of the water, those that stood in the forest on four legs, those that flew through the air like migizi, the eagle, geese, and others." —*Moka'ang Giizis-Rising Sun Joe Rose Sr.*

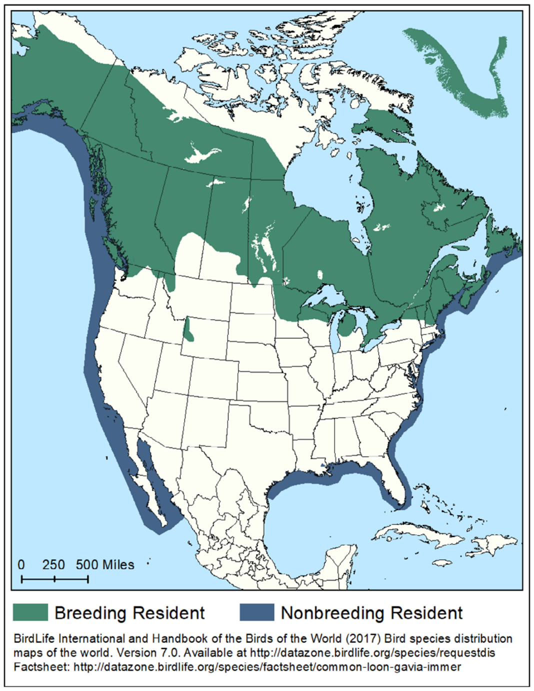
For complete results from the Climate Change Vulnerability Index, see Appendix 4. For references associated with a particular being or beings, please contact the author team.



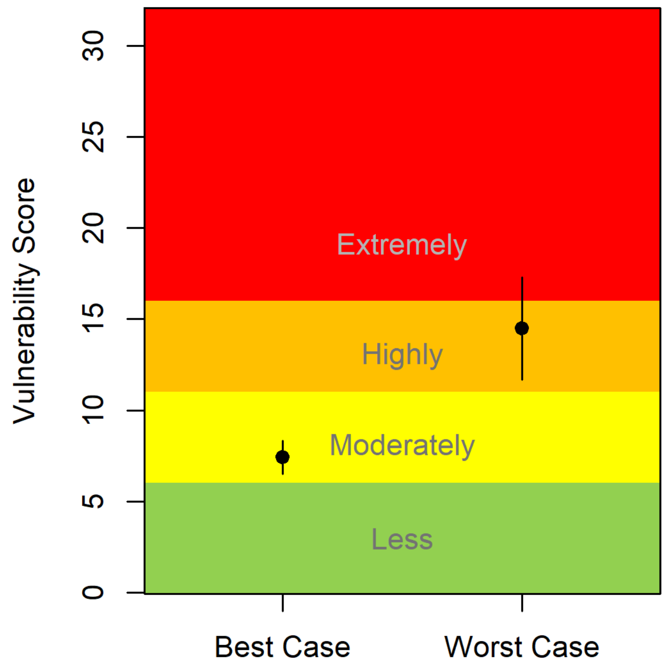
Maang

Maangwag (plural) / Common loon / *Gavia immer*

Moderately - Highly Vulnerable
(Confidence Level: Moderate)



Range map of maang.



Climate change vulnerability scores for maang on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Mewinzha (a long time ago), Wenaboozhoo invited various water birds, including the maang, to his fire to share stories, sing, and dance. While Wenaboozhoo sang a song, he had all the water birds dance with their eyes closed. He warned them not to peek or their eyes would turn red. One by one, he began to wring their necks. Maang heard their screeches, so he opened his eyes and saw what was happening. He yelled out to the others to open their eyes before they too were grabbed by Wenaboozhoo. Thanks to maang, the others escaped. Wenaboozhoo became very angry and kicked maang in the legs, crippling him. The elders say this is why maang can't walk well on land, but instead spends the majority of his time swimming around on lakes and only going onto land to nest. Just as Wenaboozhoo had warned, maang has red eyes to this day because he was the first one to open them.

The Ojibwe follow a clan system divided into main and sub clans. Maang, one of the main clans, was traditionally given the role of chieftainship and leadership alongside the Ajijaak (Crane) Clan. By working together, they helped keep the balance within tribal government and community. This balance is now maintained in many other ways and by various people, including those of other clans. The Maang Clan is also known to be in charge of settling internal issues. Both the late Gichi-weshkiinh (Chief Buffalo), a principal Chief of the Lake Superior Band of Ojibwe and the late Makoons (Walt Bresette), a well-known environmental activist from Gaa-miskwaabikaang (Red Cliff) were of the Maang Clan.

Maang utilizes lakes larger than 10 acres, preferably with clear water, abundant fish, and islands and irregular shorelines for cover and nesting areas. Nests are located in quiet areas, close to the water's edge or on an artificial platform. Maang is a migratory being, arriving soon after ice-out and departing to coastal areas beginning in mid-September after staging, or congregating, in big groups on larger bodies of water.

The breeding range of maang historically extended to the southern parts of Wisconsin, Minnesota, and Michigan, but declines at the southern end of its range have limited it to the northern third of these states. However, populations are increasing in this area, and the Great Lakes region continues to support roughly half of the United States population. Threats to the maang population include lead fishing sinkers, mercury from coal burning, fishing nets, acid rain, and oil spills. Maang is listed as a threatened species in Minnesota and is protected under one or more tribal on and off-reservation Conservation Codes.

Maang was mentioned infrequently in interviews, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. In one interview, a Waaswaaganing (Lac du Flambeau) elder spoke to how highly regarded maangwag are when he described them as “blue angels.”

Another Ojibwe story tells of two brothers who went everywhere together. One day while wandering in the woods, they became lost and got separated. One of the brothers went to the sky and is now known as Giiwedanang (the North Star) and is the ogimaa (leader or chief) of the stars. Circling around Giiwedanang are seven other stars, all forming the maang star constellation (also known as the Little Dipper). The other brother remained on earth and is now referred to as Baswewe or Baswenaazhi (One Who Echoes) which is also known as the ajijaak (crane). This story is reflected on the back of maang in the white dots on its black feathers. In honor of this story, it is said by elders that when a maang is killed, the back of the maang is to face the night sky and it should never be turned upside down.

Summary of climate threats:

Maang was the most vulnerable flyer and in the 81st percentile relative to other beings in the assessment. Maang is a northern being that is likely to be impacted by climate change in several ways, including increasing temperatures, changes in water levels, storm events, and increases in pathogens. Maang is well-known as an iconic Northwoods being and is the focus of much study in this region, including citizen science monitoring (LoonWatch).

Factors that increase the vulnerability of maang to climate change:

I/GI Physiological thermal niche: The Ceded Territories are at the southern end of the maang range and it is sensitive to warm temperatures. Increasing summer water temperatures may continue to push maang farther north.

SI Physiological hydrological niche: In Voyageur’s National Park in Minnesota between 1979 and 1986, 60-70% of nests failed due to human water level management. Climate change will alter water levels, which may in turn impact maang during nesting season (May – June) and could cause nests to fail. Water clarity is also important to maang – it is typically not found on lakes with water clarity less than 2.5 feet. Climate change may impact water clarity as water levels change connections to backwaters and bogs, though water clarity has been improving in some Ceded Territory lakes.

SI/I Disturbance regime: Extreme storm events during nesting season (May – June) can flood and destroy maang nests. Water clarity can also be affected by extreme storm events, as erosion and sedimentation increase with the influx of precipitation and increased flow.

N/SI Pathogens or natural enemies: Avian botulism outbreaks have killed thousands of maangwag in Lake Michigan. An increase in temperature due to climate change could increase the frequency and severity of outbreaks in the Ceded Territories. Increasing spring temperatures and earlier ice-off may also increase or alter the timing of outbreaks of black flies, which are known to affect maang and can transmit parasites and cause nest abandonment if severe.

I — Future change in range size: Audubon models show a 60% decline in the suitable habitat of maang by mid-century in the Ceded Territories.

SI — Overlap of future and current range: The projected mid-century range of maang will overlap its current range in the Ceded Territories by 30-60%.

Legend

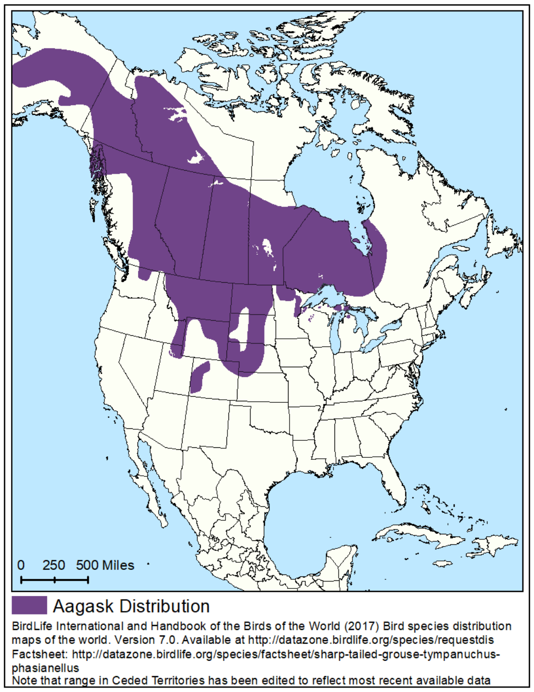
GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Aagask

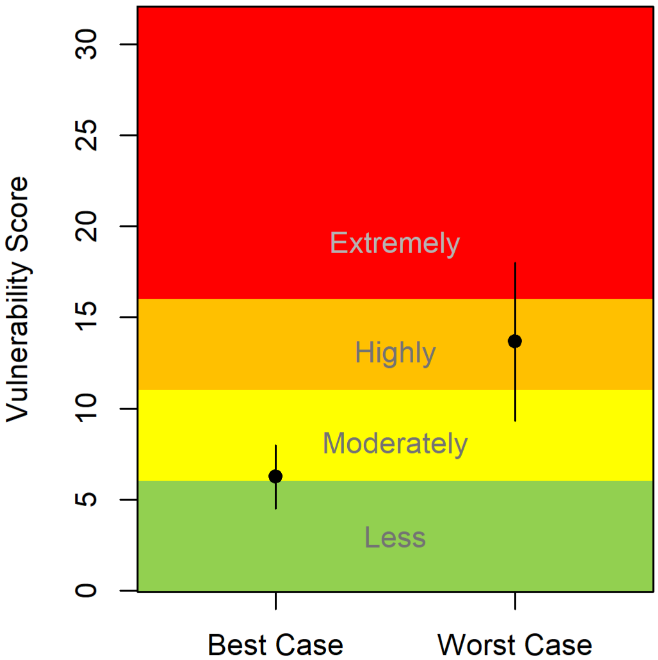
Aagaskoog (plural) / Sharp-tailed grouse / *Tympanuchus phasianellus*

Moderately – Highly Vulnerable

(Confidence Level: Moderate)



Range map of aagask.



Climate change vulnerability scores for aagask on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Aagask has been nicknamed the “fire bird” due to its dependence on ecosystem disturbance, especially fire, to maintain or create preferred habitat. It is believed that the decrease in prescribed and cultural fires is contributing to a decrease in their population. Aagask is known to be one of the clans rarely heard of in recent years and is one of many beings for which little Traditional Ecological Knowledge was shared by interviewees, though all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation.

Aagask inhabits brush prairie, barrens, cut or burned-over forestland, wet meadows, pine/oak savannah, mixed deciduous-coniferous forest, and abandoned farmland. Aagask prefers big blocks of suitable habitat. Male aagaskoog congregate in communal dancing grounds, called leks, to attract mates. Leks are found in open areas. Prior to European settlement, much of aagask habitat was created by fires.

Historically, aagask was found in much of central and northern North America, but conversion of native prairie and grasslands to agriculture and forestlands caused extensive habitat loss and resulted in isolated and fragmented habitat and dramatic population declines. Today in the Ceded Territories, aagask (the Prairie Sharp-tailed Grouse, the subspecies found here) is found only in isolated sites in the eastern Upper Peninsula, northwest Wisconsin, and northern Minnesota. Recent translocation efforts brought in aagaskoog from northwest Minnesota to the Makwa Barrens in northwest Wisconsin. Despite these efforts, there are continued concerns about aagask populations in the upper Midwest, and a recent model done by researchers at the University of Wisconsin-Madison shows a low probability of persistence of aagask in the state over the next 50 years. In 2020, the state of Wisconsin closed the aagask hunting season for the second year in a row to protect the population. It is listed as a species of Special Concern in Minnesota, Wisconsin, and Michigan.

Although aagask was once a heavily relied upon food source, few observations about them were collected. A tribal member from Nagaajiwanaang (Fond du Lac) talked about aagaskoog, noting that they are "one of the major, easier food sources for a lot of predators, so that makes them very cyclical in how their population goes, boom or bust." He also mentioned that "they are making a comeback now."

Summary of climate threats:

Aagask was in the 92nd percentile relative to other flyers and in the 75th percentile relative to other beings in the assessment. Aagask is likely to be very vulnerable to climate change, due in part to its low and fragmented population. Natural and anthropogenic barriers, limited dispersal ability, dependence on snow and uncommon landscape features, limited dietary versatility, susceptibility to pathogens, and low genetic variation are all factors in the vulnerability of aagask vulnerability to climate change.

Factors that increase the vulnerability of aagask to climate change:

SI/I — Natural barriers: Many habitat patches are bordered by dense forested areas or the Great Lakes. Both of these will limit aagask movement.

SI — Anthropogenic barriers: Roads and other development can be barriers to aagask movement. Aagask will not breed near structures such as wind turbines and power lines. Intensive agricultural development or a shift in the type of agricultural crop could also create non-habitat for aagask and therefore limit movement. Reforestation efforts will result in additional barriers.

N/SI — Dispersal: Aagask is capable of significant dispersal; a Wisconsin study showed movements between 5 and 21 miles from a release site. However, it also has very high site fidelity, limited habitat in patches, and individuals with established habitats do not always disperse that far.

N/SI — Dependence on snow or ice: In the Ceded Territories, aagask is dependent on deep powdery snow for protection against wind and cold temperatures. Aagask will spend the night and some parts of the day in the snow. A reduction in the snowpack or an increase in the density of the snow may make it more difficult for aagask to take cover in the snow, and result in an increase in mortality rates.

SI — Uncommon landscape features: Aagask depends on large open spaces to use as leks, and these habitats are generally uncommon in the assessment area due to increasing human population and fragmentation. Brush prairie, barrens, pine/oak savannah, and abandoned farmland are also good aagask habitat and are all fairly uncommon in the Ceded Territories.

N/SI — Dietary versatility: In the winter, aagask depends on a few beings for subsistence, including parts of shrubs such as gozigwaakomin (serviceberry), asasawemin (chokecherry), miinensagaawanzh (hawthorn), and ma'iingaananaatig (snowberry); tree beings such as wiigwaasaatig (paper birch) and oziisigobiminzh (willow) provide some buds. Many of these are northern beings likely to decline due to climate change.

N/SI — Pathogens or natural enemies: Many predators of aagask may increase, including esiban (raccoon), wiisagizi ma'iingan (coyote), waagosh (red fox), aandeg (American crow), gaagaagi (common raven), zhaangweshi (American mink), or various raptors. Infectious diseases are not common, but avian influenza may increase and could affect aagask.

I

Genetic variation: Lack of genetic variation is a significant issue for aagask. The Ceded Territory population remains in isolated subpopulations. However, there have been new individuals introduced into northwest Wisconsin, and reproduction has been confirmed, which should boost genetic diversity.

N/SI

Future change in range size: Audubon models show a reduction in suitable habitat of 20% for aagask in the Ceded Territories by mid-century.

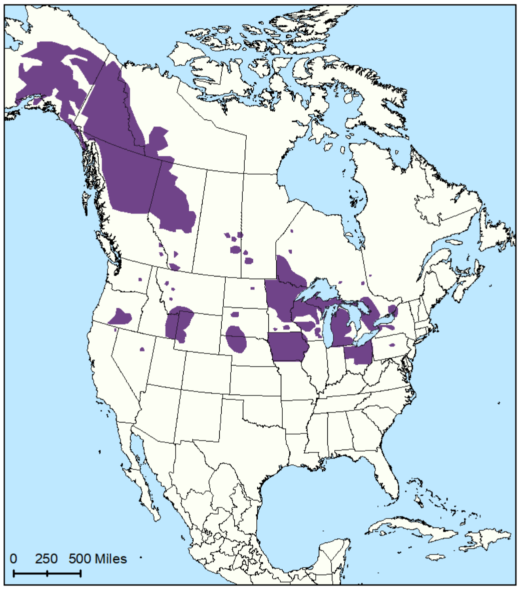
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Waabizii

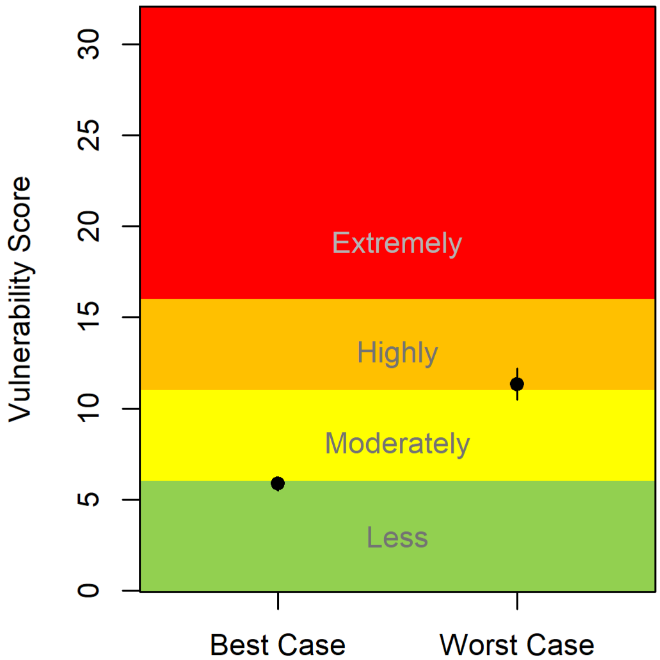
Waabiziig (plural) / Trumpeter swan / *Cygnus buccinator*

Less – Highly Vulnerable
(Confidence Level: Moderate)



Waabizii Distribution
Digitized from Groves 2017. Population in Ceded Territories is known as the Interior Population, which includes flocks in the Central, Mississippi, and Atlantic Flyways

Range map of waabizii.



Climate change vulnerability scores for waabizii on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Historically waabiziig were an important food source during certain times of the year. Waabizii is one of a group of beings for which little Traditional Ecological Knowledge (TEK) was shared during the interview process, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation.

Waabizii can use ponds, lakes, and marshes, but prefers large, shallow wetlands with abundant emergent vegetation for nesting and abundant aquatic vegetation for food. Waabizii usually selects sites with little human impact. Nests are built using plant material in emergent vegetation, or on a muskrat house, beaver lodge, or island, and are used by the same individuals for multiple years. In the winter, waabizii moves south to areas with open water; northern Wisconsin waabiziig generally move to Minnesota or southern Illinois.

The waabizii population in the continental United States was reduced to less than 100 individuals by 1933 due to habitat loss and hunting, though a healthy population remained in Alaska. Today, all waabiziig found in the assessment area are the result of the reintroduction of around 400 individuals, primarily from Alaska, in the late 1900s. Since the introductions, the population has grown substantially – the Interior Population grew from just over 7,000 in 2010 to over 27,000 in 2015.

Within the Ceded Territories, waabizii has the following listings: threatened in Michigan, a species of Special Concern in Minnesota, and protected by one or more tribal on or off-reservation conservation codes. During a TEK interview held in Waaswaaganing (Lac du Flambeau), a tribal member expressed concern for their population. He also described them as being like a canary in a coal mine and a decrease in their population signifies something bad is happening or about to happen. However, in places where their populations are growing, there are also concerns that waabiziig will eat manoomin (wild rice) and cause damage to manoomin beds.

A tribal waabizii hunting season was instituted in the 1837 and 1842 Ceded Territories in 2014 with a maximum total harvest of 10 birds per year for all GLIFWC tribes; in 2018 the total tribal harvest was 2 waabiziig and in 2019 the harvest was 9.

Summary of climate threats:

Waabizii was in the 77th percentile relative to other flyers and in the 63rd percentile relative to other beings in the vulnerability assessment. The waabizii population is continuing to increase but has lingering effects from population recovery and the resulting lack of genetic diversity. Waabizii is sensitive to some climate-related changes including changes in water levels. This being is susceptible to disease on its wintering grounds and dependent on beaver for habitat in parts of its range, both of which increase its vulnerability. Waabizii could also be increasingly impacted by bakaan ingoji gaa-ondaadag (non-local beings) as the climate conditions for carp become more favorable.

Factors that increase the vulnerability of waabizii to climate change:

SI Physiological hydrological niche: Waabizii is dependent on stable water levels during the spring and summer for nesting and aquatic vegetation growth. Changes in the seasonal hydrologic regime could make nest sites more accessible by predators or cause nest sites to flood.

SI Disturbance regime: Extreme storm events can flood and destroy waabizii nests. Severe droughts can reduce habitat and cause waabizii to relocate cygnets to find food, making them vulnerable to predation.

N/SI Dependence on other species to generate habitat: In many parts of its range, waabizii is dependent on amik (beaver) ponds in natural settings. Without amik, waabizii would have less habitat.

SI Pathogens or natural enemies: Waabizii congregates in very high densities in wintering areas, leading to overcrowding, physical stress, lack of food, and creating serious potential for a disease outbreak. Warmer temperatures and an increase in available wintering habitat may temper this effect, but waabizii is highly philopatric and it may take a long time for any new wintering habitat to be utilized. Increased predation from predators such as mikinaak (snapping turtle), ginoozhe (northern pike), zhaangweshi (mink), wiisagizi ma'iingan (coyote), ma'iingan (gray wolf), and migizi (bald eagle) may decrease survival of cygnets.

SI Competition: Non-local carp is expected to increase its range and distribution and negatively impacts waabizii by reducing water quality and suppressing submergent aquatic vegetation.

I Genetic variation: Waabizii genetic variation is lower than in other waterfowl beings. The individuals found here were introduced from other parts of the United States and the population continues to carry effects of that bottleneck. This can make it more susceptible to any climate-related changes.

Legend

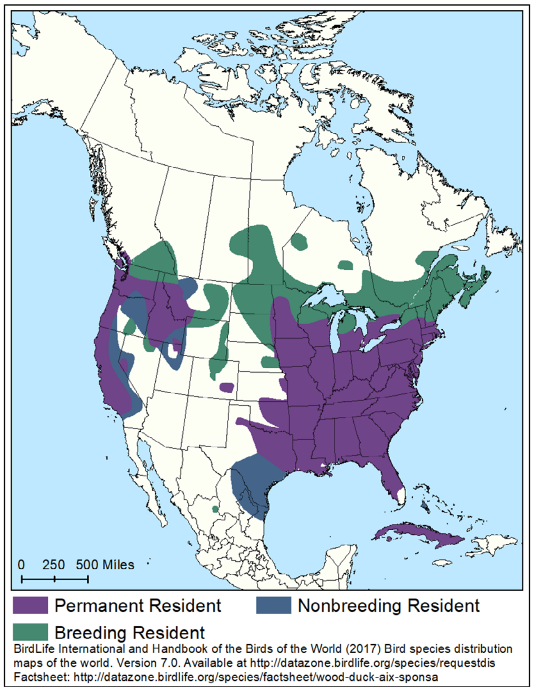
GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Mitigoningwiishib

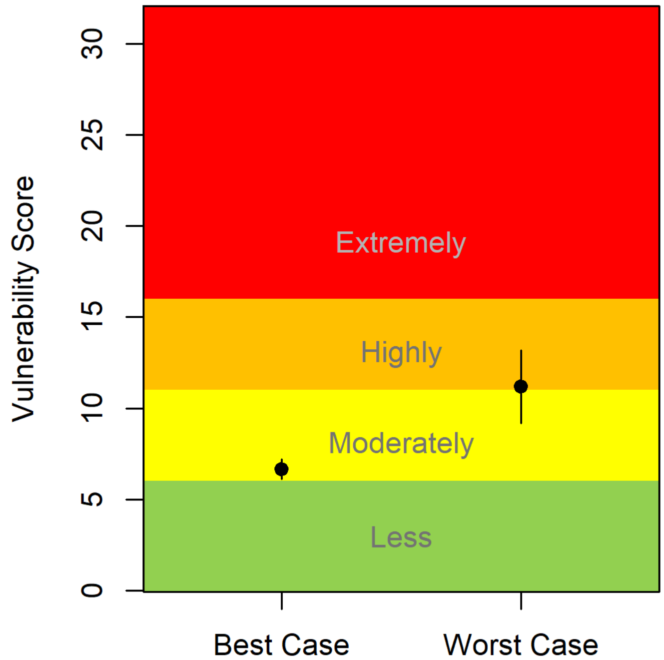
Mitigoningwiishibag (plural) / Wood duck / *Aix sponsa*

Moderately – Highly Vulnerable

(Confidence Level: High)



Range map of mitigoningwiishib.



Climate change vulnerability scores for mitigoningwiishib on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Mitigoningwiishib is broken down as “mitig” = wood, “oningwiigan” = wing, “zhiishiib” = duck. Mitigoningwiishib is also known as “zii’amo” on the White Earth reservation. Zhiishiibag (ducks) in general are important food sources during certain times of the year and are referenced in traditional teachings.

Mitigoningwiishib inhabits a variety of wet habitats, including creeks, streams, rivers, swamps, marshes, beaver ponds, and farm ponds. It prefers open water interspersed with 50-75% vegetative cover, and dense stands of emergent vegetation. Mitigoningwiishibag nest in tree cavities, often in quaking aspen or other mature mixed hardwood stands or artificial nest boxes. Manoomin (wild rice) is part of its diet and a decline in manoomin could negatively affect local mitigoningwiishib populations.

The mitigoningwiishib population was healthy until the late 19th century, when it began to decline due to overharvest, deforestation, and wetland loss. Many believed the population would go extinct, but due to healthy populations in remote swamps, the re-growth of larger cavity-producing trees, and protection by the Migratory Bird Treaty Act of 1918, the population rebounded and is currently stable or increasing in the Ceded Territories. Over the past 17 years, mitigoningwiishib has been the second-most harvested zhiishiib by GLIFWC member tribes, accounting for about 21% of the harvest (on average, 280/year).

Mitigoningwiishib was mentioned infrequently in interviews. However, all beings are of equal importance to Ojibwe people based on their cultural beliefs in the original treaties with all of creation.

Summary of climate threats:

Mitigoningwiishib was in the 85th percentile relative to other flyers and in the 68th percentile relative to other beings in the vulnerability assessment. Mitigoningwiishib is vulnerable to climate change in several ways, including changes in precipitation and storm events, dependence on other beings for habitat, predation, and competition.

Factors that increase the vulnerability of mitigoningwiishib to climate change:

N/SI Physiological thermal niche: Increasing summer temperatures may affect duckling survival.

GI Physiological hydrological niche: Mitigoningwiishib typically prefers a very narrow range of water depth during breeding (3-18 inches) and brood-rearing (less than 12 inches are preferred for chicks foraging for insects) from mid-April to late September. Summer precipitation projections are uncertain, but projected increases in spring precipitation could have serious consequences for breeding and brood-rearing of mitigoningwiishib by altering water levels. Water speed is also important; mitigoningwiishib prefers currents less than 1 mile per hour and can tolerate a maximum of only 3 miles per hour during breeding and brooding. Increases in precipitation may increase water speed and therefore have the potential to disrupt mitigoningwiishib reproduction.

SI Disturbance regime: As noted above, water depth is extremely important to mitigoningwiishib during breeding. Extreme rain events associated with climate change are predicted to increase and large amounts of rain are likely to alter or disrupt mitigoningwiishib breeding habitat.

SI Dependence on other species to generate habitat: Mitigoningwiishib requires cavities for nesting. Climate change may cause changes in the distribution or abundance of trees that can provide natural cavities. One study in north central Minnesota found that only four tree beings were used for nesting, one of which no longer grows large enough to form cavities (American elm). This study found that Pileated Woodpeckers were important in creating the cavities used by mitigoningwiishib. The fact that mitigoningwiishib relies on a small number of beings for nesting habitat makes it vulnerable to any changes in the distribution of those beings.

SI Pathogens or natural enemies: Esibanag (raccoons) are the biggest threat to mitigoningwiishib eggs and incubating hens, as most chicks die within the first two weeks of life. Esiban populations have been increasing and are expected to be favored by climate change. Increasing esiban populations will have negative effects on mitigoningwiishib.

N/SI Competition: European Starlings can outcompete mitigoningwiishib for nesting cavities, particularly in nest boxes – they often cause mitigoningwiishib to abandon its nest or begin occupying nests earlier than mitigoningwiishib. Other cavity-nesting waterfowl and mammals, such as misajidamoo (gray squirrel) and zhagashkaandawe (northern flying squirrel), may also outcompete mitigoningwiishib for nesting sites.

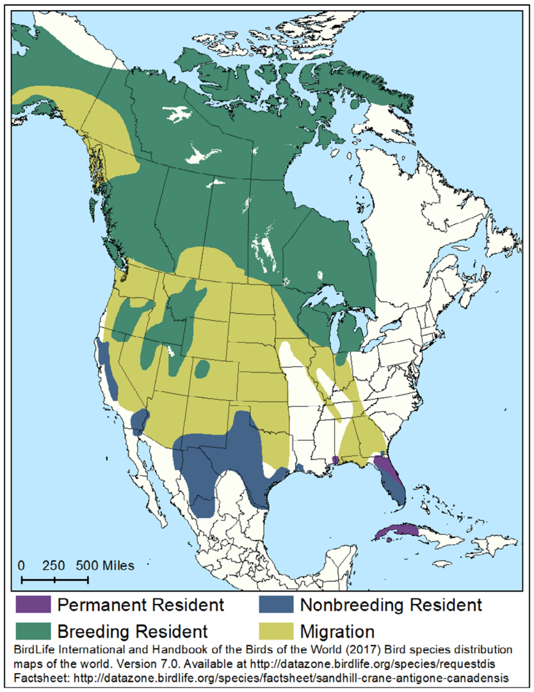
Legend

GI **Greatly Increase** This factor greatly increases vulnerability	**I/GI** **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I** **Increase** This factor increases vulnerability
SI/I **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI** **Somewhat Increase** This factor somewhat increases vulnerability	**N/SI** **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

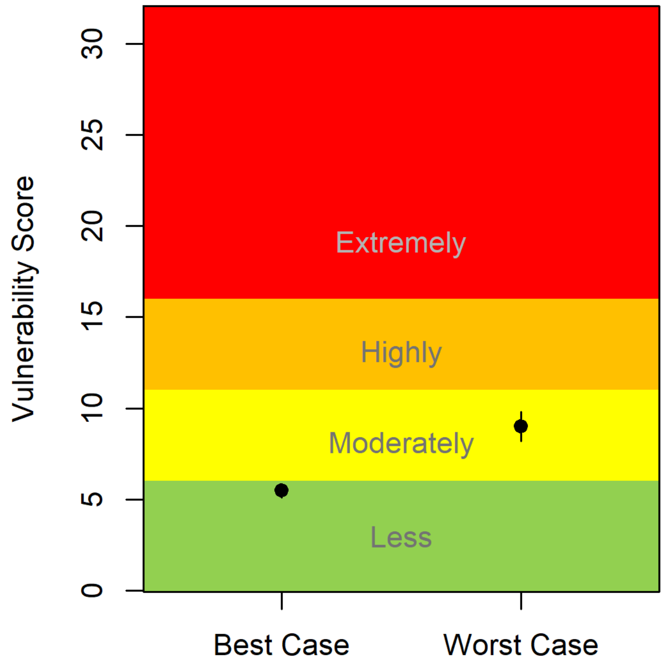
Ajijaak

Ajijaakwag (plural) / Sandhill crane / *Grus canadensis*

Less – Moderately Vulnerable
(Confidence Level: Moderate)



Range map of ajijaak.



Climate change vulnerability scores for ajijaak on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

In Baawating (also known as Place of the Rapids or Sault Ste. Marie, Michigan) many elders tell the story that mewinzha (a long time ago), Gichi-manidoo (Great Spirit, also referred to as the Creator) sent ajijaak flying down to aki (earth) to search around the Great Lakes to see where the Anishinaabeg could gather for various events such as ceremonies. Ajijaak flew down several times, stopping at ideal gathering areas that were identified for their beauty, available food, plants, and medicines. The first stop was at Baawating where he looked around and communicated with the other beings there about the beauty of the area.

According to Ojibwe star knowledge, ajijaak is seen in the night sky as Cygnus, a northern constellation that is cross-shaped and falls along the plane of the milky way. It is said that ajijaak is the one who made maang the first in council leadership among the animal beings represented in the stars. Therefore, maang (loon) is in charge in the night sky but ajijaak is the one who placed him there.

Ajijaak is a part of the Ojibwe clan system whose clan members have historically held the role of Chieftainship along with helping to provide a balanced government by working in collaboration with the Maang Clan. Members of the Ajijaak Clan have been known to be very intelligent and possess strong leadership skills. They have been respected as speakers and decision-makers. Many members of the Ajijaak Clan have been great advocates, orators, translators, and ambassadors. Some elders shared that the Ajijaak Clan is also sometimes referred to as the Baswenaazhi (echo maker) Clan because of the sound of ajijaak whose echoes brought together the Anishinaabe people for ceremonies and other gatherings. They are to serve as a reminder to us to think things through before speaking because what we share can be carried as echoes to others. Today members of the Ajijaak Clan are less common but still exist.

Ajijaak uses a mosaic of habitats, including wetlands for nesting, fields for feeding, and protection from disturbance. Nesting usually occurs in open wetlands, such as sedge meadows, marshes, or bogs, surrounded by shrubs and forests. Ajijaak can also use grasslands with shallow pools of water. In the winter, ajijaakwag from the Midwest fly south to Florida, and other populations of ajijaakwag overwinter in the southwestern US and Mexico.

Ajijaak populations declined following unrestricted harvest, development, and the loss of wetland habitats. In the early 1900s, there were fewer than 50 breeding pairs scattered across Minnesota, Wisconsin, and Michigan. The population has since recovered naturally due to hunting bans, wetland protection, and their ability to use agricultural landscapes. Its population has grown to about 95,000 ajijaakwag in the Eastern Population (which includes the Upper Midwest) in 2016.

Ajijaak was mentioned infrequently in interviews, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. During one interview, a member of Waaswaaganing (Lac du Flambeau) described how he would often hear their echoes across the lake near his house and how it reminded him of the roles of the Ajijaak Clan. In addition, elders from Gaa-miskwaabikaang (Red Cliff) and Ginoozhekaaning (Bay Mills) shared that they have observed increases in their population from around 2010 to present.

Summary of climate threats:

Ajijaak was in the 69th percentile relative to other flyers and in the 57th percentile relative to other beings in the vulnerability assessment. Populations have grown quickly and ajijaak is now so abundant that it is unlikely this being will be highly affected by climate change, though it is vulnerable to climate-related changes in precipitation, disturbances, pathogens and predators, and low genetic diversity due to past bottlenecks.

Factors that increase the vulnerability of ajijaak to climate change:

SI — Physiological hydrological niche: Seasonally flooded wetlands are important for nesting, chick rearing, and for migration and wintering habitat. Some ajijaakwag nest in seasonally flooded wetlands and depend on them for food and water as well as protection from predation. Changes in precipitation are likely to affect these life stages.

SI — Disturbance regime: Both extreme precipitation events that cause flooding and severe drought would negatively impact ajijaak during nesting. Flooding can destroy eggs and kill chicks, and drought can reduce water levels, increasing predation risk and reducing the availability of food and water.

N/SI — Pathogens or natural enemies: Predation is the most common reason for nest failure; many predators of ajijaak, such as wiisagizi ma'iingan (coyote), migizi (bald eagle), esiban (raccoon), nigig (otter), gidagaa-bizhiw (bobcat), and makwa (black bear) are expected to be favored by climate change. Diseases including avian cholera and botulism are also risks as ajijaak congregates on migration and wintering grounds and a high density creates susceptibility to disease.

I — Bottlenecks: The ajijaak population was reduced to fewer than 50 breeding pairs scattered throughout Minnesota, Michigan, and Wisconsin in the early 1900s. This bottleneck makes ajijaak more susceptible to changes in climate, as genetic diversity is likely reduced.

SI — Future change in range size: The suitable habitat of ajijaak in the Ceded Territories is expected to decline by about 31% by mid-century.

Legend

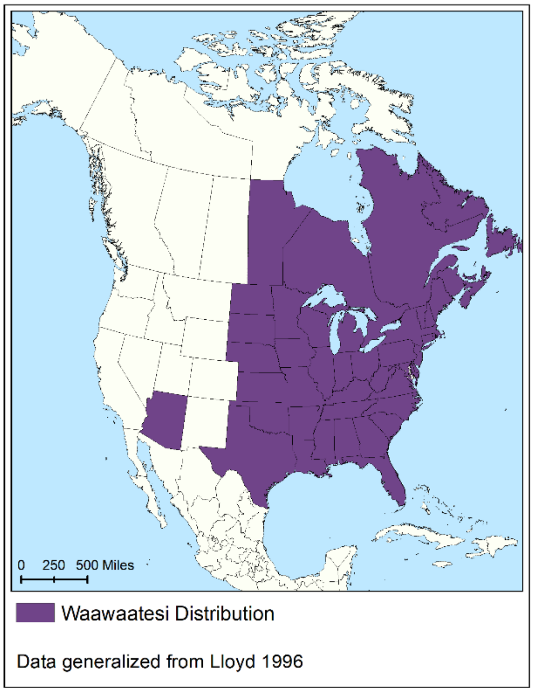
GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Waawaatesi

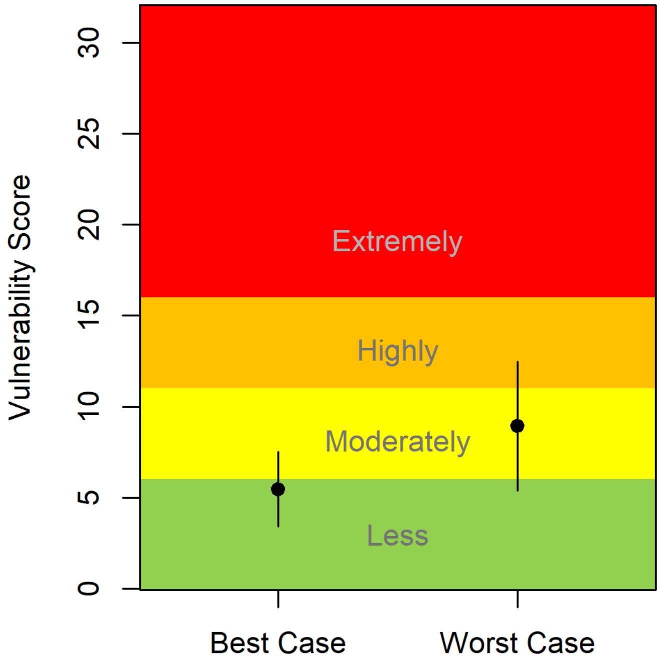
Waawaatesiwag (plural) / Firefly / *Photinus pyralis*

Less – Moderately Vulnerable

(Confidence Level: Low)



Range map of waawaatesi.



Climate change vulnerability scores for waawaatesi on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

To some, waawaatesi may be a simple small insect that children catch in jars in the summertime. However, in many cultures, waawaatesi is the subject of many stories, often symbolizing enlightenment and beings that bring help to those in need. The Ojibwe people also have stories about these little beings, often in connection with waawaashkeshi (deer).

Waawaatesi lives in a wide variety of habitats, including meadows, lawns, at the edges of woodlands, and near streams. Waawaatesi uses its light in summer evenings to attract mates, and each species has a different light pattern. Eggs are laid in moist soil, and when larvae hatch, they live in moist places on the ground, under bark, and near streams. Larvae spend the winter underground and emerge as adults the following summer.

Little is known about waawaatesi populations, as there are over 2,000 species, many of which are extremely difficult to identify, and each has a unique habitat and life history. Waawaatesi is generally considered to be in decline in many parts of North America, but research is limited.

Most tribal members that mentioned waawaatesi spoke of it as being one of the first signs that it is acceptable to start hunting waawaashkeshi. Numerous generations observed that when waawaatesiwag are first seen around June or early July that waawaashkeshi will start coming around.

Observations by tribal members indicate fewer waawaatesiwag and some years they seem to be appearing later in the year. There was also concern expressed regarding the use of pesticides, herbicides, and fertilizers, which many feel is contributing to habitat loss for these beings. It is known that waawaatesiwag need clean water and undisturbed streams to survive, and some feel pollution is negatively affecting these beings.

Summary of climate threats:

Waawaatesi was in the 62nd percentile relative to other flyers and in the 56th percentile relative to other beings in the assessment. Although little is known about waawaatesi in general, there are several factors that make it vulnerable to climate change, including anthropogenic barriers, changes in precipitation, and susceptibility to predators.

Factors that increase the vulnerability of waawaatesi to climate change:

SI/I — Anthropogenic barriers: Logged areas and forest clear-cutting, as well as wetland fragmentation and loss, are likely to reduce habitat with adequate soil moisture for waawaatesi. Interviewees also mentioned that cutting grass in lawns decreases waawaatesi habitat. Light pollution is thought to negatively affect waawaatesi by disrupting its flash communication. In general, most of these barriers are unstudied.

SI/I/G — Physiological hydrological niche: Waawaatesi larvae require mesic conditions with ample soil and substrate, and waawaatesi is therefore dependent on adequate soil moisture and aquatic habitats. Changes in precipitation could cause areas to become either too dry or too wet for waawaatesi.

SI/I — Disturbance regime: Flooding and drought could both negatively affect conditions required for waawaatesi larvae.

N/SI — Pathogens or natural enemies: Waawaatesi has many predators, enigoonsag (ants), bapakwaanaajiinh (bats), bineshiinyag (birds), centipedes, crustaceans, giigoonyag (fish), oojiinsag (flies), omakakiig (frogs), obiigomakakiig (toads), mites, snails, asabikeshiinyag (spiders), other manidoonsag (insects), and aamoog (wasps), some of which are likely to increase in a warmer climate. Waawaatesi is not highly affected by parasites, as it exudes a milky substance that acts as a protective agent.

Legend

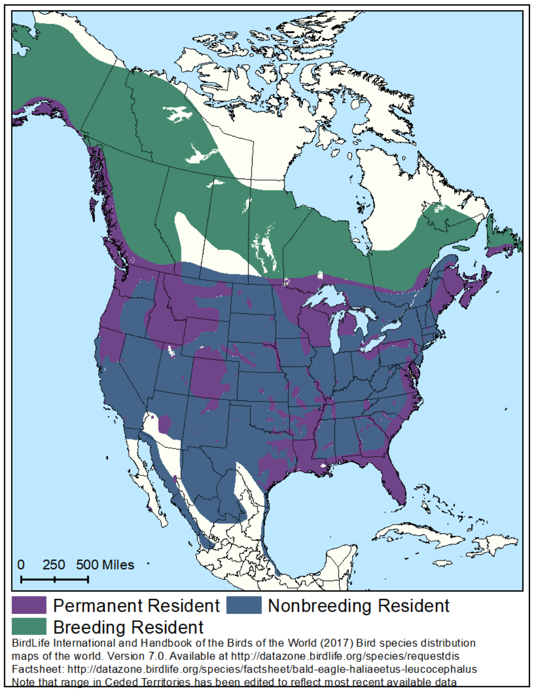
GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Migizi

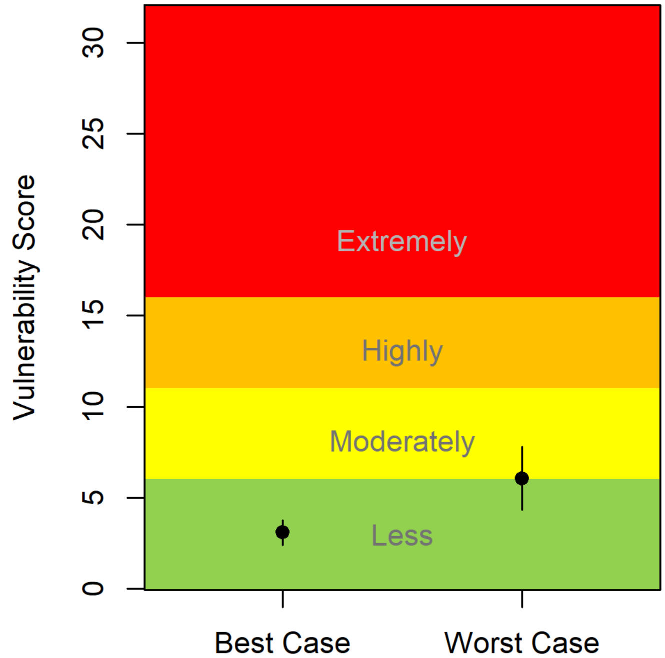
Migiziwag (plural) / Bald eagle / *Haliaeetus leucocephalus*

Less-Moderately Vulnerable

(Confidence Level: Moderate)



Range map of migizi.



Climate change vulnerability scores for migizi on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

To the Ojibwe people, migizi is known as a bird closest to the Creator and who carries up messages and prayers. Migizi is part of the Bird Clan; those who belong to this clan are known to be very intuitive, keepers of knowledge, and responsible for sharing this knowledge. However, members of other clans also sometimes hold these same traits and responsibility today.

Like many other sacred articles, it is a great honor when gifted with or being a caretaker of feathers from migizi. The feathers are treated with great respect and taken care of by cleaning them, feasting them, and/or keeping them from falling to the ground. Other parts of migizi, such as bones and talons, are used in ceremonies, celebrations, healings, and everyday cultural practice. Many pray with tobacco when one is seen in order to show respect and appreciation.

Migizi lives near rivers, large lakes, and other large areas of large open water. Nests are built in mature or old-growth conifers or hardwoods in areas with good visibility, near water, and with ample prey. Nests made of sticks, grasses, mosses, and other woody material are 5 to 6 feet in diameter and can weigh up to 3 tons. Migizi uses areas with minimal to moderate human development and disturbance. Some migiziwag remain in the Ceded Territories for the winter if there is enough food; others migrate short distances.

The migizi population declined in the 1900s due to settlement, bounty hunting, logging, and pesticides. The biggest threat to migizi was DDT, a pesticide used to control mosquitoes, which was used heavily in the late 1940s. Migiziwag ate fish contaminated with a byproduct of DDT, causing them to lay thin-shelled eggs that broke before hatching. This devastated migizi populations for decades, and only 417 nesting pairs remained in the continental United States in 1963. DDT was banned in 1972, and the population has since rebounded and is now widespread in North America. There are now 1590 documented migizi nests in the state of Wisconsin, with some indication that suitable nesting habitat in the northern part of the state is saturated for this being. Migizi was removed from the Endangered Species list in 2007. The presence of migiziwag in the Ceded Territories is evident in knowledge surrounding Ojibwe place names. One example is Migiziwis-minis (Bald Eagle Island) which is known today as Eagle Island, one of the Wenaboozhoo Minisan (Apostle Islands) in northern Wisconsin.

Even though migizi is highly respected and commonly used by the Ojibwe, it wasn't mentioned in Traditional Ecological Knowledge interviews as frequently as other beings. However, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. Some discussed the lengthy process a tribal member is required to use to obtain feathers and/or an entire migizi through the United States Fish and Wildlife Service's National Eagle Repository. A Nagaajiwanaang (Fond du Lac) tribal member who had been tapping ziinzibaakwadwaatigoog (sugar maples) for nearly 40 years stated that migizi would fly over his sugarbush every time and carry news of his efforts to the Creator. He believed migizi would tell the Creator that the gift of ziinzibaakwadwaatig (sugar maple) was being used by the Anishinaabe people.

Summary of climate threats:

Migizi was in the 54th percentile relative to other flyers and in the 34th percentile relative to other beings in the assessment. The migizi population is currently large in the Ceded Territories, and it is a mobile being unlikely to be affected seriously by climate change. However, there are pathogens that could increasingly affect migizi, and previous population bottlenecks might have resulted in low genetic diversity that could affect it in the future.

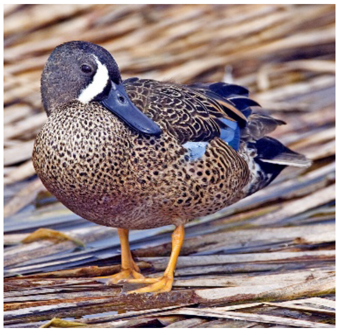
Factors that increase the vulnerability of migizi to climate change:

N/SI — Pathogens or natural enemies: Several diseases have been shown to affect migizi, including avian pox, peritonitis, pneumonia, enteritis, septicemia, avian cholera, aspergillosis, hepatic necrosis, and myocardial infarction. There has been a possible occurrence of avian pox in Chequamegon Bay. These diseases may become more prevalent as conditions change. Humans and environmental contaminants remain the biggest threat to migizi.

I — Bottlenecks: In 1963 there were only 417 nesting pairs remaining in the continental United States, and only 103 individuals in the state of Wisconsin. This bottleneck might have reduced genetic diversity, although more research is needed.

Legend

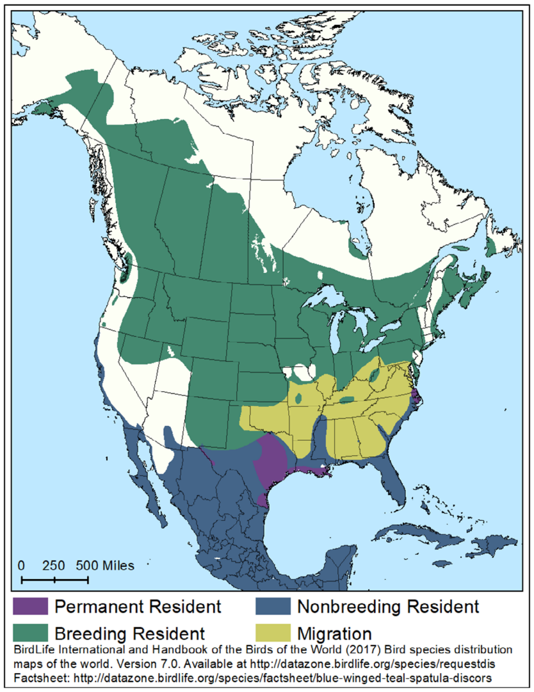
GI — **Greatly Increase** This factor greatly increases vulnerability	**I/GI** — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I** — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI** — **Somewhat Increase** This factor somewhat increases vulnerability	**N/SI** — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability



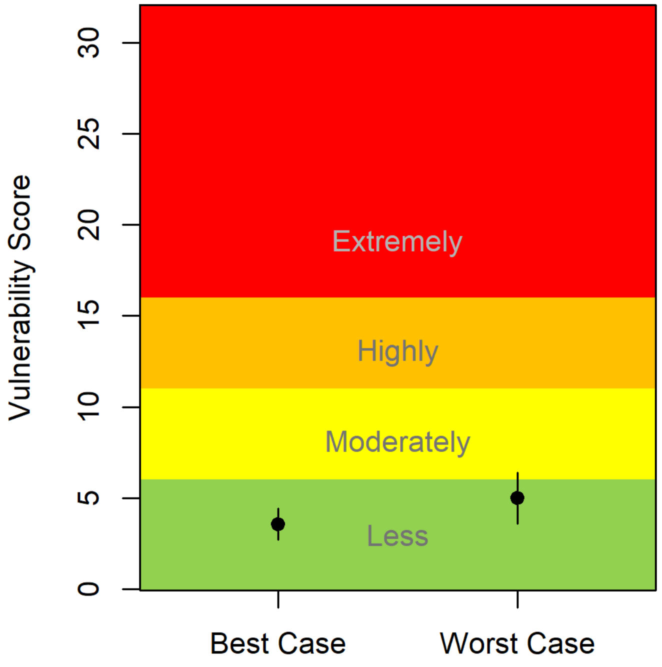
Ozhaawashkonebiisibens

Ozhaawashkonebiisibensag (plural) / Blue-winged teal / *Spatula discors*

Less Vulnerable
(Confidence Level: Low)



Range map of ozhaawashkonebiisibens.



Climate change vulnerability scores for ozhaawashkonebiisibens on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

The name "ozhaawashkonebiisibens" of this small zhiishiib (duck) refers the blue-green color of the feathers. "Wewiibingwaange" is also used in some areas and has been translated by Cooke (1884) as "making a noise while fluttering its wings." There are place names in both Wisconsin and Michigan associated with this name (Wewiibingwaangeg-zaaga'igan or Teal Lake) and may be a reference to a historically high teal population at these locations.

Ozhaawashkonebiisibens utilizes shallow ponds and seasonal and permanent wetlands for feeding. Ozhaawashkonebiisibens is known by tribal members to feast on manoomin (wild rice) seeds. It nests in wetland areas within grasslands, such as shallow marshes, temporary ponds, and flooded ditches. Its late summer flightless molt period is spent in prairie potholes or large marshes. Ozhaawashkonebiisibens migrates south for the winter.

Ozhaawashkonebiisibensag are difficult to survey in a particular region as breeding locations shift across their entire range. There was a decline in the ozhaawashkonebiisibens population in Wisconsin in the 1970s and 1980s that corresponded with a regional decline. Since then, the Wisconsin population has remained low, but the population in the Prairie Pothole region (a region in the northern Great Plains including parts of the United States and Canada that contains thousands of shallow wetlands known as potholes) has dramatically increased. Over the past 19 years, ozhaawashkonebiisibens has made up about 10% of the off-reservation zhiishiib (duck) harvest by GLIFWC member tribes.

Ozhaawashkonebiisibens was mentioned infrequently in interviews. However, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. Tribal members from several communities reported observing a decrease in ozhaawashkonebiisibensag, along with other zhiishiibag. One individual from Nagaajiwanaang (Fond du Lac) said, “I remember our lakes used to be covered with them, and they’re down, really down.”

Summary of climate threats:

Ozhaawashkonebiisibens was in the 46th percentile relative to other flyers and in the 32nd percentile relative to other beings in the assessment. A migratory waterfowl species, ozhaawashkonebiisibens is not common in the Ceded Territories due to the mostly forested landscape, and any reductions in grassland will further reduce ozhaawashkonebiisibens habitat. Climate-related changes that may affect ozhaawashkonebiisibens are drying of wetlands and increases in pathogens and predators.

Factors that increase the vulnerability of ozhaawashkonebiisibens to climate change:

SI/I — Physiological hydrological niche: Seasonal and shallow marshes are particularly important to ozhaawashkonebiisibens and those wetlands are susceptible to drying. If drying occurs during the nesting and brooding season, this could cause significant regional losses of ozhaawashkonebiisibens.

SI/I — Pathogens or natural enemies: Both pathogens and predators of ozhaawashkonebiisibens are expected to increase. Ozhaawashkonebiisibens is susceptible to botulism and avian cholera, particularly as ducklings. Predation is also a big factor in limiting ozhaawashkonebiisibens populations. Zhingos (long-tailed weasels) often consume eggs. During incubation, females are vulnerable to predation by raptors and waagosh (red fox). Nest failure due to predation is often greater than 90%. Other predators include esibanag (raccoons), zhaangeweshiwag (minks), migiziwag (eagles), wiisagizi ma’iinganag (coyotes), zhigaagwag (skunks), and aandegwag (crows). Many of these predators are expected to be favored by climate change and are therefore expected to impact ozhaawashkonebiisibens populations.

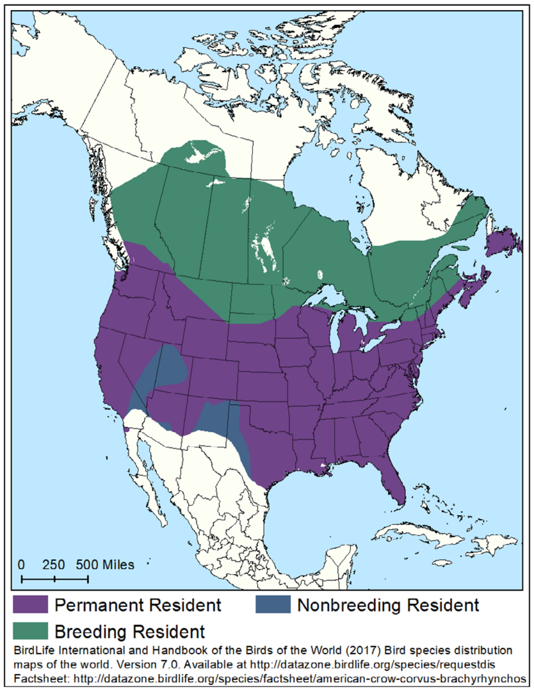
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

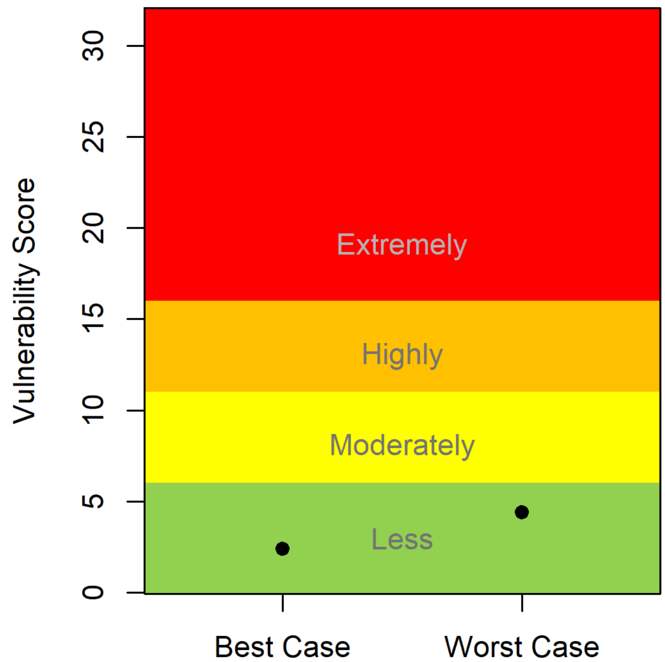
Aandeg

Aandegwag (plural) / American crow / *Corvus brachyrhynchos*

Less Vulnerable
(Confidence Level: High)



Range map of aandeg.



Climate change vulnerability scores for aandeg on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score. No error bars exist for this being because there was no variability in its scores.

General Description:

Aandeg, like all flyers, is highly respected and symbolic to Indigenous people, including the Ojibwe. Many traditional stories have been shared over the years about this being. One story describes its connection to fire. Mewinzha (a long time ago), the climate was consistently warm, but it was taken for granted by the Anishinaabeg. As a result, the climate shifted to continual cold and darkness. Aandeg saw this and took pity on the Anishinaabeg and with the Creator's help, brought fire to the Anishinaabeg. Some stories tell of how aandeg came to have feathers with an iridescent look, and others speak to why aandeg talks and sings with a rasp yet has the ability to mimic human and other animal sounds. Stories such as these are incorporated into sacred songs. For many, aandeg reminds them of teachings that speak to having a purpose in life. Like migizi, aandeg is often a messenger and carries out this responsibility in many ways.

Aandeg is found in a variety of habitats, particularly open landscapes with scattered trees and woodlots, but also in farmland, pasture, parks, golf courses, cemeteries, yards, and the shores of streams and marshes. Forest clearing, suburbanization, and agriculture have created abundant habitat for aandeg, which generally avoids large dense forested areas.

Aandeg was uncommon before the mid-1800s but became widespread in the Ceded Territories by the late 1800s due to abundant habitat created by clearing land. The population increased in the assessment area from 1966 – 2015 by over 0.25% per year.

The Ojibwe follow a lunar calendar that consists of 13 moons and has connections to phenological events. Aandego-giizis (Crow moon) is one name used for the month of March, in addition to Onaabani-giizis, which refers to the hard crust on the snow. Various elders during Traditional Ecological Knowledge interviews shared that Aandego-giizis (or Onaabani-giizis) is the time of year when aandeg arrives and announces the news that it is time to prepare for tapping ziizibaakwadwaatigoog (sugar maples). Tribal members described being inside their homes when hearing aandeg and in return, offering asemaa (tobacco) to give thanks. They also mentioned that aandeg often follows them around when they are carrying out activities in the forest and believe that aandeg communicates to others that they are respecting and utilizing the gifts given by the Creator. The changing climate in the Ceded Territories is already impacting these phenological connections; many years ziizibaakwadwaatig tapping (and the arrival of aandeg) occur prior to March.

Summary of climate threats:

Aandeg was in the 38th percentile relative to other flyers and in the 26th percentile relative to other beings in the assessment. Aandeg is an adaptable and mobile being with a broad distribution and is unlikely to be affected to a large extent by climate change. However, West Nile virus is a threat that has the potential to affect a large proportion of the population.

Factors that increase the vulnerability of aandeg to climate change:

I <u>Pathogens or natural enemies</u>: West Nile virus was identified in New York in 1999 and has since spread throughout North America, killing 57,000 aandegwag in the first 3 years. Aandeg is particularly sensitive to the virus, and outbreaks have caused local extirpations. West Nile virus is present in the Ceded Territories and has been found in over half of Wisconsin counties. It is carried by mosquitoes and can be transmitted in food or water. Higher temperatures and lower summer precipitation are likely to lead to more cases and a wider distribution of West Nile virus.

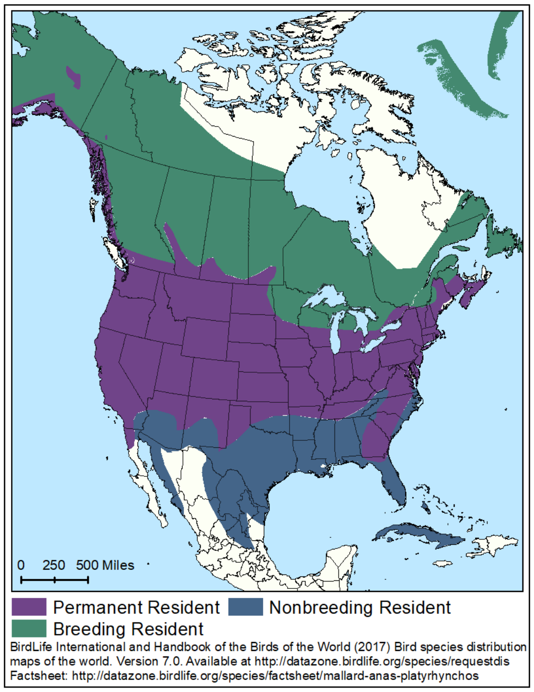
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

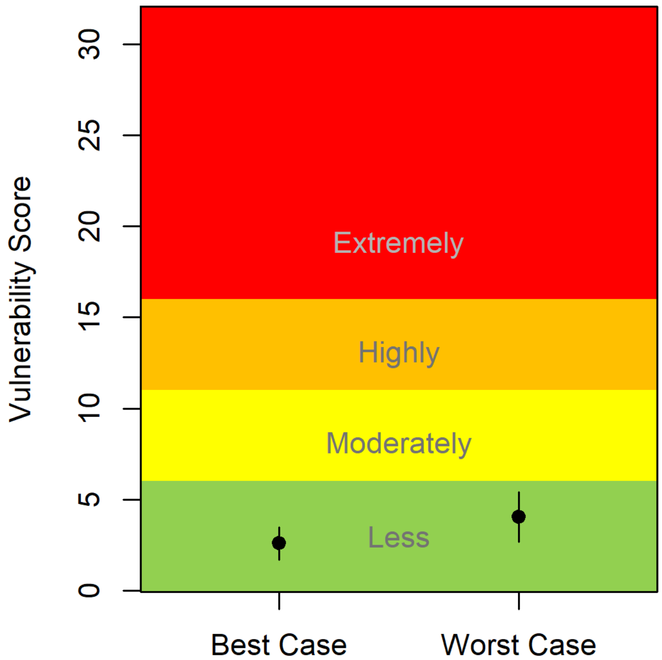
Ininishib

Ininishibag (plural) / Mallard / *Anas platyrhynchos*

Less Vulnerable
(Confidence Level: Moderate)



Range map of ininishib.



Climate change vulnerability scores for ininishib on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Ininishib and other zhiishiibag (ducks) play an important role in traditional Ojibwe teachings and stories which often include a cultural hero known as Wenaboozhoo. One version of a story in particular tells of when Wenaboozhoo went to visit ininishib and became hungry. Ininishib painted his head green and asked his wife to hang the kettle so that he could prepare some food for Wenaboozhoo. Ininishib then placed himself over the kettle and made specific sounds while his wife continuously stirred. Eventually Wenaboozhoo could hear manoomin (wild rice) cooking. Ininishib told Wenaboozhoo he needed to bring what he could not finish, back to his children (the Anishinaabeg).

There came a time that Wenaboozhoo also had company and found himself without food for his guest. He attempted to carry out the same ritual as ininishib. He painted his head green, asked his wife to hang the kettle, and repeated the same sounds as ininishib while his wife continuously stirred. Unfortunately, all he was able to produce was a droplet of dung. Having been embarrassed, his wife washed out the kettle. The guest then painted his own head green and made the same sounds over the kettle. Eventually manoomin came pouring out of his anus. Story summarized from *Wild Rice and the Ojibwe People*.

Ininishib lives in almost any kind of wetland habitat, including permanent wetlands such as bogs, marshes, floodplains, ponds, lakes, reservoirs, and city parks. It can also utilize seasonally flooded wetlands. Nests are typically located in grasslands near water, and very rarely in old bird nests or tree cavities. It is very tolerant of human activities. Individuals in the northern areas migrate to wintering habitat in the southern United States.

Ininishib is the most widespread and abundant duck in North America. Its population in Wisconsin and Michigan increased for several decades through the 1990s, but has since been stable or slightly declining, though the population estimate for ininishib in Wisconsin is currently high at over 180,000 individuals.

Ininishib is an important food source at certain times of the year and is the most harvested of the zhiishiibag. For the last 17 years, ininishib made up 35% of the tribal zhiishiibag harvest off-reservation (on average, 464 birds a year). Tribal members who spoke about this being felt that they were seeing fewer of them now than in the past, and that this decline might be due to changes in climate. During a Traditional Ecological Knowledge interview with Mashkiiziibiing (Bad River) tribal members, a memory was shared of when an ininishib was seen in February of 2012 in a pond somewhere on the reservation. The interviewee believed the ininishib may have become a year-round resident at the Ashland, Wisconsin area hot ponds, where warm water is discharged in the spring which draws in various fish beings such as noosa'owesi (smallmouth bass), ginoozhe (pike), and ogaa (walleye).

Summary of climate threats:

Ininishib was in the 31st percentile relative to other flyers and in the 24th percentile relative to other beings in the vulnerability assessment. Ininishib is a highly adaptable being that has the potential to adapt to most climate-related changes, though there is the potential for changes in disturbance regime (e.g., drought) or pathogens and predators to impact ininishib.

Factors that increase the vulnerability of ininishib vulnerability to climate change:

N/SI Disturbance regime: Ininishib populations within the assessment area may be dependent on dynamics in this or other regions, especially the prairie pothole region. Widespread drought in prairies or in the assessment area may have negative effects on the population as a whole.

SI Pathogens or natural enemies: Ininishib is susceptible to parasites and diseases that have the potential to increase in the Ceded Territories as climate change favors conditions for those vectors. Additionally, ininishib is often found in urban areas close to humans, which can increase contact with vectors from domesticated waterfowl. Examples of pathogens that may affect ininishib are avian cholera, avian influenza, avian botulism, aspergillosis, duck plague, duck viral enteritis, blood parasites, and coccidiosis. An avian cholera outbreak in Nebraska in the late 1970s killed over 72,000 birds, 30% of which were ininishibag. Warm temperatures and dry conditions (leading to low lake levels) will increase the prevalence of avian botulism, which killed 1.5 million ducks in California in the mid-1900s. There are many ininishib predators which may be favored by climate change as well, such as esiban (raccoon), zhigaag (skunk), aandeg (American crow), gaagaagi (common raven), migizi (bald eagle), and other raptors. Several pathogens and predators that may negatively affect ininishib populations as climate change progresses.

N/SI Documented response to climate change: Ininishib was mentioned as declining by at least two interviewees.

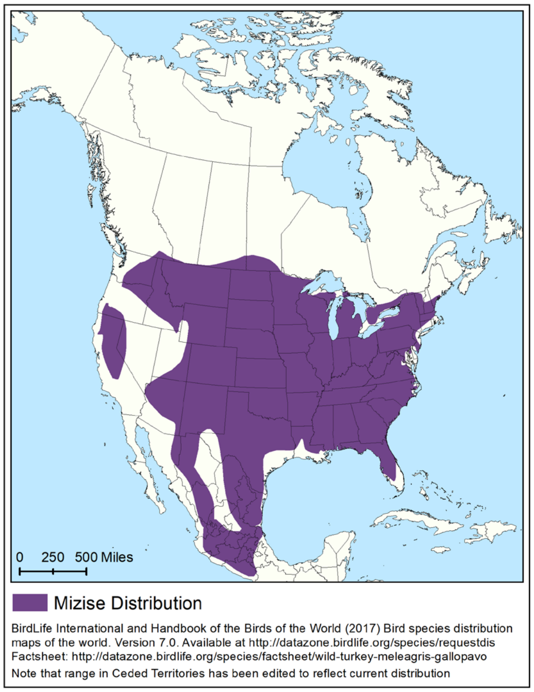
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

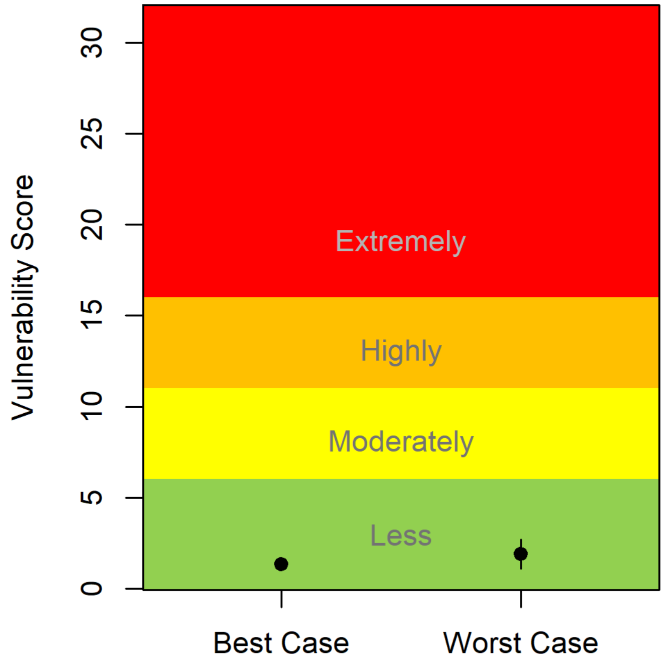
Mizise

Miziseg (plural) / Wild turkey / *Meleagris gallopavo*

Less Vulnerable
(Confidence Level: High)



Range map of mizise.



Climate change vulnerability scores for mizise on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Mizise is also known as giche-bine, particularly around the Red Lake Reservation. Mizise is one of a group of beings for which little Traditional Ecological Knowledge was shared during the interview process, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation.

Mizise occupies a variety of habitats, including both hardwood and mixed coniferous-hardwood forests. Preferred forests are oak and pine as well as lowland hardwood forests. These forests are typically interspersed with openings such as fields, pastures, or grasslands. Mizise is often seen in large groups on the sides of roads or in backyards.

Mizise was historically found in southern and central Wisconsin but was extirpated from the upper Midwest by 1900 due to habitat loss, a thriving wild game market, and unregulated hunting. There were several failed attempts at reintroduction between 1887 and 1957. In the mid-1970s, miziseg were reintroduced successfully in southern parts of Wisconsin. After 30 years, the population has recovered and mizise is currently found throughout Wisconsin and much of Michigan and Minnesota. An average of 32 miziseg per year have been harvested off-reservation by tribal hunters since 2005.

Tribal members who did mention miziseg in interviews suggested that they are increasing in both numbers and in range, with individuals from Odaawaa-zaaga'iganiing (Lac Courte Oreilles) and Mashkiiziibiing (Bad River) saying that in the past they were rarely seen and now are common, especially along roadsides, where they often cause damage to cars. One individual from Nagaajiwanaang (Fond du Lac) attributed this increase to climate change and milder winters. An interviewee from Odaawaa-zaaga'iganiing suggested that miziseg ruin the land by scratching up all the grass and "digging up all the worms and things that fertilize the ground." It was also mentioned during another interview in Odaawaa-zaaga'iganiing that miziseg will continue to thrive until they are threatened more by larger predators.

Summary of climate threats:

Mizise was in the 15th percentile relative to other flyers and in the 9th percentile relative to other beings in the assessment. Mizise is not likely to be negatively impacted by climate change, and will likely benefit from many aspects, such as less severe winters, smaller snowpack, drier conditions that favor its preferred habitats, and warmer winter temperatures. One climate-related factor that might affect mizise is an increase in pathogen prevalence.

Factors that increase the vulnerability of mizise to climate change:

N/SI Pathogens or natural enemies: As its population continues to increase, mizise could come into more contact with humans and domestic poultry, which can carry transmissible diseases such as avian influenza. High densities of mizise could also be affected by pathogens such as avian pox and blackhead, both of which are currently uncommon but could increase in prevalence as climate conditions change and become more suitable for the vectors of those diseases.

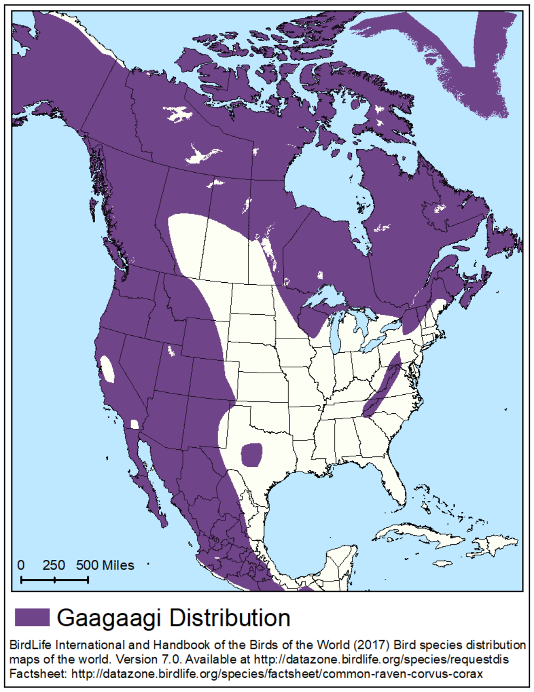
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

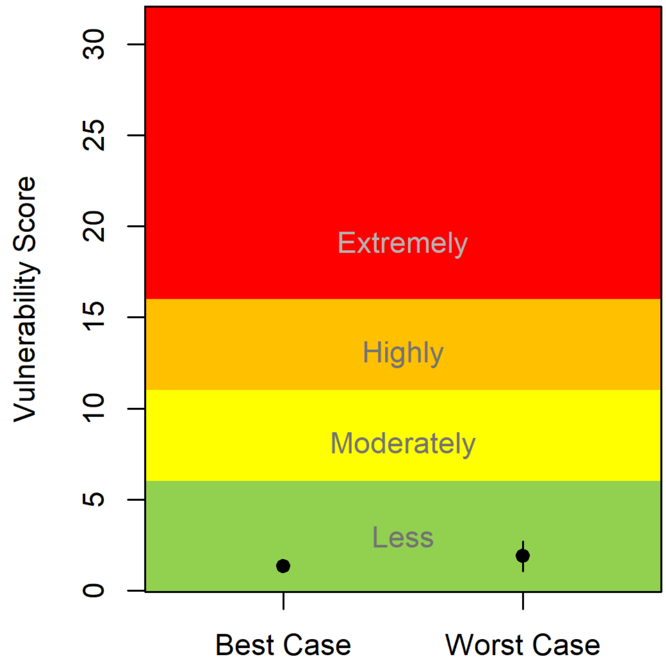
Gaagaagi

Gaagaagiwag (plural) / Common raven / *Corvus corax*

Less Vulnerable
(Confidence Level: Moderate)



Range map of gaagaagi.



Climate change vulnerability scores for gaagaagi on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Gaagaagi is highly intelligent and can solve complicated problems as well as adult apes and chimpanzees. Experiments have shown that it is able to remember past events, plan for the future, understand numbers, follow cues, and make tools, among other abilities.

Gaagaagiwag are called “wolf birds” by various cultures and are known to form reciprocal relationships with ma’iinganag (wolves). Gaagaagiwag have often been observed not only feeding alongside ma’iinganag at kills but also playing with ma’iingaansag (wolf pups).

Gaagaagi is a year-round resident of the Ceded Territories and lives in a large variety of habitats, including boreal, coniferous, and deciduous forests, prairies and grasslands, suburban and urban areas, and agricultural fields. Locations with cliffs, trees, or manmade structures such as power poles, bridges, or billboards are preferred for nesting. Habitats with complex topography that create thermals for soaring while foraging are also preferred.

Historically, gaagaagi was common and found as far south as Ohio, Indiana, and Illinois, but was extirpated from those states and other areas south of the Ceded Territories due to forest clearing and shooting. Its population has since begun increasing and reclaiming parts of its former range, although it is still restricted to the northern parts of the Midwest. The gaagaagi population has expanded throughout most of the Ceded Territories from 1966 to 2013 by more than 1.5% per year, and gaagaagiwag are becoming more adept at living near humans. Gaagaagiwag in the Ceded Territories are reflected in very few place names including

Gaagaagiwigwani-zaaga'igan (Raven Wing Lake), also known as Gaagaagimiigwani-zaaga'igan (Raven Feather Lake) in northeastern Minnesota.

Gaagaagi was mentioned infrequently in interviews, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. An interviewee from Ginoozhekaaning (Bay Mills) shared that there are a few examples of plant names associated with gaagaagi, however the significance of these names is unknown. Hemlock, for example, is referred to as gaagaagimizh (raven small tree or shrub). The suffix “-mizh” implies that it is a small tree or shrub, despite how large hemlocks can grow. It may be the case that this name was originally used for another plant that resembled a hemlock. Additionally, the wild black currant plant is known as gaagaagimin (raven berries) in some regions.

Summary of climate threats:

Gaagaagi was in the 20th percentile relative to other flyers and in the 10th percentile relative to other beings in the assessment. Gaagaagi is an adaptable and mobile being that is unlikely to see significant effects from climate change, although it is currently restricted to the northern third of Michigan, Minnesota, and Wisconsin. Gaagaagi may be affected by interactions with other beings.

Factors that increase the vulnerability of gaagaagi to climate change:

N/SI — Interspecific interactions: Models developed for Yellowstone National Park show that shorter winters resulted in a substantial reduction of late-winter carrion, on which gaagaagiwag depend. However, this was without the presence of ma’iinganag; ma’iinganag in the Ceded Territories may buffer these effects by providing meat for gaagaagi year-round. Though ma’iingan is not highly vulnerable to climate change, its populations are largely determined by politics and may fluctuate in the future, therefore affecting gaagaagi.

Legend

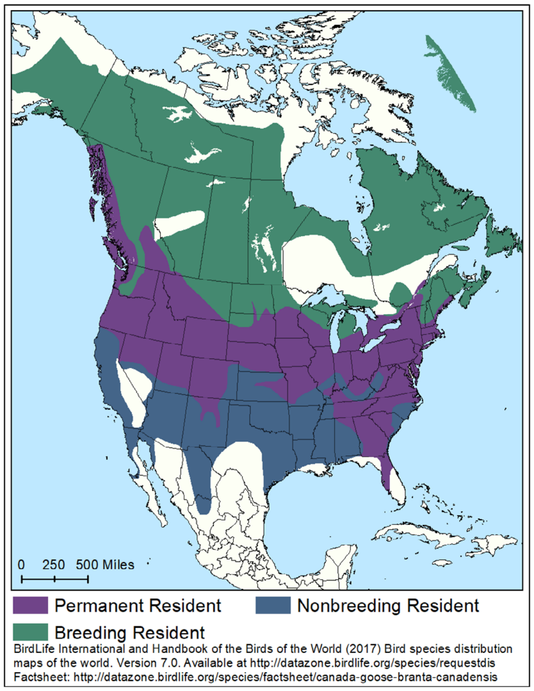
GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Nika

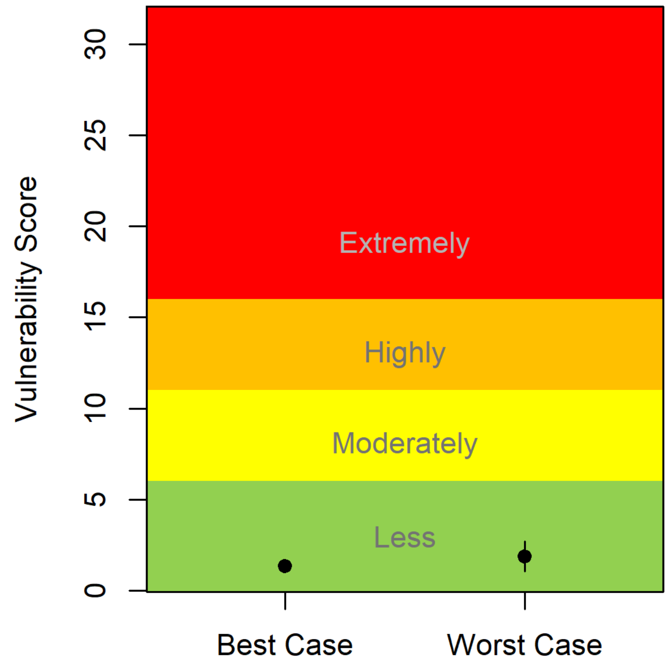
Nikag (plural) / Canada goose / *Branta canadensis*

Less Vulnerable

(Confidence Level: Moderate)



Range map of nika.



Climate change vulnerability scores for nika on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

In the Ojibwe culture, many stories are told about the interaction between various beings and the spirit being Wenaboozhoo who is known to be a hero or trickster, and one who teaches life lessons through his often-mischievous actions. One story in particular relates to nika. Wenaboozhoo was in a forest near a lake searching for food when he heard nikag flying over. The nikag became exhausted while migrating so they decided to take a break on the small lake. Since Wenaboozhoo was so hungry he decided to sneak into the water below them and use cedar cordage to tie the feet of a few of them together for a good meal. In the process he became greedy and tied the feet of all the nikag together. He then startled the nika in the middle and it took off flying, pulling all of the others with it. Wenaboozhoo was still hanging onto one of the nikag as they flew and eventually dropped down into a swamp. All the nikag remained tied to the one in the middle, causing them to fly in the formation of a V, which they can still be observed doing to this day.

Nika is one of a group of beings for which little Traditional Ecological Knowledge was shared during the interview process, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation.

Nikag occupy a wide variety of habitats near lakes, rivers, ponds, or other bodies of water, and are found in yards, park lawns, farm fields, and wetlands with abundant aquatic vegetation. Preferred nesting habitat is on dry ground near water and feeding areas, and nests can be built on the ground, on muskrat lodges, on platforms, or on cliffs. Nikag usually return to the nesting territory used in previous years.

In the Ceded Territories there are both resident and migratory nikag. The resident population has increased dramatically in the last 25 years; the migratory population seems to be stable or slightly declining. The development of large mowed grassy areas has provided nika with additional habitat.

A few tribal members shared information about nika abundance in their communities. Some mentioned seeing them more frequently, and others reported a decline. One Nagaajiwanaang (Fond du Lac) interviewee reported that nikag were "up to the bad, they're becoming like an invasive." During an interview in Waaswaaganing (Lac du Flambeau) in August of 2015, a few tribal members noted their observation of an increase in population, and that "years back nikag weren't much of a problem." There is also concern that increased grazing by nikag on young manoomin (wild rice) plants is decreasing or even decimating manoomin populations on some waters. Tribal harvest off-reservation over the last four years has averaged 621 nikag per year.

Summary of climate threats:

Nika was the least vulnerable flyer and was in the 7th percentile relative to all other beings in the assessment. Nika is an adaptable and long-lived being that will likely not be affected to a large extent by climate change. The resident population has expanded rapidly and most climate-related changes, such as warmer temperatures and land use changes, will benefit nika. However, there are pathogens that may affect nika as conditions change.

Factors that increase the vulnerability of nika to climate change:

N/SI Pathogens or natural enemies: Nika is susceptible to avian influenza, which may increase in prevalence as climate change creates conditions that favor the vector. Large populations and high densities of nika in an area make it even more susceptible, as disease can quickly spread. There are other possible disease vectors that could negatively affect nika as well as increases in predators that target nika eggs or chicks, such as gaagaagi (common raven), aandeg (American crow), waagosh (red fox), wiisagizi ma'iingan (coyote), esiban (raccoon), and gidagaa-bizhiw (bobcat) and that will be favored by climate change.

Legend			
GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability
I	**Increase** This factor increases vulnerability	SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability
SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Crawlers

Crawlers are those beings in the animal world who crawl on the ground. Crawlers are in the third order of creation:

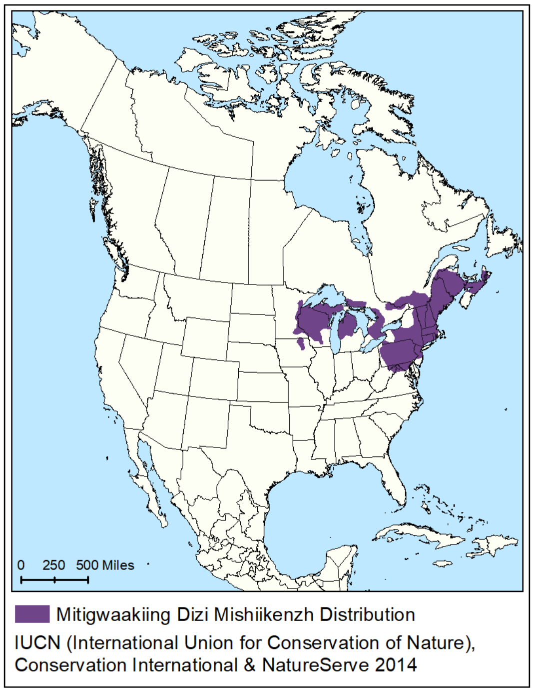
> "Great Spirit decided to create everything in the third order and that would be the animal world. All those that swam under the surface of the water, those that stood in the forest on four legs, those that flew through the air like migizi, the eagle, geese, and others." —*Moka'ang Giizis-Rising Sun Joe Rose Sr.*

For complete results from the Climate Change Vulnerability Index, see Appendix 5. For references associated with a particular being or beings, please contact the author team.

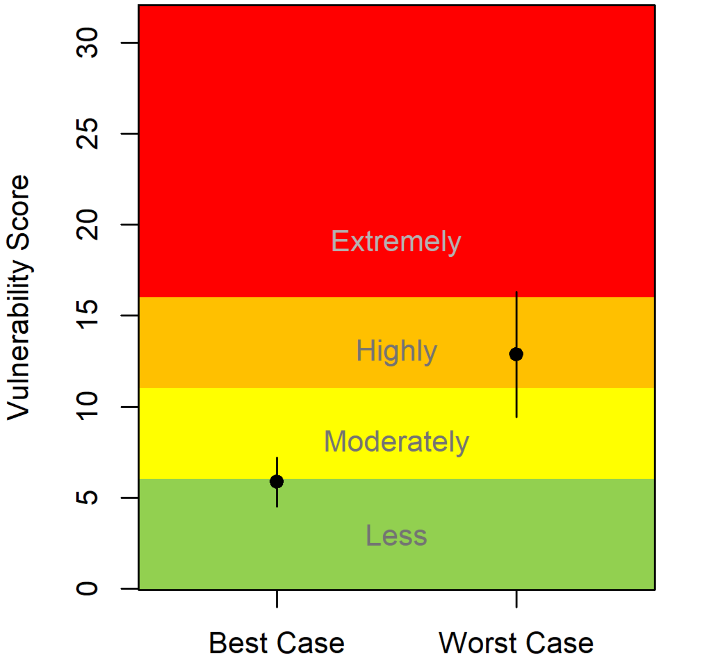
Mitigwaakiing dizi mishiikenzh

Mitigwaakiing dizi mishiikenyag (plural) / Wood turtle / *Glyptemys insculpta*

Less - Highly Vulnerable
(Confidence Level: Moderate)



Range map of mitigwaakiing dizi mishiikenzh.



Climate change vulnerability scores for mitigwaakiing dizi mishiikenzh on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Mitigwaakiing dizi mishiikenzh, along with other turtles, is a part of the Ojibwe clan system and is believed to be descended from the Giigoonh (Fish) Clan. Members of this clan are known and respected for their wisdom, patience, and their abilities to teach and heal.

Mitigwaakiing dizi mishiikenzh lives near moving water, preferring clear, medium-sized, hard-bottomed (sand, gravel, or cobble substrate) streams and rivers. Mitigwaakiing dizi mishiikenzh also uses a variety of forested habitats near water, as well as meadows, fields, pastures, swamps, and bogs. Eggs are laid in areas with sandy or gravelly substrates such as sand banks, barrens, agricultural fields, gravel pits, yards, gardens, and roadsides. Over the winter, mitigwaakiing dizi mishiikenzh lives underwater in deep pools, under overhanging banks, roots, and logs, and in beaver lodges and muskrat burrows.

The mitigwaakiing dizi mishiikenzh population is thought to have been in decline throughout the last century and is currently threatened by over-collection for the pet trade, habitat loss, and fragmentation. Currently, mitigwaakiing dizi mishiikenzh is found in many small, isolated populations across its range that generally range from 66 to 238 individuals. Mitigwaakiing dizi mishiikenzh range includes most of the Wisconsin and Michigan portions of the Ceded Territories, but only a few counties in Minnesota. Mitigwaakiing dizi mishiikenzh is listed as a threatened being by the states of Minnesota and Wisconsin, and a being of special concern by the state of Michigan.

Although turtles in general were mentioned frequently during interviews, mitigwaakiing dizi mishiikenzh was not. However, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. What was consistently expressed during the interviews was a strong concern regarding their low population and vulnerability to many factors such as climate change. A fear of other turtle beings also eventually declining was expressed by an elder of Gete-gitigaaning (Lac Vieux Desert). She felt that the low population of mitigwaakiing dizi mishiikenzh might be a sign of decline in others yet to come.

Also of importance is that the Ojibwe name for this particular turtle being was difficult to obtain. Knowledge holders expressed that this is likely due to their low population over so many years and a shift in cultural knowledge as it relates to this being. The name of mitigwaakiing dizi mishiikenzh was suggested by a first language Ojibwe speaker in the Treaty 3 area of Ontario, Canada.

Summary of climate threats:

Mitigwaakiing dizi mishiikenzh was the most vulnerable crawler and in the 69th percentile relative to other beings in the vulnerability assessment. Mitigwaakiing dizi mishiikenzh is threatened by humans in several ways and is also highly vulnerable to the loss of individuals from a population, as their isolated populations are so small. On top of these threats, climate change poses added threats to mitigwaakiing dizi mishiikenzh, which will likely be affected by natural and anthropogenic barriers, limited dispersal, disturbances such as flooding, limited nesting habitat, and pathogens and predators.

Factors that increase the vulnerability of mitigwaakiing dizi mishiikenzh to climate change:

SI/I Natural barriers: Lake Superior is a barrier to the north of the Ceded Territories that would limit mitigwaakiing dizi mishiikenzh northward movement, particularly because mitigwaakiing dizi mishiikenzh is not currently found north of Lake Superior.

SI Anthropogenic barriers: Roads and railroads are the primary anthropogenic barriers to mitigwaakiing dizi mishiikenzh in the Ceded Territories. Others include agricultural fields, urban areas, and channelized streams.

N/SI Dispersal: Mitigwaakiing dizi mishiikenzh is capable of longer movements but has high site fidelity and rarely disperses. Individuals have been observed using the same hibernation and nesting location in successive years. Additionally, fragmentation of suitable habitat limits dispersal.

SI/I Disturbance regime: Extreme precipitation events and flooding can affect mitigwaakiing dizi mishiikenzh in several ways, including direct mortality from drowning, washing out or eroding nests, flooding nests that causes hatch failures, or even burying nests.

SI Uncommon landscape features: Nesting habitat for mitigwaakiing dizi mishiikenyag is largely found in non-natural sites such as road shoulders and gravel pits and is not extremely common across the assessment area.

SI/I Pathogens or natural enemies: Unknown and known fungal and bacterial pathogens could increase in warming climate and negatively affect mitigwaakiing dizi mishiikenzh. There are also a variety of predators that consume mitigwaakiing dizi mishiikenzh eggs that are expected to be favored by climate change, particularly esiban (raccoon), zhigaag (skunk), and waagosh (fox). Nest predation and adult mortality are both major threats to mishiikenzh.

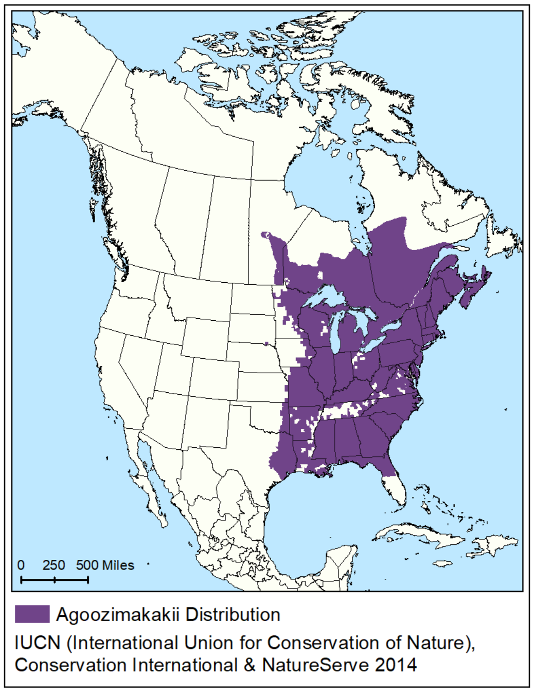
Legend

GI **Greatly Increase** This factor greatly increases vulnerability	**I/GI** **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I** **Increase** This factor increases vulnerability
SI/I **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI** **Somewhat Increase** This factor somewhat increases vulnerability	**N/SI** **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

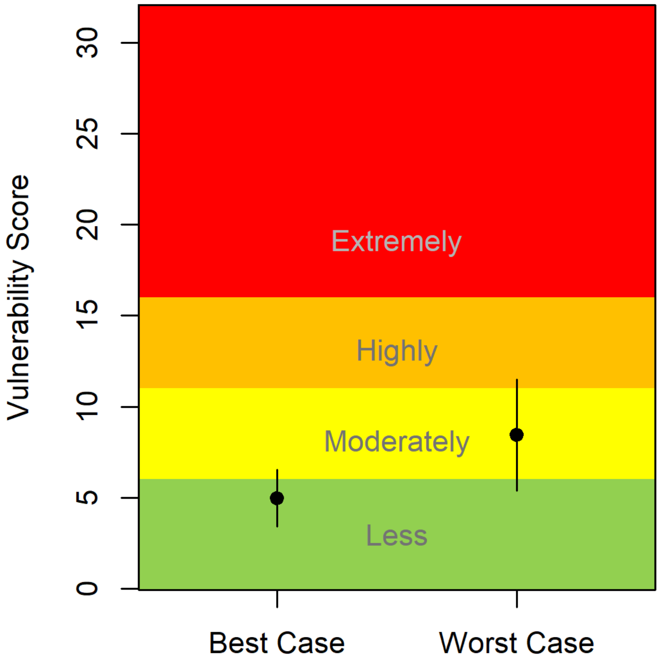
Agoozimakakii

Agoozimakakiig (plural) / Spring peeper / *Pseudacris crucifer*

Less - Moderately Vulnerable
(Confidence Level: Moderate)



Range map of agoozimakakii.



Climate change vulnerability scores for agoozimakakii on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Agoozimakakiig are best known for their calls and their connection to the weather and phenology. An elder in Nagaajiwanaang (Fond du Lac) mentioned that their singing serves as a barometer and can be used to forecast the weather. Agoozimakakii calls also indicate when it is time to harvest certain giigoonyag (fish).

Agoozimakakii lives in wooded areas near temporary, semipermanent, or permanent ponds, marshes, or swamps where it breeds. Agoozimakakii is ground-dwelling and hides under the leaf litter, logs, and rocks in the winter and when not active. Males call to attract mates from vegetation adjacent to or standing in water.

There is not a lot known about agoozimakakii population, but citizen science data in Wisconsin indicate that it is abundant and populations have appeared to be relatively stable for the past 35 years. It is also the most abundant frog in Michigan and is common statewide. In Minnesota, it is found in the eastern half of the state.

Tribal members from seven out of 11 GLIFWC member tribes mentioned agoozimakakiig during interviews, two of which expressed concern about an observed decrease in their population. A member of Mashkiiziibiing (Bad River) stated in 2017 that they were hearing them as early as February, which meant the weather was changing earlier than expected and it was time to prepare for spring activities. A Waaswaaganing (Lac du Flambeau) member shared that their songs tease the ogaa (walleye) and maashkinoozhe (muskellunge) and brings them closer to the shore, and the Anishinaabeg are then able to start spearing them. An elder in Gaa-miskwaabikaang (Red Cliff) from Mashkiiziibiing said her mom used to share the same knowledge and that it was so consistent and important that she lived by it. The singing of agoozimakakii also serves as an indicator for other giigoonyag. An elder of Ginoozhekaaning (Bay Mills) said their sound indicates the smelt are running.

An elder in Misi-zaaga'iganiing (Mille Lacs) mentioned that she knows the name (sturgeon) are spawning when she hears agoozimakakiig sing with a steady whistle.

The same Misi-zaaga'iganiing elder expressed concern about various omakakiig (frogs). She mentioned that one of their jobs is to clean the water, and because of water pollution their population is decreasing, some have deformities, and they're not able to clean the water as much anymore. An elder of Zaka'aaganing (Mole Lake) expressed concern about how they used to scatter anytime he would get near them, but now they move away slowly or sometimes even stay put. He felt that this means they're trying to communicate something important to us.

Summary of climate threats:

Agoozimakakii was in the 75th percentile relative to other crawlers and in the 49th percentile compared to other beings in the vulnerability assessment. Amphibians are cold-blooded (ectotherms) and dependent on their environment for temperature regulation, which may make them more sensitive to climate change. Agoozimakakii is vulnerable to climate change by way of natural and anthropogenic barriers, limited dispersal, hydrological niche (sensitivity to changes in precipitation), changes in disturbance regime, and low genetic variation.

Factors that increase the vulnerability of agoozimakakii to climate change:

N/SI — Natural barriers: Non-wetland habitat is a barrier to agoozimakakii, and breeding wetlands are becoming increasingly isolated. However, the assessment area still contains a high proportion of intact wetlands, and there is some research to suggest that open areas are not as inhospitable as previously thought.

N/SI — Anthropogenic barriers: Roadways, agriculture, and deforestation are all anthropogenic barriers that have been shown to limit the movement of agoozimakakii. Use of breeding wetlands near roads is reduced. Salt from roadways may negatively impact wetlands near roads for agoozimakakii habitat.

SI — Dispersal: Agoozimakakii moves from breeding ponds to forested areas, but often moves short distances. Maximum dispersal distances for agoozimakakii are around ~1/3 mile.

SI/I — Physiological hydrological niche: Agoozimakakii is dependent on vernal (temporary) pools for breeding that dry up later in the season. Changes in precipitation may have effects on the availability of vernal pools. Agoozimakakii can migrate to deeper wetlands during dry years, but only if there are deeper wetlands nearby.

SI — Disturbance regime: Drought and flooding will both affect agoozimakakii. Extreme drought will reduce breeding habitat and dry up vernal pools, and flooding will inundate vernal pools in the spring, which may change the nature of the pools and allow fish to begin breeding, making it unsuitable for agoozimakakii.

N/SI — Genetic variation: Genetic variation of agoozimakakii is reported as low to moderate in the assessment area, which may indicate a low ability to adapt to climate-related changes. However, since the population in the region is large, this may not be too much of a concern.

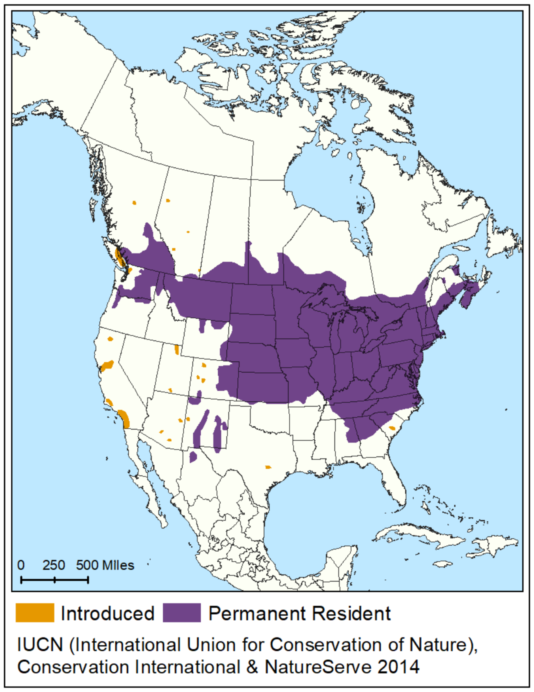
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

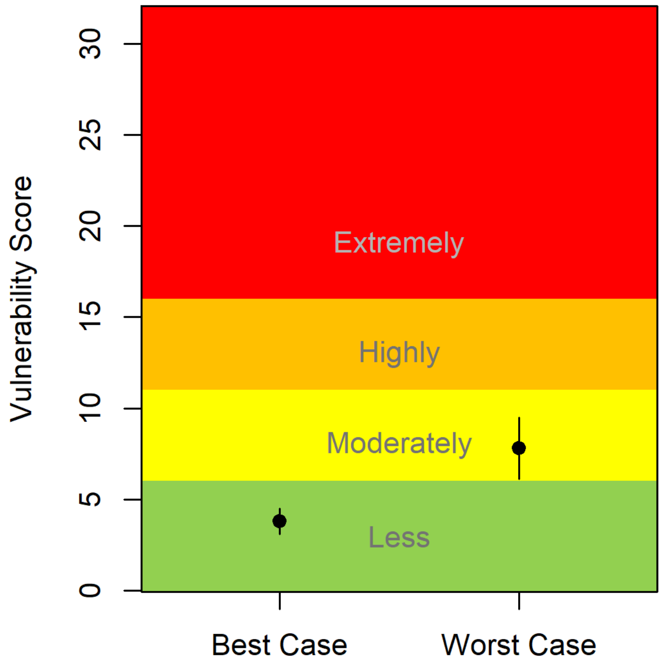
Miskwaadesi

Miskwaadesiwag (plural) / Painted turtle / *Chrysemys picta*

Less - Moderately Vulnerable
(Confidence Level: Moderate)



Range map of miskwaadesi.



Climate change vulnerability scores for miskwaadesi on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Some stories featuring miskwaadesi tell of how the makwa (bear) came to have a back with a hump in it. Miskwaadesi fed what was said to be miinan (blueberries) to makwa. Makwa then asked where the miinan were and miskwaadesi told him that they were up over the hill. Makwa realized they weren't really miinan and wrestled with miskwaadesi and killed him. Eventually miskwaadesi came back to life and wrestled with makwa, breaking makwa's back and killing him. It is said from that moment on, all makwag have humps on their backs.

Miskwaadesi lives in shallow water habitats with slow-moving water, such as ponds, lakes, marshes, and creeks. It uses sites that have soft or muddy bottoms, basking sites, and dense aquatic vegetation. Miskwaadesi eats aquatic vegetation, insects, crustaceans, and fish. During the day, it can often be seen basking on logs or rocks for warmth. In the winter, miskwaadesi hibernates in the mucky bottom. Eggs are laid on land in soft sandy soil in the spring.

Miskwaadesi, like other turtles, has low reproductive success due to high levels of egg predation, but females live long lives (there are reports of one individual surviving to 55 years) and produce large clutches (4-10 eggs). The western painted turtle is the more abundant of the two subspecies found in the Ceded Territories, although the midland painted turtle is also found in the region. Habitat loss and road crossings are the two biggest threats to miskwaadesi.

Miskwaadesi wasn't spoken of in interviews as much as other beings, but it was mentioned as a culturally significant being to the Ojibwe people. Miskwaadesi was a major food source for the Ojibwe for many years but is rarely eaten today. Today, the shell is commonly used for rattles and shields for both ceremonial and craft purposes. There are numerous stories involving turtles, one of which is of great importance to the Ojibwe people and tells of the creation story in which earth was placed on the back of a turtle to create Turtle Island, also known as North America. The Ojibwe follow a lunar calendar system which references thirteen moons on the turtle's back.

Summary of climate threats:

Miskwaadesi was in the 50th percentile relative to other crawlers and in the 43rd percentile relative to other beings in the vulnerability assessment. Miskwaadesi may be vulnerable to climate change in many ways, including natural and anthropogenic barriers, limited dispersal, increased disturbances, and an increase in pathogens and predators. Temperature directly affects the sex of miskwaadesi offspring; warmer temperatures mean more females will hatch from nests. In the Ceded Territories, this may have a positive effect on the miskwaadesi population.

Factors that increase the vulnerability of miskwaadesi to climate change:

N/SI	Natural barriers: Lake Superior is a barrier to the north of the Ceded Territories that would limit miskwaadesi northward movement.
SI	Anthropogenic barriers: Roads and railroads are barriers to miskwaadesi movement. Many individuals are killed by vehicles when attempting to cross roads (often to lay eggs in the spring), and females tend to move farther than males and are therefore more prone to road mortality. Farm equipment can be harmful to miskwaadesi attempting to cross agricultural fields.
SI	Dispersal: Although miskwaadesi is capable of dispersal, it is a slow disperser. It also hides when threatened by vehicles and other potential threats, slowing down dispersal. Some literature questions the ability of miskwaadesi to disperse to its preferred habitat as the climate changes.
N/SI	Disturbance regime: Extreme precipitation events can wash out or erode miskwaadesi nests or prevent them from drying, which can reduce hatching rates.
SI	Pathogens or natural enemies: Unknown and known fungal and/or bacterial pathogens such as herpesvirus and ranavirus could proliferate in warming climates. These viruses can increase stress, compromise immune systems, and potentially lead to range-wide or isolated declines in population.

Legend

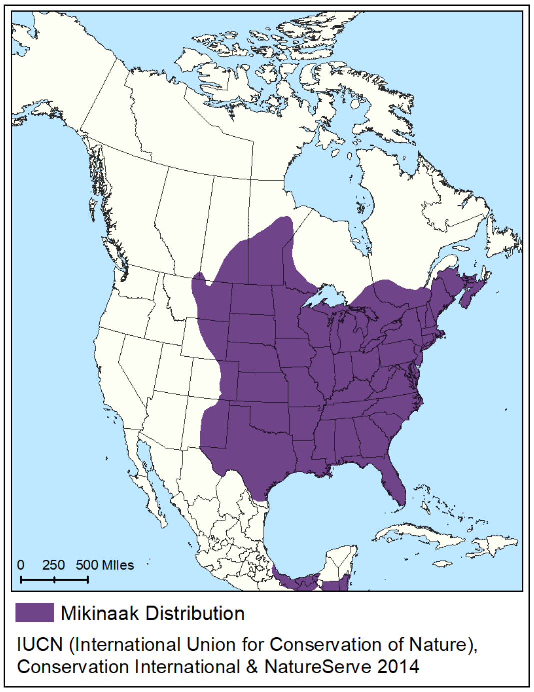
GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Mikinaak

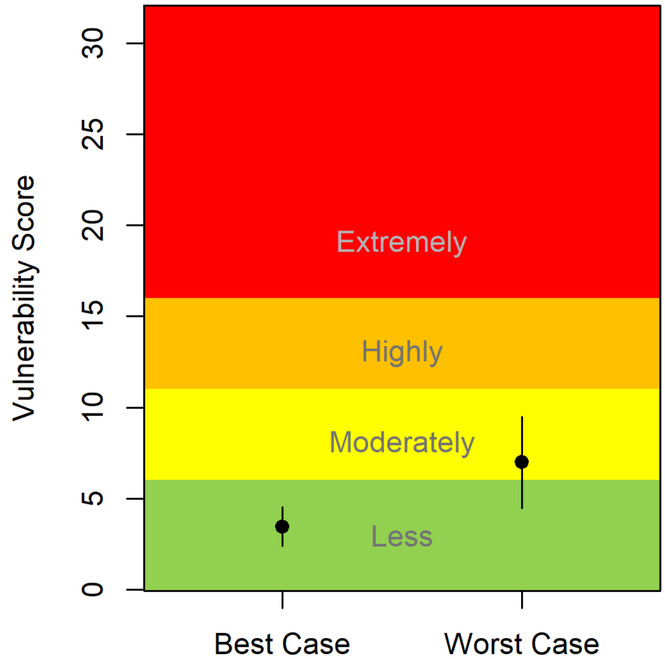
Mikinaakwag (plural) / Snapping turtle / *Chelydra serpentina*

Less - Moderately Vulnerable

(Confidence Level: Moderate)



Range map of mikinaak.



Climate change vulnerability scores for mikinaak on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Mewinzha (a long time ago), when the Creator placed human beings on earth, he gave them important instructions known as the seven grandfather teachings. These teachings told humans to carry themselves according to values such as respect, humility, and kindness. However, the Creator noticed that the humans were not following the teachings and were treating each other and the earth poorly. Knowing that, he decided to send down water so that all could be cleansed. A great flood ensued which covered the entire earth. Wenaboozhoo and a few other awesiinh (animal) beings were the only ones to survive. Wenaboozhoo survived by floating on a large log, but he quickly began to slip. A giant mikinaak (also sometimes referred to as a sea turtle) saw Wenboozhoo struggling and rose up underneath to save him. As they went along, Wenaboozhoo pulled up the other awesiinh onto the back of mikinaak. Eventually they all decided the only way they could continue to survive was for them to dive down to grab some of the earth below and place it on the back of mikinaak. One by one each awesiinh tried and one by one they each failed. Finally, despite being laughed at, the smallest of them all, wazhashk (muskrat), volunteered to dive down. As time went by, Wenaboozhoo and all the other awesiinyag became very worried. Wazhashk had been down under the water longer than any of the others. Finally, his little body surfaced, and they all realized he was no longer alive. However, they noticed his little hand was closed very tightly. When they gently opened his paw, they were shocked to see it held a small amount of earth. They then placed the earth on the back of mikinaak. Shortly afterwards they watched as grass and trees quickly began to grow, which led to the “recreation” on the back of mikinaak, now referred to as “Turtle Island” and commonly known as North America.

According to an elder from Mashkiiziibiing (Bad River), the shell of mikinaak is often used to tell this story. He also specified that their shells contain thirteen sections, relating to other teachings about the thirteen moons, also referred to as months, of the Ojibwe lunar calendar.

Mikinaak is a part of the Ojibwe clan system and is said to have descended from the Giigoonh (Fish) Clan. Mikinaak clan are known and respected for their wisdom, patience, and their abilities to teach and heal.

Mikinaak can inhabit almost any kind of water body, including rivers, lakes, reservoirs, ponds, streams, marshes, and swamps. It prefers places with soft muddy bottoms and abundant aquatic vegetation. Sometimes mikinaak basks out of the water but is usually found on the bottom. Mikinaak hibernates in the mud, in muskrat tunnels, or under overhanging banks. Eggs are laid in soft soil in open areas away from the water. Mikinaak feeds on aquatic vegetation and aquatic animals including fish.

Mikinaak, like other turtles, has low reproductive success due to high levels of egg predation, but females live long lives and produce large clutches. In Michigan, mikinaak was trapped heavily in the 1980s, which reduced populations, though by 2009 the population had recovered. Current population numbers throughout the region are unknown, and due in part to this lack of data, mikinaak is not a protected being. Various place names in Ojibwe referring to mikinaak are found throughout the Ceded Territories. Gichi-mikinaakong-minis (The Island of the Great Snapping Turtle), Mikinaako-neyaashi (Snapping Turtle Point), and Mikinaako-zaaga'iganiing (Place of Snapping Turtle Lake) are just a few of the many examples throughout the region.

During interviews with knowledge holders, turtle in general was mentioned frequently. Specific to mikinaak, an elder in Odaawaa-zaaga'iganiing (Lac Courte Oreilles) shared his concern about their vulnerability to predators, especially their eggs. An elder in Misi-zaaga'iganiing (Mille Lacs) also mentioned that his family (especially grandparents) used to eat them periodically when he was young, though he never did; as he got older, he saw a significant decrease in their population. A group of knowledge holders in Waaswaaganing (Lac du Flambeau) also referenced the connection between mikinaak and the Ojibwe Creation story.

Summary of climate threats:

Mikinaak was the least vulnerable crawler and was in the 41st percentile relative to other beings in the vulnerability assessment. Temperature directly affects the sex of mikinaak offspring; warmer temperatures result in a higher percentage of female hatchlings. Mikinaak is also affected by natural and anthropogenic barriers, disturbances such as flooding, pathogens, predators, and low genetic variation.

Factors that increase the vulnerability of mikinaak to climate change:

N/SI Natural barriers: Lake Superior is a barrier to the north of the Ceded Territories that would limit mikinaak northward movement.

N/SI Anthropogenic barriers: Roads and railroads are barriers to mikinaak movement. Many individuals are killed while attempting to cross roads or lay eggs; females tend to move farther than males and are more susceptible to road mortality.

N/SI Disturbance regime: Extreme precipitation events can wash out or erode mikinaak nests. Flooding can also disrupt moisture levels in nests, causing hatch failures.

SI Pathogens or natural enemies: Fungal and bacterial pathogens could increase in a warming climate and cause regional or larger declines in the mikinaak population, though this is largely unknown. There are also a variety of predators such as esibanag (raccoons), waagoshag (foxes), zhigaagwag (skunks), aandegwag (crows), predatory giigoonh (fish), and ginebigoog (snakes) that consume mikinaak eggs, which are expected to be favored as a result of climate change.

SI Genetic variation: Genetic variation in mikinaak is thought to be lower than other generalist beings. This may mean that mikinaak is less able to adapt to changes in climate.

Legend

GI — **Greatly Increase**: This factor greatly increases vulnerability	**I/GI** — **Increase/Greatly Increase**: This factor may increase or greatly increase vulnerability	**I** — **Increase**: This factor increases vulnerability
SI/I — **Somewhat Increase/Increase**: This factor may somewhat increase or increase vulnerability	**SI** — **Somewhat Increase**: This factor somewhat increases vulnerability	**N/SI** — **Neutral/Somewhat Increase**: This factor may not increase or may somewhat increase vulnerability

Four-legged

Four-leggeds are those beings in the animal world who stand on four legs. Four-leggeds are in the third order of creation:

> "Great Spirit decided to create everything in the third order and that would be the animal world. All those that swam under the surface of the water, those that stood in the forest on four legs, those that flew through the air like migizi, the eagle, geese, and others." —*Moka'ang Giizis-Rising Sun Joe Rose Sr.*

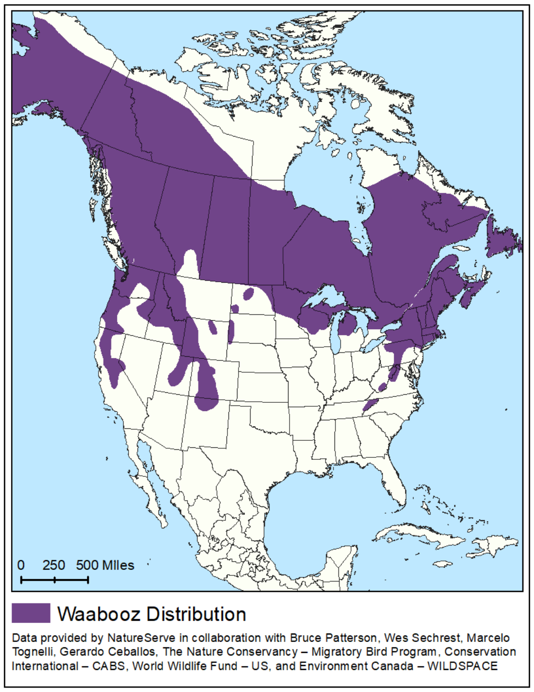
Note that the being page for bapakwaanaajiinh (bat) includes both cave bats and tree bats, and the being page for zhingos (weasel) includes short-tailed, long-tailed, and least weasels. The Ojibwe words for these beings translates to "bat" and "weasel," respectively, and much of the TEK shared did not differentiate. In other tables throughout the assessment, bat was split into "cave bat" and "tree bat," and weasel was split into "short-tailed/least weasel" and "long-tailed weasel" as their vulnerability rankings are different.

For complete results from the Climate Change Vulnerability Index, see Appendix 6. For references associated with a particular being or beings, please contact the author team.

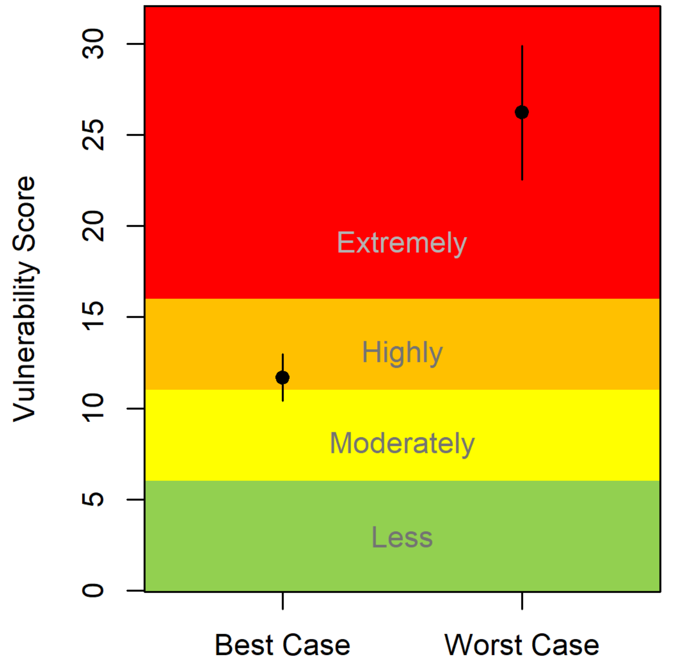
Waabooz

Waaboozoog (plural) / Snowshoe hare / *Lepus americanus*

Highly - Extremely Vulnerable
(Confidence Level: High)



Range map of waabooz.



Climate change vulnerability scores for waabooz on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

A traditional teaching about the waabooz describes him telling Nenabozhoo how he would help the Anishinaabe when they arrived: "'Here, I have something too. I too have something to offer the Anishinaabe.' The rabbit was looking at Nenabozhoo. 'Who do you think you are? Look at you and how small you are. You don't even have much meat on you.' And the rabbit said, 'Nope, don't think of me that way. I will sense when the Anishinaabe is struggling to find food to eat. I will not go anywhere. Whenever I see a round snare, that is where I will put my head. That is how much I care about the Anishinaabe… Anishinaabe will know how to use my gift, like sometimes, somewhere, when they get a skin rash… children suffer with that. They will use my rabbit fur, my hide. I will not be far away. All they need to do is look around, and they will find my trail; this is where they can get me.'"

Waabooz utilizes primarily coniferous and mixed forest, as well as bogs, swamps, lowland shrub, and forest edges. Early successional forests often have a higher waabooz abundance. Waabooz also requires a dense understory for cover. Areas with greater than 60% forest cover and dense understories have the highest probability of having waabooz.

As forest was cleared for agriculture in the late 1800s, the waabooz range contracted northward. Currently, waabooz is at the southern end of its range in the Ceded Territories, and its range continues to shift northward. Its range has shifted 18.4 miles north from 1980 to 2014 in Wisconsin, and 28 miles north over the last 20 years in Michigan. Waabooz populations undergo cyclical patterns in abundance, though at the southern end of its range these cycles are not as dramatic as in other regions. The presence of waabooz in the Ceded Territories in the past is evident in TEK as Ojibwe place names. One example is Waaboozo-minis (Rabbit Island), known today as South Twin Island, in the Wenaboozhoo Minisan (Apostle Islands) in northern Wisconsin.

Nearly all Traditional Ecological Knowledge (TEK) interviewees have expressed concern about a decline in the waabooz population. One tribal elder from Odaawaa-zaaga'iganiing (Lac Courte Oreilles) shared that in the past, there was a link between the waabooz and waagosh (fox) population but waabooz is now linked to the wiisagizi ma'iingan (coyote) population. The wiisagizi ma'iingan puts a tremendous amount of pressure on the waabooz population, and if the wiisagizi ma'iingan population is high, the waabooz population will be low.

The days of noticing waabooz tracks in the snow, seeing them in the backyard, and setting numerous snares to trap them are now mostly gone. When interviewees were asked how long they had been noticing the population decline, the average response was 15 years. Most interviewees also noted a decrease in snowfall during that time frame, which some feel is contributing to the waabooz decline. There are concerns about the loss of traditional teachings and stories regarding the waabooz and waabooz trapping. Tribal members fear the traditional knowledge and stories about waabooz will soon only be memories and the younger generations will likely never see a waabooz in their backyard.

Tribal members also shared information about waabooz habits. Waabooz tends to eat any vegetation and its population normally goes in two- to three-year cycles. It used to be a major source of food and was also used for furs, traditional crafts, and general livelihood. Most tribal members used to look for waaboozoog but could not hunt them until it got cold enough – if they were harvested too soon, the waaboozoog would often have blisters on and underneath their skin, making them unfit for consumption. However, it was shared that the first cold snap usually killed off the bacteria and any viruses that were affecting them. A tribal elder of the Misi-zaaga'iganiing (Mille Lacs) band shared that his favorite part of the waabooz to eat was the brains, though recently, it is rare for waaboozoog to be sought after as a source of food.

One individual recalled walking from his house on Lake Superior in Red Cliff, Wisconsin, to Oak Island on the ice in order to snare waaboozoog: "It was tough going over in the wintertime, got over there and had no shack over there. They had a halfway decent stove, one of those air tights, and you had to keep adding wood like you would never believe. Rabbits, we snared like ten rabbits the first night. The fishermen used to go by there. They would come in and trade rabbits for fish, which we did… We had to walk out there, then they would give us a ride home… I haven't seen a rabbit in 15 years and I shot hundreds and hundreds of them. I used to sell rabbits to go to the show and if you shot them you'd get 50 cents for them and if you snared them you'd get a dollar. My aunt used to ask what is the difference. When you shoot them you lose all the blood. If you snare them, we add that blood to the soup."

Summary of climate threats:

Waabooz was the most vulnerable four-legged in the vulnerability assessment and in the 99th percentile relative to other beings in the assessment. Its population is strongly linked to the duration of snow cover, which is likely to continue to decline, especially at the southern end of its range. Many other factors contribute to its vulnerability, including natural and anthropogenic barriers, sensitivity to increasing temperatures, increased predation risk, and phenological mismatches. This being is the subject of much ongoing research, including models projecting its future range, and it is likely to be severely impacted by climate change.

Factors that increase the vulnerability of waabooz to climate change:

SI Natural barriers: Edge habitat in fragmented landscapes is a barrier to waabooz. Any increases in unsuitable non-forested habitats would likely increase mortality.

SI/I Anthropogenic barriers: Agriculture, roads and other urban development can all be barriers to waabooz.

I/GI Physiological thermal niche: Waabooz is a winter-adapted being restricted to cold environments that will continue warming, particularly in the winter. Models have linked local waabooz extinction in Michigan to an increase in maximum summer/fall temperature.

GI

Dependence on snow or ice: Snow cover is a critical component of waabooz habitat and may be the primary factor in its vulnerability to climate change. Decreases in duration and depth and increases in the density of the snowpack are expected to negatively impact waabooz. Reductions in the depth of the snowpack will decrease the availability of browse on upper branches. Waabooz is also dependent on snow cover for camouflage, and fewer days with snow on the ground has been linked to increases in predation. Decreasing duration of snow cover has been found to be the most important driving factor in the range shift of waabooz in Wisconsin.

SI

Pathogens or predators: Waabooz is a major prey item for many carnivores that are less vulnerable to or may benefit from climate change in the Ceded Territories, including gidagaa-bizhiw (bobcat), wiisagizi ma'iingan (coyote), and ojiig (fisher). Pathogens that affect waabooz and may become more prevalent with climate change include tularemia and snowshoe hare virus, though there may be others. Rabbit hemorrhagic disease virus has been found in the southwestern US and has the potential to spread to the Ceded Territories.

N/SI

Interspecific interactions: Population cycling in waabooz has been tied to specific predators, including bizhiw (lynx) and wiisagizi ma'iingan (see above), and beings with overlapping ranges (such as bine (ruffed grouse)). If those beings are also affected by climate change, waabooz population cycles may be dampened and abundance may be affected.

N/SI

Genetic variation: Northern and eastern populations of waabooz in Canada and the eastern US are generally characterized by high genetic diversity, but at the southern end of its range in the Ceded Territories, genetic diversity is lower.

I

Phenological response: Two Montana studies found waaboozoog did not vary the date or rate of fall molt (turning color from brown to white) with the timing of snowfall, indicating that fall molt is initiated by day length and not presence of snow. The spring molt did vary with longer or shorter snow seasons. The consistent timing of the waabooz fall color change will cause waabooz to stand out to predators if snows come later in the year. However, the studies did find some variation in timing and rate of molt among regional populations of waabooz, and another study found waabooz in Pennsylvania had less white winter coats than in northern Canada. Both of these may indicate some ability of waabooz to adapt to changing winter conditions. However, models in Wisconsin and Michigan show waabooz is currently not able to keep pace with recent declines in snow cover. Continuing phenological mismatches will cause waabooz to lose its camouflage, particularly in the fall, and be subject to increased predation.

I

Documented response to climate change: Waabooz has already begun responding to climate change; waabooz range receded northward in the Ceded Territories at an average rate of 5.4 miles per decade from 1980 to 2014. This recession is primarily linked to duration in snow cover. Interviewees from three tribal communities also mentioned decreases in waabooz.

SI

Future change in range size: Models show waabooz range continuing to move northward, though uncertainty about snowfall projections complicates the models, especially given snow cover is likely the primary driver of waabooz range.

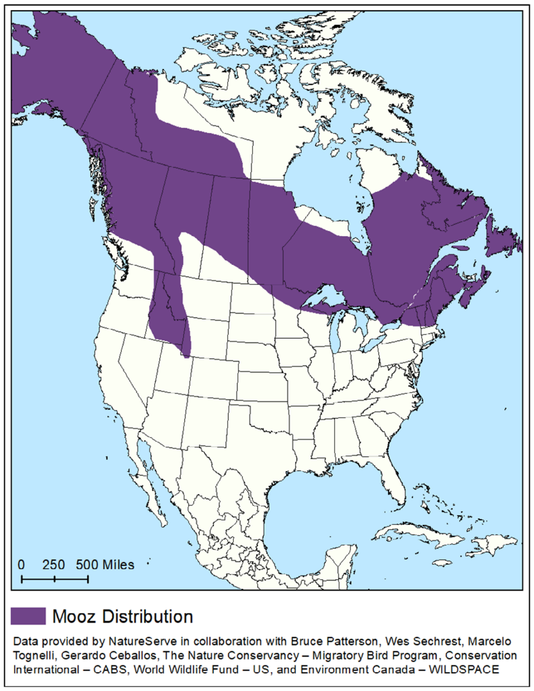
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

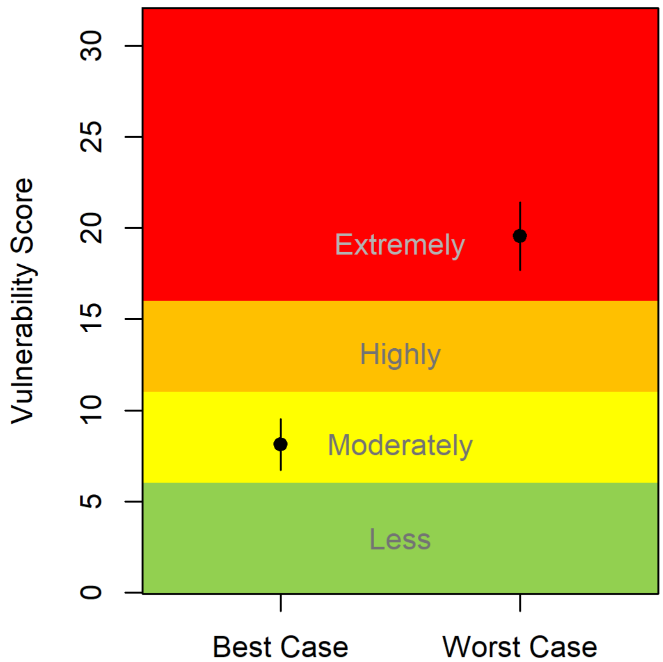
Mooz

Moozoog (plural) / Moose / *Alces americanus*

Moderately - Extremely Vulnerable
(Confidence Level: Moderate)



Range map of mooz.



Climate change vulnerability scores for mooz on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

The English word “moose” is believed to derive from the Ojibwe language. There are other Ojibwe names for moozoog depending on their life stage. They are referred to differently when they are born, around one year of age, when they begin to mate, and later in their life. The Ojibwe clan system includes a Hoof Clan which is rarely known of today. Those who belong to it are known to be gentle, soft-spoken, and kind. However, members of other clans also carry those same traits today.

There are sacred stories about moozoog that speak to their importance to the Anishinaabe people. It is said that mewinizha (a long time ago) the mooz felt he had to look after the people from the sky, which are the Anishinaabeg. Therefore, the mooz took pity on the Anishinaabeg and helped them. However, there came a time that the Creator felt the mooz was doing too much for the Anishinaabeg and put a stop to the mooz excessively helping the Anishinaabeg. There is a handprint shape on the center of a bull’s head that still reminds the Anishinaabeg of this knowledge today and serves as a reminder to not take the mooz for granted. It is believed that the mooz will forever provide for the people. When the mooz ceases to exist, the people will cease to exist.

It is known by the Anishinaabeg that the night sky is a direct reflection of what is on the ground and therefore stories of beings such as mooz are recognized in the constellations. Most interesting is that the Ojibwe constellation of the mooz dominates the night sky in the fall from late September through November. Traditionally, this is known to be the prime season for mooz hunting and it is when the big dipper sits upright like a shopping cart in the sky. One star represents the mooz heart, and the beard that falls under the chin of the mooz can also be clearly identified. Traditionally when the life of a mooz was taken, it was considered disrespectful for the beard of the mooz to touch the ground. Therefore, out of respect and to acknowledge the mooz in the sky, the beard was hung in a tree.

Mooz uses a variety of habitats, including wetlands, shrublands, and conifer, hardwood, and mixed forests. Mooz seems to require both young and old forests. Young forests, shrublands, and aquatic habitats are important for food; mature closed-canopy forests are important for cover. Mooz selects habitat based on the density, biomass, and nutrition of browse (food).

Mooz was once widespread and abundant, but populations declined due to habitat loss, competition with deer, disease, and hunting pressure. Mooz was reintroduced in Michigan, and the 2019 population in the western Upper Peninsula is estimated at 509 animals. In Minnesota the population peaked in 2006 and has since declined over 50% to around 4,000 individuals. Mooz was extirpated from Wisconsin until the early 2000s, when it began dispersing naturally into the state. Wisconsin's mooz population is currently less than 50 individuals. Mooz is currently listed as a species of special concern in Michigan and Minnesota and is protected by one or more on or off-reservation tribal Conservation Codes.

During visits with tribal elders, harvesters, and gatherers, mooz is periodically mentioned as being important to the Anishinaabe people in many ways. It provides gifts of food, clothing, and shelter. It is hunted for various uses and spoken of in traditional stories and teachings. In addition to the gift of food, it is also used for things such as thicker makizinan (leather moccasins), bone tools, and teeth for items such as jewelry. Unfortunately, the same knowledge holders also expressed strong concern regarding the decline in the population of the mooz. One individual mentioned that there may be a correlation between the decline in mooz and manoomin (wild rice) because mooz relies on manoomin as part of its diet. It was said that as manoomin declines the mooz will decline.

Summary of climate threats:

Mooz was in the 94th percentile relative to both other four-leggeds and other beings in the assessment. Mooz has become a symbol of climate change in the region and is the subject of intensive studies. Climate change is expected to cause many direct (such as increasing temperatures), and indirect (such as increased competition and predation, diseases, and changes in vegetation and snowpack) effects on mooz. Declines have already been linked to increasing temperatures, and there are multiple aspects of the lifeway of mooz that make it vulnerable to climate change.

Factors that increase the vulnerability of mooz to climate change:

SI — Natural barriers: Lake Superior is a barrier to northward shifts in mooz range, though it is likely that the range of mooz will contract over time instead of individuals moving north.

I — Physiological thermal niche: Multiple sources suggest that mooz is likely to be influenced by increases in temperature. One study found that mooz experiences heat stress at temperatures above 23°F in the winter and 59°F in the summer, though those thresholds are still under investigation. Temperatures over portions of their range may also be moderated by Lake Superior. Increased temperatures and heat stress may influence movement patterns, limit the use of some habitats, and influence its distribution. Declines in the Minnesota mooz population have already been correlated with increasing temperatures.

N/SI — Physiological hydrological niche: Mooz depends on aquatic habitat in much of its range. Mooz typically utilizes wetlands for food in the late spring and early summer during peak sodium requirements, and again in the late summer when there are abundant aquatic plants. Drying of wetlands during those times may negatively impact mooz. In some areas of northeast Minnesota, however, mooz uses relatively few wetlands.

I <u>Dependence on snow or ice</u>: While mooz is not directly dependent on snow, it is a winter-adapted being better suited for long winters than shorter and warmer winters, and mooz range overlaps with areas with a seasonal snow cover. Other snow-related adaptations for mooz include legs that allow them to travel through deep snow, fat reserves for cold winters, and a thick winter coat. Mooz can easily feed in areas with fluffy snow; snow that becomes crusty or icy from warmer temperatures or rain can make feeding difficult.

I <u>Pathogens or predators</u>: Many predators of mooz, such as ma'iingan (wolf) and makwa (black bear), are expected to increase; predation accounts for up to 80% of calf mortality. There are also many manidoonsag (insects and pathogens) that affect mooz. Severe winter tick infestations have been documented and may intensify if increasing winter temperatures allow ticks to better survive the winter. One individual mooz has been found with over 100,000 ticks. The ticks feed on the mooz and irritate its skin, causing it to rub hair off its body, and increase energy expenditures, heat loss, and stress. Brainworm can affect mooz where waawaashkeshi (white-tailed deer) range overlaps. Giant liver flukes have also affected mooz in Minnesota. Other parasites and diseases are possible as well as conditions change.

SI/I <u>Competition</u>: Research suggests that an increasing waawaashkeshi population will negatively affect mooz. There is little competition between the beings for browse, but waawaashkeshi carries brainworm and liver flukes that can harm mooz. Additionally, higher waawaashkeshi numbers may lead to higher ma'iingan numbers and increased predation on mooz.

SI <u>Genetic variation</u>: Research indicates mooz has low genetic variation in general, particularly in the Ceded Territories where reintroductions occurred.

N/SI <u>Documented response to climate change</u>: Mooz populations in northeast and northwest Minnesota have shown dramatic declines. In other parts of its range, such as Michigan, the population is relatively stable.

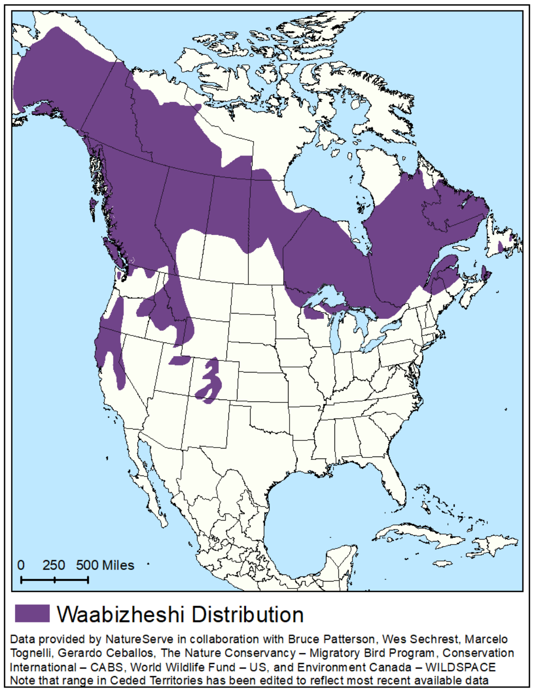
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	**I/GI** — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I** — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI** — **Somewhat Increase** This factor somewhat increases vulnerability	**N/SI** — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

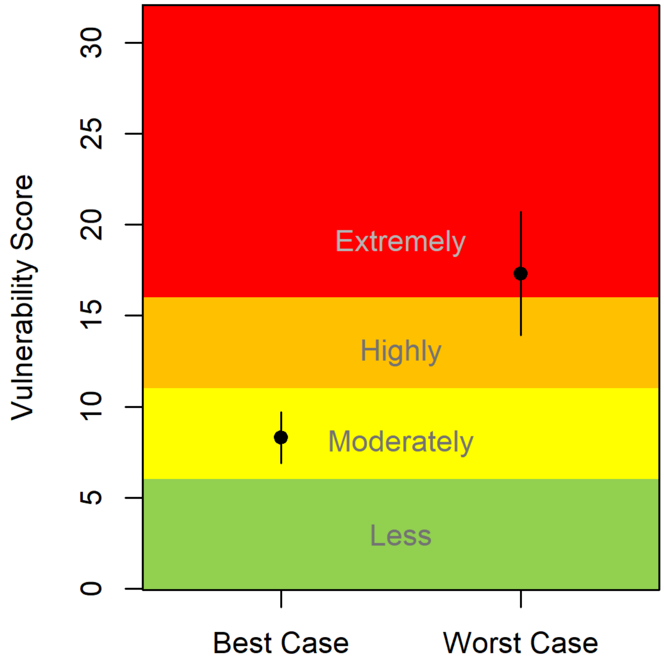
Waabizheshi

Waabizheshiwag (plural) / American marten / *Martes americana*

Moderately - Extremely Vulnerable
(Confidence Level: Moderate)



Range map of waabizheshi.



Climate change vulnerability scores for waabizheshi on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Waabizheshi is a clan animal whose members traditionally served as pipe bearers and message carriers for the chiefs. Currently, however, members of other clans also serve in these roles. Waabizheshi Clan were also known to represent hunters and be warriors. The pelts of waabizheshi are highly respected and utilized in various ceremonies of the Ojibwe.

Waabizheshiwag live in coniferous, deciduous, and mixed forests. Undisturbed, structurally complex, mature coniferous or mixed forests with closed canopies are preferred habitat; in northern Wisconsin, waabizheshiwag select resting and den sites within hemlock-cedar pockets. Waabizheshi utilizes large-diameter trees and snags (especially those with cavities or broken tops), coarse woody debris, stumps, and root masses which provide access to the subnivean layer (in and under the snow) for resting or foraging. These areas also provide habitat for prey species.

Waabizheshi was extirpated from most of the Ceded Territories by the 1930s because of unregulated harvest, timber harvest, and forest fires. It was reintroduced in parts of Wisconsin and Michigan in multiple introductions between 1975 and 2010. Waabizheshi is currently listed as endangered by the state of Wisconsin and is protected under one or more tribal on- and off-reservation Conservation Codes. Populations in northwestern Wisconsin have likely declined, but have been stable or increased in northeastern Wisconsin. Abundance is greater in northern Michigan and Minnesota, where the waabizheshi population has recovered fairly well (though its distribution in those states is still limited). In the last decade, waabizheshiwag have been found on some of the Wenaboozhoo Minisan (Apostle Islands) in northern Wisconsin.

Waabizheshi was mentioned infrequently in interviews, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. Both an increase and a decrease in the presence of waabizheshiwag was heard during Traditional Ecological Knowledge interviews. A member of Nagaajiwanaang (Fond du Lac) noted that he has seen an increase in their population on and around the Nagaajiwanaang Reservation, which the interviewee thought was due in part to a decline in the value of waabizheshi hides and the number of people trapping them. A member of the Mashkiiziibiing (Bad River) tribe observed a significant decrease in their population on and near the Mashkiiziibiing Reservation but knew of increased waabizheshi presence on some of the Wenaboozhoo Minisan in northern Wisconsin.

Summary of climate threats:

Waabizheshi was in the 88th percentile relative to other four-leggeds and all other beings in the assessment. Climate change could have both direct and indirect effects on waabizheshi. Direct effects include thermoregulatory costs in a shallower and denser snowpack; indirect effects are numerous, including effects on predators and prey, increased competition, and changes in vegetation. Waabizheshi is also at the southern end of its range in the assessment area. Other factors that increase waabizheshi vulnerability are natural and anthropogenic barriers, limited dispersal, and potential low genetic diversity.

Factors that increase the vulnerability of waabizheshi to climate change:

SI Natural barriers: Non-forested land and even low levels of habitat fragmentation can be barriers to waabizheshi movement. Waabizheshi is typically not present in areas with less than 25% forest cover.

SI Anthropogenic barriers: Agricultural land and clearcuts are barriers to waabizheshi movement.

N/SI Dispersal: Waabizheshi can move long distances, but rarely does, as habitat in the assessment area is patchy. There is also little evidence that it can disperse long distances through non-habitat.

SI/I Dependence on snow or ice: A reduction in the depth or an increase in density of the snowpack would negatively impact waabizheshi, as a deep, fluffy snowpack is critical to waabizheshi for resting and denning sites, protection from predators, and foraging opportunities. Waabizheshi also has a relatively high lower critical temperature (60.8°F) and requires deep snow for thermal protection. Deep snow may also give it a competitive advantage over competitors, especially ojiig (fisher). Any positive effects resulting from an increase in snowfall in the winter would likely be offset by an increase in snow density.

N/SI Dietary versatility: Waabizheshi relies on northern prey species such as amikowaabigozhiish (red-backed vole) and waabooz (snowshoe hare), particularly in the winter, which are likely to be affected by climate change as well. It is possible that waabizheshi could rely more heavily on other prey species in the future, but this is largely unknown.

SI Pathogens or predators: Many predators of waabizheshi, including ojiig, gidagaa-bizhiw (bobcat), wiisagizi ma'iingan (coyote), and waagosh (fox), will be favored by climate change largely due to reduced snow cover. Sensitivity to pathogens is generally unknown, but it is possible that novel parasites or diseases could contribute to waabizheshi mortality.

SI/I Competition: Many competitors of waabizheshi, including ojiig, gidagaa-bizhiw, wiisagizi ma'iingan, and waagosh, will be favored by climate change largely due to reduced snow cover.

I Bottlenecks: Waabizheshi was recently extirpated from the assessment area and has therefore undergone a genetic bottleneck. This bottleneck has created potential for low genetic diversity, making waabizheshi more vulnerable to environmental changes.

SI

Future change in range size: Climate modeling for waabizheshi using a middle-of-the-road scenario suggests minor range loss by 2050.

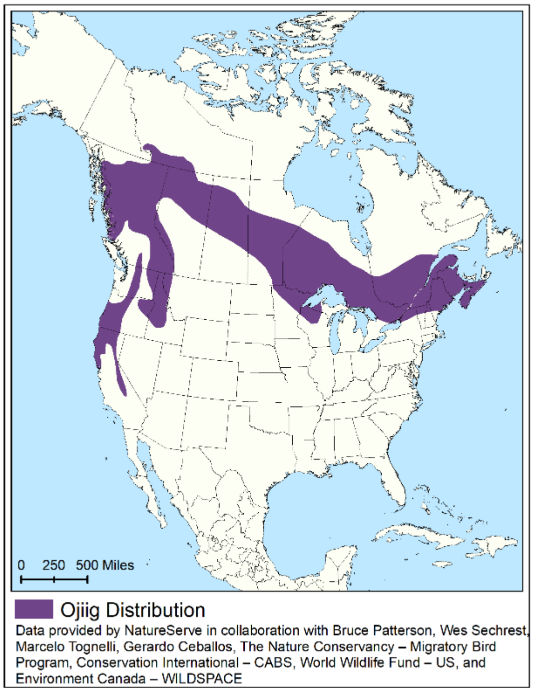
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

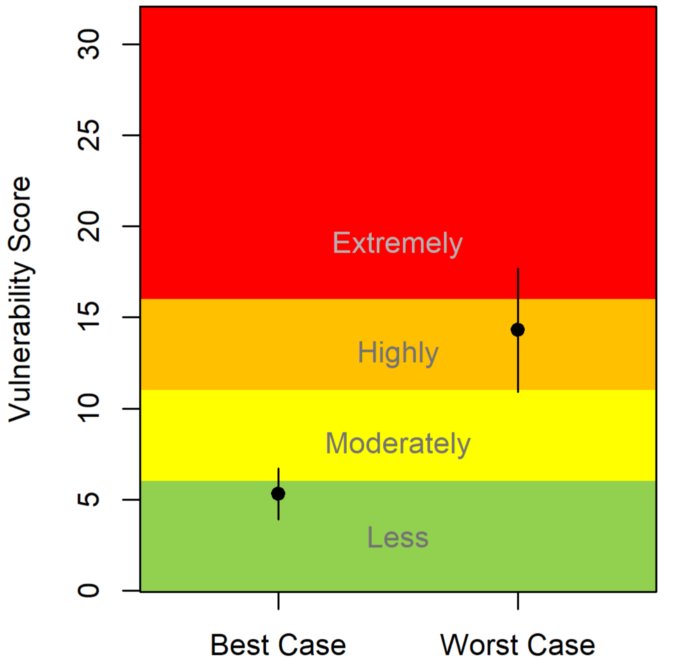
Ojiig

Ojiigag (plural) / Fisher / *Pekania pennanti*

Less - Highly Vulnerable
(Confidence Level: Moderate)



Range map of ojiig.



Climate change vulnerability scores for ojiig on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

The ojiig is highly respected by the Ojibwe people and known to be one of the few animals that can kill and eat a porcupine. Also, it is often on the go during both day and night. The ojiig holds a place in the traditional teachings and legends. For example, the Ojibwe hold star knowledge in which the ojiig is a constellation in the night sky (the Big Dipper). Through the teachings of the ojiig constellation, one can learn about the origin of the seasons and the importance of certain values such as cooperation and self-sacrifice.

Ojiig is a forest being. It is found in the highest densities in late successional or old-growth forests, although it can also be found in managed and younger forests, which provide prey habitat. It prefers structurally complex habitats and typically prefers coniferous boreal or mixed forests to hardwood forests. Large-diameter aspen or other cavity trees are important for den and rest sites. Ojiig also prefers large habitat patches.

Ojiig declined in the Ceded Territories in the late 1800s and early 1900s due to clearcutting and overharvest through trapping and hunting. By the 1930s, ojiig was only found in a small area in Minnesota, but has been increasing its range, both naturally and with the help of several reintroductions throughout northern Minnesota, the Upper Peninsula of Michigan, and northern Wisconsin. Currently, ojiig is found as far south as central Wisconsin in Manitowoc County and Door County.

Ojiig was mentioned infrequently in interviews. However, all beings are of equal importance to Ojibwe people based on their cultural beliefs in the original treaties with all of creation. Ojiig was mentioned by a Waaswaaganing (Lac du Flambeau) member as a being that he is seeing more of now than when he was younger.

Summary of climate threats:

Ojiig was in the 82nd percentile relative to other four-leggeds and in the 72nd percentile relative to other beings in the vulnerability assessment. Ojiig will be affected by warming temperatures, a decrease in winter snowpack, competition with gidagaa-bizhiw (bobcat) and other beings, and a decline in boreal forest (particularly large-diameter cavity trees such as aspen). It may be somewhat limited by diet as waabooz (snowshoe hare) also declines as climate change continues.

Factors that increase the vulnerability of ojiig to climate change:

I — Physiological thermal niche: Ojiigag can become stressed at temperatures > 68°F and generally choose microhabitats that allow them to avoid higher temperatures. Ojiig is well-adapted physiologically and behaviorally to cold climates. Particularly at the southern end of its range, ojiig may do poorly with increasing temperatures.

N/SI — Disturbance regime: If fires increase in frequency and severity in the Ceded Territories, this would have a negative impact on ojiig (though fires are often suppressed in the area). Fires may reduce the connectivity and extent of late-successional forests, as well as the structural diversity on which ojiig relies.

SI — Dependence on snow or ice: Ojiig is found exclusively in areas with snowy winters. Evidence that deep snow limits movements of ojiig is conflicting; it is likely that deep snow can limit, but not exclude, ojiig. Ojiig may utilize the subnivean zone less than waabizheshi (American marten), but ojiig have been observed using snow dens for rest sites. Overall, ojiig appear to rely on some form of snow cover in the winter and are potentially vulnerable to decreases in snowpack.

N/SI — Dietary versatility: The ojiig diet is relatively diverse and includes small to medium-sized mammals, birds, carrion, insects, fruits, and berries. Ojiig specializes on gaag (porcupine), for which they have few competitors, but they also consume waabooz (snowshoe hare) wherever they are abundant. A reduction in waabooz, in part due to a changing climate, may affect ojiig populations.

N/SI — Pathogens or predators: Gidagaa-bizhiw (bobcat) is a predator of ojiig and is expected to increase in population. Effects of pathogens are unknown.

N/SI — Competition: Competition, primarily with gidagaa-bizhiw, but also with wiisagizi ma'iingan (coyote), waagosh (fox), and ma'iingan (wolf), is expected to increase as those beings are likely to increase in population as climate change intensifies and snow becomes less limiting.

I — Bottlenecks: Ojiig was extirpated from the 1837 and 1842 Ceded Territories by the early 1900s, and its population has since rebounded naturally and with the help of several reintroductions. However, a bottleneck in population may mean that ojiig still has limited genetic diversity to help it adapt to climate changes.

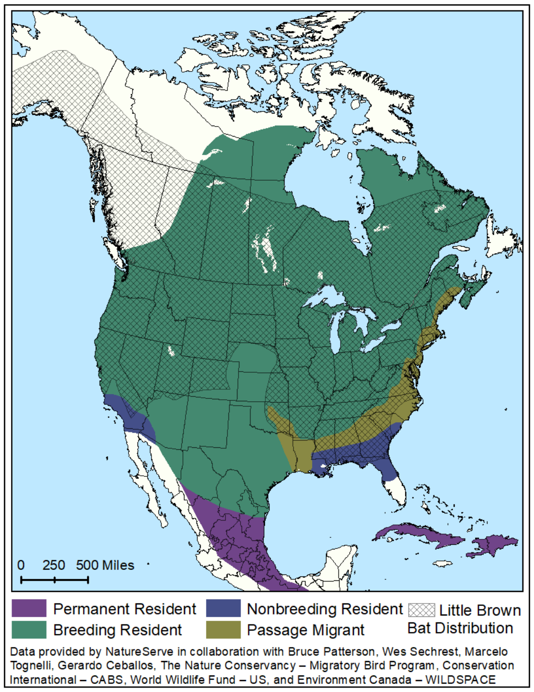
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	**I/GI** — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	**I** — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	**SI** — **Somewhat Increase** This factor somewhat increases vulnerability	**N/SI** — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

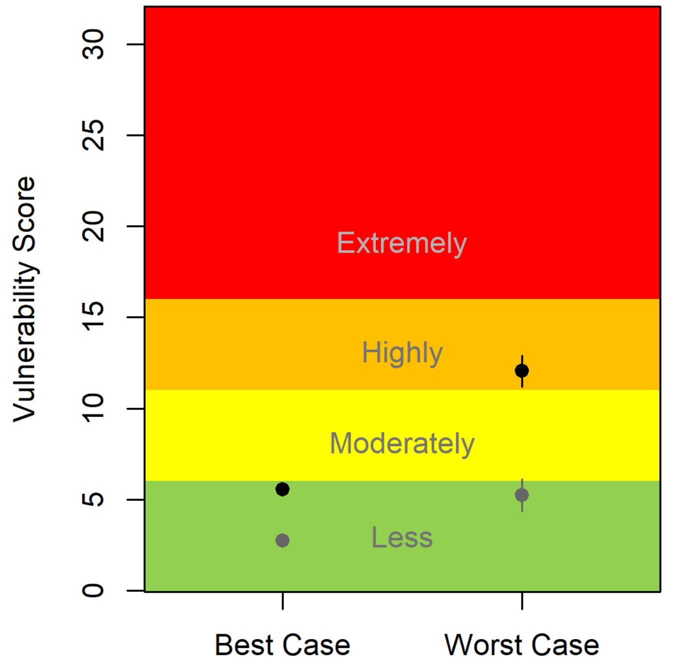
Bapakwaanaajiinh

Bapakwaanaajiinyag (plural) / Bats

Less - Highly Vulnerable
(Confidence Level: High)



Range map of two bapakwaanaajiinyag. Solid colors represent hoary bat (a tree bat), which migrates, and crosshatch represents little brown bat (a cave bat), which does not migrate.



Climate change vulnerability scores for bapakwaanaajiinh on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario. Black dots represent cave bats; gray dots represent tree bats.

General Description:

One day mewinzha (long ago), as the giizis (sun) was rising, he kept moving dangerously close to the earth and became tangled in the top of a tall tree. Giizis tried repeatedly to become untangled but the more he tried, the more intertwined his rays became with the many branches. This went on for so long that unfortunately the dawn did not come.

All the awesiinyag (animals) on earth became very confused, especially the bineshiinyag (birds), since they spend a lot of time passing through the sky carrying messages to the Creator. Some of them woke up at their usual times and went back to sleep when they didn't see giizis. Other night-loving animals such as the gookooko'oo (owl) were happy to have such long continuous darkness. The night bineshiinyag celebrated by spending many extra hours hunting.

After four dark days, all the awesiinyag knew something was terribly wrong. The various clan awesiinh leaders called a council meeting to discuss the issue. Migizi (eagle) was the first to speak up, saying that he thought giizis was lost. Makwa (bear) called for action and said that everyone needed to go looking for giizis. The awesiinyag had a large feast before beginning their search. They travelled the earth through the forests, various bodies of nibi (water), deep into the waazhan (caves), and through the rest of the aki (land). Giizis was nowhere to be found.

Finally, the smallest ajidamoo (squirrel) decided to travel waabanong (to the east) from mitig (tree) to mitig. Eventually he came across the tallest mitig he had ever seen. At first, he stared up at it, knowing it would be a long climb but that he had to get to the top in hopes of using it as a lookout for giizis. Then he noticed a glowing light coming from the very top. He ran as fast as he could towards the top and as he got closer, he realized it was giizis but with a very soft fading light. Giizis looked sad and weak.

Giizis, noticing the little ajidamoo down below, called out to him for help. Ajidamoo noticed how tangled giizis was and decided to chew away the branches to help giizis escape and rise once again. The more branches he chewed, the closer he got to giizis, and the hotter he became. Finally, ajidamoo called out to giizis and told him he must stop because his hair was starting to burn and turn black. Giizis pleaded with ajidamoo to do a little more because he was nearly free. Ajidamoo agreed, but then his tail began to burn off. Giizis begged ajidamoo to continue trying.

The more ajidamoo tried to help, the more things happened to his body. After his skin was blackened and he lost his tail, he began to go blind. It was at that moment giizis finally broke free and slowly rose into the sky. Once again there was daylight across the earth. All the awesiinyag began to celebrate, except for little ajidamoo. He remained near the top of the tree, blackened, without his tail and vision, and unable to move, with the light all around him.

Once back up into the giizhig (sky), giizis began to feel bad for little ajidamoo. He thought about all the suffering ajidamoo went through to save him. He called down to ajidamoo and asked if there was anything he needed in return for helping him. Ajidamoo cried out that he had always wanted to fly and now he'd never be able to.

Giizis yelled down to ajidamoo with wonderful news. "I can help you. From now on you will not only be able to fly, but fly better than all of the bineshiinyag. You may believe you're blind, but you will have excellent vision in the night and be able to navigate with your hearing that will pick up frequencies not even the Anishinaabeg will be able to hear. We will never see each other again as when I rise into the sky each day you will sleep. When I come back down, you'll wake to travel the world in the dark."

Once giizis began to set for the night little ajidamoo jumped down from the branch, opened his arms (which were now wings), and began to fly for the first time. He enjoyed himself so much that he didn't miss anything about being the ajidamoo the beings once knew. Instead, from this day on, he celebrated each night by living as the first bapakwaanaajiinh (bat) on earth and enjoying life among all the other bapakwaanaajiinyag who came after him, along with all other nocturnal beings.

Story shared by a Bikoganoogan (St. Croix) tribal member

Bapakwaanaajiinyag in the Ceded Territories include both cave bats and tree bats. Cave bats are the little brown, big brown, eastern pipistrelle, northern long-eared, and Indiana bats, though the two most common are the little brown and big brown. Tree bats consist of the silver-haired, eastern red, and hoary bats. Both cave and tree bats use a wide variety of habitats. The edges of forests near wetlands and other water bodies are ideal habitats because they generally have a high density of insects to forage. Some use woodlands adjacent to wetlands exclusively throughout the summer months for roosting. Cave bats hibernate over the winter in caves and mines, and tree bats migrate south to warmer regions for the winter.

In general, bapakwaanaajiinyag are susceptible to habitat loss, degradation, and drastic drops in population. White-nose syndrome is currently the biggest threat to cave bat populations. Before the rapid spread of white-nose syndrome, the cave bat population in the Midwest was stable, but from 2014 to 2020 the Midwest cave bat population declined by 97%. All five cave bats are listed as endangered, threatened, or of special concern either at the federal or state level in the Ceded Territories. Tree bat populations are difficult to monitor, as these beings do not form large colonies and do not typically return to the same roost sites. They also use trees instead of bat houses or any other manmade structures. These beings also have slow population growth rates as most have only one pup per year. The silver-haired bat is a species of special concern in Wisconsin.

Although bapakwaanaajiinyag were mentioned infrequently in interviews, all beings are of equal importance to Ojibwe people based on the cultural beliefs in the original treaties with all of creation. In addition to the story shared above, a member of the White Earth tribe who has resided in Gaa-miskwaabikaang (Red Cliff) for many years shared the following story regarding the traditional Ojibwe game of baaga'adowewin (lacrosse).

Mewinzha all the awesiinyag, including the bineshiinyag, living on Mooningwanekaaning (Home of the Yellow Breasted Woodpecker, also known as Madeline Island in northern Wisconsin), were experiencing a great deal of tension. Eventually the tension led to a lot of arguing so they decided to play a game of baaga'adowewin to resolve things. It was agreed by all that the winning team would become the main decision-makers in the area. They set the date and decided to play from sun-up to sundown. Whichever team had the most points once giizis set would be deemed the winner.

All the beings lined up with the bineshiinyag on one side and the awesiinyag on the other side, except for one little being. That little being stretched out his wings and walked up to migizi (eagle) and told him he was going to play on the bineshiinyag team. Unfortunately, migizi told him no. The little being then went over to the makwa (bear) and asked if he could be on the awesiinyag team. Makwa agreed.

The first game started with a "jump ball," in which one member from each team is chosen to jump up to grab the ball after it's thrown into the air. The one who catches the ball determines which team goes first. The first game started with the awesiinyag going first. Several games were played all day with one team scoring then the other.

Eventually it was dusk, and the teams were tied, so they decided to play one more game to break the tie. The ball was thrown high up into the air. From the awesiinyag team, that one little being again stretched his wings and flew up and grabbed it. He began swooping up, down, and around all the bineshiinyag beings, moving so swiftly that none of them could get the ball from him. Eventually he dove down and scored the final point for the awesiinyag team! The awesiinyag ran over to that little being, picked him up, and rode him around on their backs, shouting with excitement.

Once the game was finished all the beings stayed up through the night discussing what decisions were going to be made to help ease the tension they had all been experiencing. As the winners, the awesiinyag told the bineshiinyag how much they loved them but that some of them would need to leave for part of the year. The bineshiinyag agreed and chose amongst themselves which ones would leave and that it would be during the winter, with the agreement that they would return every spring. The other decision was made in honor of that little being that scored the winning point – the bapakwaanaajiinh. From then on, even though bapakwaanaajiinh had wings, he would always be known as an awesiinh instead of a binesiinh. It was also said that some of his own could choose to travel with the bineshiinyag each winter in recognition of his ability to fly and not having been able to play on the team of the bineshiinyag. To this day, some still stay while others go during the time of migration.

Summary of climate threats:

Cave bats were in the 76th percentile relative to other four-leggeds and in the 66th percentile relative to other beings in the assessment. Tree bats were in the 59th percentile relative to other four-leggeds and in the 29th percentile relative to other beings in the assessment. All bapakwaanaajiinyag are likely to be affected by land use changes and changes in flooding and drought. Cave bats will also be affected by white-nose syndrome and phenological mismatches.

Factors that increase the vulnerability of bapakwaanaajiinh to climate change:

SI — Human land use changes: Over 500,000 bapakwaanaajiinyag are estimated to be killed annually across Canada and the United States; additional wind development in the Ceded Territories may threaten their populations. One study suggests the hoary bat, which is most frequently killed by turbines, could decline by 90% in the next 50 years due to expansions in wind infrastructure. Bats are killed by the blades striking them, but also by pressure changes near the blades that cause their lungs to fill with air. Tree bats are particularly susceptible to wind turbine fatality because they migrate in the spring and fall. Cave bats could also be affected by underground industrial sand mines, many of which are found in the southwest portion of the 1837 Ceded Territory, but little is known about this.

N/SI — Disturbance regime: Extremely high levels of precipitation have caused delayed reproduction in bapakwaanaajiinyag, and some individuals have even skipped breeding altogether. Precipitation can reduce foraging time and/or make foraging more difficult, reduce prey abundance, and increase energetic costs. Cave bat hibernacula can also be vulnerable to flooding, and there are documented cases of cave bat populations drowning in hibernacula. Drought could also reduce insect abundance and negatively affect the food supply of all bapakwaanaajiinyag.

SI — Uncommon landscape features: Cave bats are dependent on hibernacula in the winter. Hibernacula can include caves, mines, tunnels, and other similar sites. This dependence can increase their vulnerability to climate change.

I — Pathogens or predators: white-nose syndrome affects cave bats and was detected in the Ceded Territories in 2014. It has since spread to many counties, particularly in the Upper Peninsula of Michigan, far western and southern Wisconsin, and northeast Minnesota. As of 2020, the population of Midwest cave bats had declined by 97% and populations are expected to continue to decline as the disease spreads.

I — Phenological response: One long-term study in Wisconsin found that emergence of little brown bats in the spring was relatively consistent in date from year to year, even in the record warm spring of 2012, and are less likely to advance their phenology in the spring than other taxa. Peak cave bat activity also took place before peak insect activity; white-nose syndrome can intensify this mismatch as it causes cave bats to emerge from hibernation early. Climate change may contribute to mismatches in cave bat emergence and prey availability, and cave bats may not be able to respond.

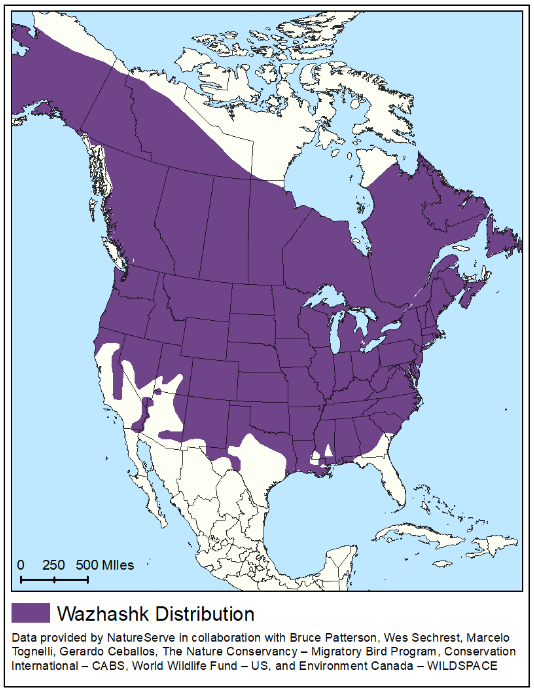
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

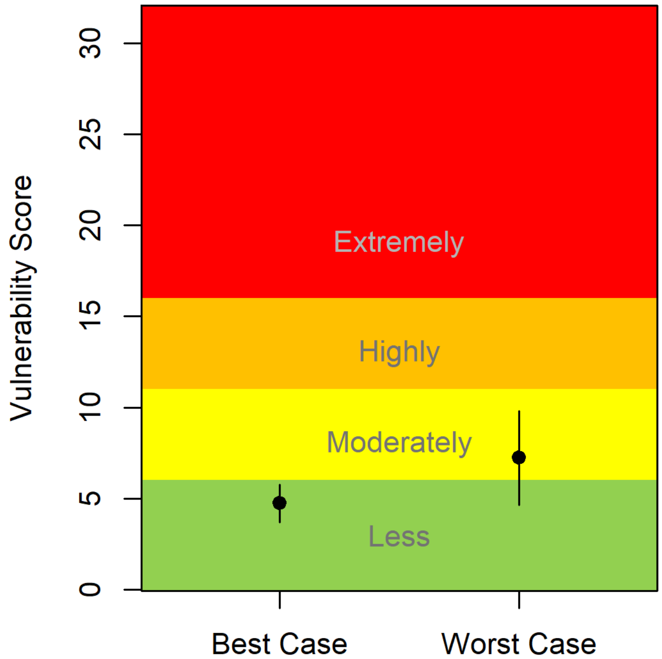
Wazhashk

Wazhashkwag (plural) / Common muskrat / *Ondatra zibethicus*

Less - Moderately Vulnerable
(Confidence Level: Moderate)



Range map of wazhashk.



Climate change vulnerability scores for wazhashk on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

One important teaching of the Anishinaabeg tells of how long ago humans strayed from their original teachings and were no longer living in harmony with each other or with the earth. The Creator saw this and decided to purify the earth by bringing about a great flood which only a few animals, birds, and Wenaboozhoo were able to survive by floating on a log. As they floated, they searched for land but were unable to find any. They decided to dive down one at a time to try to obtain some earth. Wenaboozhoo, maang (loon), zhaangweshi (mink), and mikinaak (turtle) were some of the beings who tried but were unsuccessful. Finally, wazhashk tried. He was underwater longer than all the other beings, and when he surfaced, he was no longer alive, but held a small ball of earth in his hand. This earth was used as the start of land to bring new life for all the other beings. Since wazhashk risked his life for all others, the Creator decided to gift wazhashk with always being plentiful as long as all beings continue to live in a good way. It is also said that wherever there are Anishinaabeg, there will always be wazhashkwag.

Wazhashk inhabits wet environments such as ponds, lakes, streams, swamps, and marshes. Populations tend to be highest in marshes with abundant and dense emergent vegetation. Wazhashk constructs houses out of mud, sticks, grass, cattails, and other aquatic vegetation in which to live and raise young. It can also build elaborate burrows in the bank. Wazhashk often builds feeding platforms to sit on while feeding.

Wazhashk in general is widespread and abundant, though it has been affected by wetland loss and a reduction in habitat quality because of human development. It reproduces quickly and can breed up to four times a year with litters as large as 11 in good habitat with abundant food. Despite the prevalence of wazhashkwag in the

Ceded Territories, there are only a few Ojibwe place names that relate to their presence on the landscape, including Wazhashkoonsing (Little Muskrat Lodges River) which is in northeastern Wisconsin. One interviewee from Bikoganoogan believes wazhashk place names are less common because wazhashkwag were so abundant – if every place where wazhashkwag lived was named for them, there would be very few places named for the presence of other beings.

Wazhashk was mentioned in about a quarter of the Traditional Ecological Knowledge interviews, including much about its spiritual significance. In Mashkiiziibiing (Bad River), one elder talked about the significance of the circle and its occurrence in nature, including the shape of the wazhashk home. It was said during an interview with an elder in Odaawaa-zaaga'iganiing (Lac Courte Oreilles) that a significant decrease in the population of wazhashk indicates something is out of balance. He related this to the creation story and said that the earth will cease to exist once there are no longer wazhashkwag.

Memories of trapping them were also mentioned during interviews in Misi-zaaga'iganiing (Mille Lacs), Gaa-miskwaabikaang (Red Cliff), and Waaswaaganing (Lac du Flambeau). In Misi-zaaga'iganiing, one elder shared memories of his uncles trapping them all the time while he was growing up. His grandma and grandpa's living room used to be filled with 20 to 30 stretched hides at a time, which felt like hundreds to him by the end of the season. Their population was high enough in the Misi-zaaga'iganiing area that no one needed to travel out of the area to trap them. This is no longer the case, as very few trap them anymore and there is no longer a market for them.

There is also concern about human impacts on wazhashk. The Misi-zaaga'iganiing interviewee was concerned that wazhashk habitats are now being destroyed by humans. Boat traffic is high on Mille Lacs Lake and changes to the lakeshore are forcing wazhashk to live in the sides of the banks. Other concerns about its wellbeing were expressed in Odaawaa-zaaga'iganiing, Bikoganoogan (St. Croix), and Waaswaaganing. It was said that it can survive without frozen ground in the winter, but it is believed to be more susceptible to climate change as an animal of the water. There was also a concern that they are being contaminated by mercury in some waterbodies. The importance of balance was also mentioned. If wazhashkwag are not sustainably harvested, they will become overpopulated and experience an increase in diseases.

Summary of climate threats:

Wazhashk was in the 71st percentile relative to other four-leggeds and in the 44th percentile relative to other beings in the assessment. Wazhashk is widespread and reproduces quickly but could experience regional declines because of climate change. Changing water levels, which directly relate to food availability, may negatively impact wazhashk habitat, and a limited dispersal ability may limit relocation ability. Climate change may also increase favorable conditions for pathogens and predators that affect wazhashk populations.

Factors that increase the vulnerability of wazhashk to climate change:

N/SI Anthropogenic barriers: Interviewees mentioned that development on lakes and boat traffic have displaced wazhashkwag and destroyed wazhashkwag habitat in certain locations.

N/SI Dispersal and movements: Successful dispersal will decline if dry conditions and droughts cause distance between suitable habitat patches to increase. Wazhashk is often reluctant to leave established home ranges and may be susceptible to predation during dispersal.

I Physiological hydrological niche: Wazhashk depends on particular water levels and vegetation characteristics for food. Drier summer and fall conditions may cause drying of semi-permanent and permanent wetlands, which would decrease habitat for wazhashk. Lower water levels could also decrease food availability as shallow-rooted or drought-intolerant vegetation is unable to persist. However, increases in water level may create more suitable habitat for wazhashk.

SI

Disturbance regime: Flooding in the summer months can impact survival of young in houses and burrows, and prolonged flooding can negatively affect vegetation. During drought conditions, mortality from predation may be high as wazhashkwag are reluctant to leave established home ranges and have limited mobility if displaced.

N/SI

Pathogens or predators: Increased predation from zhaangweshi (mink), nigig (otter), raptors, waagosh (red fox), esiban (raccoon), and wiisagizi ma'iingan (coyote) may threaten wazhashk as changing water levels increase its vulnerability. Tyzzer's disease, caused by *Clostridium* bacteria, is found in wazhashkwag and may increase in distribution or abundance, though little is known about how climate change will affect this disease.

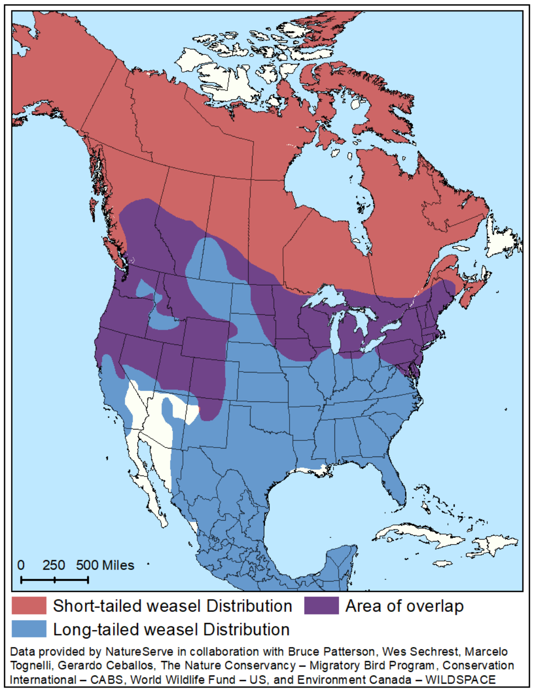
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

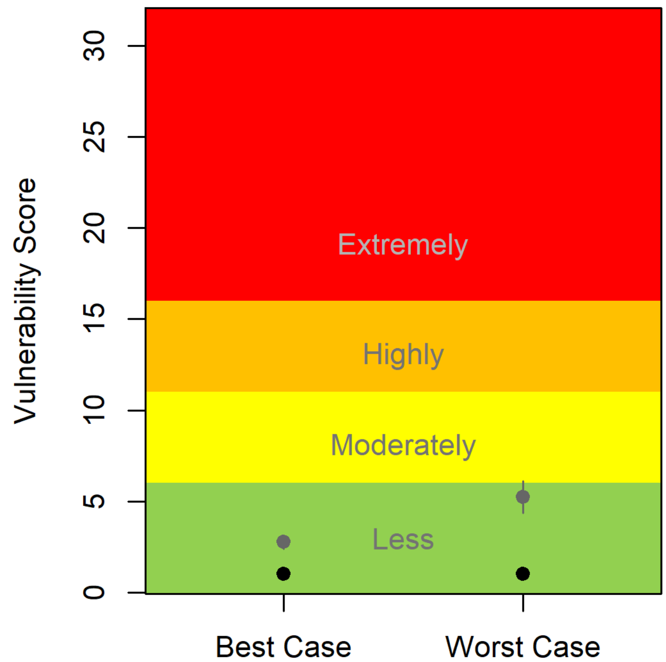
Zhingos

Zhingosag (plural) / Short-tailed/least/long-tailed weasels /
Short-tailed: *Mustela erminea*; Least: *M. nivalis*; Long-tailed: *M. frenata*

Less Vulnerable
(Confidence Level: Moderate)



Range map of zhingosag. Note least weasel range is not displayed but roughly overlaps short-tailed range.



Climate change vulnerability scores for zhingos on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario. Black dots represent long-tailed weasel; gray dots represent short-tailed and least weasels.

General Description:

The Ojibwe use the name “zhingos” for all weasels, including short-tailed, long-tailed, and least weasels.

According to a Misi-zaaga'iganiing (Mille Lacs) band member, “The reason [zhingos] has a black tail and he’s white is ‘cause Wenabozho used him to kill a Windigo and the only part that stuck out of the Windigo’s ass was the tail that he had pinched... They say he chewed his heart string, whatever that is, the center of his heart and killed him. When they pulled him out he was pure white.”

An elder of the Bikoganoogan (St. Croix) Band tells a story about the zhingos and the ajidamoo (squirrel). A long time ago the zhingos felt its life was the best and the only way to live. The zhingos went around trying to convince the other animal beings to abandon their way of life and follow the life of the zhingos. Eventually it convinced the ajidamoo (squirrel) to follow the ways of the zhingos. The ajidamoo then began raising their children to follow the ways of the zhingos. However, a small amount of ajidamoog (squirrels) continued to follow the old ways of the ajidamoo and eventually more ajidamoog returned to their ways. The manidoog (spirits) saw this happening and became happy. The same has occurred with the Anishinaabeg people. Many have followed the non-native ways, leaving their original instructions, teachings, and overall way of life behind, yet a small amount of Anishinaabeg have chosen to continue living the Anishinaabe way or return to it.

Short-tailed and least weasels use a variety of habitats, including meadows, grasslands, marshy and shrubby areas, though short-tailed weasels prefer more heavily forested habitat. Long-tailed weasels can be found in more developed areas such as crop fields, small woodlots, and suburban areas, but all three are generally found wherever they can find prey. Zhingos uses tree roots, brushpiles, logs, and rodent burrows as dens. All are carnivores and will eat a variety of small mammals, including amikowaabigozhiishag (voles), jiibiskozii-waabiganoojiiyensag (shrews), and agongosag (chipmunks). Long-tailed weasels may even eat manidoo-waaboozoog (cottontail rabbits) or waaboozoog (snowshoe hares). They will also eat reptiles, manidoonsag (insects), bineshiinyag (birds) and waawanoon (eggs).

All zhingosag are found in the Ceded Territories. The least weasel is uncommon and is listed as a species of special concern in Minnesota; only one has been found in Minnesota since 1967. The long-tailed weasel is widespread and fairly common throughout its range.

Zhingos was mentioned very little in interviews, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties. An interviewee from Misi-zaaga'iganiing mentioned that they are “sensitive because they eat frogs, is a lot of their diet, frogs and insects. They’re really sensitive.” Historically zhingos had been trapped by many Ojibwe and their furs were used in various ceremonies and as a part of traditional clothing. Today they are not as commonly trapped but are still widely used for both ceremonies and clothing.

Summary of climate threats:

Short-tailed and least weasels were in the 65^{th} percentile relative to other four-leggeds and in the 31^{st} percentile relative to other beings in the assessment. Long-tailed weasels were in the 6^{th} percentile relative to other four-leggeds and in the 3^{rd} percentile relative to other beings in the assessment. None of the zhingosag are highly vulnerable to climate change but could be affected by changes in the snowpack or changes in their prey. However, based on information from interviews, localized changes in the population or timing of zhingos will continue to occur.

Factors that increase the vulnerability of zhingos to climate change:

I Dependence on snow or ice: For short-tailed weasels in particular, adequate snow cover is important, along with subnivean spaces used for protection, reducing competition, and hunting. A reduction in the duration and depth and increases in the density of snow cover could all negatively affect short-tailed weasels. Reduced snow cover could also mean increased competition from long-tailed weasels.

N/SI Dietary versatility: Interviewees mentioned that zhingosag are sensitive because they depend on frogs and insects for a large part of their diet.

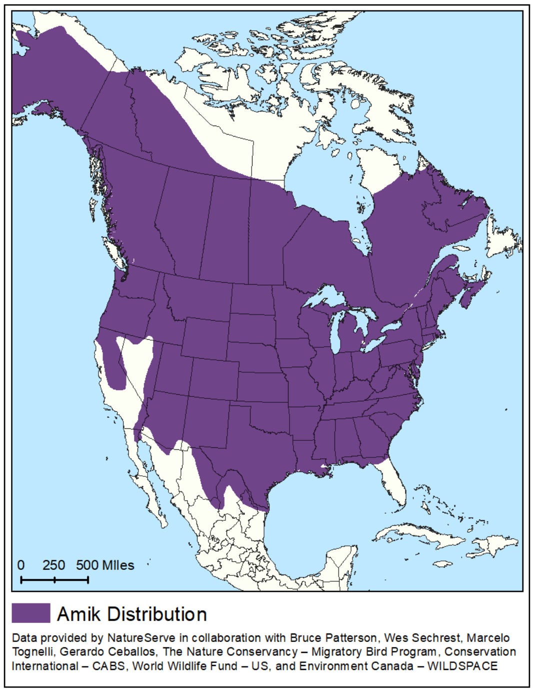
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

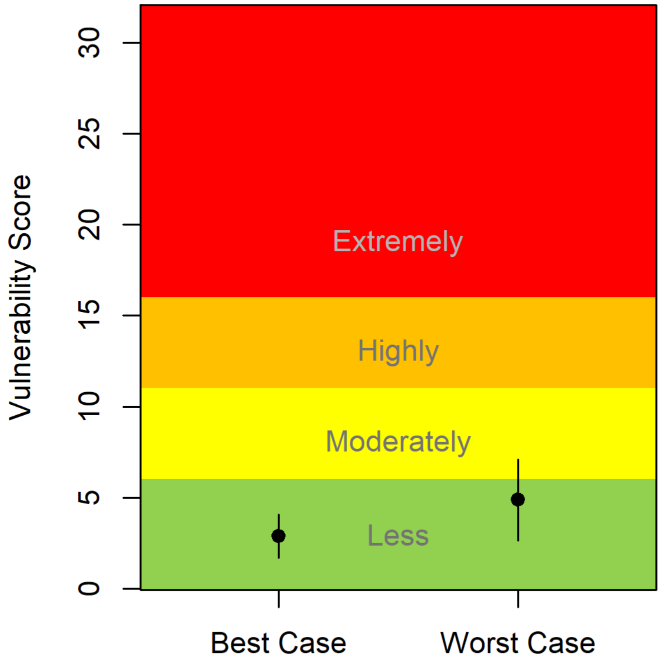
Amik

Amikwag (plural) / American beaver / *Castor canadensis*

Less Vulnerable
(Confidence Level: Moderate)



Range map of amik.



Climate change vulnerability scores for amik on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

A long time ago, amik thought he had the most beautiful, fluffy tail. He pranced around showing it to the other animal beings and asking if they liked it. Amik wanted to be known for his wisdom, kindness, resourcefulness, and beautiful tail. Wazhashk (muskrat) asked amik if his tail was strong. Amik was unsure, so he decided to cut down a tree for wazhashk to test out the strength of his tail. Unfortunately, many things went wrong while cutting the tree and it landed right on his tail, flattening it completely. Amik then went to the Creator with his sadness and pain, asking him for guidance. The Creator said not to worry and that he would always be known for his wisdom, kindness, and resourcefulness. However, instead of a beautiful fluffy tail, he was told he will always have one of great strength that can also be used to communicate warnings of danger to all around him.

Amik is part of the Ojibwe clan system and is a sub-clan of the Waabizheshi (Marten) Clan. Although members of the Amik Clan are now few compared to members of other clans, those who belong to it are believed to be providers (which includes hunters and gatherers), strategists, and builders. Members of other clans also carry some of the same traits today.

The Ojibwe hold a large amount of knowledge about the night sky, including amik. Amik is believed to be a winter constellation but can also be seen in the springtime. This Ojibwe constellation is referred to as Gemini on western star charts and represents Amik Clan members.

Amik can use a variety of aquatic habitats, as long as the habitat has suitable food availability, adequate water, and a low channel gradient (elevation drop). Amik prefers ponds, small lakes with muddy bottoms, and meandering streams, but will also use artificial ponds and drainage ditches. Amik builds lodges for resting, thermal, and reproductive cover.

Prior to European settlement, the amik population in the Great Lakes drainage was estimated at two million. Overharvest and massive habitat alteration (logging) caused populations to decline dramatically, and the Wisconsin population dropped to around 500 individuals in 1900. The population has since rebounded substantially following the implementation of trapping regulations and the regeneration of young forests, though for the past 10 years, the amik population in northern Wisconsin has been undergoing a gradual decline. There are also several Ojibwe place names that speak to the historical and significant presence of amik in the Ceded Territories. Some examples are Amiko-gaagibaakwa'iganing (Place of Beaver Dam) in northeast Michigan, Amikowiish-zaaga'igan (Beaver Lodge Lake) in west central Wisconsin, and Amiko-ziibiins (Beaver Creek) in north central Wisconsin.

Amik was mentioned frequently in interviews. Amik taught the Ojibwe how to build a wigwam and how to be an Anishinaabe. It is considered a highly sacred being with human-like behavior and who reminds us how to be better human beings. It is because of this that special care is to be taken when killing and eating amikwag. When harvesting an amik, nearly all of its body should be used out of respect. In addition, its bones are to be placed in a body of water along with asemaa (tobacco) which will assure that its life will return and amikwag will always be plentiful. This is rarely practiced today.

Hunting and trapping amik was a recurring theme in interviews. A Misi-zaaga'iganiing (Mille Lacs) interviewee mentioned that during times in which the Ojibwe ate more amik, the children played a game with various parts of the amik, including the bones. While playing, they sang songs believed to be heard by the manidoog (spirits) and which carried messages for the hunters of the amik. The hunters frequently asked if they'd be able to harvest more amikwag that summer or later the next harvesting season, and pieces won by the children determined the answers to those questions. A Waaswaaganing (Lac du Flambeau) interviewee recalled trapping them years back when their population was higher and recalled stories of amik pelts being used to make clothing. An interviewee in Gaa-miskwaabikaang (Red Cliff) said there used to be many amikwag on Stockton Island, one of the Wenaboozhoo Minisan (Apostle Islands) in northern Wisconsin. He learned that a heavy frost in the fall of the year is needed for the animals to produce thick fur which makes them worth more when selling their hides. Their hides were in their prime after the second frost which is when they'd focus the most on trapping them. The interviewee stated that the heavier the fur, the better the price. He used to get $70 for one amik, but now they are only worth around $5 each. An interviewee in Mashkiiziibiing (Bad River) mentioned that amikwag are often observed in the swamp near their home on Highway 169. They preferred to trap them there as few other trappers were likely to go due to the nearly two-mile hike in and out. They also expressed their preference for trapping amikwag in the winter because it was easier to pull them out across the top of the snow. An interviewee in Waaswaaganing also mentioned that when amikwag are not being harvested in a sustainable way, they are likely to either overpopulate or experience a high rate of mortality due to disease. Regular sustainable harvesting will help maintain a balance in their population.

It was said that the amik helps take care of our nibi (water), which is another reason we need to return to the practices of caring for amik properly. An interviewee in Odaawaa-zaaga'iganiing (Lac Courte Oreilles) shared that amik is highly vulnerable because it is a being of the water. It relies on regrowth of saplings for its diet which commonly consists of popple (aspen) but other foods as well. In Waaswaaganing an elder said that when amik houses are tall and strong, it indicates there will be a lot of snow and that mother nature always has a way of taking care of herself.

Concern was expressed in Waaswaaganing about the impact of amiko-gibaakwa'igan (beaver dams) on ponds, and private landowners blocking access to them. There was also concern over dams drowning out giizhikaatig (northern white cedar) and other trees such as mashkiigwaatig (tamarack) and zesegaandag (black spruce). The interviewee had also observed three brook namegos (trout) streams disappearing but wasn't certain if it was caused by the amik.

Summary of climate threats:

Amik was in the 53rd percentile relative to other four-leggeds and in the 28th percentile relative to other beings in the assessment. Amik utilizes a wide range of aquatic habitats and is not likely to be heavily impacted by a changing climate. Shorter winters and longer growing seasons may even benefit amik. Most amik mortality is human-related, from harvest or elimination of nuisance animals. However, increases in extreme storm events, diseases, and past bottlenecks in population may increase its vulnerability. Decreases in availability of aspen, willow, alder, birch, and certain wetland plants may also affect amik.

Factors that increase the vulnerability of amik to climate change:

N/SI — Physiological hydrological niche: One interviewee mentioned that amik is sensitive because it is a water-born creature.

N/SI — Disturbance regime: Extreme rain events and/or droughts may affect amik. Extreme storm events may cause flooding, soil erosion, and sediment transport, which could negatively alter amik habitat. Flooding could also destroy dams and lodges. However, dams made by amik may also buffer many effects of flooding. Significant droughts may also make some habitats unsuitable for amik, increase its vulnerability to predators, and decrease access to food.

N/SI — Pathogens or predators: Conditions may improve for the vectors of tularemia, a highly infectious bacterial disease. A major tularemia outbreak caused significant amik mortality (with reports of up to 300 dead individuals) in the late 1940s and spread throughout northern Minnesota, Wisconsin, and Michigan. Vectors of tularemia, the wood tick and deer fly, have the potential to increase with warming winter temperatures. Tyzzer's disease is a disease new to northern Michigan and has been found in wazhashk (muskrat) and manidoo-waabooz (cottontail rabbit), but little is known about how or if it will affect amik. There are few natural predators of amik, and climate change is likely to have little impact on amik predation.

SI — Bottlenecks: The amik population in Wisconsin was reduced to around 500 individuals in 1900. This may be an indication of low genetic diversity in the current population, though it is likely that significant dispersal from Minnesota and Michigan to Wisconsin maintained most genetic variation.

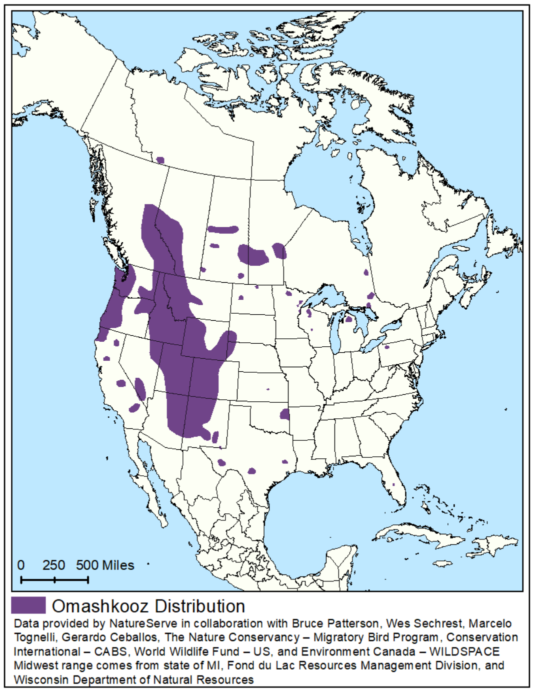
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

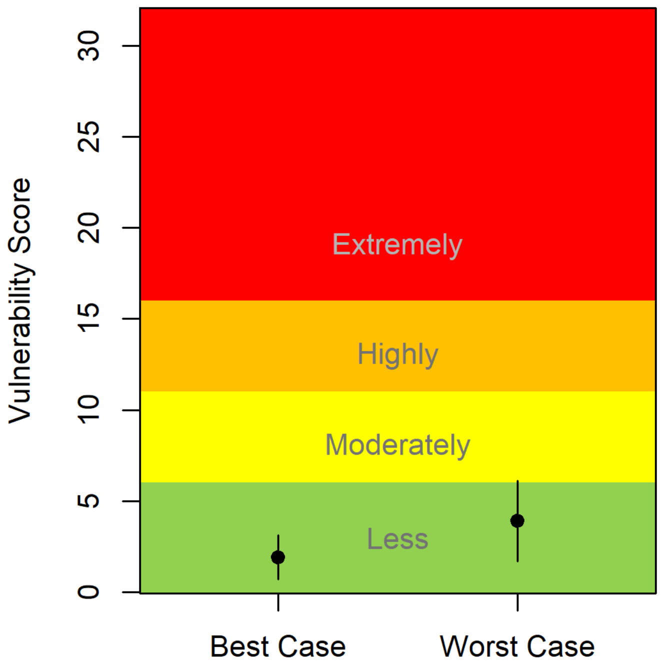
Omashkooz

Omashkoozoog (plural) / Elk / *Cervus elaphus*

Less Vulnerable
(Confidence Level: Moderate)



Range map of omashkooz.



Climate change vulnerability scores for omashkooz on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

To many of the GLIFWC member tribes, omashkooz embodies great medicine and fortitude. Only a small number of omashkoozoog are currently harvested by the Ojibwe, but when they are, they are seen as a gift and nearly all parts of them are used for food, clothing, and tools, as well as in ceremonies such as the first kill feast.

Omashkooz is part of the Hoof Clan. Although members of the Hoof Clan are now few compared to members of other clans, those who belong to it tend to carry traits of gentleness and kindness and are soft-spoken. However, members of other clans also carry the same traits today.

Across its range, omashkooz inhabits a wide variety of habitats, including grasslands, wetlands, shrublands, and forests in all ages of succession. In the Ceded Territories, omashkooz uses young aspen and other young forest interspersed with mature forest, forest openings, water bodies, and lowland conifer.

Historically, omashkooz inhabited much of the Ceded Territories, mostly in the prairie and oak savanna landscapes, but was extirpated by the late 1800s due to habitat loss and unregulated hunting. A reintroduction effort in Wisconsin in the 1930s was unsuccessful. Additional reintroductions beginning in 1995 established a herd in Clam Lake, Wisconsin, and another in the Black River State Forest, near Black River Falls, Wisconsin. The Clam Lake herd has had two subsequent introductions of Kentucky omashkoozoog – 31 in the summer of 2017 and an additional 60 in the summer of 2019. The additional omashkoozoog increased the genetic diversity and number of breeding age females in the herd. The Wisconsin population has not grown or dispersed as quickly as expected but continues to grow. A limited hunting season was implemented in 2018 and has continued each year since, though due to concern over the population, the tribes chose not to take any omashkoozoog in 2020. Seven omashkoozoog were introduced in Michigan in the 1836 Ceded Territory in 1918 and have founded a herd that currently has around 1,100 individuals. Omashkooz is listed as a species of special concern in Minnesota and is protected under one or more on or off-reservation tribal Conservation Codes. The historical presence and importance of omashkooz in the Ceded Territories is evident in Traditional Ecological Knowledge of Ojibwe place names in Wisconsin and Minnesota. Omashkoozo-ziibi (Elk River), Omashkoozoons-ziibi (Little Elk River), and Omashkoozo-zaaga'igan (Elk Lake) are just a few of those place names.

Native Americans in the Ceded Territories have historically used controlled burns for various purposes such as clearing village sites, preparing agricultural lands, and facilitating hunting by maintaining habitat for beings such as omashkooz. Burning on a regular basis (mostly in the spring and fall) resulted in a dynamic landscape including both grasslands and forests which created and maintained preferred habitat for omashkooz and other beings. Suppression of this practice after colonization, along with logging, conversion to intensive agriculture, and development contributed to the loss of preferred omashkooz habitat, especially prairies and oak savanna.

Omashkooz was mentioned infrequently in interviews, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation.

Summary of climate threats:

Omashkooz was in the 47th percentile relative to other four-leggeds and in the 21st percentile relative to other beings in the assessment. In general, omashkooz is adapted to a broad range of habitat and climatic conditions and is not likely to be highly impacted by climate change. However, omashkooz may be affected by anthropogenic barriers, increasing predators and pathogens, and low genetic variation.

Factors that increase the vulnerability of omashkooz to climate change:

N/SI — Anthropogenic barriers: Development in northern Wisconsin may be a barrier to omashkooz movements.

SI — Pathogens or predators: Predators of omashkooz, such as ma'iingan (wolf), makwa (black bear), and wiisagizi ma'iingan (coyote), will be favored under warming conditions and predation pressure on omashkooz may increase. Several diseases and parasites may affect omashkooz, particularly if waawaashkeshi (white-tailed deer) populations continue to rise, as waawaashkeshi can carry and pass on diseases to omashkooz. The risk of omashkooz to contagious disease is high because it spends much of its time in groups. Babesiosis is a tick-borne disease that has been attributed to a handful of omashkooz deaths in Wisconsin. Brainworm and liver flukes can also cause mortality, but evidence for effects on omashkooz is limited. Tuberculosis and chronic wasting disease are diseases that may also affect omashkooz in the future.

N/SI — Genetic variation: As the population in Wisconsin has been founded a small number of reintroduced individuals, genetic diversity is currently low. However, the introductions of omashkooz from Kentucky in 2017 and 2019 will likely improve the genetic diversity of the herd.

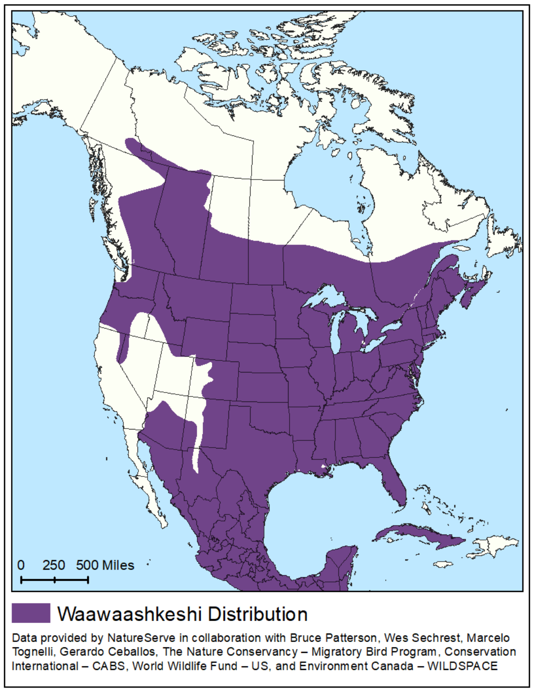
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

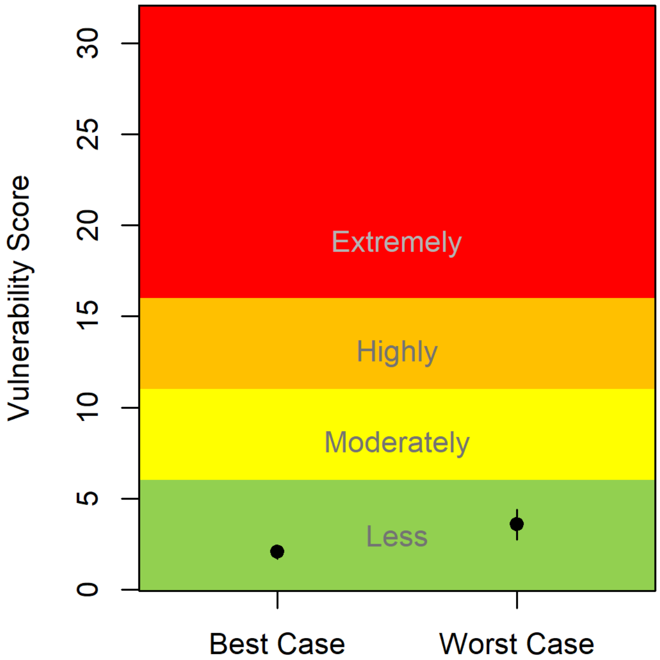
Waawaashkeshi

Waawaashkeshiwag (plural) / White-tailed deer / *Odocoileus virginianus*

Less Vulnerable
(Confidence Level: High)



Range map of waawaashkeshi.



Climate change vulnerability scores for waawaashkeshi on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Waawaashkeshi is highly respected by many indigenous people, including the Ojibwe, for which waawaashkeshi is one of the main clan animals. Members of the Waawaashkeshi Clan tend to carry traits of kindness and gentleness, which are also associated with waawaashkeshi. Historically, Waawaashkeshi Clan members were responsible for taking care of social aspects within their community such as feasts, ceremonies, and various gatherings. These roles still exist today but are mostly shared by members of all clans. The Ojibwe utilize waawaashkeshi as a food source, and nearly all parts of the waawaashkeshi are used for clothing, for tools, and in ceremonies such as first kill feast for young boys.

Waawaashkeshi occupies a wide variety of habitats in the Ceded Territories, including woodlands, shrublands, grasslands, croplands, and residential areas. It is often associated with early successional vegetation. In some regions, waawaashkeshi shifts its habitat in the winter, particularly in areas with cold temperatures and deep snow such as the Upper Peninsula of Michigan. In these locations, waawaashkeshi may exhibit seasonal migratory behavior between summer and winter ranges and congregate in “waawaashkeshi yards,” or areas with lower snow cover, such as mature northern white cedar stands nearer the Great Lakes shoreline.

Hunter harvest, winter severity, and habitat quality are the most important drivers of the waawaashkeshi population in the Ceded Territories, which fluctuates considerably from year to year. Population estimates are difficult, but waawaashkeshi is generally managed at high densities throughout the region as a result of social pressure on wildlife managers.

Waawaashkeshi was one of the beings mentioned most often during Traditional Ecological Knowledge interviews. The first observation of fireflies (around July 1st) indicates that waawaashkeshi will start coming around and it is time to start hunting. In order to encourage a successful hunt, bearberry is used as a charm. Waawaashkeshi tends to favor oak during winters that have a lot of snowfall and, if it doesn't have access to many acorns, the winter will be hard. When the acorns start dropping, it's time to hunt the oak stands for waawaashkeshi, especially where there was frost on the acorns, which makes them sweeter. The presence of trilliums indicates that waawaashkeshi is most likely in the area.

Various concerns regarding waawaashkeshi were mentioned during the interviews, with most of them focusing on the health of the animals. A tribal member referred to waawaashkeshi as a canary in a coal mine when waawaashkeshi health and population declines, that means its habitat is not healthy. The recent rise in chronic wasting disease (CWD) has led to increased concerns about waawaashkeshi health. One tribal member noted that there seem to be more cases of CWD in southern Wisconsin, which they feel is due to the waawaashkeshi not having access to the proper plants (such as giizhikaatig (northern white cedar) and Canada yew) to medicate itself and a loss of habitat due to logging. The use of lead ammunition is another concern as lead bullets can fragment and spread lead particles throughout the waawaashkeshi, impacting the health of any who consume the meat, including hunters, their families, and other beings that feed on the remains of carcasses. After more than 50 years of hunting and personal observation, a tribal member from Gaa-miskwaabikaang (Red Cliff) estimated that the waawaashkeshi herd in northwestern Wisconsin decreased 50 percent between 2010 and 2015, which is concerning because of how important harvesting and consuming waawaashkeshi is to the Ojibwe.

One Gaa-miskwaabikaang elder spoke of his diet consisting of mostly waawaashkeshi and fish while growing up. There was a large population of waawaashkeshi on two of the Wenaboozhoo Minisan (Apostle Islands) in northern Wisconsin (Stockton and Basswood Islands) several years ago, and he would snare them with an emergency cable from a car. The same elder mentioned that when he was growing up there was always snow on the ground in mid- to late November during waawaashkeshi season. During the last 20 to 30 years, the snow is coming nearly a month later.

Summary of climate threats:

Waawaashkeshi was in the 41st percentile relative to other four-leggeds and in the 19th percentile relative to other beings in the vulnerability assessment. As waawaashkeshi is a highly adaptable and versatile being, climate change is not likely to be a large threat to its population. However, based on information from interviews, localized changes in the population or timing of waawaashkeshi will continue to occur. Additionally, diseases such as epizootic hemorrhagic disease (EHD) may increase with warming temperatures and have the potential to impact the population. Cold temperatures and deep snows cause direct (through malnutrition) and indirect (neonatal) mortality and an increase in lake effect snow as Lake Superior warms could reduce waawaashkeshi populations in heavy snow regions, though this effect is likely to lessen as climate change continues.

Factors that increase the vulnerability of waawaashkeshi to climate change:

SI/I

Pathogens or predators: Epizootic hemorrhagic disease (EHD) has progressed northward from its previously known range and may continue moving north as climate conditions improve for the vector, the biting midge. If EHD affects waawaashkeshi populations in the Ceded Territories, significant periodic losses are possible, potentially leading to more frequent fluctuations in localized populations. CWD is also a threat to waawaashkeshi, and one that concerns many tribal members. Though links between CWD prevalence and climate change are still unclear, CWD may spread more quickly through a herd if climate conditions continue to favor waawaashkeshi and population densities increase. Since evidence suggests that climate change is a primary driver of waawaashkeshi range expansion at the northern extent of its range, individual waawaashkeshiwag could also potentially carry CWD into areas with other ungulate species, such as mooz (moose), omashkooz (elk) and adik (caribou), and affect their populations. Waawaashkeshi predators, particularly wiisagizi ma'iinganag (coyote), are also expected to increase, which could increase predation mortality on waawaashkeshi.

Legend

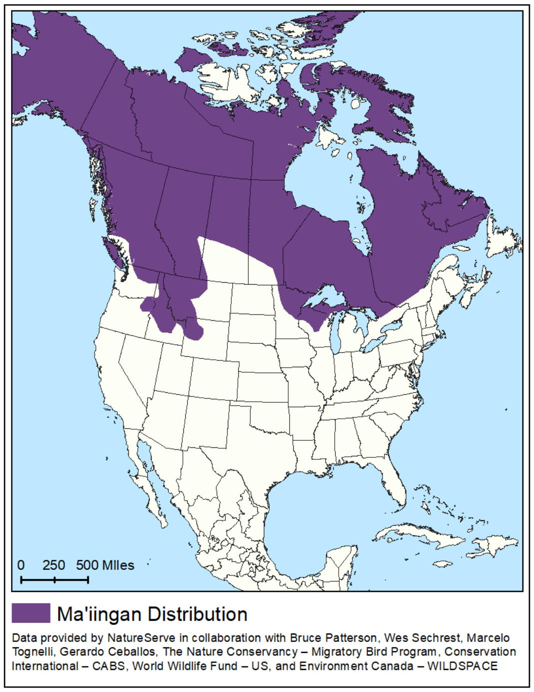
GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Ma’iingan

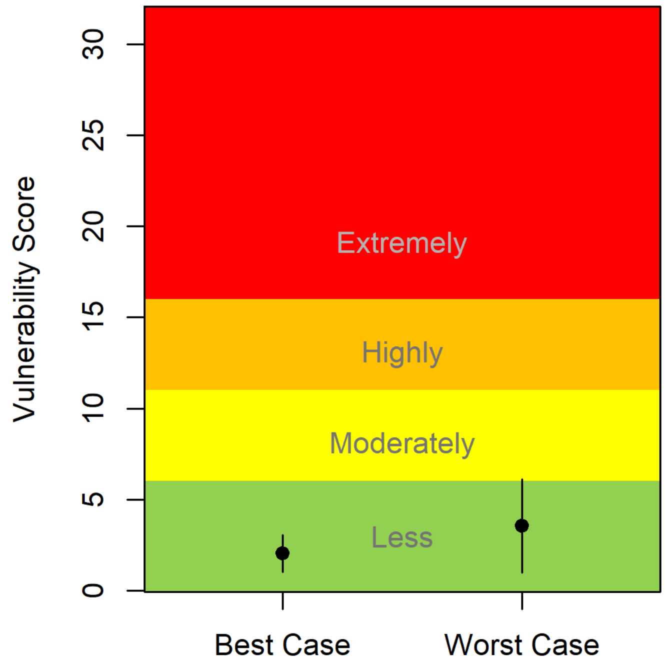
Ma’iinganag (plural) / Gray wolf / *Canis lupus*

Less Vulnerable

(Confidence Level: High)



Range map of ma’iingan.



Climate change vulnerability scores for ma’iingan on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

The Anishinaabeg believe that during the time of creation, all non-human beings were created and placed on the earth before them. After the Anishinaabeg were placed, they were instructed by the Creator to travel around and name all of the places and the plant and animal beings. While carrying out this responsibility, they observed that all the plants and animals had partners; they came in pairs. As a result, the Anishinaabeg began to feel lonely and decided to consult the Creator. The Creator took pity on the Anishinaabeg and decided to assign them a companion, the ma’iingan.

The Anishinaabeg continued to travel the earth naming the various beings, and this time the ma’iingan traveled with them. During these travels their relationship with each other became so strong as partners that they developed a brotherhood to each other and with the rest of creation.

Once the task of naming all of the plants, animals, and places was completed, the Creator instructed the Anishinaabeg to separate from the ma’iingan and to go on their own paths, recognizing that their futures were still intertwined. However, before the Creator sent them on their way, they were given an important warning. Both the Anishinaabeg and the ma’iingan will be misunderstood and feared by the other humans that would later be placed on the earth to join them. They were told that what shall happen to the ma’iingan will also happen to the Anishinaabeg.

“We see the wolf as a predictor of our future. And what happens to wolf happens to Anishinaabe…whether other people see it or not, the same will happen to them…” —Moka’ang Giizisban Joe Rose Sr.

This perception of the ma'iingan still exists among the Anishinaabeg today. Ma'iingan is a main being in many of the traditional stories and serves as one of the clan animals. The ma'iingan is considered a relative and a teacher, one who shows the Anishinaabeg how to live in their often harsh environment, raise families, and how to survive persecution. Due to their intertwined destinies, the Anishinaabeg have always been concerned about the survival and fate of the ma'iingan.

Ma'iinganag are generalists, which means they can survive on a wide range of food sources and inhabit a variety of habitat types. Although they are carnivores and prefer a diet of waawaashkeshi (white-tailed deer), they are also known to eat berries, small mammals, fish, mooz (moose), and even amikwag (beavers). These food preferences also vary by season and availability. Ma'iinganag occupy territories that can range in size from 20-215 square miles. In the Ceded Territories, habitats chosen by ma'iinganag typically contain a mix of forested uplands with interspersed open areas.

Ma'iinganag were once widespread in the United States. Due to unregulated bounty hunting and habitat loss, they were extirpated from the most of their former range, including Wisconsin, Michigan, and the majority of Minnesota, by the 1950s. Aided by protections provided by the Endangered Species Act, ma'iinganag began naturally recolonizing former territory in Wisconsin and Michigan in the late 1970s and 1980s. In the past 30 years, the ma'iingan population has shown significant increases in the Midwest. In 2021, Wisconsin had an estimated population of 937-1,364 individuals in 292 packs. A 2019-2020 survey estimated a population of 700 individuals in the Upper Peninsula of Michigan. In 2020 Minnesota had an estimated population of 2,700 ma'iinganag.

Ma'iingan numbers in the Great Lakes region are primarily determined by human attitudes and actions. Because of their cultural importance, ma'iinganag are protected under tribal conservation codes which prohibit ma'iingan hunting by tribal members. As of February 2022, ma'iingan is currently protected under the federal Endangered Species Act as threatened in Minnesota and endangered in Wisconsin and Michigan, although listing, delisting and re-listing have occurred multiple times over the past 40 years. Past delisting triggered hunting seasons in some states and allowed for lethal control of ma'iinganag preying on livestock, which is currently still allowable only in Minnesota. Michigan, Minnesota and Wisconsin are updating their state ma'iingan management plans, which will likely allow for hunting seasons and lethal depredation control should delisting reoccur. Poaching and vehicle collisions are other significant forms of mortality. Some people believe that ma'iinganag compete with humans for waawaashkeshiwag and negatively affect the waawaashkeshi population, but research has shown that ma'iinganag select older, sick, or injured waawaashkeshiwag, making for a healthier herd.

While concern about ma'iinganag was evident during TEK interviews, no ma'iingan-specific TEK was shared.

Summary of climate threats:
Ma'iingan was in the 35th percentile relative to other four-leggeds and in the 18th percentile relative to other beings in the vulnerability assessment. Influences on ma'iingan population mentioned above are likely to have a greater impact on ma'iingan than climate, though it may experience indirect effects via prey availability. Waawaashkeshi are likely to benefit from climate change, which would also benefit ma'iingan; declines in mooz or amik may negatively affect this being. Ma'iingan can be negatively impacted by human development and agricultural expansion, and may also carry some residual genetic effects from its low numbers in the mid-1900s. Based on information from interviews, localized changes in the population or timing of ma'iingan will continue to occur.

Factors that increase the vulnerability of ma'iingan to climate change:

N/SI — Anthropogenic barriers: Increased urban and agricultural development may be a barrier to ma'iingan. The I-35 corridor between Duluth and the Twin Cities may become a particularly large barrier, as well as development between central and northern forests in Wisconsin.

N/SI — Pathogens or predators: Ma'iingan is susceptible to mange which could increasingly affect populations if abundance grows in the Ceded Territories. Other potential diseases that may affect ma'iingan are heartworm, West Nile virus, ehrlichiosis, and anaplasmosis, though in general, little is known about these.

N/SI — Genetic variation: Ma'iingan was once nearly extirpated from the assessment area and has therefore experienced a genetic bottleneck. Despite bottleneck effects, recent genetic papers suggest ma'iingan populations in the region are healthy and well-connected, and therefore have sufficient genetic variation. However, ma'iingan populations in the Ceded Territories also have a relatively narrow connection to other populations, and the individuals here may be at a higher risk of genetic issues.

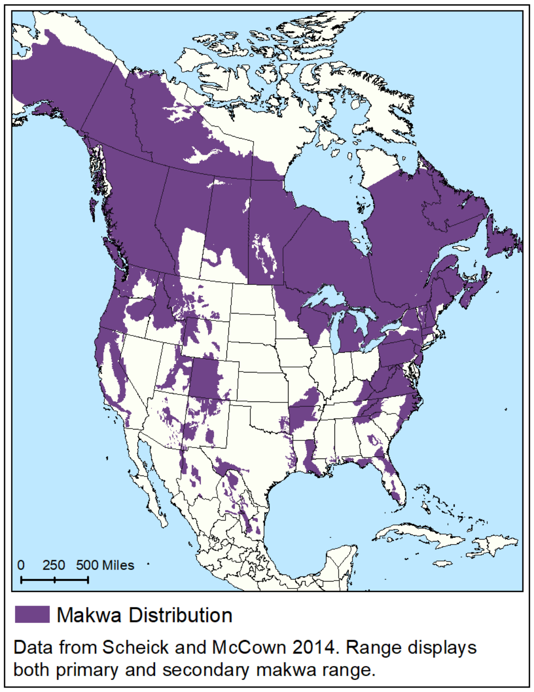
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

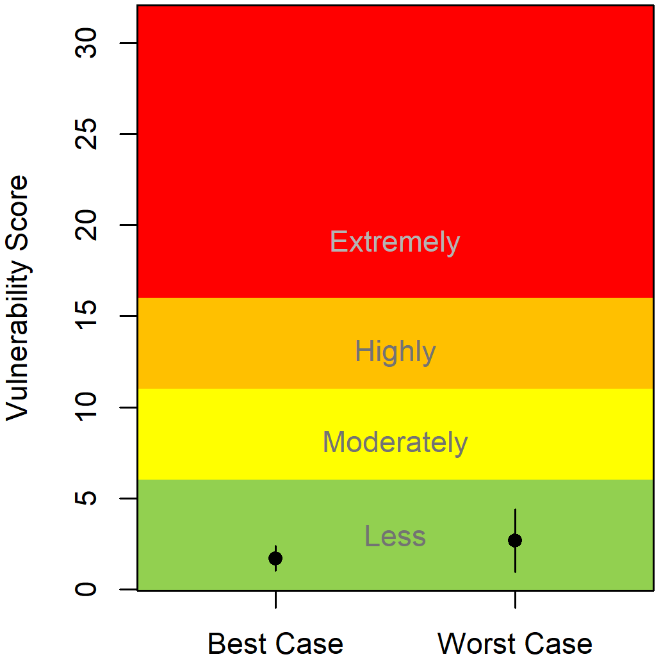
Makwa

Makwag (plural) / Black bear / *Ursus americanus*

Less Vulnerable
(Confidence Level: Moderate)



Range map of makwa.



Climate change vulnerability scores for makwa on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Makwa is highly respected by many Indigenous people, including the Ojibwe, for whom makwa is one of the main clan animals. Historically, those who belonged to the Makwa Clan tended to be strong protectors of family, friends, community, and their environment. They were also known to hold a strong connection with plants and often carried knowledge about medicines and healing. Today these traits are still often held by those of the Makwa Clan as well as those of other clans.

It is believed that the makwag are born from medicine and we learn a spiritual connection from them. They help take care of the Anishinaabeg when it is needed. The spirit of makwa is incorporated into aspects of various ceremonies still practiced today, such as drum and healing-related ceremonies. Only a small number of makwag are harvested each year by tribal members, and nearly all parts of the animal are used. The meat is used for food; the fat for making grease; the hide, bones, claws, and teeth for medicinal- and ceremonial-related use.

Makwa uses a mixture of habitats, including deciduous lowland forests, riparian areas, alder and ash swamps, mature and early successional upland forests, wet meadows, and forest openings. Upland forests provide hard mast (acorns, hazelnuts, etc.) and young forests and open habitats provide soft mast (berries) and herbaceous vegetation. Makwag are omnivores, meaning they eat a variety of plants and meat. This includes berries/fruits, roots, insects, fish and, even waawaashkeshi fawns in the spring. In the Ceded Territories, makwag move to dens in the winter when food is scarce. While makwa generally prefers large undeveloped areas, it is becoming more common in suburban and fragmented habitats.

Makwa populations have been increasing in the Ceded Territories since the 1980s. In Wisconsin, the estimated population has risen from about 9,000 in 1989 to over 24,000 in 2020; makwa has also expanded its range to the south and southwest in the state due to the large population and presence of suitable habitat. Populations in Michigan have also been rising, particularly in the Upper Peninsula, which has an estimated population over 13,000. In Minnesota, the makwag population is estimated at 12,000 – 15,000. The historical presence of makwag in the Ceded Territories is evident through Traditional Ecological Knowledge of Ojibwe place names, many of which include the name Makwa. One example is Mako-minis (also written as Makwa-minis), or Bear Island, one of the Wenaboozhoo Minisan (Apostle Islands) in northern Wisconsin.

Makwa was described in interviews as medicine, a deep sleeper, and more sensitive to change than other beings. Makwa is also described as a nuisance in some areas, though this was attributed primarily to human behavior, such as feeding them or not disposing of waste properly. One tribal member mentioned that several years ago the population was much larger in northwestern Wisconsin.

Summary of climate threats:

Makwa was in the 29th percentile relative to other four-leggeds and in the 15th percentile relative to other beings in the assessment. Makwag are generalist mammals and will likely be able to accommodate most climate changes. However, based on information from interviews, localized changes in the population or timing of makwa will continue to occur. Makwag are primarily affected by human-related sources of mortality – hunting, elimination of nuisance makwag, and vehicle collisions. Poaching and commercialization of makwag paws, gall bladders, and other parts are a concern in some locations. Any climate-related changes in food sources that bring makwag into closer contact with humans may result in more negative makwa-human interactions. A shorter winter season might result in changes to the timing of winter denning, but more importantly, warmer temperatures might cause flooding and abandonment of dens.

Factors that increase the vulnerability of makwa to climate change:

N/SI — Anthropogenic barriers: Major highways can be a barrier to makwa, and any reduction in food production caused by climate change will lead to more road crossings and, therefore, increased mortality. Highways account for around 100 road kills each year in the Upper Great Lakes region.

N/SI — Dependence on snow or ice: Makwa is not dependent on snow for denning but can be adversely affected by thawing of a snowpack and flooding of winter dens. This can cause it to vacate the den at times of the year when food is not readily available and could result in weight loss or cub mortality. Den abandonment due to flooding has been documented in Minnesota in two recent winters.

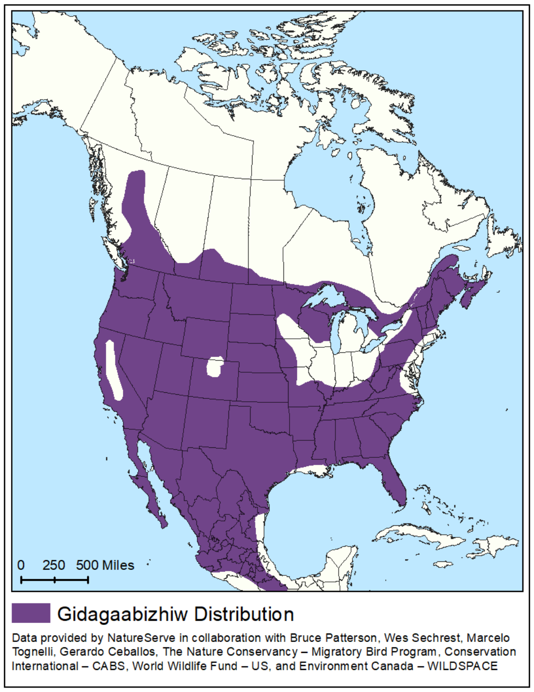
Legend

GI — **Greatly Increase** This factor greatly increases vulnerability	I/GI — **Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I — **Increase** This factor increases vulnerability
SI/I — **Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI — **Somewhat Increase** This factor somewhat increases vulnerability	N/SI — **Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

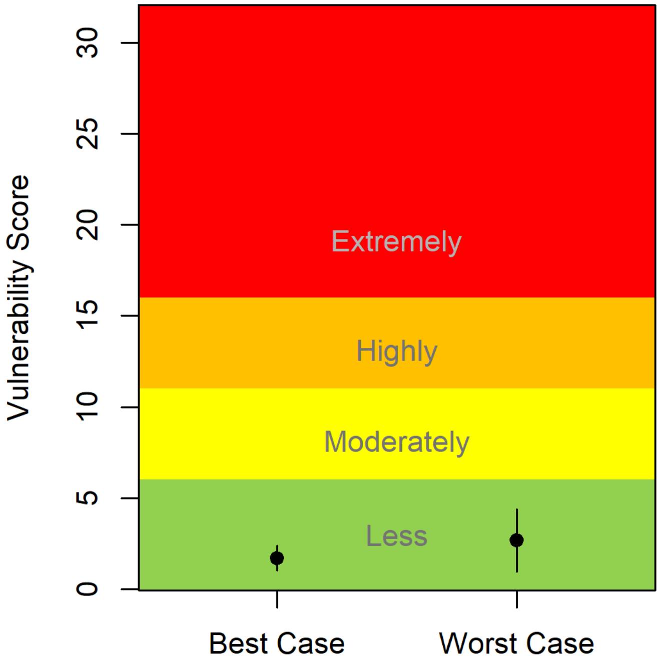
Gidagaa-bizhiw

Gidagaa-bizhiwag (plural) / Bobcat / *Lynx rufus*

Less Vulnerable
(Confidence Level: Moderate)



Range map of gidagaa-bizhiw.



Climate change vulnerability scores for gidagaa-bizhiw on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

From a scientific perspective, bizhiw (Canada lynx) and gidagaa-bizhiw belong to the same genus but are different species. From an Ojibwe perspective, the two are considered very close relatives to not only each other, but also to mishi-bizhiw (referred to as the Great Lynx, Underwater Panther, Water Cat, and other similar variants) who is considered a manidoo (spirit) of the water. When stories are told about mishi-bizhiw, most associate the manidoo with bizhiw, but some Ojibwe knowledge holders describe mishi-bizhiw as a gidagaa-bizhiw. While bizhiw and gidagaa-bizhiw are seen as relatives, bizhiw is the main cat being in the Ojibwe clan system.

Gidagaa-bizhiw uses a variety of habitats, including swamps, bogs, lowland coniferous forest, and occasionally hardwood forests and forest edges. Gidagaa-bizhiw prefers large forest tracts but seems capable of dealing with moderate human influence on the environment. Stumps, logs, woody debris, or rock features are important for denning and resting cover. Unlike bizhiw, deep snow can limit gidagaa-bizhiw use of an area.

Gidagaa-bizhiw is secretive and hard to observe and track, making population estimates and habitat studies difficult. However, increased gidagaa-bizhiw sightings in Wisconsin in recent years may indicate a population increase. An ongoing Wisconsin DNR study placed GPS collars on over 50 gidagaa-bizhiwag in the Ceded Territories and has not found any population concerns for the being to date. Historical Ojibwe place names may indicate gidigaa-bizhiw populations were higher years ago. Ojibwe place names often suggest a significant presence of a being or indicate some other connection of that being to a given location. Gidagaa-bizhiw'iganiing (Lake of the Bobcats), located in the western Upper Peninsula of Michigan, is one of those examples.

Although gidagaa-bizhiw was mentioned infrequently in interviews, all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. One interviewee from Mashkiiziibiing (Bad River) shared that they had only seen a gidagaa-bizhiw a few times in their life, once around 1988 in Marengo, Wisconsin, and once around 2014 in Odanah, Wisconsin. An elder in Gaa-miskwaabikaang (Red Cliff) mentioned that tribal members can obtain tags for trapping gidigaa-bizhiwag, but most choose to hunt them instead because the traps need to be checked too often. Both interviewees mentioned that they are very secretive beings, keep to themselves, and are rarely seen by humans.

Summary of climate threats:

Gidagaa-bizhiw was in the 24th percentile relative to other four-leggeds and in the 13th percentile relative to other beings in the assessment. Gidagaa-bizhiw is an adaptable and generalist being, and not likely to be vulnerable to gradual climate changes; in fact, some climate changes may benefit gidagaa-bizhiw. As it is limited by deep snow, increases in winter precipitation in the form of rain will decrease snowpack and would likely benefit gidagaa-bizhiw. Anthropogenic barriers and competition may also contribute to climate change effects on gidagaa-bizhiw.

Factors that increase the vulnerability of gidagaa-bizhiw to climate change:

N/SI Anthropogenic barriers: Agriculture is a barrier to gidagaa-bizhiw movement. No evidence of roads limiting gidagaa-bizhiw movement has been found in the Wisconsin portion of the Ceded Territories.

N/SI Competition: Gidagaa-bizhiw coexists with a variety of other carnivores across its extensive range and does not seem to be seriously limited by competition. However, increased competition with wiisagizi ma'iingan (coyote), waagosh (fox), and other medium-sized carnivores in the Ceded Territories is likely in the future and has the potential to impact gidagaa-bizhiw.

Legend

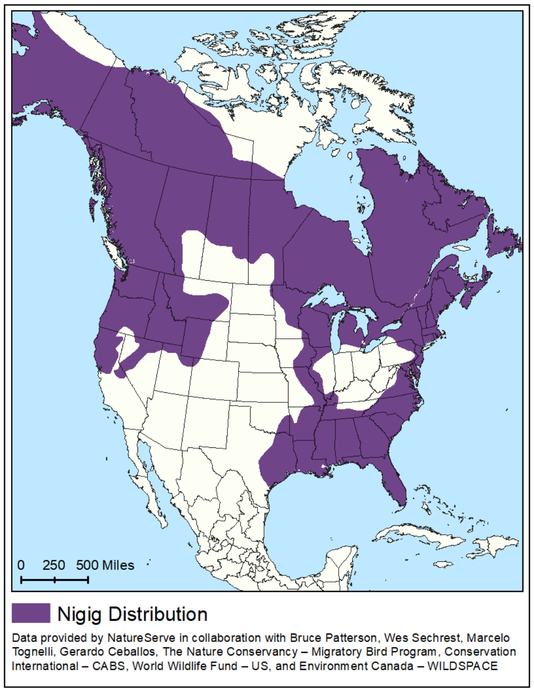
GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

Nigig

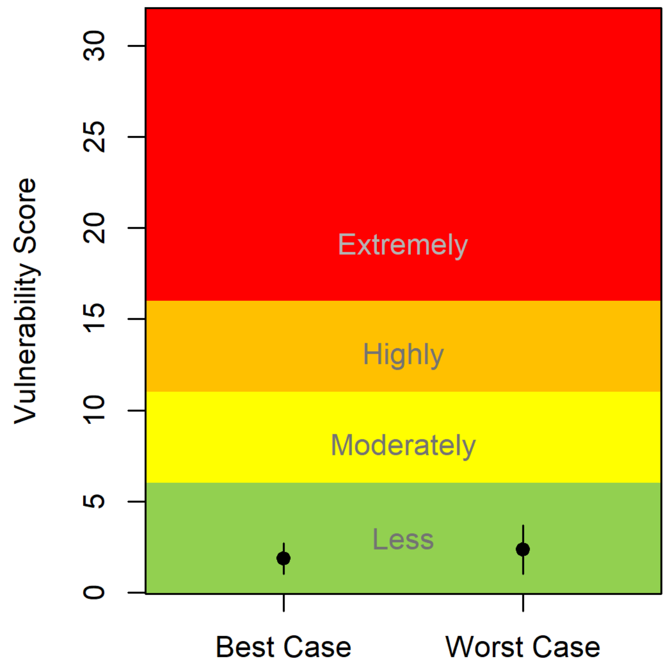
Nigigwag (plural) / River otter / *Lontra canadensis*

Less Vulnerable

(Confidence Level: Moderate)



Range map of nigig.



Climate change vulnerability scores for nigig on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

There are several versions of one story about nigig that speak to the cultural role and responsibility of this being. The stories talk about when the Great Spirit created the earth and held a meeting with all the spirits where he relayed his intention to place humans on the earth. He told them that each of them would play a particular role in the creation process and asked each one how they would like to help. The guardian spirit of nigig was one who spoke up. He felt that with his gifts and character he could show the people how to work together and live in harmony as well as protect their families and groups. He also wanted to show them how to get to a place of unity. The Great Spirit agreed and selected nigig to carry out those roles for the Anishinaabeg.

Nigig uses a large variety of aquatic habitats but prefers slow-moving water with deep pools, abundant fish, and riparian vegetation. Riparian vegetation present in nigig habitat typically includes oziisigobiminzh (willow), wiigwaasaatig (paper birch), zesegaandag (black spruce), cattail, miskwaabiimizh (red-osier dogwood), mashkosiw (grass), bulrush, and sedge. In the winter months, nigig uses outflows from lakes with open water and travels and hunts under the ice. Nigig frequently uses abandoned beaver lodges or other burrows, hollow logs, or overhangs for resting and raising young.

Nigig once ranged over much of North America but was extirpated from much of the interior United States after European colonization as a result of pollution, habitat loss, and overharvest. Since the 1970s, it has re-colonized many areas. Population models from the Wisconsin DNR suggest nigig populations declined in the early 2000s and have since increased, but uncertainty about the population remains. The presence of nigig in the Ceded Territories is evident in Traditional Ecological Knowledge of Ojibwe place names. Otter Island, one of the Wenaboozhoo Minisan (Apostle Islands) in northern Wisconsin, is referred to in Ojibwe as both Anweshin-nigig-minis (Otter Rest Island) and Nigig-minis (Otter Island). There are other places throughout Wisconsin, Minnesota, and Michigan that also refer to nigigwag, such as Nigigo-zaaga'igan (Otter Lake).

Nigigwag were mentioned infrequently in interviews, but all beings are of equal importance to Ojibwe people based on the cultural belief in the original treaties with all of creation. Interviewees in Nagaajiwanaang (Fond du Lac) and Mashkiiziibiing (Bad River) relayed that they have seen an increase in their populations, and in Mashkiiziibiing nigigwag are often observed taking over amik (beaver) lodges. Concern was expressed by both Waaswaaganing (Lac du Flambeau) and Gaa-miskwaabikaang (Red Cliff) interviewees about a significant decrease in their populations, which has impacted the number that can be trapped. Trapping of nigigwag, mostly for their hides, has been a cultural and economic activity for generations that has decreased recently due to lower populations of nigigwag and a general lack of interest in trapping by current generations.

Summary of climate threats:

Nigig was in the 18th percentile relative to other four-leggeds and in the 12th percentile relative to other beings in the vulnerability assessment. Nigig is a habitat and diet generalist, which makes it less vulnerable to climate change. However, based on information from interviews, localized changes in the population or timing of nigig will continue to occur. Nigig may be somewhat dependent on amik for habitat. Changes in hydrology may also affect nigig through food availability, but projected changes to hydrology are uncertain and effects on nigig are relatively unknown.

Factors that increase the vulnerability of nigig to climate change:

N/SI Physiological hydrological niche: Nigig has seasonal needs related to prey availability, and changes in precipitation and hydrology may affect nigig, though how climate change will affect hydrology is relatively unknown.

N/SI Dependence on other species to generate habitat: Nigig is linked directly to the presence of amik in the Ceded Territories and uses amik ponds for foraging as well as natal den sites. While amik is not highly vulnerable to climate change, the partial reliance of nigig on amik for habitat may somewhat increase its vulnerability to climate change.

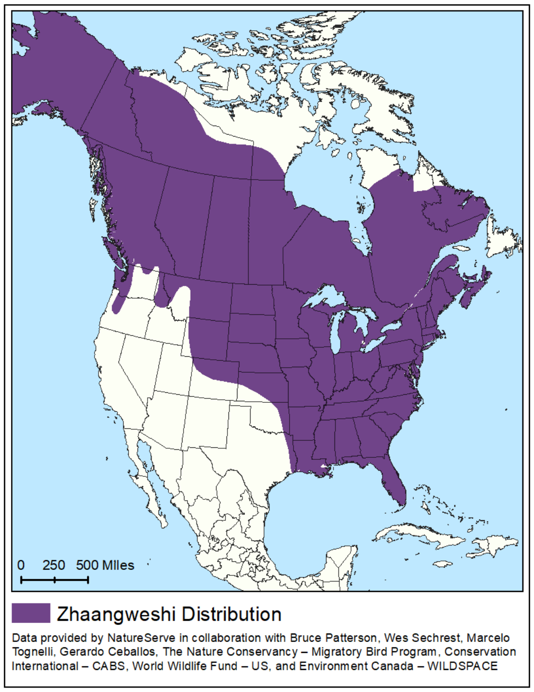
Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

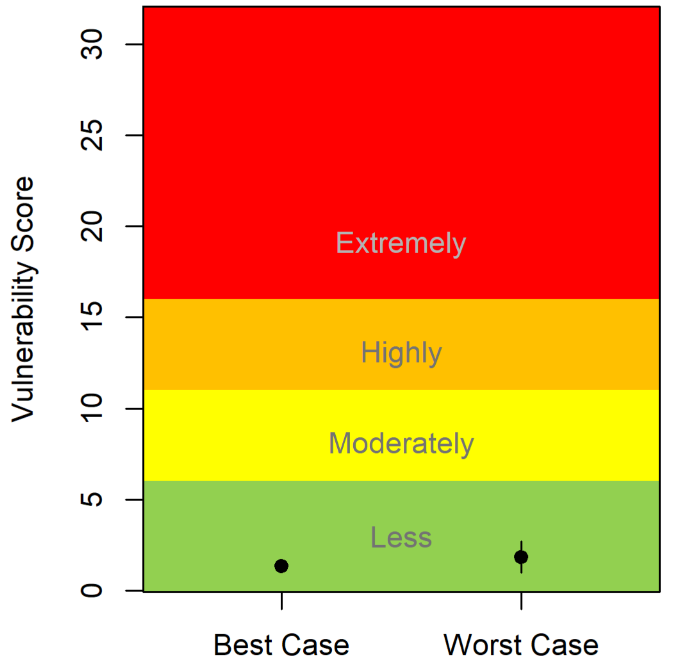
Zhaangweshi

Zhaangweshiwag (plural) / American mink / *Neovison vison*

Less Vulnerable
(Confidence Level: Moderate)



Range map of zhaangweshi.



Climate change vulnerability scores for zhaangweshi on a scale of 0 (lowest vulnerability) to 32 (highest vulnerability). Dots indicate average score; lines indicate possible range of scores for each scenario.

General Description:

Zhaangweshi is a clan animal and has been trapped for its pelt. A story about zhaangweshi and giigoonh (fish) talks about the nature of zhaangweshi: “Mink found a live pike on the lakeshore. He told the pike, ‘Pike, the Muskie is calling you all kinds of names.’ ‘What is he calling me?’ asked Pike. Mink answered, ‘He says you’re wall-eyed.’ Pike did not like to be called names and said, ‘Well, he’s got teeth like a saw blade and a long plated face. He’s not pretty either.’ There was a muskie nearby, and Mink told him what Pike had said about him. Mink went back and forth, back and forth, getting Muskie and Pike mad at one another. Finally, Pike and Muskie had a big fight and Mink acted as referee. Muskie and Pike ended up killing each other in the fight, so Mink had the last laugh on them. Mink got a big kettle and boiled and dried the meat. Then he lay down to rest. He was taking life easy. He had the fish eggs, which were his favorite, all together next to him and all he had to do was open his eyes and stick out his tongue to eat them. Finally, he dozed off. Some Indians came by in their canoes and saw Mink lying there with all those fish. They came ashore and picked up all the fish and put them in their canoes. Where Mink had all the fish eggs right next to him, they put rocks there. Then they went away. When Mink woke up, he reached with his tongue for the fish eggs, but instead there was only rocks and stones which broke his teeth. He realized they’d played a trick on him and he just walked away.” (Adapted from Victor Barnouw's Wisconsin Chippewa Myths and Tales and Their Relation to Chippewa Life).

Zhaangweshi is a semi-aquatic being that lives near water and prefers streams or riverbanks, lakeshores, marshes, and swamps. Diverse shorelines and abundant cover from shrubs, fallen trees, and rocks provide the best habitat. Zhaangweshi sometimes hunts in upland habitat as well as in wetlands. They eat a variety of fish, reptiles, amphibians, and fresh-water crustaceans. They will also eat eggs, birds, and small mammals.

Zhaangweshi has a large range in North America and is found in most wetlands, lakes, and creeks in the Ceded Territories, even those in more developed areas. Little is known about its population in the region, but it does have a large range and abundant habitat in the Ceded Territories.

Some interviewees spoke about zhaangweshi and mentioned changes they are seeing on the landscape. One tribal member from Misi-zaaga'iganiing (Mille Lacs) alluded to a decline in zhaangweshi populations in the area. Another interviewee from Waaswaaganing (Lac du Flambeau) mentioned that he uses zhaangweshi and other beings that run along the shorelines of water bodies as a “barometer” – if they are no longer around, things are out of balance. An elder in Ginoozhekaaning (Bay Mills) mentioned that zhaangweshi has a large range but that its population was higher in the past. This knowledge is connected to a lake in Michigan known to many Ojibwe as Zhaangweshi-zaaga’igan, or Mink Lake.

Summary of climate threats:

Zhaangweshi was in the 12th percentile relative to other four-leggeds and in the 6th percentile relative to other beings in the assessment. Zhaangweshi is among the least vulnerable beings to climate change in this assessment, likely due to its widespread habitat, particularly in the Ceded Territories. However, changes in the flood or drought regimes may negatively impact zhaangweshi, and despite having widespread habitat, tribal members are seeing declines in localized parts of the Ceded Territories.

Factors that increase the vulnerability of zhaangweshi to climate change:

N/SI — Disturbance regime: Drought or flooding may reduce feeding or foraging areas, and stream flashiness may negatively impact prey availability. However, flooding may also increase habitat for zhaangweshi.

Legend

GI	**Greatly Increase** This factor greatly increases vulnerability	I/GI	**Increase/Greatly Increase** This factor may increase or greatly increase vulnerability	I	**Increase** This factor increases vulnerability
SI/I	**Somewhat Increase/Increase** This factor may somewhat increase or increase vulnerability	SI	**Somewhat Increase** This factor somewhat increases vulnerability	N/SI	**Neutral/Somewhat Increase** This factor may not increase or may somewhat increase vulnerability

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Appendix 1: Interview Resources

GLIFWC TEK Interview Guidelines

These guidelines were followed for all interviews conducted as part of this assessment.

Introduction

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) is an intertribal agency that assists its eleven member tribes with the co-management of their off-reservation treaty rights to hunt, fish, and gather in the ceded territories. Healthy resources in abundant number are necessary to continue Anishinaabe bimaadiziwin (lifeways) and to meet spiritual, cultural, medicinal, subsistence, and economic needs. Since its formation in 1984, GLIFWC has sought to infuse Anishinaabe culture and values in all aspects of its mission and has done so by incorporating Traditional Ecological Knowledge (TEK) into various natural resource management plans, and rules and regulations.

GLIFWC recognizes that TEK is a source for understanding what constitutes proper respect of a particular resource and continues to incorporate TEK into treaty resource management plans to effectively serve its member tribes. For the Anishinaabe, natural resource management often has a different approach than that of state or federal management due to the desire to ensure that a certain resource is widely available for all tribal members' physical and spiritual needs in the present and for seven generations into the future. The idea of resources being needed for spiritual health is also reciprocal in that a resource needs respect and love from the Anishinaabe in order for Anishinaabe to receive the benefits from it.

There are multiple definitions of TEK and what information is categorized as such. For GLIFWC, TEK is typically recognized as a subset of the wealth of Anishinaabe gikendaasowin or traditional knowledge. TEK is the process of gathering the knowledge that has been gained from generations of indigenous people's connection and interactions with the environment and that is willingly shared. This knowledge system is based upon direct environmental observations and is typically transmitted orally through aadizookaanan (sacred stories), dibaajimowinan (oral histories), nagamonan (songs), and ceremonies over generations.

The information gathered often includes harvesting techniques, best management practices, species habitat and distribution, and explanations of consequences and effects of certain actions. Such information can be applied to and compared among the harvests for various years. If the harvest was successful, then the validity of such knowledge was reinforced. For unsuccessful harvests, different factors were compared to previous harvests and analyzed, until an explanation was eventually found and then subsequently incorporated into future use. There is no Ojibwe word or phrase analogous to TEK and, as such, tribal elders and harvesters do not make a distinction between their ecological knowledge and knowledge of other aspects of Anishinaabe bimaadiziwin; it is all viewed as information gained as a result of living.

TEK holders are people who have learned from years of experience. This experience may come from years of first-hand resource harvesting, observations of family or community members working with a resource and/or listening to elders' teachings about a resource. Typical TEK holders are elders and harvesters, although different communities may also consider other tribal members to be TEK holders, such as tribal historians who may not be an elder or harvester. It should also be noted that different communities also have disparate criteria for elder status. For some, a person is considered an elder once s/he has gray hair while others may have set ages, or whenever a person becomes a grandparent. TEK holders may also be referred to as "traditional knowledge holders" or as "Anishinaabe resource providers" since, as mentioned above, the holistic Ojibwe way of thinking often does not make a distinction between ecological knowledge and other aspects of Anishinaabe cultural knowledge.

How to Ask Anishinaabe Resource Providers to Participate in a TEK Interview

The Cultural Importance of Asemaa (Tobacco)

Asemaa is one of the four most common nookwezigan, or sacred herbs, characterized by their fragrant smoke and slowing-burning properties, along with bashkodejiibik (sage), wiingashk (sweetgrass) and giizhikaandagoons (cedar leaves). These herbs are used for smudging, healing, cleansing, and other ceremonial purposes. Asemaa in particular is used when offering prayers and asking for help or favors because it acts as a spiritual signifier that an exchange is occurring. An Anishinaabe resource provider sharing their knowledge is a gift. Since knowledge is intangible, that person is sharing a part of his or her spiritual energy and, through the act of explaining his or her experiences, he or she is providing years' worth of data that someone else would have to experience to gain the same level of knowledge.

Offering asemaa demonstrates humility by acknowledging one's ignorance and need for help and honoring the wisdom and knowledge that will be shared. The proper use of asemaa indicates to both the TEK holder and the spirits that may be associated with the topics that will be discussed that the knowledge will be respected by those seeking it. Asemaa is the minimum requirement for such a request of information. It is often important to offer additional gifts, such as a stipend for the Anishinaabe resource provider's time, milage, per diem, etc., and a cloth item or food to reinforce the Anishinaabe cultural view that knowledge is highly respected and valued.

Approaching Anishinaabe Resource Providers

GLIFWC staff are typically aware of certain TEK holders because of previous projects. However, with GLIFWC's 11 member tribes, it is unlikely that GLIFWC staff are aware of every Anishinaabe resource provider that has knowledge about natural resources of the ceded territories. As such, GLIFWC staff should reach out to GLIFWC's Board of Commissioners and the Voigt Task Force Representatives as a first step to identify potential TEK holders for each project; they are valuable resources for identifying TEK holders in the communities of GLIFWC member tribes. As another resource, the GLIFWC Advisory and Guidance Input Group of Elders (GAAGIGE) has several members who are harvesters and more often than not eager to participate in TEK projects. However, this group only meets twice a year, so projects with short timelines may not be able to be presented during the TEK gathering process. Tribal Historic Preservation Officers (THPOs) are a resource for historical accounts containing sources of TEK and typically are aware of families who continue to harvest in their community. Once TEK holders have been identified, they may reference other harvesters or elders during the interview. After the interview, it is useful to follow up and ask if that person would be open to participating the project and his or her contact information.

Asemaa needs to be offered to an Anishinaabe resource provider when asking whether an interview can be conducted, and again before the interview is conducted. It is very effective to offer asemaa first in the manner of asking a TEK holder for a favor of just listening to a basic overview of the project. Each community and even individual TEK holders have different preferences for the proper manner of offering asemaa. However, the most widely accepted method of asking an Anishinaabe to help you is to offer a pinch of loose pipe tobacco with one's left hand. Some elders may even prefer a pack of their favorite brand of cigarettes while others would prefer kinnikinnick. It is useful to carry a small piece of cloth and string in case if a TEK holder does not plan on using the asemaa right away to prevent it from staining hands or being lost during transport.

Once she or he agrees, explain the project details: what type of information the project will be documenting, why that information is useful to GLIFWC, and the manner in which the information will be used during the project, how the information will be stored, and whether or not the information is intended to be used after the project. At this point, the Anishinaabe resource provider is able to agree to be interviewed or can politely decline if uncomfortable with sharing that type of information. If the interview will occur at a later time, one should offer asemaa again before the interview, this time signifying that respect for the knowledge that is going to be shared. If the interview occurs shortly after the asemaa is given the first time, such as later that same day, then an additional asemaa offering for participating in the interview is usually not necessary unless the TEK holder requests it.

Information Anishinaabe Resource Providers Need to Know Before Interviewing

An Anishinaabe Resource Provider should be aware of the scope of the project, what information or input the project requires, and the manner in which the interview transcript and information obtained from the interview will be used for the project as well as any future projects. At this time, it is important to emphasize that any information shared for a project is owned by the Anishinaabe resource provider, not the Commission or GLIFWC staff member(s). GLIFWC will only use the information as authorized to do so. Compensation for the interview, if any, needs to be explained, i.e., a social security number is required for tax purposes, before recording necessary interviewee information for payment.

Any additional questions or concerns that a TEK holder has should be addressed before the interview occurs. The transparent nature of how the information will be used and emphasizing his or her ownership and control of the information provided will foster good will towards the project and GLIFWC. This is especially useful when helping to create community buy-in for greater participation and reception.

Suggestions for Effective TEK Interviews

Interview questions should be broad to allow for self-editing answers. For some Anishinaabe, some topics are considered off-limits to record, such as aadizookaanan (sacred stories) or even references to the sacred stories. Others may prefer to keep other knowledge "off the record," such as the location of a resource that may only have enough output for one person's harvest. The manner and detail in which one can respond to a broad question helps ensure that an interviewee will share only what they believe is appropriate to be shared. Having broad questions will also allow for the interviewee to feel comfortable with informal questions and counters the sentiment "I don't know anything" that many TEK holders respond with when asked to provide information about a resource. This response is especially common when asked a complex or technical question.

Broad questions also help reduce the total number of questions to be included in the interview which in turn helps to add to the casual nature of the interview. By having 3-5 broad questions, the interviewer should not need a physical list of questions to conduct the interview, which may be intimidating for some elders or harvesters. Follow-up questions can be asked for additional clarification, but working without a list results in more organic conversation and information. A list can also be perceived as being too impersonal for some elders. Another way to reinforce the casual nature is to refer to the interview appointment or interview itself as a "visit" or a "chance to sit and talk."

The length of each interview will be determined by the TEK holder and by the amount of information she or he chooses to share with you. It is not unusual to have to schedule additional interviews with the same individual for a number of reasons. It may be that an elder is tired of talking for the day but wants to share more information, or for last minute community obligations, such as running a funeral, may arise. An additional follow up meeting should be offered to the Anishinaabe resource provider when she or he is sent the interview transcript in case of transcripts edits that need to be made or additional information to be included if the interview was recorded.

It is important to remember that there is a history of tribal knowledge being abused by early anthropologists and enthographers, as well as the knowledge holders. Such scholars used traditional knowledge with little to no acknowledgement to the tribal members, often times passing off such knowledge as their own. Recorded knowledge may have also been presented in a culturally insensitive way that reinforced the notion that tribal culture was "primitive", "savage", or "dying". Taboo subjects were sometimes published without consent from the information provider. As such, it is important to respect what information is shared during the interview as well as what information is not shared. The interviewee should at no point feel like she or he is being pressured or bullied into answering a given question.

Guidelines for Conducting TEK Interviews

Once an Anishinaabe resource provider has agreed to participate in a TEK interview, reiterate what information the project is attempting to document, how the information from the interview will be used within the scope of the project and any future uses if applicable. If the interview is being recorded, double check that recording is acceptable and do not record until given approval to begin. It is helpful to have drinks on hand during the interview in case of coughing or dry mouth. It is more than likely for some small talk to occur before the interview begins while drinks are being poured and the interviewee and interviewer get comfortable. Bringing beverages and light snacks can go a long way to ease any tension. It also reinforces the reciprocal way of Anishinaabe culture; the TEK holder is feeding one with knowledge so one should feed them with food or drinks.

If the interview is being recorded, try to ensure that there is limited background noise that the microphone can pick up. Try to avoid areas near windows as recording equipment may record ambient road noise during the interview. Be sure that the microphone is pointed toward the speaker, and, if recording a group, have the recording equipment in the best available position for the group setup. If the background noise of a location is particularly audible, record 10 to 15 seconds of the room without anyone speaking to identify the background noise later during the audio editing process.

Once finished with the interview questions, ask the interviewee if there is anything she or he would like to add. When the interview is over, once again reiterate how the information and transcript if applicable from the interview will be used in the project and any other future uses. It is often more useful to ask if there are uses the Anishinaabe resource provider does not want his or her TEK used instead of a long list of potential scenarios on the spot. If the interview was recorded, explain how the recording will be stored at GLIFWC, who will have access to it, and what will happen to the recording once the project is completed. Asking if the Anishinaabe resource provider would like a copy of the recording, or if the recording should be kept after the project is completed also reinforces the fact that she or he is the owner of the TEK that was shared in the interview.

The interviewees have the right to determine what happens with the transcripts and any recordings of their interviews as well as the TEK shared during the interview. Ask the interviewee what the preferred method of the transcript review would be. Although some TEK holders may decline reviewing the transcript of their interview, each recorded interview needs to be transcribed in order to ensure accuracy of the information shared and as an accessible reference for later use when creating project deliverables. Often, when reviewing an interview transcript, there may be information that needs clarification or additional information would be useful in project deliverables. If such information is needed, the TEK holder can provide it, if she or he deems it as appropriate to share. The transcript review also provides another opportunity to ensure that the TEK holder is approves what information was shared and if there is any information that she or he wants deleted, edited, or added to, then she or he can do so as the owner of such information.

The transcript review is an opportunity for the interviewee to determine what information is shared and used. Any information edited or removed from the transcript by the interviewee after review, must not be used in any way for the project or future use. Finally, if any information from the interview is intended to be used for another purpose besides the project under which the interview took place, contact the Anishinaabe resource provider and ask for her or his permission to do so.

GLIFWC Climate Change Traditional Ecological Knowledge Interview Questions

The following is a list of questions provided to each interviewee. Interviews were semi-directed, meaning questions were provided as prompts but were not required to be answered directly. These questions were last updated in May 2016.

- When you gather/harvest in areas that you are most familiar with, do you notice changes in the environment (such as plants, animals, land, water, and air) over time?
    - Are there any particular changes that concern you? If so, why?
    - If there is not a concern, is there something to be learned from these differences?
- What beings do you feel are more impacted by changes in the environment than others (such as plants, trees, animals, insects)?
- Is there anything in particular happening (such as human activity) that is having either a positive or negative impact on the items you harvest?
- What cues do you look for to understand if the harvest will be good or not (such as environmental or other)?
- Are there any indicators, meaning other things you look for to know when it is time to harvest or stop harvesting certain things/beings (such as when you hear spring peepers, thunderstorms, or when certain plants bloom)?
- When you think back about stories your elders told you, have you noticed any changes in when things were harvested vs. now?
- Can you share any Ojibwe words, stories, or songs about certain beings or elements in the environment and surroundings such as trees, insects, birds, stars, moons, etc.?

List of Interviewees

List of those interviewed for the GLIFWC climate change vulnerability assessment, including the date and location of the interview. Those in bold font have since passed on. This list reflects where the interviews were conducted, not the tribal affiliation of the interviewees. Most interviewees are members of GLIFWC member tribes.

Date of Interview	Location	Interviewee
8/13/2015	St. Croix	Jeremy Bloomquist
		Carmen Butler
		Conrad St. John
8/24/2015	Mole Lake	**Makoons Fred Ackley Jr.**
8/27/2015	Lac Vieux Desert	Vera Klingman
		Daisy McGeshick
		Giiwegiizhigookway Martin
8/28/2015	Lac du Flambeau	Dee Ann Allen
		Kristen Hanson
		Brian Poupart
		Duane Poupart Sr.
		James Peterson
		Bill Wildcat

Date of Interview	Location	Interviewee
1/12/2016	Lac Courte Oreilles	**Niso-asin Sean Fahrlander** Jason Schlender Kekek Jason Stark
2/27/2016	Lac Courte Oreilles	Maryellen Baker
3/8/2016	Lac Courte Oreilles	**Niso-asin Sean Fahrlander** Jason Schlender Kekek Jason Stark
3/16/2016	Red Cliff	Gezhiibideg Damon Panek
4/3/2016	Lac du Flambeau	Tom Maulson Sr.
4/7/2016	Fond du Lac	**Chibinesi Jim Northrup Jr.** Pat Northrup
4/8/2016	Mille Lacs	**Leonard Sam**
5/6/2016	Mille Lacs	**Leonard Moose** Mary Moose
5/25/2016	Mille Lacs	Curt Kalk
7/1/2016	Bad River	April Stone Jarrod Dahl
7/5/2016	Red Cliff	Lawrence Deragon Sr.
11/17/2016	Bay Mills	Kathy LaBlanc
1/23/2017	Bad River	JD Lemieux Maria Nevala Mike Wiggins Jr.
1/26/2017	Red Cliff	**Joseph Duffy** Mark Duffy Mary Duffy
2/1/2017	Fond du Lac	Vern Northrup
6/5/2017	St. Croix	Lee Obizaan Staples
8/2/2017	Red Cliff	**Leon "Olie" Basina Sr.**
2/16/2018	Keweenaw Bay	Gidigaa bizhiw Jerry Jondreau
9/11/2018	Bay Mills	Cheryl Baragwanath
7/25/2019	Lac du Flambeau	Arthur LaBarge Pamela Green-LaBarge **Phillip "Poda" LaBarge**
1/24/2020	Bad River	**Moka’ang Giizis-Rising Sun Joe Rose Sr.**

Example TEK Interview Summary

The following is a summary compiled after each interview was transcribed, to allow us to reference keywords and climate change-related information quickly. The table at the end of the summary lists some of the main topics of the interview and a brief description of what was discussed.

Key words:

animals, apples, bear, bearberry, berries, birch, birds, Bishop Lake, black birds, brown bird, brown moths, brown spot, butterflies, cattails, ceremony, change, clover, cold, degrees, different, DNA, drought, duck, earth, earthquakes, famine, feast, fire, fireflies, fish, fish hawks, flowers, food, frogs, global warming, goldenrod, snails, wild rice

Interviewer:

Melonee Montano

Who interviewed:

Bob

Date of interview:

08/24/2015

Locations referred to:

Mole Lake Reservation, Bishop Lake, Crandon

Names of beings/spp mentioned:

animals, apples, bear, bearberry, berries, birch, birds, black birds, brown bird, brown moths, butterflies, cattails, clover, duck, fireflies, fish, fish hawks, flowers, frogs, goldenrod, snails, wild rice

Changes in populations of beings (decrease/increase/other (specify)):

- Increase – brown moths, goldenrod
- Decrease – animals, bearberry, blackbirds, clover, fireflies, fish hawks, wild rice
- Other – flowers (different)

Beings more sensitive to change:

Unknown (none specifically named that are more sensitive than others)

Environmental change:

Year of 2015 very hot - air conditioning not used one day.

Changes that cause concern:

All

If no concern, anything to be learned:

N/A

Indicator mentioned:

- Birds: get happy when it rains.
- Snails: indicate water getting hot.

Changes noticed in indicators:

None specifically mentioned.

Other impacts (culverts, logging, etc):

- Human activities causing earthquakes.
- Trees being cut down.

Cues that indicate how a harvest will be (increase in rain helps with fiddleheads):

None specifically mentioned.

Changes noticed from elder stories vs todays harvests:

None specified.

Traditional stories or songs:

Little brown bird too busy flying around…

Topic	Key Points
Resources	• People with wealth over-using
Sun	• Different
Natural Disasters	• Human-caused • Moves seeds/brings change/brings new life
Birds	• Get happy when it rains • Little brown bird traditional story
Water	• Affected by “global warming”
Pollution	• Power companies causing changes • Concern of earth being polluted • Concern of water being polluted and fish not edible
Fish	• Concern of water being polluted and fish not edible
Waste dumps	• Concern of waste dumps getting larger
Wild Rice	• Talked about like it’s a human • Put there for us to use, eat, and watch grow • Brown spot infestation seen in 2003
Changing climate	• Getting worse last 15 years • Over 30-year period experiencing warming
Earth/Planets/Solar System	• Limit on what humans can do to it
Wild rice	• Mentioned numerous times throughout summary. • Normally two-week window for gathering
Climate Change	• Various changes noted throughout interview
Fire	• Brings change/new life to entire ecosystem
Birch Bark (paper birch)	• Time of day for gathering has gotten earlier due to hotter days • Didn’t gather if it rained
Mercury	• Contaminating fish (concern)

Interview Word List

Word list from Traditional Ecological Knowledge interviews, showing the word and the number of times it was mentioned among all interviews. This list excludes stop words, such as and, but, and or.

Mentions	Word
1823	know
821	going
795	see
688	use
650	time
606	years
600	think
577	people
552	look
544	now
470	lot
369	tree
360	way
355	laughter
351	big
348	make
339	good
337	take
334	change
303	want
295	little
288	never
281	water
278	lake
270	start
263	went
240	day
237	tell
231	try
230	different
224	work
220	fish
216	everything
207	remember
204	rice
200	happen
187	call
180	give
180	hear

Mentions	Word
165	every
165	story
163	still
162	old
161	deer
161	told
157	plant
156	much
155	always
151	grow
148	eat
145	pick
142	last
139	anything
139	long
138	birch
138	seed
137	ago
136	many
135	came
135	live
134	find
132	species
130	name
128	getting
128	wood
127	earth
124	kid
123	ask
120	climate
118	keep
118	place
118	thought
117	made
117	took
116	probably
115	harvest
114	medicine
113	nothing

Mentions	Word
113	road
113	today
112	gather
112	hard
110	bark
108	ever
108	help
106	cut
106	life
104	area
101	house
101	Indian
101	walk
101	whole
99	done
99	tribe
98	anymore
98	white
97	need
96	away
96	somebody
95	run
95	snow
93	bit
93	sit
92	man
92	wild
92	young
91	else
90	three
89	guess
88	home
87	money
86	bring
86	everybody
86	maple
84	meet
84	might
81	gone

Mentions	Word
81	hunt
81	knew
81	night
80	animal
80	berry
80	spirit
80	warm
79	ground
79	next
78	notice
78	spring
77	wow
76	built
76	move
76	seem
76	world
75	kill
75	natural
75	reservation
74	stay
73	side
73	tap
71	river
70	Mille Lacs
68	grandma
68	syrup
66	learn
65	ash
65	black
65	end
64	small
64	trap
63	along
63	bad
63	early
62	ice
62	new
62	week
62	yet
61	dad
61	far
61	fire
61	state
61	tobacco

Mentions	Word
60	across
60	interest
58	able
58	believe
58	enough
58	land
58	late
58	watch
57	leave
57	rain
57	stand
57	winter
56	better
55	basket
55	gave
55	top
54	anyway
54	collect
54	food
54	hell
54	nobody
54	question
54	share
54	sometime
53	either
53	sap
53	stop
52	beaver
52	bird
52	blueberry
52	die
52	job
52	nice
52	show
52	weather
51	cedar
51	cold
51	reason
51	word
50	actually
50	fall
50	hit
50	line
50	member

Mentions	Word
50	real
50	record
50	resource
50	season
50	turn
49	elder
49	information
49	morning
49	mother
49	program
49	teach
49	together
48	environment
48	fly
48	order
48	person
48	speak
48	study
47	hand
47	impact
47	lose
47	rabbit
46	clean
46	human
46	wonder
45	already
45	care
45	close
45	open
45	traditional
45	usually
44	become
44	mind
44	problem
44	red
44	swamp
44	walleye
43	course
43	head
43	important
43	month
43	number
43	wait
42	boy

Mentions	Word
42	feel
42	forest
42	school
41	almost
41	car
41	family
41	mine
41	someone
40	affect
40	boat
40	found
40	half
40	Ojibwe
40	project
40	pull
40	ready
40	set
40	understand
40	woman
39	list
39	sell
38	boil
38	mile
38	picture
38	type
37	bear
37	burn
37	creek
37	full
37	heart
36	forget
36	hope
36	left
36	north
36	outside
36	quite
36	since
36	soon
36	sound
36	sugar
36	temperature
35	bay
35	clear
35	crazy

Mentions	Word
35	dollar
35	dry
35	inside
35	language
35	past
34	catch
34	caught
34	deep
34	frog
34	GLIFWC
34	god
34	group
34	high
34	knowledge
34	level
34	pound
34	Red Cliff
34	sun
34	tie
34	write
33	baby
33	book
33	drive
33	native
33	root
32	Anishinaabe
32	ate
32	involved
32	realize
32	relate
32	summer
31	brought
31	concern
31	cook
31	eagle
31	pay
31	son

Being Reviewer List

Reviewers were given the scores GLIFWC staff gave each question and provided feedback on whether they felt the score was accurate, based on their own knowledge of the being and its natural history in the Ceded Territories. Reviewer knowledge was considered in determining final scores.

Being (English)	Being (Ojibwe)	Reviewer 1	Reviewer 2
Northern wild rice	Manoomin	Peter David	Jason Fleener
Tamarack	Mashkiigwaatig	Alex Wrobel	Laura Reuling
Labrador tea	Mashkiigobag	Susan Knight	
Balsam fir	Ininaandag	Robin Clark	Josh Cohen
Northern white cedar	Giizhikaatig	Robin Clark	Josh Cohen
Sugar maple	Ziinzibaakwadwaatig	Tara Bal	
American ginseng	Jiisens	Kelly Kearns	Charmaine Robaidek
Paper birch	Wiigwaasaatig	Robin Clark	Josh Cohen
Wild ginger	Namepin	Sarah Johnson	
Black ash	Baapaagimaak	Jeff Carstens	
Wild leek	Bagwaji'zhigaagawanzh	Colleen Matula	Ryan O'Connor
White ash	Aagimaak	Jeff Carstens	
Princess pine	Gaagigebag	Colleen Matula	Sarah Johnson
Bloodroot	Miskojiibik	Colleen Matula	Amy Staffen
Sweet flag	Wiikenh	Steve Garske	
Broadleaf arrowhead	Bagwajipin	Susan Knight	Quita Sheehan
Blueberry	Miin	Alex Wrobel	Dawn White
American basswood	Wiigobaatig	Marla Emery	
Sweetgrass	Wiingashk	Steven Spickerman	Kelly Kearns
Red-osier dogwood	Miskwaabiimizh	Quita Sheehan	
Strawberry	Ode'imin	Kevin Doyle	Quita Sheehan
Wild sage	Mashkodewashk	Steven Spickerman	
Ostrich fern	Anaaganabag	Steve White	Ian Shackleford
Raspberry	Miskomin	Ryan O'Connor	Marjory Brzeskiewicz
Tullibee	Odoonibiins	Ben Michaels	Bill Mattes
Lake Whitefish	Adikameg	Bill Mattes	
Walleye	Ogaa	Mark Luehring	Gretchen Hansen
Lake trout	Namegos	Bill Mattes	
Northern pike	Ginoozhe	Patrick Schmalz	Matthew Faust
Muskellunge	Maashkinoozhe	Matthew Faust	
Smallmouth bass	Noosa'owesi	Carl Climah	Mike Preul
Sturgeon	Name	Joshua Schloesser	
Largemouth bass	Ashigan	Greg Sass	Mike Preul

Being (English)	Being (Ojibwe)	Reviewer 1	Reviewer 2
Common Loon	Maang	Mike Meyer	Erica LeMoine
Sharp-tailed grouse	Aagask	Ted Gostomski	Brian Heeringa
Trumpeter Swan	Waabizii	Sumner Matteson	Gary Ivey
Wood duck	Mitigoningwiishib	William Mueller	Ed Zlonis
Sandhill crane	Ajijaak	Andrew Gossens	
Firefly	Waawaatesi	Daniel Young	
Bald eagle	Migizi	Mike Meyer	Bill Route
Blue-winged teal	Ozhaawashkonebiisibens	Bruce Bacon	Ed Zlonis
American Crow	Aandeg	Joan Elias	
Mallard	Ininishib	Bruce Bacon	Ed Zlonis
Wild turkey	Mizise	Ted Gostomski	Maxime Lavoie
Common Raven	Gaagaagi	Joan Elias	
Canada goose	Nika	William Mueller	
Wood turtle	Mitigwaakiing dizi mishiikenzh	Carly Lapin	Yu Man Lee
Spring peeper	Agoozimakakii	Andrew Badje	Gary Casper
Painted turtle	Miskwaadesi	Tara Bergeson	Andrew Badje
Snapping turtle	Mikinaak	Andrew Badje	Gary Casper
Snowshoe hare	Waabooz	Ben Zuckerberg	Sean Sultaire
Moose	Mooz	Mike Schrage	Ron Moen
American marten	Waabizheshi	Nick McCann	Michael Joyce
Fisher	Ojiig	Nick McCann	Roger Powell
Tree Bat	Bapakwaanaajiinh	Brian Heeringa	Paul White
Cave Bat	Bapakwaanaajiinh	Brian Heeringa	Paul White
Common Muskrat	Wazhashk	John Erb	Adam Bump
Short-tailed/Least Weasel	Zhingos	Roger Powell	Serge Lariviere
Long-tailed Weasel	Zhingos	Roger Powell	Brian Roell
American Beaver	Amik	John Olson	Brian Roell
Elk	Omashkooz	Mike Schrage	Adrian Wydeven
White-tailed deer	Waawaashkeshi	Keith McCaffery	Jon Gilbert
Gray Wolf	Ma'iingan	Peter David	Adrian Wydeven
Black bear	Makwa	Roger Powell	Dave Garshelis
Bobcat	Gidagaa-bizhiw	Nathan Roberts	Jon Gilbert
River otter	Nigig	Brian Roell	John Olson
American Mink	Zhaangweshi	Roger Powell	Adam Bump

Appendix 2: Plants Climate Change Vulnerability Index Results

Northern Wild Rice

Factors that influenced the vulnerability of manoomin to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	SI	Upland habitat is a barrier to manoomin.
Anthropogenic barriers	N	No significant anthropogenic barriers.
Predicted land use change in response to CC	SI	Any human responses will likely impact manoomin - more recreation on lakes, dam installations, more development.
Dispersal and movement	I	Poor natural dispersal except downstream. Most establishments of manoomin populations are due to human seeding efforts.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	I	Seed production may decline with increasing temperatures. Manoomin in the Ceded Territory is on the southern edge of its range and adapted to cool temperatures. It also needs a frozen cycle for seed germination.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	I	Manoomin is sensitive to changes in water levels, and year-to-year or fluctuating water levels can impact this being.
Dependence on disturbance regime likely to be impacted by CC	I	Flooding has the potential to drown manoomin plants in the floating leaf stage and water level fluctuations can affect plants at any stage. Wind and large rain storms are other disturbances that can affect manoomin.
Dependence on ice, ice-edge or snow	I	Ice cover helps the seed break dormancy, and can knock back competing plant beings.
Restriction to uncommon landscape	N/SI	Manoomin is limited to particular aquatic habitats in the Ceded Territories.
Dependence on other species to generate habitat	N	Not dependent on other beings (except humans) to generate habitat. Can grow in amik (beaver) ponds, but not dependent on them.
Dietary versatility	N/A	
Pollinator versatility	N	Wind pollinated.
Dependence on other species for propagule dispersal	N	Dispersal is somewhat dependent on humans.
Sensitivity to pathogens or natural enemies	I	Brown spot disease and rice worms. Carp may also impact manoomin, and many communities are seeing areas where waabiziig (swans) are devastating manoomin beds.
Sensitivity to competition from native or non-native species	SI	There are many possible bakaan ingoji gaa-ondaadag (non-local beings) that could outcompete manoomin. Pondweeds, water lilies, cattail, pickerelweed, flowering rush, and Phragmites are among them.

Factor	Score	Comments
Other interspecific interaction	U	Not enough known about interspecific interactions with manoomin.
Measured genetic variation	N/SI	There are concerns that because entire manoomin beds have been lost, and manoomin has limited dispersal, genetic variation is not particularly high.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information about phenology.
Documented response to CC	I	GLIFWC data are consistent with a reduction in abundance due to CC impacts.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Tamarack

Factors that influenced the vulnerability of mashkiigwaatig to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N/SI	Upland habitats or lowland habitats affected by water loss or increased saturation could limit mashkiigwaatig distribution.
Anthropogenic barriers	N/SI	Some roads that affect wetlands could increase vulnerability. Otherwise, there are not many current examples of direct anthropogenic barriers that are impacting mashkiigwaatig.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	I	Most seeds land within a distance of two tree heights, but can travel up to 60 m.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	I	Primarily restricted to cool environments.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	SI/I	Dependent on a specific hydrological regime and can be highly affected by drought.
Dependence on disturbance regime likely to be impacted by CC	I	Flooding often kills mashkiigwaatig stands. May also be susceptible to ishkode (fire).
Dependence on ice, ice-edge or snow	SI	Reduced snowpack can lead to deeper soil frost and increased mashkiigwaatig mortality.
Restriction to uncommon landscape	N	Mashkiigwaatig habitat is not uncommon in the assessment area.
Dependence on other species to generate habitat	SI	Mashkiigwaatig is associated with bogs, and bogs are closely associated with sphagnum moss. Sphagnum controls the chemistry of the bog, contributes substantial biomass to the accumulating peat, and is responsible for much of the waterlogging of the soils.

Factor	Score	Comments
Dietary versatility	N/A	
Pollinator versatility	N	Wind pollinated.
Dependence on other species for propagule dispersal	N	Wind dispersed.
Sensitivity to pathogens or natural enemies	SI	Quite a few manidoonsag (insects) negatively affect mashkiigwaatig and are expected to increase in distribution or abundance with CC.
Sensitivity to competition from native or non-native species	N	Easily outcompeted, although many competing beings are not necessarily favored by climate.
Other interspecific interaction	U	Not enough information found in the literature.
Measured genetic variation	N	Genetic variation is reported as high.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	U	Insufficient information found in the literature.
Modeled future (2050) change in range or population size	N	Not projected to lose suitable habitat by mid-century.
Overlap of modeled future (2050) range with current range	N	Future range overlaps current range by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N	National Forests, state land, county land, private property.

Labrador Tea

Factors that influenced the vulnerability of mashkiigobag to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	SI	Upland habitat is a barrier for this being, as most reproduction is vegetative.
Anthropogenic barriers	N/SI	Agriculture, urban areas, roads, logged areas are all barriers for mashkiigobag, depending on location.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	SI/I	Seeds are mobile, but are likely short-lived in the seed bank. Seeds must reach new, suitable habitat shortly after seed arrival at new site.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	I	Mashkiigobag is found in cool or cold environments, and wetland soils may be seriously affected by warmer temperatures. As the climate warms, the wetland peat soils found in the Ceded Territories will likely decompose more rapidly, and mashkiigobag habitat may be seriously impaired.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	I	Worldwide, mashkiigobag is found in places with a variety of moisture levels, but in the Ceded Territories, it is generally found in bogs and conifer swamps, which are vulnerable to drying and/or variable conditions.

Factor	Score	Comments
Dependence on disturbance regime likely to be impacted by CC	N	Low intensity ishkode (fire) may benefit mashkiigobag. High intensity ishkode may negatively impact mashkiigobag, but not a lot is known about how the ishkode regime will change in the Ceded Territories. Mashkiigobag is not sensitive to flooding.
Dependence on ice, ice-edge or snow	N/SI	Only found in places with snowpack in winter, and changes in snowpack have an impact on evergreen shrubs.
Restriction to uncommon landscape	N	Mashkiigobag is particular about soil conditions (acidic, nutrient poor, water-logged) but these conditions are not uncommon.
Dependence on other species to generate habitat	SI/I	Mashkiigobag in the Ceded Territories is associated with bogs, and bogs are closely associated with sphagnum moss. Sphagnum controls the chemistry of the bog, contributes substantial biomass to the accumulating peat, and is responsible for much of the water-logging of the soils. Interviewees also mentioned the dependence of mashkiigobag on zesegaandag (black spruce) and mashkiigwaatig (tamarack) for habitat and for shade.
Dietary versatility	N/A	
Pollinator versatility	N	Five or more beings make significant contributions to pollination.
Dependence on other species for propagule dispersal	N	Wind-dispersed.
Sensitivity to pathogens or natural enemies	N	Can be browsed by waabooz (snowshoe hare), but this pressure is not likely to increase.
Sensitivity to competition from native or non-native species	N/SI	Possible that non-local aquatic plants (such as narrow-leaved cattail) will begin to outcompete mashkiigobag.
Other interspecific interaction	N/SI	Often associated with ericoid mycorrhizal associations but does not appear to be highly specific.
Measured genetic variation	U	Not enough information found in the literature.
Occurrence of bottlenecks	U	Not enough information found in the literature.
Reproductive systems	N	Mashkiigobag reproduces both sexually and asexually.
Phenological response to CC	U	Not enough information found in the literature, although one study did find that Arctic evergreen shrubs were fairly flexible in their flowering times with changes in snowmelt timing.
Documented response to CC	U	Not enough information found in the literature.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Balsam Fir

Factors that influenced the vulnerability of ininaandag to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No natural barriers in the assessment area.
Anthropogenic barriers	U	Insufficient information found in the literature.
Predicted land use change in response to CC	N/SI	Agriculture, urban areas.

Factor	Score	Comments
Dispersal and movement	SI/I	Propagules dispersed 10-1000 meters.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	I	Primarily restricted to cool environments.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	SI/I	Requires abundant soil moisture which may be limited as the climate changes. Drought stress can affect ininaandag as well.
Dependence on disturbance regime likely to be impacted by CC	SI	Ishkode (fire) intolerant. Can also be affected by windthrow.
Dependence on ice, ice-edge or snow	U	No information found in the literature.
Restriction to uncommon landscape	N	Not restricted to uncommon landscape features.
Dependence on other species to generate habitat	N	No dependence.
Dietary versatility	N/A	
Pollinator versatility	N	Wind pollinated.
Dependence on other species for propagule dispersal	N	Primarily wind dispersed.
Sensitivity to pathogens or natural enemies	SI/I	Some manidoonsag (insects) such as spruce budworm and a few others can cause ininaandag mortality. These manidoonsag are expected to have higher survival rates as the climate warms.
Sensitivity to competition from native or non-native species	N	Very shade tolerant and not highly affected by competitors.
Other interspecific interaction	U	Insufficient information found in the literature.
Measured genetic variation	SI	Genetic variation reported as low compared to findings using similar techniques on related taxa.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	U	Insufficient information found in the literature.
Modeled future (2050) change in range or population size	SI	Projected to decrease in abundance 20-50% by mid-century.
Overlap of modeled future (2050) range with current range	N	Future range overlaps current range by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N	National Forests, state land, county land, private property.

Northern White Cedar

Factors that influenced the vulnerability of giizhikaatig to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N/SI	Unsuitable habitat.
Anthropogenic barriers	N/SI	Agriculture, urban areas.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	I	Seeds dispersed around 150-200 feet from parent tree.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	SI/I	Almost entirely restricted to cool environments.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	I	Strongly dependent on a particular hydrologic regime. Drought stress can negatively affect giizhikaatig as well.
Dependence on disturbance regime likely to be impacted by CC	U	Giizhikaatig grows in diverse habitats, where multiple types of disturbances drive those systems, which makes this too difficult to estimate.
Dependence on ice, ice-edge or snow	SI	May respond positively to snow cover.
Restriction to uncommon landscape	N	Not restricted to uncommon landscape features.
Dependence on other species to generate habitat	N	No dependence.
Dietary versatility	N/A	
Pollinator versatility	N	Wind pollinated.
Dependence on other species for propagule dispersal	N	Wind dispersed.
Sensitivity to pathogens or natural enemies	I	Waawaashkeshi (white-tailed deer) herbivory is expected to increase with CC. Giizhikaatig is preferred waawaashkeshi browse in winter. A few manidoonsag (insects) that can damage giizhikaatig may also increase in abundance or distribution with CC.
Sensitivity to competition from native or non-native species	U	Again, giizhikaatig habitat is quite diverse, so it is difficult to answer this question.
Other interspecific interaction	N	No interspecific interaction known.
Measured genetic variation	U	Not enough information found to answer this question.
Occurrence of bottlenecks	U	Not enough information found to answer this question.
Reproductive systems	N	Can reproduce both sexually and vegetatively.
Phenological response to CC	U	Nothing found in the literature.
Documented response to CC	N/SI	In interviews, mentioned as increasing in one community but decreasing in several others.
Modeled future (2050) change in range or population size	N	Little projected decline in suitable habitat in Ceded Territories.
Overlap of modeled future (2050) range with current range	N	Future range overlaps current range by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N	National Forests, state land, county land, private property.

Sugar Maple

Factors that influenced the vulnerability of ziinzibaakwadwaatig to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No major natural barriers in the Ceded Territories.
Anthropogenic barriers	N/SI	Intolerant of compacted soil, air pollution, and road salt.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	SI	Ziinzibaakwadwaatig seeds can be carried several hundred meters by the wind, though most typically do not travel more than 50 feet. Some animal dispersal also occurs.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	SI/I	Restricted to regions with cool climates. Also, hotter/drier summers and later in spring or earlier in fall freeze/thaw temperature events will negatively impact pockets of trees on the landscape.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	SI	Little dependence on a seasonal hydrological regime, but drought stress can affect ziinzibaakwadwaatig.
Dependence on disturbance regime likely to be impacted by CC	SI	Can be affected by flooding, possible increases in fire, wind damage, and ice storms.
Dependence on ice, ice-edge or snow	SI/I	Lack of adequate snow cover may expose shallow roots to freezing conditions.
Restriction to uncommon landscape	N	None found in the literature.
Dependence on other species to generate habitat	N	No dependence.
Dietary versatility	N/A	
Pollinator versatility	N	Primarily wind pollinated.
Dependence on other species for propagule dispersal	N	None mentioned in the literature.
Sensitivity to pathogens or natural enemies	N/SI	Susceptible to many manidoonsag (insects) but serious outbreaks are not common. Biggest potential threats include asian longhorned beetle (if its range were to expand to the Ceded Territories) and defoliators such as the spongy moth and forest tent caterpillar. There are also potential pathogenic and canker fungi that may affect ziinzibaakwadwaatig. Waawaashkeshi (white-tailed deer) browse is also a major factor, and waawaashkeshi is expected to be favored by CC.
Sensitivity to competition from native or non-native species	SI	Non-local mooseg gaa-biimaabiigiziwaad (earthworms) have several negative effects on ziinzibaakwadwaatig and some models show mooseg gaa-biimaabiigiziwaad will inhabit over 90% of terrestrial habitats in less than a century.
Other interspecific interaction	N/SI	Interviewees mentioned that you'll never find ziinzibaakwadwaatig without wiigobaatig (American basswood).
Measured genetic variation	N	Recognized as a being with substantial genetic variation.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	

Factor	Score	Comments
Phenological response to CC	N	Ziinzibaakwadwaatig phenology has shifted with changes in climate.
Documented response to CC	U	Crown dieback affected by climate and has been reported, but no long-term data on ziinzibaakwadwaatig distribution/abundance associated with CC.
Modeled future (2050) change in range or population size	N	Projected to gain suitable habitat in the assessment area.
Overlap of modeled future (2050) range with current range	N	Projected future range overlaps current range entirely.
Occurrence of protected areas in modeled future (2050) distribution	N	National Forests, state land, county land, private property.

American Ginseng

Factors that influenced the vulnerability of jiisens to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	SI	Lake Superior (as jiisens is not currently found north of Lake Superior), wetlands, and inland lakes limit the movement of jiisens.
Anthropogenic barriers	SI	Agriculture, urban and developed areas, and logging can all be barriers to jiisens.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	I/GI	Small mammals such as waawaabiganoojiinyag (mice) and agongosag (chipmunks) destroy the seed rather than disperse it. Waawaashkeshiwag (white-tailed deer) also feed on fruits and digested fruits are not viable. Seeds can be dispersed by birds such as thrushes and gravity.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Based on range, large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Dependent on moist soils, and could be affected by drying and/or variable conditions.
Dependence on disturbance regime likely to be impacted by CC	SI	Jiisens grows best in undisturbed intact forests. Disturbances such as heavy storms, ishkode (fire), blowdowns, bakaan ingoji gaa-ondaadag (non-local beings), and fragmentation could all negatively impact jiisens.
Dependence on ice, ice-edge or snow	N	Wide habitat range in the United States shows that regular snow cover is probably not critical.
Restriction to uncommon landscape	N	Fairly broad habitat requirements. Does not do well in sandy soils. Found primarily in the southwest part of the Ceded Territories.
Dependence on other species to generate habitat	N	Does not depend on particular beings for habitat.
Dietary versatility	N/A	
Pollinator versatility	N	Few good data in the upper Midwest, but there are two main generalist groups of pollinators for jiisens.
Dependence on other species for propagule dispersal	U	Thrushes seem to be the main disperser of jiisens, but other small animals may play a role as well. Generally unknown.

Factor	Score	Comments
Sensitivity to pathogens or natural enemies	SI/I	Waawaashkeshi browse negatively impacts jiisens, along with small mammals causing root damage. Mizise (wild turkey) scratching can uproot plants. Jiisens is also susceptible to various fungal infections, nematodes and slugs, and non-local mooseg gaa-biimaabiigiziwaad (earthworms), which may all negatively impact jiisens in the Ceded Territories.
Sensitivity to competition from native or non-native species	SI/I	Multiple bakaan ingoji gaa-ondaadag (non-local beings) such as honeysuckle, buckthorn, multiflora rose, and barberry have reduced populations in some areas of Wisconsin and will likely continue to do so as CC progresses.
Other interspecific interaction	N	No interspecific interactions known.
Measured genetic variation	U	No information on genetic variation in the Ceded Territories, but many wild populations are likely dependent on outplanting of cultivated seed by jiisens harvesters, and consist of a mix of many different seed sources.
Occurrence of bottlenecks	U	Not enough information found in the literature.
Reproductive systems	U	Due to outplanting of cultivated seed it is hard to know much about genetic variation.
Phenological response to CC	U	Not enough information found in the literature.
Documented response to CC	U	Not enough information found in the literature.
Modeled future (2050) change in range or population size	U	Unknown, but no evidence that areas outside of the current range in the Ceded Territories will become favorable. Many factors outside of CC are causing declining populations.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Paper Birch

Factors that influenced the vulnerability of wiigwaasaatig to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to Ceded Territories.
Natural barriers	N	Found north of Lake Superior as well. No natural barriers known in the Ceded Territories.
Anthropogenic barriers	N	Wiigwaasaatig does well in disturbed areas. Likely no anthropogenic barriers.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	SI	Wind-dispersed seeds regularly move 30-60 m.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	SI/I	Wiigwaasaatig is at the southern end of its range in the Ceded Territories, and projected temperatures may be beyond its physiological limits.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	SI/I	Drought risk for seedlings and established trees.
Dependence on disturbance regime likely to be impacted by CC	N	In many cases wiigwaasaatig benefits from fire or windthrow as a disturbance.

Factor	Score	Comments
Dependence on ice, ice-edge or snow	N/SI	No direct dependence found in the literature, but its range is restricted to areas with snowy winters.
Restriction to uncommon landscape	N	Adapted to a wide variety of soils.
Dependence on other species to generate habitat	N	No dependence.
Dietary versatility	N/A	
Pollinator versatility	N	Wind pollinated.
Dependence on other species for propagule dispersal	N	Wind dispersed.
Sensitivity to pathogens or natural enemies	SI/I	Waawaashkeshi (white-tailed deer) herbivory, along with manidoonsag (insects) such as bronze birch borer, forest tent caterpillar, and spongy moth can all negatively affect wiigwaasaatig. Threats from waawaashkeshi browse in particular, but also bronze birch borer, are expected to increase with CC. The overharvest of young wiigwaasaatig by humans is also a serious threat.
Sensitivity to competition from native or non-native species	SI	Wiigwaasaatig is outcompeted by more shade-tolerant beings after one generation. Seedlings often compete with beings in the genus Rubus.
Other interspecific interaction	U	None found in the literature.
Measured genetic variation	N	Genetic diversity is high.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Nothing found in the literature.
Documented response to CC	SI	Mentioned in at least four communities as declining, likely due in part to CC.
Modeled future (2050) change in range or population size	N	Little projected decline in suitable habitat by mid-century.
Overlap of modeled future (2050) range with current range	N	Future range overlaps current range by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N	National Forests, state land, county land, private property.

Wild Ginger

Factors that influenced the vulnerability of namepin to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	Significant barriers do not exist for this being.
Anthropogenic barriers	SI	Urban areas, logging, agriculture, roads can be barriers to this being.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	I/GI	Dispersed by enigoonsag (ants), though not very far.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Based on range, large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.

Factor	Score	Comments
Physiological hydrological niche	N/SI	Somewhat dependent on localized moisture regime that is highly vulnerable to loss or reduction with CC.
Dependence on disturbance regime likely to be impacted by CC	SI	Increase in ishkode (fire) frequency/intensity and flooding could negatively affect namepin.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	Somewhat flexible in dependence upon geological features or derivatives.
Dependence on other species to generate habitat	N	Habitat requirements do not involve species-specific processes.
Dietary versatility	N/A	N/A
Pollinator versatility	N	Largely self-pollinated; therefore, not limited by pollinators.
Dependence on other species for propagule dispersal	SI	Somewhat dependent on an unknown number of enigoonsag for dispersal.
Sensitivity to pathogens or natural enemies	N/SI	Snails, slugs, and non-local mooseg gaa-biimaabiigiziwaad (earthworms) can all negatively impact namepin.
Sensitivity to competition from native or non-native species	SI	There are several non-local forest plants that could impact namepin - garlic mustard, buckthorn, barberry, etc.
Other interspecific interaction	U	Not enough information found in the literature.
Measured genetic variation	U	Not enough information found in the literature.
Occurrence of bottlenecks	U	Not enough information found in the literature.
Reproductive systems	N	Genetic variation is assumed to be "average" in the assessment area based on reproductive system.
Phenological response to CC	U	Not enough information found in the literature.
Documented response to CC	U	Not enough information found in the literature.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Black Ash

Factors that influenced the vulnerability of baapaagimaak to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No major natural barriers in the assessment area.
Anthropogenic barriers	SI	Agriculture, urban areas, roads, logged areas can be barriers for baapaagimaak, depending on location. Any activities that would influence hydrology.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	SI	Seeds may disperse 100-1,000 meters, rarely farther.
Historical thermal niche	N	Based on NatureServe data.

Factor	Score	Comments
Physiological thermal niche	N/SI	Abundance is largely restricted to cool/cold environments, though it does have a fairly large range.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	GI	Almost entirely dependent on a specific habitat likely to be vulnerable to CC. Also susceptible to drought.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Susceptible to windthrow, silting.
Dependence on ice, ice-edge or snow	U	Lives exclusively in places with winter snow cover but does not appear to be dependent on it.
Restriction to uncommon landscape	N	Baapaagimaak habitat is not uncommon in the Ceded Territories.
Dependence on other species to generate habitat	N	No dependence.
Dietary versatility	N/A	
Pollinator versatility	N	Wind pollinated.
Dependence on other species for propagule dispersal	N	Wind dispersed.
Sensitivity to pathogens or natural enemies	I	Emerald ash borer expected to decimate baapaagimaak populations.
Sensitivity to competition from native or non-native species	N	Not highly vulnerable to invasion.
Other interspecific interaction	U	Insufficient information found in the literature.
Measured genetic variation	U	Insufficient information found in the literature.
Occurrence of bottlenecks	U	Insufficient information found in the literature.
Reproductive systems	N	Capable of sexual and asexual reproduction.
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	U	Insufficient information found in the literature.
Modeled future (2050) change in range or population size	N	No projected change in suitable habitat by mid-century.
Overlap of modeled future (2050) range with current range	N	Future range overlaps current range by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N	National Forests, state land, county land, private property.

Wild Leek

Factors that influenced the vulnerability of bagwaji'zhigaagawanzh to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N/SI	Large waterways, open areas, non-habitat, lack of connectivity of suitable rich woods.
Anthropogenic barriers	SI	Agriculture, urban areas, major roads, logged areas - anything that fragments habitat or removes canopy.

Factor	Score	Comments
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	I	Mostly dispersed by gravity; sometimes dispersed by waawaabiganoojiinyag (deer mice).
Historical thermal niche	N	Based on NatureServe data
Physiological thermal niche	N	Based on range in United States, bagwaji'zhigaagawanzh distribution is not significantly affected by thermal characteristics of the environment in the assessment area.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N/SI	Susceptible to drought and decreased soil moisture.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Bagwaji'zhigaagawanzh thrives in areas with minimal disturbance. Extreme storms, soil erosion, and a loss of canopy trees may all impact bagwaji'zhigaagawanzh.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	Somewhat flexible in dependence upon geological features or derivatives.
Dependence on other species to generate habitat	N	No dependence found in the literature.
Dietary versatility	N/A	
Pollinator versatility	N	Five or more beings make significant contributions to pollination.
Dependence on other species for propagule dispersal	N	Disperses on its own or with the help of waawaabiganoojiinyag, but not strictly dependent on them.
Sensitivity to pathogens or natural enemies	N	Herbivores rarely browse bagwaji'zhigaagawanzh.
Sensitivity to competition from native or non-native species	SI	Non-local mooseg gaa-biimaabiigiziwaad (earthworms) compact soil and reduce the duff layer, both of which impact bagwaji'zhigaagawanzh. Non-local sedges can outcompete bagwaji'zhigaagawanzh.
Other interspecific interaction	U	Not enough information found in the literature.
Measured genetic variation	SI	Genetic variation reported as "low" compared to findings using similar techniques on related taxa.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Not enough information found in the literature.
Documented response to CC	U	Not enough information found in the literature.
Modeled future (2050) change in range or population size	U	Not enough information found in the literature.
Overlap of modeled future (2050) range with current range	U	Not enough information found in the literature.
Occurrence of protected areas in modeled future (2050) distribution	U	Not enough information found in the literature.

White Ash

Factors that influenced the vulnerability of aagimaak to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No major natural barriers in the assessment area.
Anthropogenic barriers	N	Aagimaak is widespread. Likely no anthropogenic barriers.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	SI	Seeds dispersed up to 140 m from parent tree.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N/SI	Can be restricted to micro-climates such as north-facing slopes.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	SI	Largely restricted to environments with readily or intermittently available moisture.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Could be impacted by ishkode (fire) if increases occur in the future.
Dependence on ice, ice-edge or snow	N	Found in areas without snow cover.
Restriction to uncommon landscape	N	Not restricted to uncommon landscape features.
Dependence on other species to generate habitat	N	No dependence.
Dietary versatility	N/A	N/A
Pollinator versatility	N	Wind pollinated
Dependence on other species for propagule dispersal	N	Wind dispersed.
Sensitivity to pathogens or natural enemies	I	Emerald ash borer likely to decimate aagimaak populations.
Sensitivity to competition from native or non-native species	N/SI	Little to moderate response to bakaan ingoji gaa-ondaadag (non-local beings). Aagimaak is often the first being to grow up but can still be outcompeted.
Other interspecific interaction	U	Insufficient information found in the literature.
Measured genetic variation	U	Insufficient information found in the literature.
Occurrence of bottlenecks	U	Insufficient information found in the literature.
Reproductive systems	N/A	N/A
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	U	Insufficient information found in the literature.
Modeled future (2050) change in range or population size	N	Projected to gain suitable habitat.
Overlap of modeled future (2050) range with current range	N	Projected to gain suitable habitat.
Occurrence of protected areas in modeled future (2050) distribution	N	National Forests, state land, county land, private property.

Princess Pine

Factors that influenced the vulnerability of gaagigebag to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No major natural barriers within Ceded Territories.
Anthropogenic barriers	SI	Roads, agriculture, logged areas, and urban areas may all be barriers that cause habitat fragmentation.
Predicted land use change in response to CC	U	Not enough information about this, although increased logging would negatively affect gaagigebag, as it requires evergreen cover.
Dispersal and movement	SI/I	Mainly disperses via rhizomes. Reported dispersal distances vary, but <100m.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	SI	gaagigebag generally requires a forest canopy and therefore cooler environments. Will be vulnerable to increasing temperatures.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N/SI	Dependent on moist soils; long periods of drought can impact gaagigebag.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Canopy removal or damage from manidoonsag (insects) would impact gaagigebag. Ishkode (fire) could also reduce habitat in the short term.
Dependence on ice, ice-edge or snow	N	Not dependent on snow. Possibly affected by waawaashkeshi (white-tailed deer) browse in low snow years but no research available.
Restriction to uncommon landscape	N	Not restricted to uncommon landscape features.
Dependence on other species to generate habitat	N/SI	Dependent on conifer cover or past coverage by conifers to promote acidic soils and podzolization.
Dietary versatility	N/A	
Pollinator versatility	N	Wind-dispersed, not pollinated.
Dependence on other species for propagule dispersal	N	Wind-dispersed.
Sensitivity to pathogens or natural enemies	U	Minimal impact by browsing, but pathogen impact unknown.
Sensitivity to competition from native or non-native species	N	No mention of competition in the literature.
Other interspecific interaction	U	Insufficient information.
Measured genetic variation	U	Insufficient information found in the literature.
Occurrence of bottlenecks	N	Gaagigebag has been broken out into 3 species or subspecies depending on the classification. No evidence of a bottleneck.
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	U	Insufficient information found in the literature.
Modeled future (2050) change in range or population size	U	Insufficient information found in the literature.
Overlap of modeled future (2050) range with current range	U	Insufficient information found in the literature.
Occurrence of protected areas in modeled future (2050) distribution	U	Insufficient information found in the literature.

Bloodroot

Factors that influenced the vulnerability of miskojiibik to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	Major natural barriers do not exist for this being in the Ceded Territories.
Anthropogenic barriers	SI	Agriculture, logged areas, urban areas, and roads are all barriers to miskojiibik.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	I	Dispersed by enigoonsag (ants) very short distances.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Miskojiibik tolerates a wide range of thermal characteristics.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Can handle variable conditions, including some drought.
Dependence on disturbance regime likely to be impacted by CC	U	Not enough information found in the literature.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	Flexible in dependence upon geological features or derivatives.
Dependence on other species to generate habitat	N	No dependence found in the literature.
Dietary versatility	N/A	
Pollinator versatility	N	Pollination apparently flexible; five or more beings make significant contributions to pollination.
Dependence on other species for propagule dispersal	SI	Dependent on an unknown number of enigoonsag for dispersal. Miskojiibik also has capacity to reproduce vegetatively.
Sensitivity to pathogens or natural enemies	N	No indication that miskojiibik is likely to be affected by a pathogen or natural enemy likely to increase in distribution, abundance, or impact as a result of CC.
Sensitivity to competition from native or non-native species	SI	Non-local mooseg gaa-biimaabiigiziwaad (earthworms) and other non-local beings can negatively affect miskojiibik.
Other interspecific interaction	U	Not enough information found in the literature.
Measured genetic variation	U	Not enough information found in the literature.
Occurrence of bottlenecks	U	Not enough information found in the literature.
Reproductive systems	N	Genetic variation is assumed to be "average" in the assessment area based on reproductive system.
Phenological response to CC	N	Miskojiibik has shifted its flowering dates in some regions in response to warming conditions.
Documented response to CC	U	Not enough information found in the literature.

Factor	Score	Comments
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Sweet Flag

Factors that influenced the vulnerability of wiikenh to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	SI	Upland habitat is a barrier for this being, as most reproduction is vegetative.
Anthropogenic barriers	SI	Agriculture, urban areas are barriers to this being.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	N/SI	Rhizomes and seeds dispersed by water, and seeds have high viability, but not easily dispersed to new habitats by wind.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Based on range, fairly large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	SI	Depends on wetland habitat that is sensitive to varying moisture conditions. Drought could affect wiikenh.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Wiikenh prefers quiet water, and severe storms and subsequent flooding could affect this being.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats; seeds don't need cold-stratification to germinate.
Restriction to uncommon landscape	N	Prefers wetland habitat, but that is common in the Ceded Territories.
Dependence on other species to generate habitat	N	Habitat requirements do not involve species-specific processes.
Dietary versatility	N/A	
Pollinator versatility	U	Not enough information found in the literature.
Dependence on other species for propagule dispersal	N	Dispersed by quite a few mammals and birds, and by water.
Sensitivity to pathogens or natural enemies	U	No known diseases affecting this being.
Sensitivity to competition from native or non-native species	SI	Non-local wiikenh can compete with native wiikenh, as well as cattail, Phragmites, flowering rush, and purple loosestrife.
Other interspecific interaction	U	Not enough information found in the literature.
Measured genetic variation	U	Not enough information found in the literature.
Occurrence of bottlenecks	U	Not enough information found in the literature.

Factor	Score	Comments
Reproductive systems	N	Apparently substantial reproduction by seed, though amount of outcrossing is not known.
Phenological response to CC	U	Not enough information found in the literature.
Documented response to CC	U	Not enough information found in the literature.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Broadleaf Arrowhead

Factors that influenced the vulnerability of bagwajipin to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	SI	Upland habitat is a barrier for this being, as most reproduction is vegetative.
Anthropogenic barriers	N/SI	Agriculture, urban areas, roads, and logged areas are all barriers for bagwajipin, depending on location.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	SI	Depending on location, good to moderate dispersal in water.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Bagwajipin distribution is not significantly affected by thermal characteristics of the environment in the assessment area.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	SI	Increased temperatures and possible droughts may cause wetlands to dry, resulting in fewer wetlands available as habitat.
Dependence on disturbance regime likely to be impacted by CC	N	Flooding may affect bagwajipin, but otherwise little response to a specific disturbance regime.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	None
Dependence on other species to generate habitat	N	None
Dietary versatility	N/A	
Pollinator versatility	N	Visited by a variety (5+) of pollinators.
Dependence on other species for propagule dispersal	N	Disperses on its own and with the help of waterfowl, songbirds, and wazhashkwag (muskrats).
Sensitivity to pathogens or natural enemies	N	No indication of pathogens or natural enemies likely to increase in distribution or abundance as a results of CC.

Factor	Score	Comments
Sensitivity to competition from native or non-native species	SI	Impacted by bakaan ingoji gaa-ondaadag (non-local beings) that compete with bagwajipin, such as Phragmites and Typha.
Other interspecific interaction	N	None
Measured genetic variation	U	Insufficient information found in the literature.
Occurrence of bottlenecks	U	Insufficient information found in the literature.
Reproductive systems	N	Genetic variation is assumed to be "average" in the assessment area based on reproductive system.
Phenological response to CC	U	Insufficient information found in the literature, although with a long flowering season and many pollinators, unlikely to be impacted too heavily.
Documented response to CC	U	Not much is known, but given that this being is found throughout the United States and the southern tier provinces of Canada, it seems unlikely CC will have an effect on the distribution of this being.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Blueberry

Factors that influenced the vulnerability of miin to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	Miin is found in many habitats across the Ceded Territories and easily dispersed by birds and mammals. No significant natural barriers.
Anthropogenic barriers	SI	Seeds are easily dispersed but development can threaten habitat.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	N/SI	Easily dispersed long distances by songbirds; dispersal distances are smaller when dispersed by small mammals or territorial birds.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N/SI	Miin (particularly Vaccinium myrtilloides, which is limited to areas with July average temps between 13° and 18°C) may be restricted to relatively cool or cold environments that may be reduced in the assessment area.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N/SI	Some miinan may be dependent on a consistent source of water and would be affected by drying or variable conditions. Severe drought may limit fruit production, but little information found in the literature.
Dependence on disturbance regime likely to be impacted by CC	N	Increases in ishkode (fire) would likely increase miin distribution.
Dependence on ice, ice-edge or snow	SI	Miin benefits from a snowpack in the winter for protection from cold and browsing.
Restriction to uncommon landscape	N	Lives in a variety of habitats.

Factor	Score	Comments
Dependence on other species to generate habitat	N	Not dependent on other beings for habitat.
Dietary versatility	N/A	
Pollinator versatility	N	Miin is extremely reliant on pollinators but there are many beings that can help with pollination.
Dependence on other species for propagule dispersal	N	Seeds are dispersed by many birds and mammals.
Sensitivity to pathogens or natural enemies	N	No indication of pathogen or natural enemy likely to increase in distribution or abundance due to CC.
Sensitivity to competition from native or non-native species	N	Little response to native or bakaan ingoji gaa-ondaadag (non-local beings).
Other interspecific interaction	N	No interspecific interaction known.
Measured genetic variation	U	Little information found in the literature.
Occurrence of bottlenecks	U	Little information found in the literature.
Reproductive systems	N	Genetic variation is assumed to be "average" in the assessment area based on reproductive system - reproduces vegetatively and by seed.
Phenological response to CC	N	Phenological variables show detectable change - flowering dates varied with spring temperatures in a south-central Wisconsin study.
Documented response to CC	SI	Interviewees from at least four communities mentioned recent declines in miin populations, potentially due to CC.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

American Basswood

Factors that influenced the vulnerability of wiigobaatig to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No major natural barriers in the Ceded Territories.
Anthropogenic barriers	N	No major anthropogenic barriers in the Ceded Territories.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	SI/I	Fruits are not carried long distances by the wind or gravity but are probably dispersed longer distances by animals.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Based on range, large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Not highly dependent on a particular hydrological regime.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Fairly tolerant of flooding. May be sensitive to increases in ishkode (fire).

Factor	Score	Comments
Dependence on ice, ice-edge or snow	N	Based on range, no dependence on ice or snow.
Restriction to uncommon landscape	N	Wiigobaatig habitat is not uncommon in the Ceded Territories.
Dependence on other species to generate habitat	N	No dependence.
Dietary versatility	N/A	
Pollinator versatility	N	Insect pollinated by a wide variety of beings.
Dependence on other species for propagule dispersal	U	Some doubt as to whether animals disperse the seeds, and if so, which animal beings.
Sensitivity to pathogens or natural enemies	SI	Wiigobaatig is preferred browse for waawaashkeshi (white-tailed deer), whose population is expected to increase with CC.
Sensitivity to competition from native or non-native species	N/SI	Non-local mooseg gaa-biimaabiigiziwaad (earthworms) have been documented to affect ziinzibaakwadwaatig (sugar maple) and may also affect wiigobaatig in places where they co-exist.
Other interspecific interaction	U	Insufficient information found in the literature.
Measured genetic variation	N	Genetic variation reported as high.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	U	Insufficient information found in the literature.
Modeled future (2050) change in range or population size	N	Projected to gain suitable habitat.
Overlap of modeled future (2050) range with current range	N	Future range overlaps current range by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N	National Forests, state land, county land, private property.

Sweetgrass

Factors that influenced the vulnerability of wiingashk to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No apparent major natural barriers in the Ceded Territories.
Anthropogenic barriers	N	No major anthropogenic barriers in the Ceded Territories.
Predicted land use change in response to CC	U	Not enough known about human responses to CC.
Dispersal and movement	SI	Spreads aggressively by rhizome and also disperses via seeds, though seed set is typically poor. Can move through suitable habitat well and potentially unsuitable habitat as well.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Large range and thermal niche. Found in many biomes, although it is most frequent in cool environments.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.

Factor	Score	Comments
Physiological hydrological niche	N/SI	Somewhat dependent on wetland habitat, and could be affected by drying or variable conditions.
Dependence on disturbance regime likely to be impacted by CC	N	Not observed to be affected by drought. No information on ishkode (fire) or other disturbance impacts on wiingashk.
Dependence on ice, ice-edge or snow	N	No dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	Widespread, with a range of habitat tolerances.
Dependence on other species to generate habitat	N	Does not depend on other beings for habitat.
Dietary versatility	N/A	
Pollinator versatility	N	Wind-pollinated.
Dependence on other species for propagule dispersal	N	Disperses on its own by rhizome, although humans do help it along intentionally and unintentionally.
Sensitivity to pathogens or natural enemies	U	Not enough information found in the literature.
Sensitivity to competition from native or non-native species	N/SI	Could be impacted by taller, shade-producing beings, particularly reed canary grass or Phragmites, both of which can outcompete wiingashk.
Other interspecific interaction	U	Not enough information found in the literature.
Measured genetic variation	U	Not enough information found in the literature.
Occurrence of bottlenecks	U	Not enough information found in the literature.
Reproductive systems	SI/I	The majority of reproduction is vegetative. Reproduction by seed is low.
Phenological response to CC	U	Not enough information found in the literature.
Documented response to CC	U	Not enough information found in the literature.
Modeled future (2050) change in range or population size	U	Not enough information found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Red-osier Dogwood

Factors that influenced the vulnerability of miskwaabiimizh to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	Miskwaabiimizh is widespread both north and south of Lake Superior, and dispersed by birds. Significant barriers do not exist for this being.
Anthropogenic barriers	N	Significant barriers do not exist for this being.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	SI	Dispersed by birds and mammals at least 100 m.
Historical thermal niche	N	Based on NatureServe data.

Factor	Score	Comments
Physiological thermal niche	N	Based on range, wide thermal niche. Miskwaabiimizh distribution is not significantly affected by thermal characteristics of the environment in the assessment area.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N/SI	Not particularly drought tolerant.
Dependence on disturbance regime likely to be impacted by CC	N	Does not appear to be affected by any particular disturbance regime.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	Somewhat flexible in dependence upon geological features or derivatives.
Dependence on other species to generate habitat	N	Habitat requirements do not involve species-specific processes.
Dietary versatility	N/A	
Pollinator versatility	N	Five or more beings make significant contributions to pollination.
Dependence on other species for propagule dispersal	N	Propagules can be dispersed by more than a few beings.
Sensitivity to pathogens or natural enemies	N/SI	Susceptible to waawaashkeshi (white-tailed deer) browse.
Sensitivity to competition from native or non-native species	N	Little or no response to a native or bakaan ingoji gaa-ondaadag (non-local being) that is likely to shift its distribution or abundance due to CC.
Other interspecific interaction	U	Not enough information found in the literature.
Measured genetic variation	U	Not enough information found in the literature.
Occurrence of bottlenecks	U	Not enough information found in the literature.
Reproductive systems	N	Genetic variation is assumed to be "average" in the assessment area based on reproductive system.
Phenological response to CC	U	Not enough information found in the literature.
Documented response to CC	U	Not enough information found in the literature.
Modeled future (2050) change in range or population size	U	Not enough information found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Strawberry

Factors that influenced the vulnerability of ode'imin to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No significant natural barriers.
Anthropogenic barriers	N/SI	Development can be a barrier to ode'imin.

Factor	Score	Comments
Predicted land use change in response to CC	N	Ode'imin is found in a wide variety of habitats, including disturbed habitats. Land use changes will likely not inhibit ode'imin from finding suitable places on the landscape.
Dispersal and movement	N	Seeds are dispersed long distances by birds and mammals.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Ode'imin distribution is not significantly affected by thermal characteristics of the environment in the assessment area.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Ode'imin is found across a spectrum of moisture levels, from cedar swamps to sand spits.
Dependence on disturbance regime likely to be impacted by CC	N	Ode'imin is adapted to survive low- to moderate-severity fires, and CC is likely to increase fire frequency.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	Found in a large variety of habitats.
Dependence on other species to generate habitat	N	Habitat requirements do not involve species-specific processes.
Dietary versatility	N/A	
Pollinator versatility	N	Many beings pollinate strawberries: bees, flies, ants, and butterflies.
Dependence on other species for propagule dispersal	N	Primary dispersal is vegetative, although seeds are dispersed by birds (especially grouse and songbirds) and mammals.
Sensitivity to pathogens or natural enemies	N	No indication that pathogens or natural enemies will significantly increase with CC.
Sensitivity to competition from native or non-native species	N	Little or no response to a native or bakaan ingoji gaa-ondaadag (non-local being) that is likely to shift its distribution or abundance due to CC.
Other interspecific interaction	U	Not enough information found in the literature.
Measured genetic variation	U	Not enough information found in the literature.
Occurrence of bottlenecks	U	Based on broad distribution and hybrid origin, unlikely that this being has experienced a bottleneck, but no information found in the literature.
Reproductive systems	N	Genetic variation is assumed to be average or high in assessment area based on reproductive system - plants are at least partly dioecious.
Phenological response to CC	N	Phenological variables show detectable change - a study in south-central Wisconsin showed earlier flowering dates with time.
Documented response to CC	SI/I	Several interviewees mentioned declines in strawberries in their communities, which may be related to CC.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Wild Sage

Factors that influenced the vulnerability of mashkodewashk to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No major natural barriers - can be dispersed by wind. Humid/moist areas may act as a barrier as mashkodewashk typically occurs in drier climates.
Anthropogenic barriers	N	No major anthropogenic barriers in the Ceded Territories.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	SI	Primarily reproduces vegetatively, but is sometimes dispersed by wind/ water.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Based on range, large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Mashkodewashk is found in dry sites - not dependent on aquatic or wetland habitat.
Dependence on disturbance regime likely to be impacted by CC	N	Not affected by any major disturbances; may increase after ishkode (fire).
Dependence on ice, ice-edge or snow	N	No dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	Found in a wide range of soil types.
Dependence on other species to generate habitat	N	No dependence on other beings for habitat.
Dietary versatility	N/A	
Pollinator versatility	N	Wind-pollinated.
Dependence on other species for propagule dispersal	N	Wind-dispersed.
Sensitivity to pathogens or natural enemies	N	Some browsing by waawaashkeshi (white-tailed deer) and/or grasshoppers, but little mention of other beings that eat mashkodewashk.
Sensitivity to competition from native or non-native species	U	Insufficient information.
Other interspecific interaction	U	Insufficient information.
Measured genetic variation	U	Insufficient information.
Occurrence of bottlenecks	U	Insufficient information.
Reproductive systems	N	Reproduces vegetatively and by seed.
Phenological response to CC	U	Insufficient information.
Documented response to CC	U	Insufficient information.
Modeled future (2050) change in range or population size	U	Insufficient information.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Ostrich Fern

Factors that influenced the vulnerability of anaaganabag to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No major natural barriers in the Ceded Territories.
Anthropogenic barriers	N	No major anthropogenic barriers.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	N	Anaaganabag can disperse long distances (kilometers) via wind.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Based on range, large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N/SI	Anaaganabag grows in moist to wet areas and may be affected by drying and/or variable conditions.
Dependence on disturbance regime likely to be impacted by CC	U	Logging, wind damage, and anything else that causes canopy removal can cause negative effects on anaaganabag, though little information found in the literature.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats, though it's possible that low snow cover and extreme cold may negatively impact anaaganabag.
Restriction to uncommon landscape	N	Prefers wetlands and riparian habitat, which are abundant in the Ceded Territories.
Dependence on other species to generate habitat	N	Not dependent on other beings for habitat.
Dietary versatility	N/A	
Pollinator versatility	N	Wind-dispersed.
Dependence on other species for propagule dispersal	N	Anaaganabag spores disperse on their own via air and water.
Sensitivity to pathogens or natural enemies	N	Anaaganabag is fairly resistant to manidoonsag (insects) and not heavily browsed by waawaashkeshi (white-tailed deer). No indication of a pathogen or natural enemy likely to increase in abundance or distribution because of CC.
Sensitivity to competition from native or non-native species	U	Many bakaan ingoji gaa-ondaadag (non-local beings) are becoming more common, and it is unknown how those will affect anaaganabag.
Other interspecific interaction	U	No information found in the literature.
Measured genetic variation	U	Not enough information found in the literature.
Occurrence of bottlenecks	U	Not enough information found in the literature.
Reproductive systems	U	Not enough information found in the literature.
Phenological response to CC	U	Not enough information found in the literature.

Factor	Score	Comments
Documented response to CC	U	Not enough information found in the literature.
Modeled future (2050) change in range or population size	U	Not enough information found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Raspberry

Factors that influenced the vulnerability of miskomin to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No major natural barriers in the Ceded Territories.
Anthropogenic barriers	N	No major anthropogenic barriers in the Ceded Territories.
Predicted land use change in response to CC	N	Most human responses to CC are likely to benefit miskomin.
Dispersal and movement	N	Miskomin is widespread and seeds are dispersed long distances by mammals and birds.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Based on range, large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Not dependent on any wetland habitat.
Dependence on disturbance regime likely to be impacted by CC	N	Miskomin benefits from soil disturbance.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	Not dependent on any particular habitat.
Dependence on other species to generate habitat	N	Not dependent on any beings to generate habitat.
Dietary versatility	N/A	
Pollinator versatility	N	Pollination apparently flexible; five or more beings make significant contributions to pollination.
Dependence on other species for propagule dispersal	N	Dispersed by many birds and mammals.
Sensitivity to pathogens or natural enemies	N	Literature seems to indicate that predators and pathogens are not much of a threat.
Sensitivity to competition from native or non-native species	N	Miskomin often outcompetes other beings.
Other interspecific interaction	U	Insufficient information.
Measured genetic variation	U	Insufficient information.
Occurrence of bottlenecks	U	Insufficient information.

Factor	Score	Comments
Reproductive systems	N	Genetic variation is assumed to be "average" in the assessment area based on reproductive system.
Phenological response to CC	N	One study found that miskomin changed its phenology in response to increasing temperatures. It is possible that pollinators and flowering may become out of sync, however.
Documented response to CC	U	Insufficient information.
Modeled future (2050) change in range or population size	U	Insufficient information.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Appendix 3: Swimmers Climate Change Vulnerability Index Results

Tullibee

Factors that influenced the vulnerability of odoonibiins to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	NA
Natural barriers	I/GI	Limited connectivity between waterways
Migration routes might become intolerable (too warm/low oxygen)	N	No significant anthropogenic barriers.
Anthropogenic barriers	SI	Dams and road crossings
Predicted land use change in response to CC	N	Most land use strategies will benefit odoonibiins (restoring forests, riparian zones)
Dispersal and movement	N/SI	Young have limited mobility
Historical thermal niche	N	
Physiological thermal niche	GI	Restricted to cool water habitats that may be reduced in the future
Historical hydrological niche	SI	Based on NatureServe data
Physiological hydrological niche	N	No information
Dependence on disturbance regime likely to be impacted by CC	SI/I	Heavy rains might affect spawning habitat. Heat waves can reduce available habitat
Dependence on ice, ice-edge or snow	SI	Little ice can negatively influence prey availability
Restriction to uncommon landscape	N	No restriction
Dependence on other species to generate habitat	N/SI	Limited to small prey items
Dietary Versatility	U	NA
Pollinator versatility	N	No dependence
Dependence on other species for propagule dispersal	N/SI	Parasites and pathogens might increase in abundance as the climate changes
Sensitivity to pathogens or natural enemies	SI	Non-native beings/species can consume odoonibiins and compete for prey
Sensitivity to competition from native or non-native species	U	No information
Other interspecific interaction	U	No information
Measured genetic variation	U	No information
Occurrence of bottlenecks	N/A	
Reproductive systems	U	No information

Factor	Score	Comments
Phenological response to CC	I	Distribution and abundance have decreased in some lakes
Documented response to CC	SI/I	Decrease of 20-75% by mid-century
Modeled future (2050) change in range or population size	N/SI	Based on documented and modeled trends, it is reasonable to expect distribution and abundance will decrease after 2050 for this cool water species
Overlap of modeled future (2050) range with current range	U	No information
Occurrence of protected areas in modeled future (2050) distribution	N	NA

Lake Whitefish

Factors that influenced the vulnerability of adikameg to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	NA
Natural barriers	N/SI	Areas with low dissolved oxygen concentration could be a barrier to dispersal
Anthropogenic barriers	U	No information
Predicted land use change in response to CC	N	Most land use strategies will benefit adikameg (restoring forests, riparian zones)
Dispersal and movement	N	Capable of dispersing long distances
Historical thermal niche	N	Based on NatureServe data
Physiological thermal niche	SI/I	Thermal habitat might be reduced in inland lakes but may improve in Lake Superior
Historical hydrological niche	SI	Based on NatureServe data
Physiological hydrological niche	U	No information
Dependence on disturbance regime likely to be impacted by CC	SI	Storms (wind and wave action) might result in higher egg mortality
Dependence on ice, ice-edge or snow	SI	More ice cover results in higher recruitment, presumably by damping the effects of storms
Restriction to uncommon landscape	N	No restrictions
Dependence on other species to generate habitat	N	No dependence
Dietary Versatility	N	Diet is flexible
Pollinator versatility	U	NA
Dependence on other species for propagule dispersal	N	No dependence
Sensitivity to pathogens or natural enemies	I	Sea lamprey might cause higher mortality rates at elevated temperatures
Sensitivity to competition from native or non-native species	SI	Zebra and quagga mussels compete with adikameg for food
Other interspecific interaction	U	No information
Measured genetic variation	SI	Genetic variation reported as low
Occurrence of bottlenecks	N/A	

Factor	Score	Comments
Reproductive systems	N/A	
Phenological response to CC	U	No information
Documented response to CC	U	No information
Modeled future (2050) change in range or population size	U	No information
Overlap of modeled future (2050) range with current range	U	No information
Occurrence of protected areas in modeled future (2050) distribution	U	No information

Walleye

Factors that influenced the vulnerability of ogaa to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	NA
Natural barriers	SI	Limited connectivity between waterways
Migration routes might become intolerable (too warm)	U	No information
Anthropogenic barriers	N/SI	Dams and road crossings
Predicted land use change in response to CC	N	Most land use strategies will benefit ogaa (restoring forests, riparian zones)
Dispersal and movement	N	Capable of dispersing long distances
Historical thermal niche	N	
Physiological thermal niche	SI	Restricted to cool water habitats that may be reduced in the future
Historical hydrological niche	SI	The Ceded Territories have experienced slightly lower than average variation in precipitation in the past 50 years
Physiological hydrological niche	N	Not dependent on seasonal hydrologic regime or wetland habitat
Dependence on disturbance regime likely to be impacted by CC	N/SI	Floods and droughts may affect spawning and nursery habitat
Dependence on ice, ice-edge or snow	N	Little dependence on ice or snow-associated habitats Spawning is likely correlated with temperature
Restriction to uncommon landscape	N	Prefers turbid or stained water and cobble substrate for spawning. Both are common in the Ceded Territories
Dependence on other species to generate habitat	N	Anecdotally, rusty crayfish create favorable habitat by consuming aquatic vegetation
Dietary Versatility	N/SI	Flexible diet. Prefers fish, but can consume invertebrates. Prey availability might become an issue
Pollinator versatility	U	NA
Dependence on other species for propagule dispersal	N	Disperses on its own
Sensitivity to pathogens or natural enemies	N	Not enough information, but centrarchids (e.g., bluegill, black bass) might consume young ogaa
Sensitivity to competition from native or non-native species	SI	May compete with centrarchids (e.g., bluegill, black bass) for food

Factor	Score	Comments
Other interspecific interaction	N	Somewhat dependent on yellow perch, but other species of fish can serve as forage
Measured genetic variation	N	Genetic variation reported to be average or high
Occurrence of bottlenecks	U	No information
Reproductive systems	N/A	No information
Phenological response to CC	N	Spawning has appeared to track changes in ice out/temperature. The effects of tracking ice out/temperature (larval survival) is unclear.
Documented response to CC	SI	Distribution and abundance has declined in the past ~25 years
Modeled future (2050) change in range or population size	I	A predicted decrease in range (number of lakes) of 65%.
Overlap of modeled future (2050) range with current range	SI	Only 35% of the lakes with ogaa will support it in the future
Occurrence of protected areas in modeled future (2050) distribution	I	Less than 5% of ogaa habitat in the Ceded Territories

Lake Trout

Factors that influenced the vulnerability of namegos to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	NA
Natural barriers	N/SI	Areas with low dissolved oxygen concentration could be a barrier to dispersal in inland lakes; less so in Lake Superior
Anthropogenic barriers	SI	Anthropogenic alterations in water quality (e.g., eutrophication) have the potential to create low oxygen barriers
Predicted land use change in response to CC	N	Most land use strategies will benefit namegos (restoring forests, riparian zones)
Dispersal and movement	N	Capable of dispersing long distances
Historical thermal niche	N	Based on NatureServe data
Physiological thermal niche	SI	Preferred thermal habitat is predicted to decrease, particularly in inland lakes.
Historical hydrological niche	SI	Based on NatureServe data
Physiological hydrological niche	U	No information
Dependence on disturbance regime likely to be impacted by CC	N/SI	Wind and wave action might damage or displace eggs
Dependence on ice, ice-edge or snow	U	No information
Restriction to uncommon landscape	SI	Spawning occurs on specific reefs with low sedimentation
Dependence on other species to generate habitat	N	No dependence
Dietary Versatility	N	Diet is flexible
Pollinator versatility	U	NA
Dependence on other species for propagule dispersal	N	No dependence

Factor	Score	Comments
Sensitivity to pathogens or natural enemies	SI	Sea lamprey parasitism combined with elevated temperatures might increase mortality rates of namegos
Sensitivity to competition from native or non-native species	N/SI	Future environmental conditions are predicted to favor Noosa'owesi, one of namegos primary competitors for food
Other interspecific interaction	U	No information
Measured genetic variation	SI	Genetic variation is low due to extirpation and low population abundance in the mid-1900s
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	No information
Documented response to CC	U	No information
Modeled future (2050) change in range or population size	U	No information
Overlap of modeled future (2050) range with current range	U	No information
Occurrence of protected areas in modeled future (2050) distribution	U	No information

Yellow Perch

Factors that influenced the vulnerability of asaawens to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	NA
Natural barriers	N	Beaver dams might limit dispersal, but little evidence exists
Anthropogenic barriers	N/SI	Dams and road crossings
Predicted land use change in response to CC	N	Most land use strategies will benefit asaawens (restoring forests, riparian zones)
Dispersal and movement	N	Capable of dispersing long distances
Historical thermal niche	N	Based on NatureServe data
Physiological thermal niche	SI	Restricted to cool water habitats that might be reduced in the future
Historical hydrological niche	SI	The Ceded Territories have experienced slightly lower than average variation in precipitation in the past 50 years
Physiological hydrological niche	SI	More or less rain might negatively influence spawning habitat (wetlands)
Dependence on disturbance regime likely to be impacted by CC	N/SI	Floods and droughts may affect spawning and nursery habitat
Dependence on ice, ice-edge or snow	N/SI	Spawning is likely correlated with temperature, which can be influenced by the amount of snow and ice
Restriction to uncommon landscape	N	Habitat generalists
Dependence on other species to generate habitat	N	No dependence
Dietary Versatility	N/SI	Recently hatched asaawens almost exclusively consume zooplankton
Pollinator versatility	N/A	N/A
Dependence on other species for propagule dispersal	N	Disperses on its own

Factor	Score	Comments
Sensitivity to pathogens or natural enemies	N/SI	Not enough information, but centrarchids (e.g., bluegill, black bass) might consume young asaawens
Sensitivity to competition from native or non-native species	N/SI	May compete with centrarchids (e.g., bluegill, black bass) for food. Alewife might consume more asaawens in Lake Superior as water temperatures increase
Other interspecific interaction	N	No interspecific interactions
Measured genetic variation	SI	Genetic variation reported to be low relative to other species in the Ceded Territories
Occurrence of bottlenecks	N	Asaawens populations in the Ceded Territories appear to be well-mixed
Reproductive systems	N/A	N/A
Phenological response to CC	SI	Early ice-out might result in a mismatch between recently hatched asaawens and their prey
Documented response to CC	U	No information
Modeled future (2050) change in range or population size	U	No information
Overlap of modeled future (2050) range with current range	U	No information
Occurrence of protected areas in modeled future (2050) distribution	U	No information

Northern Pike

Factors that influenced the vulnerability of ginoozhe to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	NA
Natural barriers	SI	Limited connectivity between waterways
Migration routes might become intolerable (too warm)	N/SI	Dams and road crossings
Anthropogenic barriers	SI	Dams and road crossings
Loss of wetlands from development and water management will limit reproductive habitat	N	Capable of dispersing long distances
Increase in precipitation might create new wetlands	N	Based on NatureServe data
Predicted land use change in response to CC	N	Most land use strategies will benefit ginoozhe (restoring forests, riparian zones)
Dispersal and movement	N	Capable of dispersing long distances for reproduction
Historical thermal niche	N	
Physiological thermal niche	SI	Restricted to cool water habitats that may be reduced in the future
Historical hydrological niche	SI	
Physiological hydrological niche	SI	Dependent on wetland habitat for reproduction
Dependence on disturbance regime likely to be impacted by CC	SI	Floods and droughts may affect spawning and nursery habitat
Dependence on ice, ice-edge or snow	N	Little dependence on ice or snow-associated habitats

Factor	Score	Comments
Restriction to uncommon landscape	N	
Dependence on other species to generate habitat	N	Flexible diet. Prefers fish, but can consume invertebrates
Dietary Versatility	U	NA
Pollinator versatility	N	
Dependence on other species for propagule dispersal	SI	Many known parasites that may increase in abundance/distribution as the climate changes
Sensitivity to pathogens or natural enemies	N	
Sensitivity to competition from native or non-native species	U	No information
Other interspecific interaction	U	No information
Measured genetic variation	N	No evidence of a bottleneck in the last 500 years
Occurrence of bottlenecks	U	No information
Reproductive systems	U	No information
Phenological response to CC	U	No information
Documented response to CC	U	No information
Modeled future (2050) change in range or population size	U	No information
Overlap of modeled future (2050) range with current range	U	No information
Occurrence of protected areas in modeled future (2050) distribution	N	NA

Muskellunge

Factors that influenced the vulnerability of maashkinoozhe to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	NA
Natural barriers	SI	Limited connectivity between waterways
Migration routes might become intolerable (too warm)	N/SI	Dams and road crossings
Anthropogenic barriers	SI	Dams and road crossings
Loss of wetlands from development and water management will limit reproductive habitat	N	Capable of dispersing long distances
Increase in precipitation might create new wetlands	N	Based on NatureServe data
Predicted land use change in response to CC	N	Most land use strategies will benefit maashkinoozhe (restoring forests, riparian zones)
Dispersal and movement	N	Capable of dispersing long distances for reproduction
Historical thermal niche	N	
Physiological thermal niche	SI	Restricted to cool water habitats that may be reduced in the future
Historical hydrological niche	SI	

Factor	Score	Comments
Physiological hydrological niche	SI	Dependent on wetland habitat for reproduction
Dependence on disturbance regime likely to be impacted by CC	SI	Floods and droughts may affect spawning and nursery habitat
Dependence on ice, ice-edge or snow	N	Little dependence on ice or snow-associated habitats
Restriction to uncommon landscape	N	
Dependence on other species to generate habitat	N	
Dietary Versatility	N	Flexible diet. Prefers fish, but can consume invertebrates
Pollinator versatility	U	NA
Dependence on other species for propagule dispersal	N	
Sensitivity to pathogens or natural enemies	N/SI	Many known parasites that may increase in abundance/distribution as the climate changes
Sensitivity to competition from native or non-native species	N	
Other interspecific interaction	U	No information
Measured genetic variation	U	No information
Occurrence of bottlenecks	U	No information
Reproductive systems	U	No information
Phenological response to CC	U	No information
Documented response to CC	U	No information
Modeled future (2050) change in range or population size	U	No information
Overlap of modeled future (2050) range with current range	U	No information
Occurrence of protected areas in modeled future (2050) distribution	U	No information

Smallmouth Bass

Factors that influenced the vulnerability of noosa’owesi to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	NA
Natural barriers	N/SI	Areas with low dissolved oxygen concentration could be a barrier to dispersal
Anthropogenic barriers	SI	Dams and road crossings cause significant barriers for migration
Predicted land use change in response to CC	N	Most land use strategies will benefit noosa’owesi (restoring forests, riparian zones)
Dispersal and movement	N	Capable of dispersing long distances
Historical thermal niche	N	
Physiological thermal niche	N	Adapted to warmer water
Historical hydrological niche	SI	

Factor	Score	Comments
Physiological hydrological niche	N/SI	High flow rates in the spring may negatively affect survival of young noosa'owesi
Dependence on disturbance regime likely to be impacted by CC	SI	Floods and cold snaps might induce premature nest abandonment
Dependence on ice, ice-edge or snow	N	No dependence
Restriction to uncommon landscape	N	No restrictions
Dependence on other species to generate habitat	N	No dependence
Dietary Versatility	N	Prefer crayfish but diet is flexible
Pollinator versatility	U	NA
Dependence on other species for propagule dispersal	N	No dependence
Sensitivity to pathogens or natural enemies	SI	Pathogens might increase mortality
Sensitivity to competition from native or non-native species	N/SI	Ashigan could outcompete noosa'owesi under future environmental conditions
Other interspecific interaction	U	No information
Measured genetic variation	N	Genetic variation reported as high
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	No information
Documented response to CC	N	Range and abundance has not decreased as the climate changed
Modeled future (2050) change in range or population size	N	Abundance is predicted to increase in the Ceded Territories
Overlap of modeled future (2050) range with current range	U	No information
Occurrence of protected areas in modeled future (2050) distribution	U	No information

Sturgeon

Factors that influenced the vulnerability of name to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	NA
Natural barriers	N	Significant natural barriers do not exist
Anthropogenic barriers	SI	Dams and road crossings cause significant barriers for reproduction
Predicted land use change in response to CC	N	Most land use strategies will benefit name (restoring forests, riparian zones)
Dispersal and movement	N	Capable of dispersing long distances for reproduction
Historical thermal niche	N	
Physiological thermal niche	SI	Thermal habitat is expected to decline
Historical hydrological niche	SI	

Factor	Score	Comments
Physiological hydrological niche	U	No information
Dependence on disturbance regime likely to be impacted by CC	N/SI	Floods and droughts may affect spawning grounds and early life stages
Dependence on ice, ice-edge or snow	U	No information
Restriction to uncommon landscape	SI	Return to specific areas for reproduction
Dependence on other species to generate habitat	N	Habitat requirements do not involve species-specific processes
Dietary Versatility	N	Flexible diet
Pollinator versatility	U	NA
Dependence on other species for propagule dispersal	N	No dependence
Sensitivity to pathogens or natural enemies	U	No information
Sensitivity to competition from native or non-native species	U	No information
Other interspecific interaction	U	No information
Measured genetic variation	N	Genetic variation reported as high
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	No information
Documented response to CC	U	No information
Modeled future (2050) change in range or population size	U	No information
Overlap of modeled future (2050) range with current range	U	No information
Occurrence of protected areas in modeled future (2050) distribution	U	No information

Largemouth Bass

Factors that influenced the vulnerability of ashigan to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	NA
Natural barriers	N	No significant natural barriers
Anthropogenic barriers	N	No significant anthropogenic barriers
Predicted land use change in response to CC	N	Most land use strategies will benefit ashigan (restoring forests, riparian zones)
Dispersal and movement	N	Capable of dispersing long distances
Historical thermal niche	N	Based on NatureServe data
Physiological thermal niche	N	Adapted to warmer water
Historical hydrological niche	SI	Based on NatureServe data
Physiological hydrological niche	N	No dependence

Factor	Score	Comments
Dependence on disturbance regime likely to be impacted by CC	N/SI	Cold fronts, heavy wind and waves, or drought might induce premature nest abandonment
Dependence on ice, ice-edge or snow	N	No dependence
Restriction to uncommon landscape	N	No restrictions
Dependence on other species to generate habitat	N	No dependence
Dietary Versatility	N	Diet is flexible
Pollinator versatility	U	NA
Dependence on other species for propagule dispersal	N	No dependence
Sensitivity to pathogens or natural enemies	SI	Pathogens might increase mortality at elevated temperatures
Sensitivity to competition from native or non-native species	N	Bluegill, pumpkinseed, and rock bass might compete with ashigan, but little evidence
Other interspecific interaction	U	No information
Measured genetic variation	N	Genetic variation reported as high
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	No information
Documented response to CC	N	Range and abundance has not decreased as the climate changed
Modeled future (2050) change in range or population size	N	Abundance is predicted to increase in the Ceded Territories
Overlap of modeled future (2050) range with current range	N	Predicted future range overlaps current range by >60% in Ceded Territories
Occurrence of protected areas in modeled future (2050) distribution	I	Protected areas occur in less than 5% of modeled future distribution in the Ceded Territories

Appendix 4: Flyers Climate Change Vulnerability Index Results

Common Loon

Factors that influenced the vulnerability of maang to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No significant natural barriers for maang in the Ceded Territories.
Anthropogenic barriers	N	No significant anthropogenic barriers.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories.
Dispersal and movement	N	Capable of dispersing long distances.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	I/GI	Maangwag are sensitive to temperature and are at the southern extent of their breeding range in the Ceded Territory. Warmer temperatures may push them north.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	SI	Maang is generally not found on lakes with a water clarity of less than 2.5 feet. If fluctuating water levels or big precipitation events cause decreases in water clarity, maang may be impacted.
Dependence on disturbance regime likely to be impacted by CC	SI/I	May be affected by flooding, especially during nesting. Black fly outbreaks can also disrupt nesting.
Dependence on ice, ice-edge or snow	N	Not dependent on snow/ice-associated habitats. Only arrives after ice out.
Restriction to uncommon landscape	N	None found in the literature.
Dependence on other species to generate habitat	N	Not dependent on other beings to generate habitat.
Dietary versatility	N	Diet of fish is fairly flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on own.
Sensitivity to pathogens or natural enemies	N/SI	Avian botulism outbreaks have not been seen in Lake Superior at high levels, but seen in northern Lake Michigan and have the potential to increasingly impact maang in the Ceded Territories with CC.
Sensitivity to competition from native or non-native species	N	Little competitive response to other native beings.
Other interspecific interaction	N	Nothing found in the literature.

Factor	Score	Comments
Measured genetic variation	U	Insufficient information in literature to answer this question.
Occurrence of bottlenecks	N	No evidence of bottlenecks.
Reproductive systems	N/A	
Phenological response to CC	N	Spring arrival dictated by ice-out phenology.
Documented response to CC	N	Populations increasing in Wisconsin, Minnesota, and Michigan. Not decreasing with recent CC.
Modeled future (2050) change in range or population size	I	Suitable habitat projected to decline by 60% by mid-century.
Overlap of modeled future (2050) range with current range	SI	Mid-century range will overlap current range by 30-60%.
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Sharp-tailed Grouse

Factors that influenced the vulnerability of aagask to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	SI/I	Habitat patches bordered by forested areas or Great Lakes.
Anthropogenic barriers	SI	Roads and development are barriers, as well as intensive agriculture, wind turbines, or power lines.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories, though wind or solar farms could disrupt breeding habitat.
Dispersal and movement	N/SI	Movement is common; a current study in Wisconsin shows dispersal distances of 5-21 miles, but this being has high site fidelity and limited habitat in patches.
Historical thermal niche	N	Based on NatureServe climate data.
Physiological thermal niche	N	Historical range included southern Wisconsin, Minnesota, and Iowa. Currently found as far south as Nebraska.
Historical hydrological niche	SI	Based on NatureServe climate data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Aagask has little or no dependence on a strongly seasonal hydrologic regime.
Dependence on disturbance regime likely to be impacted by CC	N	Potential for fire to benefit aagask, unless fire is severe.
Dependence on ice, ice-edge or snow	N/SI	Aagask uses deep powdery snow to insulate against wind and cold.
Restriction to uncommon landscape	SI	Aagask lek habitat is fairly specific; this being also uses open habitats such as brush prairie, barrens, pine/oak savannah, and abandoned farmland, all of which are uncommon in the Ceded Territories.
Dependence on other species to generate habitat	N	Habitat requirements do not involve species-specific processes.
Dietary versatility	N/SI	Dependent in winter on a few beings, some of which are predicted to decline.
Pollinator versatility	N/A	

Factor	Score	Comments
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	N/SI	Predators predicted to increase, but this may not have a greater-than-normal impact on aagask.
Sensitivity to competition from native or non-native species	U	Insufficient information found in the literature.
Other interspecific interaction	U	No interspecific interaction found in the literature.
Measured genetic variation	I	Lack of genetic variation identified as significant issue for aagask.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	U	Not enough information on aagask abundance/distribution in the Ceded Territories to answer this question.
Modeled future (2050) change in range or population size	N/SI	Models find that aagask will lose about 20% of its suitable habitat in the Ceded Territories by the mid-21st century.
Overlap of modeled future (2050) range with current range	N	Predicted future range overlaps current range by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Trumpeter Swan

Factors that influenced the vulnerability of waabizii to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No natural barriers.
Anthropogenic barriers	N	No anthropogenic barriers.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories; human responses are not likely to increase vulnerability to wetland habitats supporting this being.
Dispersal and movement	N	Waabizii is capable of significant dispersal; however, it displays high site fidelity which limits movement into new regions.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	This being shows a preference for environments at the warmer end of the spectrum.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	SI	Waabizii is strongly dependent on stable water levels and those may be tied to a seasonal hydrological regime.
Dependence on disturbance regime likely to be impacted by CC	SI	Potentially impacted by increases in extreme precipitation events and flooding, particularly during nesting. Prolonged drought could cause waabizii to relocate during nesting as well.
Dependence on ice, ice-edge or snow	N	No dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	No restriction to uncommon landscape features.

Factor	Score	Comments
Dependence on other species to generate habitat	N/SI	Waabizii is largely dependent on amik (beaver) ponds in natural settings.
Dietary versatility	N	Generally flexible diet. Some populations used to depend on corn in the winter, but corn is no longer provided in Wisconsin as a supplemental food source.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on own.
Sensitivity to pathogens or natural enemies	SI	Potential threats from predators favored by climate change and high potential for disease outbreaks on wintering grounds.
Sensitivity to competition from native or non-native species	SI	Carp can compete with waabizii and are likely to increase their distribution in the Ceded Territories. This might diminish food supplies for waabizii.
Other interspecific interaction	N	None found in the literature.
Measured genetic variation	I	Waabiziig across the US have low genetic diversity. The waabiziig found here currently were introduced from other parts of the United States.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Nothing found in the literature.
Documented response to CC	N	Population continuing to increase. We now have over 5,000 waabiziig in Wisconsin.
Modeled future (2050) change in range or population size	N	Suitable habitat expected to decline by less than 20% by mid-century.
Overlap of modeled future (2050) range with current range	N	Mid-century range will overlap by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Wood Duck

Factors that influenced the vulnerability of mitigoningwiishib to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	Significant natural barriers do not exist for this being.
Anthropogenic barriers	N	Significant anthropogenic barriers do not exist for this being.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories.
Dispersal and movement	N	Mitigoningwiishib is capable of significant dispersal, though it has high nest-site and wetland-site fidelity.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N/SI	Mitigoningwiishib distribution is not significantly affected by thermal characteristics of the environment in the assessment area. Increasing summer temperatures may affect duckling survival.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	GI	Precipitation projections uncertain, but mitigoningwiishib generally requires a narrow range of water depths and, thus, hydrologic regime.

Factor	Score	Comments
Dependence on disturbance regime likely to be impacted by CC	SI	Water depth so important during breeding; extreme rain events associated with CC are predicted to increase and may reduce mitigoningwiishib habitat quality.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	No restriction to uncommon landscape features.
Dependence on other species to generate habitat	SI	Require cavities for nesting, which are formed by a small number of tree beings and a few bird beings. CC could impact nesting cavities.
Dietary versatility	N	Diet is flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	SI	Esibanag (raccoons) have the greatest impact on egg success and incubating hen mortality of mitigoningwiishib; esibanag expected to increase.
Sensitivity to competition from native or non-native species	N/SI	Mitigoningwiishib may be moderately affected by starlings and other cavity-nesting waterfowl and mammals, which are likely to be favored by CC.
Other interspecific interaction	N	Does not require an interspecific interaction.
Measured genetic variation	N	Genetic variation reported as high.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	N	Mitigoningwiishib has shown responses to changing phenology.
Documented response to CC	N	Distribution and abundance not known to be decreasing with CC.
Modeled future (2050) change in range or population size	N	No projected decline in suitable habitat by mid-century.
Overlap of modeled future (2050) range with current range	N	Mid-century range will overlap by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Sandhill Crane

Factors that influenced the vulnerability of ajijaak to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No natural barriers in the Ceded Territories.
Anthropogenic barriers	N	No major anthropogenic barriers in the Ceded Territories.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories.
Dispersal and movement	N	Ajijaak is capable of significant dispersal.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Ajijaak has a large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.

Factor	Score	Comments
Physiological hydrological niche	SI	Seasonally flooded wetlands are important for nesting and chick rearing and for migration and wintering habitat.
Dependence on disturbance regime likely to be impacted by CC	SI	Ajijaak can be negatively impacted by an increase in both flooding and drought frequency during the nesting season.
Dependence on ice, ice-edge or snow	N	No dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	No restriction to uncommon landscapes.
Dependence on other species to generate habitat	N	No dependence on other beings to generate habitat.
Dietary versatility	N	Diet is diverse.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	N/SI	Increase in predator abundance would negatively affect ajijaak. Disease risks are also a factor as these birds congregate on migration and wintering habitat.
Sensitivity to competition from native or non-native species	N	Not a lot of competition with other beings.
Other interspecific interaction	N	No interspecific interactions found in the literature.
Measured genetic variation	U	Insufficient information found in the literature.
Occurrence of bottlenecks	I	Population bottleneck reduced Ceded Territory population to <250 mature individuals in early 1900s.
Reproductive systems	N/A	
Phenological response to CC	N	A few different sources suggest ajijaakwag have adjusted their arrival dates or dates of egg laying according to the weather.
Documented response to CC	N	Population increasing dramatically in the Ceded Territories.
Modeled future (2050) change in range or population size	SI	Suitable habitat expected to decline by 31% in Ceded Territories by mid-century.
Overlap of modeled future (2050) range with current range	N	Mid-century range will overlap by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Firefly

Factors that influenced the vulnerability of waawaatesi to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	For those waawaatesiwag that are capable of flight.
Anthropogenic barriers	SI/I	Forest clear-cutting may be significant but has not been studied well. Light pollution may be a disruption as well. Interviewees mentioned that cutting grass disrupts a lot of their habitat.
Predicted land use change in response to CC	U	Not enough information about human responses to CC.

Factor	Score	Comments
Dispersal and movement	U	Some species of waawaatesi cannot fly; dispersal information about those that can fly is unknown.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Large range - large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	SI/I/GI	Waawaatesi is dependent on moisture and aquatic habitats; unsure of how dependent. Larvae need mesic conditions.
Dependence on disturbance regime likely to be impacted by CC	SI/I	Affected by flooding and drought.
Dependence on ice, ice-edge or snow	N	Not dependent on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	Found in a wide range of habitats - no known dependence on uncommon landscape features.
Dependence on other species to generate habitat	N	No known dependence on other beings for habitat.
Dietary versatility	N	Diet is flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Self-dispersal.
Sensitivity to pathogens or natural enemies	N/SI	Waawaatesi has many predators, some of which are likely to increase with CC. Not highly affected by parasites as waawaatesi produces defensive compounds.
Sensitivity to competition from native or non-native species	U	No information found in the literature.
Other interspecific interaction	U	No information found in the literature.
Measured genetic variation	U	No information found in the literature.
Occurrence of bottlenecks	U	No information found in the literature.
Reproductive systems	N/A	
Phenological response to CC	U	No information found in the literature.
Documented response to CC	U	No information found in the literature.
Modeled future (2050) change in range or population size	U	No information found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Bald Eagle

Factors that influenced the vulnerability of migizi to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	Significant natural barriers do not exist for this being.
Anthropogenic barriers	N	Significant anthropogenic barriers do not exist for this being.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	N	Migizi is capable of significant dispersal.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Migizi has an extensive range, and therefore a large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Migizi has little or no dependence on a strongly seasonal hydrologic regime.
Dependence on disturbance regime likely to be impacted by CC	N	Little or no response to a specific disturbance regime.
Dependence on ice, ice-edge or snow	N/SI	Little dependence on ice- or snow-associated habitats, but a decrease in ice could affect its nesting and feeding ecology.
Restriction to uncommon landscape	N	Highly generalized relative to dependence upon geological features or derivatives.
Dependence on other species to generate habitat	N	Habitat requirements do not involve species-specific processes.
Dietary versatility	N	Diet flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	N/SI	Not a huge impact on migizi from predation, but several diseases (including avian pox) and environmental contaminants have the potential to affect migizi populations in the future.
Sensitivity to competition from native or non-native species	N	Little or no response to native beings likely to shift their distribution or abundance due to CC.
Other interspecific interaction	N	Does not require an interspecific interaction.
Measured genetic variation	U	Insufficient information found in the literature.
Occurrence of bottlenecks	I	Evidence that total population was reduced to ≤ 250 mature individuals at some point in the past 500 years.
Reproductive systems	N/A	
Phenological response to CC	U	Migizi likely to change timing of breeding and migration with phenological changes, but nothing documented so far.
Documented response to CC	N	Distribution and abundance increasing in the United States.
Modeled future (2050) change in range or population size	N	Suitable habitat not projected to decline by mid-century.
Overlap of modeled future (2050) range with current range	N	Mid-century range will overlap by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Blue-winged Teal

Factors that influenced the vulnerability of ozhaawashkonebiisibens to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No natural barriers exist for ozhaawashkonebiisibens in the Ceded Territories.
Anthropogenic barriers	N	No anthropogenic barriers exist for ozhaawashkonebiisibens in the Ceded Territories.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	N	Ozhaawashkonebiisibens is capable of significant dispersal.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Ozhaawashkonebiisibens can withstand a large range of temperatures.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	SI/I	Seasonal and shallow marshes are particularly important to this being; drier years will reduce local breeding populations.
Dependence on disturbance regime likely to be impacted by CC	U	Increase in intensity and duration of drought could have dramatic effect on breeding habitat for this being, but little found in the literature.
Dependence on ice, ice-edge or snow	N	No dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	No restriction to uncommon landscape features.
Dependence on other species to generate habitat	N	Habitat requirements do not involve species-specific processes.
Dietary versatility	N	Diet is flexible, though changes in wetland abundance or depth may affect abundance of invertebrate food.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	SI/I	Affected by parasites and diseases that may increase with CC. Mention of several predators we can expect to increase as well. Additionally, one source claims nest failure is around 90% due to predation.
Sensitivity to competition from native or non-native species	U	Insufficient information found in the literature.
Other interspecific interaction	N	Does not depend on other beings for persistence.
Measured genetic variation	U	Insufficient information found in the literature.
Occurrence of bottlenecks	U	Insufficient information found in the literature.
Reproductive systems	N/A	
Phenological response to CC	U	This being largely times its migration to the calendar instead of weather patterns, so may be affected by phenological changes, but insufficient literature.
Documented response to CC	U	This being is declining in population, but declines are more likely related to habitat issues, predator impacts, or conditions outside of the Great Lakes. Not enough information to tie this to CC.

Factor	Score	Comments
Modeled future (2050) change in range or population size	N	Less than 20% decline in suitable habitat projected by mid-century.
Overlap of modeled future (2050) range with current range	N	Mid-century range will overlap by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N/A	

American Crow

Factors that influenced the vulnerability of aandeg to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	Significant barriers do not exist for this being.
Anthropogenic barriers	N	Significant barriers do not exist for this being.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	N	Aandeg is capable of significant dispersal.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Aandeg has an extensive range, and therefore, a large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Aandeg tolerates a very wide range of moisture conditions.
Dependence on disturbance regime likely to be impacted by CC	N	Little or no response to a specific disturbance regime.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	No restriction to uncommon landscape features.
Dependence on other species to generate habitat	N	Aandeg does not require any uncommon/restricted habitats.
Dietary versatility	N	Diet flexible. Aandeg is known to eat >600 food items.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	I	West Nile Virus is a serious threat likely to increase with CC.
Sensitivity to competition from native or non-native species	N	Little or no response to a native or non-native being that is likely to shift its distribution or abundance due to CC.
Other interspecific interaction	N	Does not require an interspecific interaction.
Measured genetic variation	U	Aandeg is highly social and abundant. No known genetic bottlenecks have occurred; therefore, genetic variation is likely high, but no information found in the literature to support this.
Occurrence of bottlenecks	N	No known genetic bottlenecks have occurred.
Reproductive systems	N/A	

Factor	Score	Comments
Phenological response to CC	N	Interviewees mentioned aandegwag respond to phenological cues.
Documented response to CC	N	Distribution and abundance not known to be decreasing with CC.
Modeled future (2050) change in range or population size	N	Predicted future range represents no change relative to current range within the assessment area.
Overlap of modeled future (2050) range with current range	N	Predicted future range overlaps the current range by > 60% within the assessment area.
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Mallard

Factors that influenced the vulnerability of ininishib to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No natural barriers for ininishib in the Ceded Territories.
Anthropogenic barriers	N	No anthropogenic barriers for ininishib in the Ceded Territories.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories, though it's likely that any changes would not impact ininishib.
Dispersal and movement	N	Ininishib is capable of significant dispersal.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Ininishib has an extensive range and therefore a large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Hydrological requirements are not likely to be significantly disrupted in the Ceded Territories, though uncertainty in precipitation projections make it hard to determine hydrological impacts.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Ininishib populations in the assessment area may be impacted by disturbances here or elsewhere - particularly drought.
Dependence on ice, ice-edge or snow	N	No dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	No restriction to uncommon landscape features.
Dependence on other species to generate habitat	N	Habitat requirements do not involve species-specific processes.
Dietary versatility	N	Diet is flexible and diverse; ininishib in Romania were recently recorded hunting and eating passerines.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	SI	Susceptible to parasites and diseases that have the potential to increase in the Ceded Territories with CC; increasing abundances of mesopredators may also impact ininishib.
Sensitivity to competition from native or non-native species	N	Little or no negative response to competition with native or non-native beings.
Other interspecific interaction	N	No interspecific interaction found in the literature.

Factor	Score	Comments
Measured genetic variation	N	Genetic variation reported as high.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information in the literature, although ininishib is adaptable and likely to track seasonal variations in weather.
Documented response to CC	N/SI	Mentioned in interviews as decreasing in at least two communities, but across larger range not known to be decreasing due to CC.
Modeled future (2050) change in range or population size	N	Suitable habitat not expected to decline by mid-century.
Overlap of modeled future (2050) range with current range	N	Mid-century range will overlap by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Wild Turkey

Factors that influenced the vulnerability of mizise to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No major natural barriers in the Ceded Territories.
Anthropogenic barriers	N	No major anthropogenic barriers in the Ceded Territories.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories.
Dispersal and movement	N	Mizise is capable of significant dispersal.
Historical thermal niche	N	Based on NatureServe climate data.
Physiological thermal niche	N	Mizise thrives in much warmer environments at lower latitudes than the Ceded Territories. Climate change projections suggest milder, warmer winters which will positively impact miziseg throughout the Ceded Territories.
Historical hydrological niche	SI	Based on NatureServe climate data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Mizise is not dependent on a particular hydrologic regime.
Dependence on disturbance regime likely to be impacted by CC	N	Mizise can live in a variety of habitats and should not be impacted by changes in disturbance regimes. Increases in fire would be beneficial to oak woodlands.
Dependence on ice, ice-edge or snow	N	Mizise is limited by snow depth.
Restriction to uncommon landscape	N	Prefers a mix of forested and open areas, but those are common across the Ceded Territories.
Dependence on other species to generate habitat	N	Mizise was reliant on humans for success at one time, but that is no longer the case.
Dietary versatility	N	Diet of mizise is diverse and will eat food according to availability.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Mizise is not dependent on other beings for dispersal.

Factor	Score	Comments
Sensitivity to pathogens or natural enemies	N/SI	Predators may increase, but mizise has a large clutch size and can compensate for increases in predation. Diseases such as avian pox may increase in the future.
Sensitivity to competition from native or non-native species	N	Mizise does not seem to have competitors or negatively affect other beings.
Other interspecific interaction	N	No interspecific interaction needed.
Measured genetic variation	N	Among mizise subspecies, eastern has the most diversity. Also, estimated genetic variation (between populations) is one of the highest reported for any avian being.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	N	Expected to track snow cover in spring for nesting.
Documented response to CC	N	Mizise populations have increased in the Ceded Territories.
Modeled future (2050) change in range or population size	N	Models show mizise range will continue to expand in the Ceded Territories.
Overlap of modeled future (2050) range with current range	N	Models show mizise range will continue to expand in the Ceded Territories.
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Common Raven

Factors that influenced the vulnerability of gaagaagi to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No significant barriers exist.
Anthropogenic barriers	N	No significant barriers exist.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	N	Gaagaagi is characterized by good to excellent dispersal or movement capability.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Gaagaagi has an extensive range, and therefore a large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Gaagaagi tolerates a very wide range of moisture conditions.
Dependence on disturbance regime likely to be impacted by CC	N	Little or no response to a specific disturbance regime.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	Gaagaagi is described as a generalist.
Dependence on other species to generate habitat	N	Gaagaagi does not rely on other beings for habitat.

Factor	Score	Comments
Dietary versatility	N	Diet is flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	N	No indication that gaagaagi is currently or in the foreseeable future likely to be significantly affected by a pathogen or predator that is likely to increase in distribution, abundance, or impact as a result of CC.
Sensitivity to competition from native or non-native species	N	Little or no response to a native or non-native being that is likely to shift its distribution or abundance due to CC.
Other interspecific interaction	N/SI	Possible that wolves may buffer the effects of CC on food availability in the assessment area.
Measured genetic variation	N	Genetic variation reported as high.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	N	Gaagaagi populations are increasing in the Ceded Territories.
Modeled future (2050) change in range or population size	N	Projected decline in suitable habitat in the Ceded Territories of 5% by mid-century.
Overlap of modeled future (2050) range with current range	N	Mid-century range overlaps current by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Canada Goose

Factors that influenced the vulnerability of nika to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No natural barriers for nika in the Ceded Territories.
Anthropogenic barriers	N	No anthropogenic barriers for nika in the Ceded Territories.
Predicted land use change in response to CC	N	Not too many impacts will affect nika.
Dispersal and movement	N	Nika is capable of significant dispersal.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Nika has a wide thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Nika is a habitat generalist, though increasing drying of wetland areas may have negative effects.
Dependence on disturbance regime likely to be impacted by CC	N	No dependence on a specific disturbance regime.
Dependence on ice, ice-edge or snow	N	No known dependence. They migrate from areas that experience icy, snowy winters.

Factor	Score	Comments
Restriction to uncommon landscape	N	No restriction to uncommon landscape features.
Dependence on other species to generate habitat	N	Amik (beaver) may provide habitat, but nika does not depend on it.
Dietary versatility	N	Diet of nika is flexible and diverse.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	N/SI	Potential increasing threats from predators favored by CC and pathogens (e.g., avian influenza, other disease vectors).
Sensitivity to competition from native or non-native species	N	Little or no response to a native or non-native being that is likely to shift its distribution or abundance due to CC.
Other interspecific interaction	N	Does not require an interspecific interaction.
Measured genetic variation	U	Insufficient information found in the literature.
Occurrence of bottlenecks	N	No evidence of a bottleneck in the population within the past 500 years.
Reproductive systems	N/A	
Phenological response to CC	N	Nika phenology has been documented as changing in response to climate.
Documented response to CC	N	Distribution and abundance not known to be decreasing with CC.
Modeled future (2050) change in range or population size	N	Suitable habitat of nika not expected to decline by mid-21st century.
Overlap of modeled future (2050) range with current range	N	Future range projected to overlap current by >60%.
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Appendix 5: Crawlers Climate Change Vulnerability Index Results

Wood Turtle

Factors that influenced the vulnerability of mitigwaakiing dizi mishiikenzh to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	SI/I	Lake Superior forms a natural barrier on >50% of the northern border for the populations within the assessment area. Mitigwaakiing dizi mishiikenzh is not currently found north of Lake Superior.
Anthropogenic barriers	SI	Anthropogenic barriers in this assessment area include roads and railroads.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	N/SI	This being is capable of longer movements but exhibits high site fidelity and rarely disperses. Uses same hibernation and nesting locations in successive years, and dispersal may be dangerous.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	This being is not restricted to cool or cold above-ground terrestrial or aquatic environments.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Mitigwaakiing dizi mishiikenzh is largely aquatic, but aquatic areas are abundant in the Ceded Territories.
Dependence on disturbance regime likely to be impacted by CC	SI/I	Extreme flooding is a major threat that can cause nest flooding, resulting in reduced recruitment, as well as direct mortality.
Dependence on ice, ice-edge or snow	N	Not dependent on ice or snow - occurs in warmer climate without long cold winters.
Restriction to uncommon landscape	SI	Mitigwaakiing dizi mishiikenzh reproduction is restricted to open sandy soils within 60 m (200 ft) of suitable aquatic habitat. This is mostly found in sites such as road shoulders and gravel pits.
Dependence on other species to generate habitat	N	Not dependent on other beings for habitat.
Dietary versatility	N	Mitigwaakiing dizi mishiikenzh is an opportunistic omnivore with a flexible diet.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.

Factor	Score	Comments
Sensitivity to pathogens or natural enemies	SI/I	Predators of mitigwaakiing dizi mishiikenzh such as esibanag (raccoons) and zhigaagwag (skunks) are expected to increase with CC. Mitigwaakiing dizi mishiikenzh response to pathogens is largely unknown, but increases in other herptiles does not bode well for mitigwaakiing dizi mishiikenzh.
Sensitivity to competition from native or non-native species	U	Affected by non-local spotted knapweed and reed canary grass, but those are not competing beings. No information on competitors found.
Other interspecific interaction	N	No documented interspecific interactions.
Measured genetic variation	U	Not enough information found in the literature.
Occurrence of bottlenecks	U	Bottleneck seems unlikely, but not enough information found in the literature.
Reproductive systems	N/A	
Phenological response to CC	N	Emergence, breeding, and nesting have responded to air and water temperatures.
Documented response to CC	U	Not enough information found in the literature.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Spring Peeper

Factors that influenced the vulnerability of agoozimakakii to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N/SI	Non-wetland habitat between isolated wetlands can be a barrier.
Anthropogenic barriers	N/SI	Major roadways, agriculture, and deforested areas are all anthropogenic barriers.
Predicted land use change in response to CC	U	Not enough information about human responses to CC in the Ceded Territories.
Dispersal and movement	SI	Agoozimakakii lives in small isolated patches of suitable habitat but regularly disperses or moves among patches that are up to 1,000 m (rarely farther) apart.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Agoozimakakii is found throughout the Ceded Territories and all the way south down to Texas and Florida.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	SI/I	Dependent on vernal pools but can migrate to deeper wetlands during dry years if there are any nearby.
Dependence on disturbance regime likely to be impacted by CC	SI	Drought and flooding will both affect agoozimakakii. Drought will reduce habitat; flooding could inundate ephemeral ponds with giigoonh (fish) in the spring.
Dependence on ice, ice-edge or snow	N	Not dependent on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	No dependence on uncommon landscape features.

Factor	Score	Comments
Dependence on other species to generate habitat	N	Are not known to rely on habitats generated by specific beings.
Dietary versatility	N	Diet is flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Self-dispersal.
Sensitivity to pathogens or natural enemies	N	No indication at the moment that there are pathogens likely to increase in distribution or abundance that would affect agoozimakakii, although numerous fungal and bacterial infections linked to CC are being documented in herptiles in North America.
Sensitivity to competition from native or non-native species	N	No current information showing that agoozimakakii is negatively affected by competition from native or bakaan ingoji gaa-ondaadag (non-local beings).
Other interspecific interaction	U	Not enough information found in the literature.
Measured genetic variation	N/SI	Genetic variation reported as low/moderate in the Ceded Territories.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	N	So far, agoozimakakii has been changing phenology with the climate. However, if we get winters with month-long summer waves, this would negatively affect spring peepers. Agoozimakakii can lose its antifreeze abilities during long bouts of summerlike weather. In addition, its food sources may not change with the climate, and if it wakes up early from hibernation it may not have enough insects to eat, but more research is needed.
Documented response to CC	N	Populations seem to be slightly increasing in Wisconsin from 1984 to 2016 - however, trends are cyclical.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Painted Turtle

Factors that influenced the vulnerability of miskwaadesi to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to Lake Superior.
Natural barriers	N/SI	Lake Superior may be somewhat of a barrier.
Anthropogenic barriers	SI	Roadways, railroads, and agriculture are anthropogenic barriers for miskwaadesi in the Ceded Territories.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	SI	Miskwaadesi is capable of dispersing large distances, but is slow and takes cover when threatened.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Miskwaadesi is unlikely to be affected by changes in thermal habitat as it is not found at the edge of its range in the Ceded Territories.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.

Factor	Score	Comments
Physiological hydrological niche	N	Miskwaadesi is a wetland generalist, and not likely to be impacted by changing hydrological conditions unless significant and long-term droughts make populations isolated from one another.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Flooding can erode nest sites or prevent them from drying out and cause hatch failures.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	Miskwaadesi is a habitat generalist for the most part.
Dependence on other species to generate habitat	N	Nothing to indicate that this being is dependent on others to create habitat.
Dietary versatility	N	Opportunistic and omnivorous. Flexible diet.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	SI	Unknown and known fungal and bacterial pathogens (herpesvirus, ranavirus, etc.) could increase in a warming climate and negatively affect miskwaadesi.
Sensitivity to competition from native or non-native species	N	A possible future competitor would be the red-eared slider, but not much is known about direct competition or the possibility of this being introducing a disease to miskwaadesi.
Other interspecific interaction	U	Not enough information found in the literature.
Measured genetic variation	U	Little information.
Occurrence of bottlenecks	N	No evidence that total population was reduced to ≤ 1000 mature individuals and/or that occupied area was reduced by > 30% at some point in the past 500 years.
Reproductive systems	N/A	
Phenological response to CC	U	Nothing documented in literature. However, miskwaadesi could shift its nesting season earlier in the year to compensate for warming temperatures in the Ceded Territories. Hatchling ratios may favor more females instead of males in a warmer climate.
Documented response to CC	U	Not enough information found in the literature.
Modeled future (2050) change in range or population size	U	No known models in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Snapping Turtle

Factors that influenced the vulnerability of mikinaak to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N/SI	Lake Superior can be a barrier to this being, as it is not found very far north of the lake.
Anthropogenic barriers	N/SI	Roadways are anthropogenic barriers for mikinaak in the Ceded Territories.

Factor	Score	Comments
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	N	Mikinaak is relatively good at dispersing. However, recent literature questions whether turtles will be able to disperse fast enough to keep up with CC.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Mikinaak is not restricted to cool or cold environments, though CC could affect sex ratios of offspring.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Adult and juvenile mikinaakwag are not dependent on a narrowly defined precipitation/hydrologic regime.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Flooding can erode nest sites or prevent them from drying out and cause hatch failures.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	Mikinaak is considered an aquatic habitat generalist.
Dependence on other species to generate habitat	N	Mikinaak is not dependent on other beings for habitat.
Dietary versatility	N	Diet is flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Mikinaak is not dependent on other beings for dispersal.
Sensitivity to pathogens or natural enemies	SI	Mikinaak (particularly eggs and hatchlings) has many predators likely to increase in distribution, abundance, or impact as a result of CC. Predators include other large turtles, zhashagi (great blue heron), aandeg (crow), esiban (raccoon), zhigaag (skunk), waagosh (fox), bullfrogs, water snakes, and large predatory fish, such as ashigan (largemouth bass).
Sensitivity to competition from native or non-native species	N	The alligator snapping turtle is found in similar habitats and has a similar life history to mikinaak; however, it already co-occurs with mikinaak throughout its entire range.
Other interspecific interaction	N	Mikinaak is not known to have any significant interspecific relationships.
Measured genetic variation	SI	Genetic variation is thought to be lower than other widespread generalist species.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Not enough information found in the literature.
Documented response to CC	U	Not enough information found in the literature.
Modeled future (2050) change in range or population size	U	No known models.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Appendix 6: Four-leggeds Climate Change Vulnerability Index Results

Snowshoe Hare

Factors that influenced the vulnerability of waabooz to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	SI	Fragmented landscapes are barriers to dispersal.
Anthropogenic barriers	SI/I	Agricultural lands, non-forested habitats, and urban areas can be barriers to waabooz.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	N	Waabooz is capable of dispersing over 20 km.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	I/GI	Waabooz is a winter-adapted species restricted to cold environments.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Little or no dependence on a seasonal hydrologic regime.
Dependence on disturbance regime likely to be impacted by CC	N	No response in the literature found to flooding and/or drought; ishkode (fire) may be beneficial for waabooz.
Dependence on ice, ice-edge or snow	GI	Snow cover and quality is a critical component of their habitat needs.
Restriction to uncommon landscape	N	None found in the literature.
Dependence on other species to generate habitat	N	None found in the literature.
Dietary versatility	N	Diet is flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	No dependence.
Sensitivity to pathogens or natural enemies	SI	Species is negatively affected to a moderate degree by predators likely to increase in distribution, abundance, or impact because of CC – gidagaa-bizhiw (bobcat), wiisagizi ma'iingan (coyote), ojiig (fisher).
Sensitivity to competition from native or non-native species	N	There appears to be some competition with mooz (moose), but no substantial evidence that the competition is particularly strong. Also, mooz is expected to decline with CC.
Other interspecific interaction	N/SI	Population cycles are tied to bizhiw (lynx) and bine (ruffed grouse) - CC could affect these cycles through altered predation impacts.
Measured genetic variation	N/SI	Generally high genetic diversity, except it is lower on the edges of its range.

Factor	Score	Comments
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	I	Phenological mismatch between background snow conditions and coat color is likely the single most important factor determining the sensitivity of waabooz to CC. Seasonal temperature and precipitation dynamics are changing; the waabooz color change is not keeping up with these changes.
Documented response to CC	I	Waabooz is shifting its range in Wisconsin, likely in response to CC, but projections suggest it will persist in Wisconsin for the immediate future. Projecting future snow cover, however, is a challenging task and this uncertainty, coupled with uncertainty in how waabooz will respond to it, means that a more dramatic range shift is possible. Several communities have also observed a decline in waaboozoog.
Modeled future (2050) change in range or population size	SI	Projections show a reduction in waabooz range.
Overlap of modeled future (2050) range with current range	N	Range likely to overlap at broad scales.
Occurrence of protected areas in modeled future (2050) distribution	N	Lots of forest on the landscape.

Moose

Factors that influenced the vulnerability of mooz to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	SI	Lake Superior is a barrier to northward shifts in mooz range.
Anthropogenic barriers	N	There are no anthropogenic features that would significantly inhibit the dispersal of mooz.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories.
Dispersal and movement	N	Good to excellent dispersal capability.
Historical thermal niche	N	Based on NatureServe climate data.
Physiological thermal niche	I	Multiple sources suggest that mooz is likely to be influenced by increases in temperature.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N/SI	Hydrologic regime isn't expected to be highly vulnerable but mooz is dependent on aquatic habitat.
Dependence on disturbance regime likely to be impacted by CC	U	Dependent on a fire regime, but any likely benefits from the changes in the fire regime are likely to be neutralized by the increased risk of heat stress, ticks, disease, etc. Overall difficult to say.
Dependence on ice, ice-edge or snow	I	Mooz range overlaps entirely with places with seasonal snow cover. They are better adapted to cold temperatures and longer winters than shorter warmer winters.
Restriction to uncommon landscape	N	No restrictions to any particular landscape features.
Dependence on other species to generate habitat	N	Benefits from amik (beaver) and humans, but not dependent on them.

Factor	Score	Comments
Dietary versatility	N	Diet is fairly flexible, despite focusing on fewer species in the winter.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperse on own.
Sensitivity to pathogens or natural enemies	I	Pathogens and natural enemies expected to increase with a changing climate (and have been already).
Sensitivity to competition from native or non-native species	SI/I	Moderately affected by an increasing waawaashkeshi (white-tailed deer) population due to incidence of brainworm and liver flukes.
Other interspecific interaction	N	Does not depend on a specific interaction.
Measured genetic variation	SI	Sources indicate low genetic variation in mooz in general, and particularly in the Ceded Territories where reintroductions occurred.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Warming fall temperatures may delay rut and result in late-born calves, but more research needed.
Documented response to CC	N/SI	Michigan Department of Natural Resources surveys indicate mooz distribution and abundance in western Upper Peninsula relatively stable, although other populations (i.e. northeast Minnesota) have shown decreases likely due to climate change.
Modeled future (2050) change in range or population size	U	No models available.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

American Marten

Factors that influenced the vulnerability of waabizheshi to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	SI	Lake Superior is a natural barrier to the north and comprises ~50% of the northern border of waabizheshi range in assessment area. Fragmented forests can also be a barrier.
Anthropogenic barriers	SI	Agriculture, clearcuts, forest fragmentation are barriers to waabizheshi.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories.
Dispersal and movement	N/SI	Waabizheshiwag are capable of dispersal > 1 km but rarely move that far, particularly in fragmented landscapes.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Restricted to relatively cool environments but not necessarily dependent on those environments because of the temperature.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	No evidence that waabizheshi is dependent on particular hydrological conditions.

Factor	Score	Comments
Dependence on disturbance regime likely to be impacted by CC	U	Disturbances such as ishkode (fire), blowdown, and manidoons (insect) outbreak could have both positive and negative effects for waabizheshi. Not enough information to answer either way.
Dependence on ice, ice-edge or snow	SI/I	Most of the waabizheshi range is associated with snow cover for some portion of the year. Waabizheshiwag frequently use subnivean spaces during winter to hunt and rest. They may also benefit from deep snows, which provide a competitive advantage for waabizheshiwag relative to other predators, notably ojiigag (fishers).
Restriction to uncommon landscape	N	No dependence found in the literature.
Dependence on other species to generate habitat	N	Waabizheshiwag use cavities created by woodpeckers, but they also use cavities created by other natural processes.
Dietary versatility	N/SI	Waabizheshi diet is diverse in the summer, and more specialized in the winter.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperse on own.
Sensitivity to pathogens or natural enemies	SI	Many natural enemies will be favored: ojiig (fisher), gidagaa-bizhiw (bobcat), wiisagizi ma'iingan (coyote), waagosh (fox).
Sensitivity to competition from native or non-native species	SI/I	Native competitors will be favored: ojiig, wiisagizi ma'iingan, gidagaa-bizhiw, waagosh.
Other interspecific interaction	N	None found in literature.
Measured genetic variation	U	Insufficient information found in the literature. Genetics haven't thoroughly been evaluated in the assessment area, although there are some isolated populations that may have reduced genetic diversity.
Occurrence of bottlenecks	I	Waabizheshi experienced a bottleneck within the assessment area. Occupied area reduced by >70% at some point in the past 500 years.
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	U	Insufficient information found in the literature.
Modeled future (2050) change in range or population size	SI	Climate envelope modeling using middle of the road (RCP 4.5) climate projects suggests relatively minor range loss in the assessment area by 2050 (Ron Moen, unpublished data).
Overlap of modeled future (2050) range with current range	N	Overlap was not calculated as part of this project (for the assessment area or the larger region), but it appears to be >60% overlap for the 2050 projection (Ron Moen, unpublished data).
Occurrence of protected areas in modeled future (2050) distribution	U	Unsure of what constitutes 'protected' for waabizheshi.

Fisher

Factors that influenced the vulnerability of ojiig to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No major natural barriers for ojiig in the Ceded Territories.
Anthropogenic barriers	N	No major anthropogenic barriers for this being.
Predicted land use change in response to CC	U	Human responses to climate change in the Ceded Territories are largely unknown.

Factor	Score	Comments
Dispersal and movement	N	Ojiig can disperse long distances, commonly >1 km.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	I	Ojiig appears to be stressed at temperatures greater than 20 C and choose cooler microhabitats. It is adapted to cold climates.
Historical hydrological niche	SI	Based on NatureServe climate data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	This being tolerates a wide range of moisture conditions, though white cedar, which ojiig utilizes, may be impacted.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Any increases in fire may affect ojiig; however, fires are suppressed in general in the study area.
Dependence on ice, ice-edge or snow	SI	Ojiig range overlaps with snow-associated habitats, and the lack of winter conditions might limit their populations in the future.
Restriction to uncommon landscape	N	No apparent restriction to uncommon landscape/geological features found in the literature.
Dependence on other species to generate habitat	N	No dependence on other beings to generate habitat.
Dietary versatility	N/SI	May be significantly affected by reduction in waabooz (snowshoe hare) population.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on own.
Sensitivity to pathogens or natural enemies	N/SI	Gidagaa-bizhiwag (bobcats) are a predator of ojiig and are expected to continue increasing in population.
Sensitivity to competition from native or non-native species	N/SI	Ojiig has multiple competing species likely to be favored by climate change – gidagaa-bizhiw (bobcat), waagosh (red fox), wiisagizi ma'iingan (coyote).
Other interspecific interaction	N	Does not require interspecific interaction.
Measured genetic variation	U	Insufficient information found in the literature.
Occurrence of bottlenecks	I	Ojiig population extirpated from large portion of assessment area and has since rebounded from reintroductions and natural dispersal.
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	U	No sources that look at response to climate change.
Modeled future (2050) change in range or population size	U	Insufficient information found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Cave Bat

Factors that influenced the vulnerability of bapakwaanaajiinh (cave bat) to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No natural barriers found in the Ceded Territories.
Anthropogenic barriers	N	Towers/power lines may be impediments to movements but not complete barriers. Light pollution can be a deterrent.
Predicted land use change in response to CC	SI	Affected by both wind turbines and mining in the Ceded Territories.
Dispersal and movement	N	Bapakwaanaajiinh is characterized by good to excellent dispersal or movement capability.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Most Wisconsin bapakwaanaajiinyag have wide ranges and are found south of the Ceded Territories.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Dependent on water for foraging, but water is abundant in the Ceded Territories.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Cave bat hibernacula can be vulnerable to flooding, which can be especially problematic during hibernation.
Dependence on ice, ice-edge or snow	N	Not dependent on ice or snow.
Restriction to uncommon landscape	SI	Some cave bats are dependent on caves for hibernacula in the Ceded Territories for part of their life cycle.
Dependence on other species to generate habitat	N	No dependence on beings other than humans to generate habitat.
Dietary versatility	N	Diet is flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	No dependence.
Sensitivity to pathogens or natural enemies	I	Cave-dwelling bats are susceptible to white-nose syndrome, which has already caused massive deaths in their population.
Sensitivity to competition from native or non-native species	N	Competition is minimal.
Other interspecific interaction	N	Not part of an interspecific interaction.
Measured genetic variation	N	Genetic variation is high in little brown bat.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	I	Research has found that cave-dwelling bats are not adjusting their dates of hibernation with phenological changes.
Documented response to CC	U	Insufficient information found in the literature.

Factor	Score	Comments
Modeled future (2050) change in range or population size	U	Insufficient information found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Common Muskrat

Factors that influenced the vulnerability of wazhashk to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to Ceded Territories.
Natural barriers	N	No major natural barriers to wazhashk movement in the Ceded Territories.
Anthropogenic barriers	N/SI	Habitat alteration and development can be a barrier for wazhashk.
Predicted land use change in response to CC	U	Not enough known about human responses to CC in the Ceded Territories.
Dispersal and movement	N/SI	Wazhashk is capable of significant dispersal.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Wazhashk distribution is not significantly affected by thermal characteristics of the environment in the assessment area.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	I	Wazhashk is dependent on particular water levels and vegetation characteristics for food. CC could significantly alter habitat and food availability.
Dependence on disturbance regime likely to be impacted by CC	SI	Flooding and drought will affect wazhashk habitat and may cause reduced density in many areas.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats. Reduced snowpack might cause winter freeze-outs for wazhashk, but reduced ice cover may offset that.
Restriction to uncommon landscape	N	Wazhashk depends on a fairly narrow set of water depths and aquatic plant beings to reach higher densities, but in general, wetland habitats are not uncommon in the Ceded Territories.
Dependence on other species to generate habitat	N	Habitat requirements do not involve species-specific processes. Utilizes habitats modified by amik (beaver) where available but not completely dependent on them.
Dietary versatility	N	Diet is generally flexible, though the quality and quantity of vegetation is likely to change in ways that would negatively impact wazhashk.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Not dependent on other beings for dispersal.
Sensitivity to pathogens or natural enemies	N/SI	Predation risk may increase as predators increase with CC; flooding or drought may intensify this risk. Wazhashk is sensitive to Tyzzer's disease, a bacterial infection, but little research on how this will change with climate.

Factor	Score	Comments
Sensitivity to competition from native or non-native species	N	Possible competition with amik, but little study on the topic; nutria would be a threat if they moved into the assessment area, but this is unlikely in the time frame of this assessment. Otherwise, little indication of increasing competition.
Other interspecific interaction	N	Does not require an interspecific interaction.
Measured genetic variation	N	Genetic variation is reported as high in the Midwest.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	No information found in the literature.
Documented response to CC	U	Insufficient information found in the literature.
Modeled future (2050) change in range or population size	U	Insufficient information found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Tree Bat

Factors that influenced the vulnerability of bapakwaanaajiinh (tree bats) to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No natural barriers.
Anthropogenic barriers	N	Towers/power lines may be impediments to movements but not complete barriers. Light pollution can be a deterrent.
Predicted land use change in response to CC	I	Affected by both wind turbines and mining in the Ceded Territories.
Dispersal and movement	N	Being is characterized by good to excellent dispersal or movement capability.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Most Wisconsin tree bats have wide ranges and are found south of the Ceded Territories.
Historical hydrological niche	SI	Based on NatureServe data.
Physiological hydrological niche	N	Dependent on water for foraging, but water is abundant in the Ceded Territories.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Increased precipitation in the spring has the potential to disrupt breeding.
Dependence on ice, ice-edge or snow	N	Not dependent on ice or snow.
Restriction to uncommon landscape	N	Tree bats are not dependent on caves for hibernacula like the cave bats are in the Ceded Territories for part of their life cycle.
Dependence on other species to generate habitat	N	No dependence on beings other than humans to generate habitat.
Dietary versatility	N	Diet is flexible.

Factor	Score	Comments
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	No dependence.
Sensitivity to pathogens or natural enemies	N	Tree bats are not as susceptible to white nose syndrome as cave bats.
Sensitivity to competition from native or non-native species	N	Competition is minimal.
Other interspecific interaction	N	Not part of an interspecific interaction.
Measured genetic variation	U	Insufficient information found in the literature.
Occurrence of bottlenecks	U	Insufficient information found in the literature.
Reproductive systems	N/A	
Phenological response to CC	U	Not enough information found in the literature on tree-dwelling Wisconsin bapakwaanaajiinyag.
Documented response to CC	U	Insufficient information found in the literature.
Modeled future (2050) change in range or population size	U	Insufficient information found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Short-tailed/Least Weasel

Factors that influenced the vulnerability of zhingos (short-tailed and least weasels) to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No major natural barriers in the Ceded Territories.
Anthropogenic barriers	N	No significant anthropogenic barriers in the Ceded Territories.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories.
Dispersal and movement	N	Short-tailed and least weasels are capable of significant dispersal.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Both species have large thermal niches; the short-tailed weasel is found as far south as Illinois.
Historical hydrological niche	SI	Based on NatureServe data.
Physiological hydrological niche	N	No dependence on a particular hydrological regime.
Dependence on disturbance regime likely to be impacted by CC	N	Both species live in diverse habitats and are not likely to be impacted by changing disturbance regimes.
Dependence on ice, ice-edge or snow	I	Although most of the ranges of these two species are in areas with snow, both live in areas without snow or with little snow.
Restriction to uncommon landscape	N	No restriction to uncommon landscape features.
Dependence on other species to generate habitat	N	No dependence on other species for habitat.

Factor	Score	Comments
Dietary versatility	N/SI	Diet is flexible, although according to interviewees they depend on frogs and insects in many locations, making them more vulnerable.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Not dependent on other species for dispersal.
Sensitivity to pathogens or natural enemies	N	Little is known about parasites. Avian predators have the potential to limit zhingos populations at times but climate change will not changes potential predators in any way that might affect these zhingosag.
Sensitivity to competition from native or non-native species	N	Maybe an increase in competition with long-tailed weasels, but not expected to increase significantly.
Other interspecific interaction	N	No interspecific interactions needed.
Measured genetic variation	U	Insufficient information found in the literature.
Occurrence of bottlenecks	N	No evidence of bottlenecks in these species.
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	U	Not enough known about zhingos populations in the Ceded Territories.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

American Beaver

Factors that influenced the vulnerability of amik to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to Ceded Territories.
Natural barriers	N	No natural barriers found in the Ceded Territories.
Anthropogenic barriers	N	No anthropogenic barriers in the Ceded Territories substantial enough to limit amik movement.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories.
Dispersal and movement	N	Able to disperse long distances.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Tolerates a wide range of temperatures.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N/SI	Mentioned in interviews as vulnerable because it is a water-born creature, though aquatic habitat is abundant in the Ceded Territories.
Dependence on disturbance regime likely to be impacted by CC	N/SI	Could be affected by flooding, which is predicted to increase in the form of extreme rain events.

Factor	Score	Comments
Dependence on ice, ice-edge or snow	N	Not dependent on snow/ice.
Restriction to uncommon landscape	N	None found in the literature.
Dependence on other species to generate habitat	N	Not dependent. Generate habitat for other beings.
Dietary versatility	N	Generalist diets.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Not dependent on other beings for dispersal.
Sensitivity to pathogens or natural enemies	N/SI	Tularemia may be a threat but no data on whether it will increase with climate change, and it does not appear to be population limiting.
Sensitivity to competition from native or non-native species	N	Minimal competition.
Other interspecific interaction	N	Does not require an interspecific interaction.
Measured genetic variation	U	Not enough data about genetic variation in amik to answer this question.
Occurrence of bottlenecks	SI	Population reduced to ~500 individuals around 1900.
Reproductive systems	N/A	
Phenological response to CC	U	No data in the literature.
Documented response to CC	U	Nothing found in the literature.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Elk

Factors that influenced the vulnerability of omashkooz to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No significant natural barriers. Population does not border Lake Superior and not moving northward (for now).
Anthropogenic barriers	N/SI	Housing developments may create barriers to omashkooz movements.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories.
Dispersal and movement	N	Capable of significant dispersal, though dispersal may be altered by locations of ma'iingan (wolf) packs.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Omashkooz has an extensive range and a large thermal niche. Many of the omashkoozoog in the Ceded Territories came from Kentucky.
Historical hydrological niche	N/SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of omashkooz, this score is the same for all beings. Omashkooz has a limited range within the Ceded Territories and its score is therefore different than other beings.

Factor	Score	Comments
Physiological hydrological niche	N	Not dependent on a particular hydrological regime.
Dependence on disturbance regime likely to be impacted by CC	N	Omashkooz can benefit from a variety of disturbance such as ishkode (fire), timber harvest or reclaimed mine land.
Dependence on ice, ice-edge or snow	N	Not dependent on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	No restriction to uncommon landscapes.
Dependence on other species to generate habitat	N	Omashkooz does not depend on other beings for habitat.
Dietary versatility	N	Omashkooz diet is diverse.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Generally does not dependent on other beings for dispersal, though humans have assisted omashkooz in dispersal into Wisconsin.
Sensitivity to pathogens or natural enemies	SI	Predators expected to increase; diseases such as babesiosis and parasites such as brainworm and liver flukes may increasingly affect omashkooz as well, especially if waawaashkeshi (white-tailed deer) populations continue to rise.
Sensitivity to competition from native or non-native species	N	Little competition with waawaashkeshi.
Other interspecific interaction	N	No interspecific interactions needed.
Measured genetic variation	N/SI	Genetic diversity is currently low, but omashkoozoog introduced from Kentucky should improve the genetic diversity of omashkoozoog in the Ceded Territories.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	N	Range is currently increasing as omashkoozoog have been restored to several states and Ontario.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

White-tailed Deer

Factors that influenced the vulnerability of waawaashkeshi to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories
Natural barriers	N	No natural barriers.
Anthropogenic barriers	N	Waawaashkeshiwag can move through most habitats; no anthropogenic barriers in the Ceded Territories.
Predicted land use change in response to CC	N	Land use changes are unlikely to affect waawaashkeshiwag as they are highly adaptable.

Factor	Score	Comments
Dispersal and movement	N	Good to excellent dispersal capability. Have been known for significant seasonal migrations in the UP.
Historical thermal niche	N	Based on NatureServe climate data.
Physiological thermal niche	N	Waawaashkeshiwag inhabit areas very far south of the Ceded Territories and are not expected to be affected by increasing temperatures.
Historical hydrological niche	SI	Based on NatureServe climate data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Waawaashkeshiwag are not dependent on any kind of hydrologic regime or wetland habitat.
Dependence on disturbance regime likely to be impacted by CC	N	Climate change is unlikely to change the frequency, severity, or extent of any disturbance regimes in ways that affect the range or abundance of waawaashkeshi.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	No restrictions to uncommon landscape features.
Dependence on other species to generate habitat	N	Waawaashkeshi does not depend on other species to generate habitat.
Dietary versatility	N	Waawaashkeshi diet is flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	SI/I	Disease prevalence will increase with warmer temperatures - epizootic hemorrhagic disease and chronic wasting disease are diseases of concern. Some communities have noticed that waawaashkeshiwag are not able to obtain their own medicines to protect themselves from diseases either. Most predator populations, especially coyotes, will increase.
Sensitivity to competition from native or non-native species	N	Little evidence for competition that negatively impacts waawaashkeshi.
Other interspecific interaction	N	Does not require a known interspecific interaction.
Measured genetic variation	N	Genetic variation in waawaashkeshi is high.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	No phenological shifts documented.
Documented response to CC	N	The waawaashkeshi herd doubled in size from 1986 to 2000, partially due to an increase in mild winters. Waawaashkeshi populations have not decreased with climate change.
Modeled future (2050) change in range or population size	U	Did not find any waawaashkeshi models in the assessment area; however, waawaashkeshi populations are likely to increase.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Gray Wolf

Factors that influenced the vulnerability of ma'iingan to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply in the Ceded Territories.
Natural barriers	N	No major natural barriers for ma'iingan in the Ceded Territories.
Anthropogenic barriers	N/SI	Agriculture, roads and other urban development.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories.
Dispersal and movement	N	This being is characterized by good to excellent dispersal or movement capability.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	The distribution of this being is not significantly affected by thermal characteristics in the assessment area.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Ma'iingan has little or no dependence on a strongly seasonal hydrologic regime and/or a specific aquatic/wetland habitat or localized moisture regime that is highly vulnerable to loss or reduction with climate change.
Dependence on disturbance regime likely to be impacted by CC	N	Little or no response to a specific disturbance regime.
Dependence on ice, ice-edge or snow	N	Little dependence on ice- or snow-associated habitats. Harsh winters make prey more vulnerable but also reduce prey populations.
Restriction to uncommon landscape	N	None found in the literature.
Dependence on other species to generate habitat	N	None found in the literature.
Dietary versatility	N	Diet is flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	No dependence.
Sensitivity to pathogens or natural enemies	N/SI	If the population grows, it's possible that mange could become an issue.
Sensitivity to competition from native or non-native species	N	No significant competition. Possible future mishibizhii (cougar) populations, but that is hypothetical.
Other interspecific interaction	N	None found in the literature.
Measured genetic variation	N/SI	Recent genetic papers about ma'iinganag in the region suggest a healthy well-connected population across the region. However, they are recently reestablished, have come through a bit of a bottleneck and have a narrow connection to other ma'iingan populations.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Insufficient information found in the literature.
Documented response to CC	N	Distribution and abundance not known to be decreasing with climate change.

Factor	Score	Comments
Modeled future (2050) change in range or population size	N	Expect ma'iinganag to continue increasing in number, although human sport harvesting may affect this.
Overlap of modeled future (2050) range with current range	N	Future range expected to overlap.
Occurrence of protected areas in modeled future (2050) distribution	N	Ma'iinganag have large territories over many land uses.

Black Bear

Factors that influenced the vulnerability of makwag to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No significant natural barriers.
Anthropogenic barriers	N/SI	A decrease in makwa food will cause increased movements and road mortality.
Predicted land use change in response to CC	U	Human responses to climate change are largely unknown.
Dispersal and movement	N	Makwag are good dispersers.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Distribution not affected by thermal characteristics.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Little or no dependence on seasonal hydrologic regime; tolerates wide range of moisture conditions.
Dependence on disturbance regime likely to be impacted by CC	N	Little response to a specific disturbance regime. Fire can both positively and negatively affect makwag.
Dependence on ice, ice-edge or snow	N/SI	Not dependent on snow-associated habitats, although they are affected by thawing snowpack in the winter.
Restriction to uncommon landscape	N	No dependence on uncommon landscape features found in the literature.
Dependence on other species to generate habitat	N	Makwag do not require a specific habitat that is maintained by another species.
Dietary versatility	N	Opportunistic - diet is flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on own.
Sensitivity to pathogens or natural enemies	N	Makwag have few predators; no evidence of makwa pathogens becoming more prevalent within the assessment area.
Sensitivity to competition from native or non-native species	N	Little or no response to competitors.
Other interspecific interaction	N	None known.
Measured genetic variation	N	Genetic diversity in assessment area is average/high.
Occurrence of bottlenecks	N/A	

Factor	Score	Comments
Reproductive systems	N/A	
Phenological response to CC	U	No phenological research on makwag found.
Documented response to CC	N	Range appears to be expanding.
Modeled future (2050) change in range or population size	U	No models found.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Bobcat

Factors that influenced the vulnerability of gidagaa-bizhiw to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	No major natural barriers for gidagaa-bizhiw in the Ceded Territories.
Anthropogenic barriers	N/SI	Roads do not seem to limit movement in the Ceded Territories but increasing agricultural lands may.
Predicted land use change in response to CC	U	Human responses to climate change in the Ceded Territories are largely unknown, though gidagaa-bizhiw is likely to be adaptable to potential changes.
Dispersal and movement	N	Gidagaa-bizhiw is capable of significant dispersal.
Historical thermal niche	N	Based on NatureServe climate data.
Physiological thermal niche	N	Gidagaa-bizhiw has an extensive range that includes Mexico; therefore, it has a large thermal niche.
Historical hydrological niche	SI	Based on NatureServe climate data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Gidagaa-bizhiw is not dependent on a particular hydrologic regime.
Dependence on disturbance regime likely to be impacted by CC	N	Gidagaa-bizhiw is highly adaptable and not likely to be affected by changes in disturbance regimes.
Dependence on ice, ice-edge or snow	N	As it is limited by deep snow, increases in winter precipitation in the form of snow have the potential to limit gidagaa-bizhiw movement; but increases in the form of rain will decrease snowpack and would likely benefit gidagaa-bizhiw.
Restriction to uncommon landscape	N	Gidagaa-bizhiw can use a wide range of habitat types, demonstrated by its extensive range.
Dependence on other species to generate habitat	N	Gidagaa-bizhiw is a generalist being and not dependent on any species-specific processes.
Dietary versatility	N	Gidagaa-bizhiw has a diverse diet.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Does not rely on other beings to disperse.

Factor	Score	Comments
Sensitivity to pathogens or natural enemies	N	Gidagaa-bizhiw lacks significant predators, and there are no signs of climate-driven diseases that would affect its populations.
Sensitivity to competition from native or non-native species	N/SI	Gidagaa-bizhiw coexists with a variety of other carnivores in its extensive range and does not seem to be limited by competition. However, increased competition with wiisagizi ma'iingan (coyote), waagosh (fox), and other medium-sized carnivores is likely in the Ceded Territories and this may impact gidagaa-bizhiw.
Other interspecific interaction	N	Does not require an interspecific interaction.
Measured genetic variation	N	Gidagaa-bizhiw has a high genetic diversity in its overall range, and there is substantial gene flow throughout.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Gidagaa-bizhiw will likely be able to adapt to any phenological changes, but no studies have been completed on this yet.
Documented response to CC	N	Gidagaa-bizhiw populations are increasing in the Midwest.
Modeled future (2050) change in range or population size	U	No models found.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

River Otter

Factors that influenced the vulnerability of nigig to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Not applicable to the Ceded Territories.
Natural barriers	N	Significant natural barriers do not exist for nigig in the Ceded Territories.
Anthropogenic barriers	N	No significant anthropogenic barriers to nigig movement in the Ceded Territories.
Predicted land use change in response to CC	U	Human responses to climate change in the Ceded Territories are largely unknown.
Dispersal and movement	N	Good to excellent dispersal or movement capability. May hunt in 80-100 km of stream during the year.
Historical thermal niche	N	Based on NatureServe climate data.
Physiological thermal niche	N	Habitat not affected by thermal characteristics.
Historical hydrological niche	SI	Based on NatureServe climate data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N/SI	Climate change effects on hydrology are largely unknown, but most likely will have little impact on nigig.
Dependence on disturbance regime likely to be impacted by CC	N	Flooding may impact nigig habitat but effects uncertain. Likely little impact of disturbances on nigig.
Dependence on ice, ice-edge or snow	N	Little or no dependence on ice- or snow-associated habitat. If anything, a reduction in surface ice cover could increase food availability.

Factor	Score	Comments
Restriction to uncommon landscape	N	No known restriction to uncommon landscape features.
Dependence on other species to generate habitat	N/SI	Nigig may be somewhat dependent on amik (beaver) for habitat, though amik is not likely to be highly vulnerable to climate change.
Dietary versatility	N	Diet is diverse.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	U	Nigig is dependent on water and increases in water-borne pathogens or water pollution may negatively affect nigig; however, not enough literature on this subject.
Sensitivity to competition from native or non-native species	N	Little or no response to another species likely to shift its distribution or abundance due to climate change.
Other interspecific interaction	N	No interspecific interactions known.
Measured genetic variation	N	Genetic variation is high in Minnesota and around the Great Lakes.
Occurrence of bottlenecks	N/A	
Reproductive systems	N/A	
Phenological response to CC	U	Likely will adapt to changes in temperature and precipitation well, but no literature found on this.
Documented response to CC	U	No good data for nigig populations in the assessment area.
Modeled future (2050) change in range or population size	U	No models found for nigig.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

American Mink

Factors that influenced the vulnerability of zhaangweshi to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	No major natural barriers exist in the Ceded Territories.
Anthropogenic barriers	N	No major anthropogenic barriers exist in the Ceded Territories.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change.
Dispersal and movement	N	Zhaangweshi is capable of significant dispersal.
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Based on extensive range, zhaangweshi has a large thermal niche.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Hydrological requirements are not likely to be significantly disrupted in major portion of the range

Factor	Score	Comments
Dependence on disturbance regime likely to be impacted by CC	N/SI	Drought, flooding, and stream flashiness may reduce feeding areas or negatively impact prey.
Dependence on ice, ice-edge or snow	N	No dependence on ice- or snow-associated habitats.
Restriction to uncommon landscape	N	No restriction to uncommon landscapes.
Dependence on other species to generate habitat	N	Zhaangweshi often uses wazhashk (muskrat) lodges, but not dependent on them for habitat.
Dietary versatility	N	Diet of zhaangweshi is flexible.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Not dependent on other beings for dispersal.
Sensitivity to pathogens or natural enemies	N	Variety of parasites known to affect zhaangweshi but none that necessarily are expected to increase with climate change or that are currently posing serious threats. Predation not currently a serious issue.
Sensitivity to competition from native or non-native species	N	Little evidence of competition in the literature.
Other interspecific interaction	N	Does not require an interspecific interaction.
Measured genetic variation	U	Not enough information on genetic diversity in zhaangweshi, though it has a large connected geographic range.
Occurrence of bottlenecks	N	No bottlenecks in recent evolutionary history.
Reproductive systems	N/A	
Phenological response to CC	U	Unlikely, but nothing found in the literature.
Documented response to CC	U	Insufficient information about zhaangweshi populations in the Ceded Territories.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Long-tailed Weasel

Factors that influenced the vulnerability of zhingos (long-tailed weasel) to global climate change (CC) in the Ceded Territories. Vulnerability scores include N=Neutral, SI=Somewhat Increase, I=Increase, GI=Greatly Increase, or U=Unknown. Comments from reviewers and information from TEK interviews influenced the vulnerability score for each factor.

Factor	Score	Comments
Sea level rise	N	Does not apply to the Ceded Territories.
Natural barriers	N	Lake Superior is not a barrier, as long-tailed weasels already occur north of the lake. No other known natural barriers.
Anthropogenic barriers	N	No significant anthropogenic barriers. Urban areas are not a big enough factor in the Ceded Territories.
Predicted land use change in response to CC	U	Not enough known about human responses to climate change in the Ceded Territories.
Dispersal and movement	N	Long-tailed weasels can move long distances.

Factor	Score	Comments
Historical thermal niche	N	Based on NatureServe data.
Physiological thermal niche	N	Based on range, large thermal niche - found in areas much warmer than the Ceded Territories.
Historical hydrological niche	SI	Based on NatureServe data. Note that this score does not appear on the individual page because with the exception of one being, this score is the same for all beings and was generated for the entire Ceded Territories.
Physiological hydrological niche	N	Little/no dependence on seasonal hydrologic regime.
Dependence on disturbance regime likely to be impacted by CC	N	Long-tailed weasels live in diverse habitats and are not dependent on a particular disturbance regime.
Dependence on ice, ice-edge or snow	N	Long-tailed weasels live in many areas that have no snow.
Restriction to uncommon landscape	N	No dependence found in the literature.
Dependence on other species to generate habitat	N	Not dependent on other beings for habitat.
Dietary versatility	N	The diets of long-tailed weasels are flexible and diverse, though mammals agongos (chipmunk)-size and smaller are most important.
Pollinator versatility	N/A	
Dependence on other species for propagule dispersal	N	Disperses on its own.
Sensitivity to pathogens or natural enemies	N	Little known about parasites; long-tailed weasels are quite aggressive and are not likely to see an increase in predation due to climate change.
Sensitivity to competition from native or non-native species	N	Little or no response to native beings for competition. Long-tailed weasels often outcompete smaller zhingosag unless food (particularly prey larger than amikowaabigozhiishag [voles]) is scarce, but climate change will not likely affect this to a large degree.
Other interspecific interaction	N	No interspecific interactions required.
Measured genetic variation	U	No information found in the literature.
Occurrence of bottlenecks	U	No information found in the literature.
Reproductive systems	N/A	
Phenological response to CC	U	Not likely to affect long-tailed weasels as they live in diverse habitats with diverse climates across North America, but nothing specifically documented in the literature.
Documented response to CC	U	No data on long-tailed weasel population trends.
Modeled future (2050) change in range or population size	U	No models found in the literature.
Overlap of modeled future (2050) range with current range	N/A	
Occurrence of protected areas in modeled future (2050) distribution	N/A	

Description of Cover Art

Title: *Mino-bimaadiziwin / The Good Life*

By: *Sam Zimmerman / Zhaawanoogiizhik*

Translation by: *Manidoo Maiingan*

This painting was designed to capture traditional Ojibwe harvesting and fishing practice.

Onjida go ingii-zhizhoobii'aan owe ji-waabanda'amaan ezhi-bimaadizid awe anishinaabe.

In this piece, I wanted to capture the four hills of life one travels through with 365 stars above in the sky, one for each day of the year.

Mii niiwing ezhi-ogidaakiiwed anishinaabe mii enikawed. Shke naa niswaak ingodwaasimidana ashi naanan anangoog agoojinoog imaa giizhigong. Mii ingokinoonowin.

The Ojibwe woman in the birchbark canoe gathers wild rice, fishes for walleye, and honors the dawn and begins the new day by offering the four medicines.

Wiigwaasijiimaaning awe ojibwekwe ezhi-manoominiked, ezhi-nooji'aad ogaawan, ezhi-biidaasamigaabawitawaad waabanogiizisoon mooka'aminid, ezhi-bagidiniged onji-oshki-giizhiganiked.

The cedar, sage, sweetgrass and tobacco are represented in the embers floating up from the fire.

Gichitwaabate wenji-mazinaabategin iniwen giizhik, bashkodewashk, wiingashk, asemaa gaye.

The black bear in the background represents the guardian of the tribe keeping a watchful eye and is joined by painted turtle and crow both sitting on the cedar who are also watching over her from the shores of Lake Superior.

Mii daabishkoo ogimaa naanaagadawaabanjiged awe makwa. Owiijiiwaawaan miskwaadesi naa gaye aandeg imaa giizhiking abiwaad jiigi-gichigami onzaabiwaad.

Sam Zimmerman / Zhaawanoogiizhik (Grand Portage Band of Ojibwe, Direct Descendant) received his Bachelor of Fine Arts in Studio Art from the Rochester Institute of Technology. His work explores his Ojibwe heritage, his learnings and experiences in nature upon his return to the Grand Portage reservation while preserving shared oral histories, reimagining the symbolism of the clan animals while incorporating the natural landscape of Lake Superior's North Shore. He has recently completed the illustration of six bilingual Ojibwemowin/English children's books for the Red Cliff Band of Lake Superior Chippewa schools. He has recently completed his first Ojibwemowin/English bilingual art book, a collection of paintings and stories from his first year of creating along the northern shore of Lake Superior, titled: Following My Spirit Home published by Black Bear and Blueberries Publishing, a native owned publishing company. He has begun illustrating a new bilingual children's book for the Minnesota Historical Society Press. His current studio projects can be viewed on Facebook or Instagram [@Crane Superior].

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