



Mi'kmaq Nation



Thirteen Moons

Climate Change Adaptation Plan

Adopted by the Tribal Council on February 2, 2022

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Mi'kmaq Nation Thirteen Moons Climate Change Adaptation Plan

Forward by Dena L. Winslow, Ph.D.

With their close connections to the natural world, Micmacs of two and three centuries ago based their calendar years on four seasons which were then divided into twelve months, or “moons.” These moons were based upon the arrival of various natural events usually connected to the food cycle. While these moon names varied slightly based upon the author reporting them, they were often reported as follows:

January – frost fish (Tomcod) moon
February – snow-blinder – or snow is very strong moon
March – spawning or maple sugar moon
April – egg-laying moon
May – frog-croaking moon
June – summer or leaves full blossom moon
July – birds shed feathers moon
August – fruit and berry-picking moon
September – moose calling moon
October – animal fattening moon
November – river-freezing moon
December – great or winter moon

However, as Wallis and Wallis explained, “a thirteenth (moon) was added if plants and animals arrived at the wrongly named moon.”¹ There is no doubt that we are living in a time of thirteen moons because of the impacts of climate change.

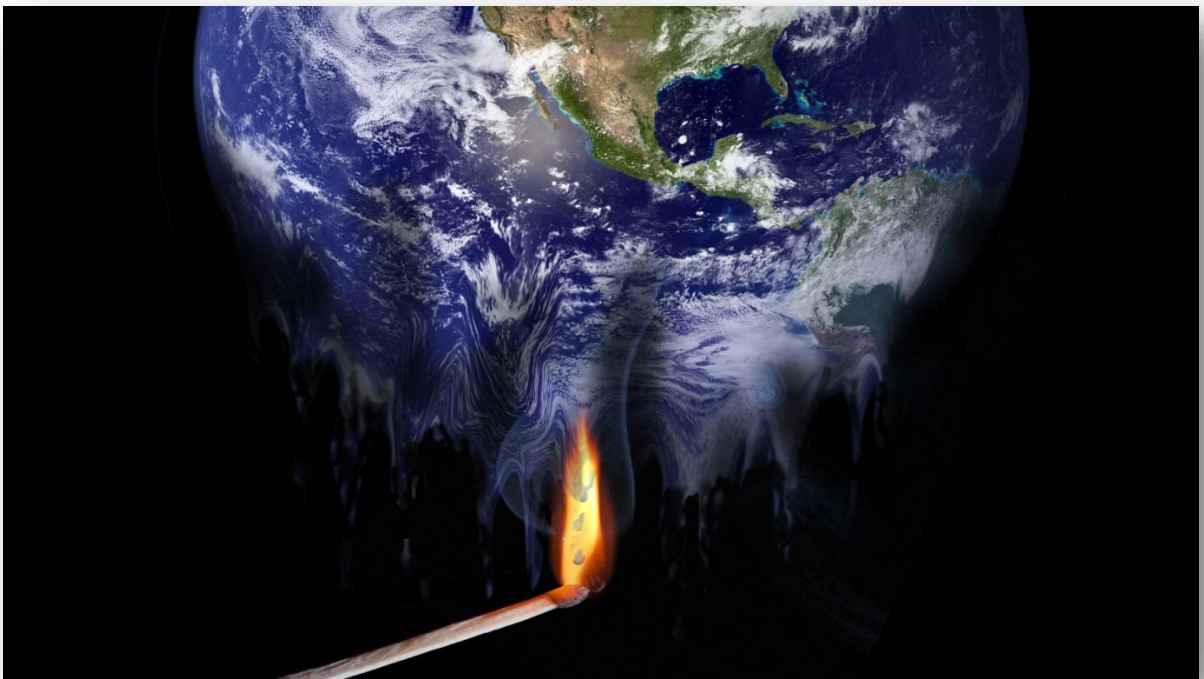
Summer is getting longer and hotter, plants are flowering when not expected, for example, in the late fall of 2021, spring plants such as forget-me-not's were flowering in October; we are receiving more precipitation which is impacting the growing seasons for many plants; and animals and plants are not behaving as we had come to expect in the past. The water in the Gulf of Maine is warming faster than anywhere else on Earth, and the lobsters are moving north to cooler waters, which is negatively impacting the fishery. Green Crabs are also moving north, into the waters of the Gulf of Maine and are considered a dangerous invasive species negatively impacting the fishery.

In addition, some other species that we have come to know in our environment will also be leaving our landscape and moving north as the climate continues to warm over the coming decades, such as the fir trees, so familiar for their use as medicinal plants, and for use as the iconic Christmas tree. We are also seeing the increase in invasive species such as the Emerald Ash Borer having impacts on plants and animals, as well as humans.

¹ Wallis, Wilson D., and Ruth Sawtell Wallis, The Micmac Indians of Eastern Canada, University of Minnesota Press, Minneapolis, 1955, 103.

We are truly living in a time of the thirteen moons when plants and animals are “behaving wrongly.” This climate change adaptation plan will discuss some of the changes that are being seen now and some options for addressing these changes. It is not all-inclusive, but instead, presents some of the most concerning issues for the Mi’kmaq Nation at this time.

Special thank you to the Bureau of Indian Affairs for their support through the Tribal Climate Resilience Program; Dr. Casey Thornbrugh, Mashpee Wampanoag Tribal Citizen, Northeast and Southeast Tribal Climate Liaison, United South and Eastern Tribes, who wrote part of this plan; Tyler Everett, B.S., M.F., Ph.D. Candidate at the University of Maine at Orono, Tribal Citizen of the Mi’kmaq Nation, Tribal Forest Adaptation Technical Assistant United South and Eastern Tribes; and an especially big thank you to Patti Cronkhite, Mi’kmaq Citizen, who provided on-going suggestions and assistance with this plan from the very beginning.



Introduction by Dena L. Winslow, Ph.D.

Climate change is real. It is naturally occurring as we know from the geological record that shows that part of the present-day area known as Aroostook County was under a warm shallow ocean 300 million years ago – complete with coral reefs and sea creatures. Not far from the Mi'kmaq Nation's Administration office was the edge of the ancient ocean and early vascular land plant fossils are found near the vicinity of the office.

Climate change is also being expedited by activities of humans on the planet. As we know carbon and other greenhouse gasses are being expelled into the atmosphere in many ways by human activities. These gasses are impacting the entire planet and speeding up the rate at which the Earth is warming. Scientists say that 2019 was the warmest year on record for the Earth, and the impacts are becoming more and more significant.

Among the major effects are global warming and melting of the polar ice caps, which are leading to rising sea levels and inundation of coastal communities around the world. Here in Maine, the Gulf of Maine is warming at unprecedented rates and is one of the fastest warming bodies of water in the world. This is having impacts on the marine fisheries and species inhabiting the Gulf of Maine region. The lobster fishery in particular is being impacted as the lobsters move north to colder water, for example. The warmer temperatures are also allowing invasive species to also move north, including the Green Crab, which is having a devastating impact on the shellfish fishery in Maine and New England.

We recognize that there are two ways of seeing the world – one is the traditional knowledge that Tribes have known about the world and their environment since the beginning of existence, another is the knowledge that professional scientists have developed from working on identifying issues of climate change. This is sometimes referred to as “two-eyed seeing” which refers to looking at these issues from both the traditional knowledge viewpoint and the traditional scientific viewpoint. Traditional knowledges are also science. These two are not separate things. Whereas traditional science sees the parts that make up the whole, Indigenous science sees the whole that organizes the parts, with a belief that everything is related. This “two-eyed seeing” informs the Mi'kmaq Nation Climate Change Adaptation Plan.

The Mi'kmaq Nation is the most northeasterly Federally recognized Tribe in the United States with a service area of all of Aroostook County in northern Maine. Aroostook County is the second largest county in the United States with a land area of 6,672 square miles – making it larger than the states of Connecticut and Rhode Island combined. Three and a half million acres of Aroostook County are forested with most of that area actively managed for the timber resources. The County is a natural resources rich area with significant impacts on the economy of the region from the natural resources. For example, with the winter snows the region receives, there are tourism activities that bring economic

benefits to the region such as snowmobiling and skiing. The amounts of winter snow and the economy of the region as well as other activities such as farming and forestry that are occurring here are all being impacted by climate change.

Why is climate adaptation important to the Mi'kmaq Nation? By Dena L. Winslow, Ph.D.

The world is changing, as it always does, both through natural occurrence and through human intervention. With this plan, the Mi'kmaq Nation is looking at what is going to change, how, and what the Tribe will do to adapt to the coming changes. For example, do we want to attempt to maintain Balsam Fir trees on Tribal lands, or will the Tribe accept that Balsam Fir trees are moving north as they adapt to the warming climate of northern Maine and will disappear from the region in time? What other species of trees can fill the void created when Balsam Fir trees no longer exist on the landscape? This plan addresses these kinds of decisions the Tribe is making with reference to Tribally significant species in the environment as they currently exist, and may exist in the future.

An example is the Emerald Ash Borer which is killing the Black Ash trees (also known as “Brown Ash”) (and the other species of Ash that exist in our landscape) from which the iconic split-Ash baskets are currently made. Since basket making is a significant cultural and economic activity of the Mi'kmaq Nation, the question of attempting to preserve the Black Ash trees at all costs – with such means as insecticides, and the parasitoid wasp *Spathius galinae*, (one of several species of wasps that have the potential to prey on the Ash Borer larvae) which can be used as a natural means of reducing the Ash Borer in the Black Ash trees, must be determined. At this time, the Emerald Ash Borer has arrived in Maine and is currently threatening Tribal Ash stands that exist on Tribal property (although it has not yet been found on Micmac Tribal lands as of December 2021 – which does not mean it isn't there yet, it just means it hasn't been found yet).

Options for the Tribe will be to use any and all means to preserve the Black Ash trees – no matter what would be involved in this effort, or how high the costs might be; or there may be a desire to adapt to the invasive species' destruction of this tree species and select a different species of tree to make baskets from. Or, the Tribal practice of making split-Ash baskets may need to change to some other similar cultural practice, such as making birch bark baskets once again. There are other species of trees which could be used in place of Black Ash for basket making, although they are not the preferred species for making baskets and lack the quality of wood for basket making found in the Black Ash. The Micmac may also decide to maintain the hydrology of the current Black Ash localities in wetlands by planting other species that can maintain the current hydrology until such time as the Black Ash can be re-introduced to the area, as some Tribes around the Great Lakes are currently doing.



Emerald Ash Borer

“It is the intention of the Aroostook Band of Micmacs to consider climate change adaptation in all of the planning work that is done because the impacts of climate change are far reaching and affect everything in both positive and negative ways. By specifically thinking about climate change now, we are aware that we will be planning for the future resiliency of the Tribe now, but also in the future for our children and grandchildren.”
(Aroostook Band of Micmacs Strategic Plan 2018 – 2023, Update for 2021, adopted by the Tribal Council on March 17, 2021).

Benefits of having a Climate Change Adaptation Plan:

Having a formal climate change adaptation plan will allow for the following benefits:

- It will bring awareness of the issues;
- It will allow for monitoring and reporting on progress to address the identified issues;
- It will allow for adjustments and revisions based upon new information as it becomes available;
- It will allow for the sharing of successes;
- It will inform other Tribal plans, such as the Strategic Plan, and the Forest Management Plan; as well as the Emergency Management Plan and others;
- It will allow us to work toward adaptation and protection of places and species that are held sacred by the Micmac community;
- It will allow the Tribe to be proactive rather than just reactive;
- It will highlight the issue of traditional foods that can be/are impacted by climate change such as Brook Trout, and Moose, and Lobster;

- It will allow the department directors to better communicate with each other about these issues;
- It will allow for education of the Tribal members and Tribal staff as new climate research brings more current information to light;
- It will keep the Tribal leadership abreast of what is happening and what threats and opportunities are being created through climate change;
- It will allow for sharing of data and information with other Tribes and other organizations in our region of Maine;
- Finally, it will allow for securing funding to support and implement important projects, including vulnerability assessments.

This plan is intended to be adaptable to changing information, new species, and new issues of concern over time.

Climate and Changing Seasons by Casey C. Thornbrugh (Ph.D. *Mashpøø Wampanoag Tribal Citizen*, NE & SE Tribal Climate Science Liaison, United South and Eastern Tribes, Inc.)

The climate in the region of the Mi'kmaq Nation in northern Maine and New Brunswick is characterized by four seasons with abundant precipitation, warm summers, and long-cold winters. This climate supports key animal species adapted to long snowy winters such as the Snowshoe Hare and the Canada Lynx; and northern forests that provide habitat for animals such as moose, bears, and deer. Trees that thrive in this climate include Brown Ash, Maple, Fir, Spruce, and Northern White Cedar. All of these plants and animals are also of cultural importance to the Tribe.

Presque Isle Maine's average annual temperature is about 41 degrees Fahrenheit (fig. 1 below). This translates to summer days frequently in the mid-to-upper 70s and winter nights in the single digits, and often below zero. There is variation from year-to-year (some years warmer or colder than average or wetter or drier than average). However, Maine's climate has a warming trend of about 3 degrees Fahrenheit (F) since the late 1800s (fig.2 below; Fernandez et al. 2015). The average annual precipitation has increased by 6 inches over the same time period (fig. 3 below). These observed trends in increasing temperature and precipitation over the past 100 years are affecting Maine's climate and seasons. For example, Maine's snow season has shortened by about 2 weeks over the past century (Fernandez et al., 2015).

Month	Total Precipitation Normal (inches)	Mean Max Temperature Normal (°F)	Mean Min Temperature Normal (°F)	Mean Avg Temperature Normal (°F)
January	2.33	21.6	2.1	11.9
February	1.71	26.1	5.7	15.9
March	2.12	35.9	16.0	25.9
April	2.50	50.2	29.8	40.0
May	3.35	65.1	40.7	52.9
June	3.38	74.0	50.1	62.0
July	3.74	77.9	55.5	66.7
August	3.70	76.6	53.9	65.2
September	3.38	67.8	45.9	56.9
October	3.79	54.2	35.7	44.9
November	3.21	39.6	25.7	32.7
December	2.59	27.8	11.5	19.6
Annual	35.80	51.4	31.1	41.2

Figure 1. Monthly Average Precipitation and High (Max) and Low (Min) Temperatures for Presque Isle, ME for the time period of 1981-2010. The data are from the NOAA Online Weather Data (NOWData): <http://www.nrcc.cornell.edu/wxstation/nowdata.html>

There are other observed changes in the seasons, with earlier springs and an earlier arrival of snow in the fall. The earlier arrival of spring is impacting the maple sugar industry with sap running earlier, and with the species moving north out of the region toward colder climates. Earlier snowfall in the fall means increasing costs for snow removal, increased costs for plowing, and increased costs for road salt and sand. When snow does fall it can be particularly heavy. Winters with heavy snowpack, but with an early and rapid snowmelt can lead to flooding events, and the potential for major flooding in the spring.

Lastly, we must consider future climate change projections. Future climate change projections are based on how much greenhouse gas will be emitted into the atmosphere from human activities across the globe (energy from burning coal, oil, and natural gas). For example, if global greenhouse gas emissions continue at current rates the average annual temperature in northern Maine could increase another 2-3 degrees by the year 2050, and could increase more by the year 2100.

Maine's Average Annual Temperature

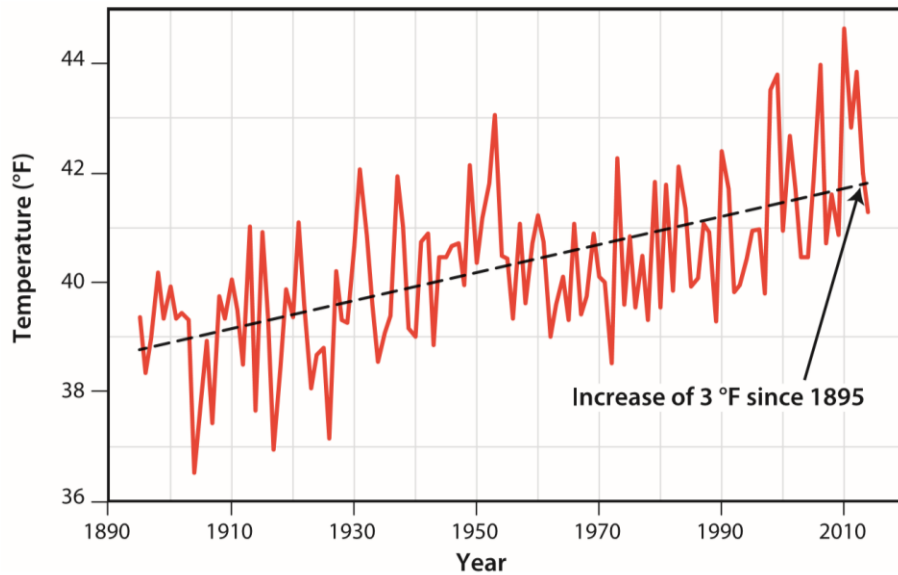


Figure 2. Maine's annual temperature, 1895–2014, based on monthly weather station records across the state. The chart is from Fernandez et al. (2015) "Maine's Climate Future."

Maine's Total Annual Precipitation

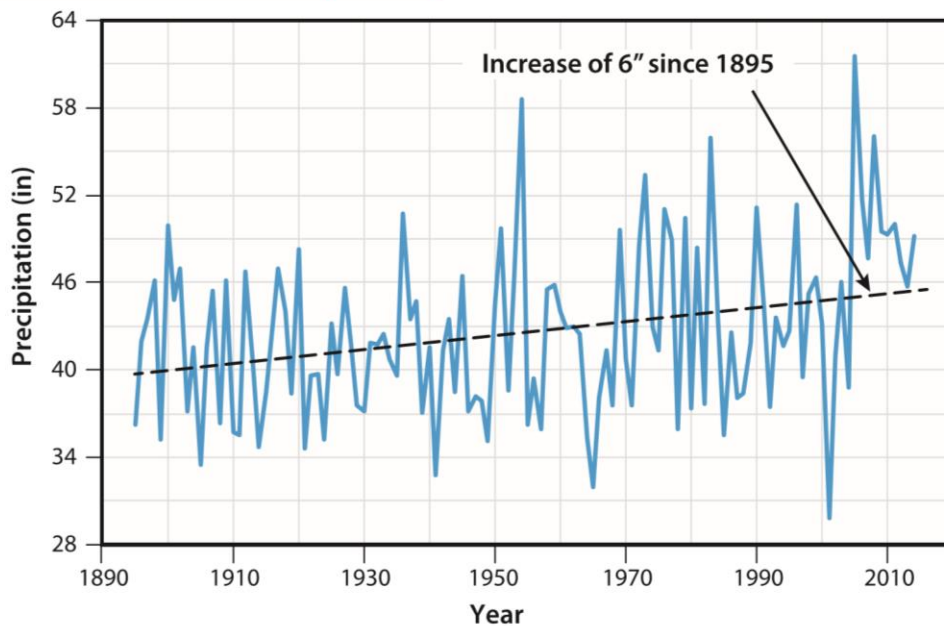


Figure 3. Maine's annual precipitation, 1895–2014, based on monthly weather station records across the state. The chart is from Fernandez et al. (2015) "Maine's Climate Future."

Priority Issues that have been identified to date affecting the Mi'kmaq Nation - and potential adaptation methods by Dena L. Winslow, Ph.D.:

Brook Trout

The brooks and streams in Aroostook County are drying up in the summer due to warming temperatures resulting from climate change, and the water temperature is warming – all causing loss of habitat for Brook Trout. In addition, mercury and other contaminants are causing the fish to be potentially dangerous when too many are consumed. Potential adaptation would be to eat a different species of wild-caught fish which is not endangered from the warming water temperatures and one that does not have the contamination issues (if any species can be found that does not have contaminants). However, the Tribe is currently adapting through the indoor fish farm where healthy Brook Trout are being raised for consumption and for pond stocking.

Invasive Species

There are invasive species which are impacting wildlife and humans, as well as plant and avian species. Some of these species carry potentially deadly vector borne diseases (*diseases from infections transmitted to humans and other animals by blood-feeding arthropods such as mosquitoes, ticks, and fleas*). For example, the Emerald Ash Borer is believed to have come to North America from China on wooden shipping pallets. Deer ticks are moving north into Aroostook County and carrying Lyme disease, which is impacting the moose and deer herd as well as humans (with advisories not to eat deer from certain areas of the State in the fall of 2021). Species of potentially disease carrying mosquitoes and ticks are crucial for the Mi'kmaq Nation Tribal members to be aware of due to the community often being outside for various cultural and other activities. Thus, people are potentially exposed to vector borne diseases – many of which are able to survive in the climate of Aroostook County when they were unable to do so before due to the warming temperatures.

Mosquitoes

They may be small, but they are definitely deadly! Mosquitoes are the deadliest creatures on Earth, and are responsible for the deaths of approximately 725,000 people per year. This number does not reflect those who become ill but do not die; and it does not reflect the large number of other mammals killed by this parasite. Making the news within the last ten years, the Zika virus has been



Estimated range of an exotic mosquito, *Aedes albopictus*, in relation to Tribal lands in the eastern United States.

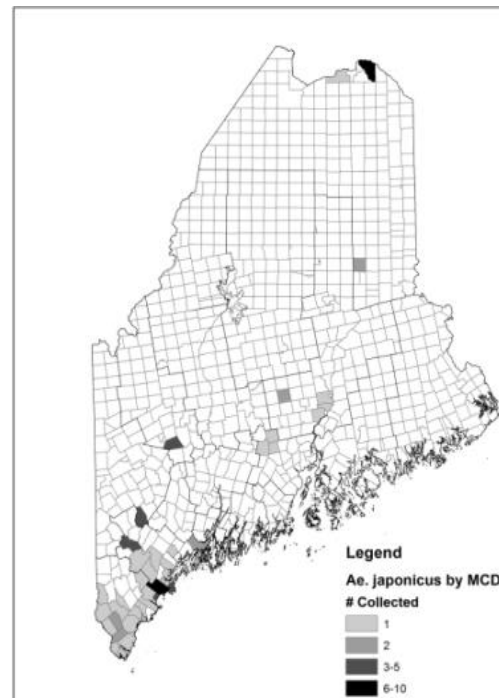
introduced to the Americas and brought renewed attention to the threats from this disease-carrying insect.

There are over 3,500 species of mosquitoes found throughout the world. Some mosquitoes that bite humans routinely act as vectors (*vectors are living organisms that can transmit infectious diseases between humans or between animals and humans*) for a number of infectious diseases affecting millions of people per year. Others that do not routinely bite humans, but are the vectors for animal diseases, may become disastrous agents for zoonosis (*infectious diseases caused by bacteria, viruses and parasites that spread between animals (usually vertebrates) and humans*) of new diseases when their habitats are disturbed, for instance by sudden deforestation, for example from forest fires and timber harvesting operations.

Although many of the mosquitoes found in Maine are native, there is evidence that exotic invasive mosquitoes have now reached Maine and are extending into northern areas of the state. While studies are being conducted looking for the presence of *Aedes aegypti* and *Ae albopictus*, the vectors of Zika virus in southern Maine; another exotic mosquito, *Aedes japonicus*, also known as the Asian bush mosquito, is known to be present in northern Maine. Originating in temperate forests of Asia, this exotic mosquito has readily adapted to the climate of the northern United States - expanding its range as far north as Canada, south to Alabama, west to Minnesota, and into the Pacific Northwest.

Documentation of the spread of this mosquito is primarily due to expanded mosquito surveillance in the United States following the introduction of West Nile virus in 1999. First detected in southern Maine in 2001 in Cumberland County, with further collections in successive years in Androscoggin, Cumberland, Kennebec, Lincoln, and Penobscot Counties, *Ae. japonicus* was found several years ago in Aroostook County, Maine in the Fort Kent/Madawaska region. Recent surveillance efforts in Maine have produced new records of this mosquito's presence in the state. Because many of these exotic mosquitoes are transported across great distances by containers holding water (tires, barrels, cars, etc.), they may be imported into new regions like northern Maine on a regular basis.

West Nile virus (WNV), Jamestown Canyon virus (JCV) and Eastern Equine Encephalitis Virus (EEEV) are mosquito-borne viruses that cause disease in domestic livestock, wildlife, and humans in New England. While birds are the primary reservoirs for the viruses, the disease is transmitted through the bite of infected mosquitoes. *Ae. japonicus* has been found to be a competent laboratory vector of several North American arboviruses, including EEEV and WNV, making its monitoring a priority for health departments in the United States. Evidence of both WNV and EEEV activity in wildlife in Maine was first documented in 2001.²



Distribution of invasive *Aedes japonicus*, collected by townships (minor civil divisions) in Maine, 2000-2015. (Lubelczk, Charles, Maine Medical Center Research Lab.)

² Winslow, Dena, and Lubelczk, Charles, grant application for the Aroostook Band of Micmacs, 2017.



Aedes japonicus

Surveillance for *Ae japonicus* has shown that the distribution of the mosquito in Maine is broader than originally expected (see map). The first occurrence of the mosquito in the state occurred three years after its introduction to the United States, indicating a rapid expansion northward. The subsequent collections suggesting a wide distribution seem to indicate that the mosquito is spreading further northward, however this may be an artifact of enhanced mosquito surveillance.

Recently, *Ae japonicus* was identified in Newfoundland and Labrador, Canada, supporting both northern and eastern expansion of the range of the mosquito. Collections of *Ae japonicus* suggest that the potential risk for both Eastern Equine Encephalitis and West Nile virus transmission may be greater than previously anticipated and speaks to the need for monitoring of importation of exotic species into native systems.

In 2009, cases of EEEV occurred in several counties in southern and central Maine from July to October. Sixteen livestock deaths (15 horses, 1 llama) were due to infection with EEEV. Substantial mortality also occurred in three pheasant flocks that were subsequently confirmed positive for the virus. Finally, a wild turkey that was captured in January 2010 and translocated within the state was seropositive for EEEV. No human cases were reported during this period. Maine's first human case of locally acquired WNV occurred in 2012 in Cumberland County, and Maine's first case of locally acquired EEEV occurred in 2014 in York County. Although rare, subsequent cases of both WNV and EEEV were reported 2015-2021. These cases renewed interest in vector-borne disease transmission and helped guide mosquito surveillance in Maine.

As a result, pilot studies began using wildlife as surveillance tools for the disease. Serosurveys (blood serum testing) of white-tailed deer harvested in southern and central Maine revealed infection prevalence of 7.1% (16 out of 226) while an expansion of surveillance included moose samples from three northern Maine counties (Aroostook Piscataquis, and Somerset) with infection rates in this species recorded at 11% (16 out of 145). Since that time, two human cases of EEE have

been reported in Maine, one a fatality in 2015. Two human cases of Jamestown Canyon virus were reported in Maine in 2017.

While WNV and EEEV impacts white-tailed deer and domestic livestock, it is currently unknown if the virus impairs moose the way it does livestock. Given the concern over moose health and related mortality, an examination of the virus' potential role in wildlife health issues and distribution is warranted. Jamestown Canyon virus is tied to populations of cervids (members of the deer and moose family), which act as the reservoir for the virus. Both deer and moose have been associated with this virus.

Sampling of free-ranging birds provides additional information that benefits surveillance programs. For example, a serosurvey of the local resident bird population (in particular, juvenile birds) following the arbovirus transmission season may help determine which local species may be important amplifiers of EEEV and WNV. This in turn could be used to map areas of greatest risk. The North American strain of WNV causes mortality in a number of the birds it infects, particularly among the corvids (including crows, ravens, magpies and jays). For this reason, the CDC guidelines for WNV surveillance recommend incorporating corvid sampling when possible. Because *Ae japonicus* invasive mosquitoes are aggressive mammal-biters and may spread WNV/EEEV, they are a growing public health concern in northern Maine. Micmac lands, including habitats with forested wetlands, and mosquito habitat near residences, will be considered active mosquito management areas to limit their potential numbers.

Adaptation Strategies:

- Education is key. People need to know how to protect themselves from mosquito bites, and know how to remove standing water and other places where mosquitoes can breed.
- Any wild game harvested should be thoroughly cooked to be sure all potential viruses are killed.
- Similarly, when field dressing wild game, rubber gloves should be worn to avoid exposure to potential viruses in the blood. It is also not a good idea to consume raw animal parts, such as moose liver due to the potential presence of the virus and bacteria; as well as high cadmium levels in the moose; and the potential for liver flukes and other diseases which may be present.
- Monitor the mosquito populations and species.

Ticks



Engorged female Moose Tick (or “Winter Tick”) on left with male on the right

Another invasive insect is the tick, which is impacting both human and animal populations. A good example of that is the Moose, or Winter Tick, impacting the moose herds in Maine. The state of Maine boasts more moose (a member of the deer family) than in the rest of the 48 contiguous U.S. states combined, and Aroostook County in northern Maine is home to the largest numbers in the state. This iconic animal is an important driver of tourism in the state, and is the official State Animal of Maine, even represented on the State flag.

But, Maine’s moose, like those located elsewhere, are endangered by a tiny arachnid known as the “Winter Tick” or “Moose Tick.” The parasite infests the animal in very large numbers, reported to be as high as 120,000 ticks per animal. These blood-suckers lodge in the animal’s fur in the fall and hold on throughout the winter, feeding off the animal’s blood. They leave the animal weak from loss of blood that results in anemia, hair loss, and death. Climate change has allowed the parasite to survive in such large numbers due to the warmer winters in the northeast. In the past, Moose Ticks would have survived the colder winter in far lower numbers than they do now.

For the Mi’kmaq Nation, moose are a very significant animal. Also significant is being good stewards to the eco-system. Even when engaged in hunting, Micmacs show respect for the animal who is sacrificing its life for them, and they harvest the animal as humanely as possible so that the animal doesn’t suffer needlessly. There is also a belief that whatever is done now needs to be in the best interests of the Tribal members for the next seven generations.

Moose or Winter Ticks are causing the death of approximately 60% of the moose herd annually. Until very recently, it was believed that Moose or Winter Ticks, did not carry any disease vectors. But in 2021, researchers in Washington State have found potential vector borne diseases that can be fatal to humans in Moose Ticks. In addition, the ticks can cause death of the moose due to blood loss; starvation due to spending too much time grooming and not enough time eating; as well as from other diseases when the animal is weakened from tick infestations. Moose Ticks can infest other species, such as horses and cattle, and they will bite humans as well, although their preferred hosts are moose.



"Ghost Moose" with Winter Tick infestation

A survey in the Province of Quebec, which abuts Aroostook County in northern Maine, showed that 93 percent of the moose surveyed south of the St. Lawrence River are infested with Moose Ticks. In nearby New Hampshire, the moose population has declined by half over the past 15 years. According to Kristine Rines, a New Hampshire Wildlife Biologist, "...winter ticks are really the major mortality source that we have for moose.... The populations continue to decline."

In a recent U.S. Department of the Interior blog posting listing the 9 animals being impacted by climate change, moose is the first animal listed. They state, "...this list is just the tip of the iceberg of what we can expect to see in years to come. Future generations shouldn't just see these animals in history books – we owe it to them to protect these creatures and their habitats."

At the present time, monitoring of moose for ticks and other diseases, such as brain worm, are being continued by the Maine Department of Inland Fisheries and Wildlife. Adaptation strategies being considered in some other states include the potential increase in moose hunting for the specific purpose of the intentional decline of the remaining moose heard with the hope that moose ticks will disappear when their preferred host animal, moose, are no longer on the landscape. Then, eventually, moose could be returned to the ecosystems with the hope that the ticks would no longer be a problem for them. Beyond monitoring, and potentially removing the species from a landscape, and choosing other species of animals to hunt instead of moose, there are no other known adaptations strategies.

Deer Ticks

Another tick which is causing a lot of disease in humans is the deer tick.



Deer Tick



Deer tick biting a human. The bite can cause Lyme disease and other infectious diseases which can be deadly.

Deer ticks are a known carrier of Lyme disease which can affect humans and animals. The tick and the disease are spreading north to Aroostook County and both humans and moose, as well as dogs and cats, and other mammals, are currently being impacted. In the fall of 2021, there were advisories in parts of Maine regarding not consuming deer meat from deer that may have Lyme disease.

There are other tick-borne diseases currently coming to Maine, including Powassan – which Tribal members need to be aware of. Ticks will become an increasingly important invasive species impacting humans and animals in the future as the climate of Aroostook County continues to warm and allows for their survival in greater numbers.

Adaptation strategies include providing education for Tribal members that will include areas where ticks are likely to be found; ways to avoid tick bites; diseases that they carry; and how to deal with a tick bite on a human or animal.

Invasive species impacting the forests in addition to Emerald Ash Borer

There are also other non-native invasive species impacting the forests in addition to the Emerald Ash Borer. These include but are not limited to Woolly Adelgid, and Beech Scale.



Woolly Adelgid eggs

Woolly Adelgid

The Woolly Adelgid originated in eastern Asia and is a threat to Eastern Hemlock and Carolina Hemlock. It feeds on the sap base of the host tree's needles and disrupts the flow of nutrients, slows the growth of the tree and causes the tree's needles to discolor and eventually fall off. As of 2015, 90% of the range of Eastern Hemlock has been impacted.

Adaptation will include education and awareness for Tribal members. Harvesting of impacted trees as soon as the infection is known is another potential adaptation strategy.

Beech Scale

Beech trees have many important uses for humans and animals alike. Beech trees have been used in the past for medicinal purposes – however, caution should be used as large doses of nuts may be poisonous to humans and animals alike. The bark has been steeped in salt water to produce a poison ivy lotion; Beech sap was one important ingredient of a syrup compounded to treat tuberculosis; decoctions of either the leaves or bark served as an ointment for burns and sores, and ulcers. Internally, it was used as a treatment for bladder, kidney and liver ailments. The leaves and roots were used to cure fevers and diabetes. Oil from the nut was used to treat intestinal worms. The bark and leaves have astringent and antiseptic properties that account for the plant's medicinal effects. The wood is used for flooring, furniture, crates, and handles for tools. The wood is also used as a high-end product by wood turners for bowls, and wood workers for many specialty products.

Beechnuts are an incredibly important nutrient-dense food source for black bears as well as for white-tailed deer, wild turkey, ruffed grouse, wood ducks, woodpeckers, and more than a dozen other mammals and birds. They have about twice as much protein and calories per edible portion as compared to acorns.

The tree is currently being negatively impacted by Beech Bark Disease which was first discovered in Maine in 1932 and is a non-native invasive species. The Beech Scale, originally from Europe, which infests the tree and will damage it in three to five years, will be followed by a fungal infection which ultimately can kill or weaken the tree.

The warmer winters that we currently have in Aroostook County are allowing the insect to survive and continue to damage the trees. Very cold winters are known to kill the insect. They are also susceptible to other species who feed on them, however, not enough to destroy their populations.



Beech Bark Nymph



Beech Tree showing damage from the Beech Scale

As with the other invasive forest pests, education of the Micmac community will be the first line of adaptation. Knowing what to look for when they are in the forest will be the first step in addressing the issues. Selectively harvesting impacted trees to destroy the insects will also be a potential adaptation strategy.

Asian Longhorned Beetle

Asian Longhorned Beetles originated in China, Korea, and Japan. They were found in this country in 1996. The beetle threatens hardwood species and although it has not yet been found in Aroostook County, it has been found in Massachusetts and is heading north. There is currently no known defense.



Asian Longhorned Beetle



Asian Longhorn Beetle

Invasive Plants

Purple Loosestrife is an example of an invasive plant in Aroostook County. It is a pretty plant commonly seen on roadsides in Maine and is a native of Eurasia first found in North America in 1814. They invade wetlands and choke out other plants causing less diversity. The best adaptation plan is to eradicate them through removing any plants roots and all. There is also a tiny *Galerucella puscilla* beetle being used to defoliate the plant which will weaken them and ultimately kill the plants. Another approach for adapting to the plant is to leave it in place because it is a pollinator species for bees and other insects.



Galerucella puscilla can be used to kill the purple loosestrife



Purple Loosestrife

Garlic Mustard



Garlic Mustard

Garlic Mustard is a highly invasive Class A noxious weed that originated in Europe and was brought to North America as a potential food source. The plant is edible by humans but is not a food source for animals or other wildlife. Once established, it out-competes other plants and is extremely difficult to control. In addition to out-competing other plant species, Garlic Mustard also emits a chemical that actually inhibits the growth of other plant species. It threatens to overtake native species both in forest lands and farmlands, and even on lawns. Extremely tough to eradicate, one form of adaptation would be harvesting and eating the weed.

Threats to Tribal Forest Resources – by Tyler D. Everett (BS, MF, Ph.D. Student, *Tribal Citizen of the Mi'kmaq Nation*, Tribal Forest Adaptation Technical Assistant United South and Eastern Tribes, Inc.)

The threats to tribal forest resources does not end with invasive forest pests. The threats expand into invasive vegetation. The principal understanding of an invasive plant is that they're invasive in nature, meaning that they often overtake and out compete our native vegetation. These plants evolved in drastically different ecosystems, often on different continents, where they have natural enemies hindering their ability to dominate the forest landscape. Once transported here those natural enemies are gone and it takes time and sometimes human intervention to serve in the place of or establish natural enemies for those plants here in our native ecosystems.

Tribal forest management often works to promote forest products of high commercial value (e.g. White Pine; *Pinus strobus*) or high cultural value (Paper Birch; *Betula papyrifera*). They have other goals and objectives as well that looked to improve wildlife habitat and or overall forest health. Whatever the goal may be, their ability to achieve it is significantly impacted by the presence of invasive vegetation

due to its hindrance of forest regeneration. This challenge is in some cases more significant for forest managers to overcome than even herbivory of regeneration by wildlife such as Moose (*Alces alces*), and deer (*Odocoileus virginianus*).

Invasive vegetation often occurs in recently disturbed areas, along road sides, and in heavily recreated areas. They often produce an overabundance of seed giving them a reproductive advantage over native vegetation. Their root systems are also unmatched by any natural enemies and often have very wide spreading and robust root systems for that reason. These root systems can crowd out and kill native vegetation and inhibit the recolonization of those native species.

These competitive advantages and others lead to a spread of the invasive species often creating a dense layer across the forest floor (herbaceous plants) or throughout the understory (shrubs, trees, and vines) (USFS, 2019). It's at this stage that most people note the presence of the invasive species and it is also at this stage that management can be costly and difficult. To avoid this, it is key to identify invasive vegetation before it is a significant issue.

Below is a table displaying many of the invasive species of concern to forest managers in the state of Maine. Each species has been identified to be either very invasive or severely invasive by the Maine Natural Areas Program.

Common Name	Invasive rating	Habitat
Japanese Barberry	Severely Invasive	Most robust in full sun but will readily germinate, grow, and produce fruit in full shade. Found in forests, forest edges, old fields, as well as disturbed habitats. Tolerates damp soils.
European Barberry	Severely Invasive	Forests, woodlands, shrub thickets, old fields, coastal grasslands, and fencerows. Prefers full sun to partial shade.
Asiatic Bittersweet	Severely Invasive	Forests, forest edges, woodlands, old fields, beaches, and dunes. Moderately shade-tolerant; more productive in sun. Tolerates dry to moist soils.
Common Buckthorn	Severely Invasive	Forests, forest edges, old fields, open areas. Shade-tolerant; will germinate, grow and reproduce under a full canopy. Tolerant to moist to well drained soils.
Glossy Buckthorn	Severely Invasive	Forests, forest edges, many types of wetlands. Moderately shade-tolerant; more productive in sun. Tolerates a wide range of soil conditions.
Shrubby Honey Suckles	Severely Invasive	Reaches largest size and fruiting capacity in full sun but is highly shade-tolerant and capable of invading intact forest understory. Grows in forests, forest edges, old fields, and roadsides. Tolerant to dry to wet, nutrient-poor soils.
Giant Knotweed	Severely Invasive	Disturbed sites, roadsides, agricultural areas, stream banks, floodplains, and logging roads and landings. Shade intolerant.
Japanese Knotweed	Severely Invasive	Open uplands, riverbanks, lakeshores, forest edges, disturbed areas within forests. Extremely adaptable, tolerant, of dry to seasonally saturated soils. Especially problematic along large rivers where spring flooding transports live rhizomes downstream.

Autumn Olive	Very Invasive	Commonly found in old fields, road sides, forest edges, and fragmented forests. Not tolerant of wet soils. Prefers full sunlight but can grow in partial and full shade. Autumn Olive is a nitrogen fixing plant and therefore can grow in very low nutrient soils.
Common Reed (Phragmites)	Severely Invasive	Open wetlands and wet ditches. Damaging in freshwater and saltwater marshes. Frequently found in roadside ditches and swales.
Multi-flora Rose	Very Invasive	Reaches largest size and fruiting capacity in full sun but is somewhat shade-tolerant. Found in forest edges, old fields, as well as disturbed sites. Can occur in forest interior after disturbances such as timber harvest. Tolerant of dry to moist soils.

The above table identifies invasive species that are of concern for tribal forest resources. Monitoring for the presence of these invasive plant species is a priority. Once identified continual monitoring should occur until some threshold set by the Tribe is seemingly achieved which would bring about the need to manage the invasive plant pest.

The Northern Institute of Applied Climate Science or NIACS gives this type of management two overall adaptive strategies and their respective approaches. One being the adaptive strategy of “reducing the impact of biological stressors” through the approach of preventing “the introduction and establishment of invasive plant species and removing existing invasive species.” The other adaptive strategy being the work of maintaining and enhancing “species and structural diversity” through the approach of maintaining and restoring the “diversity of native species” (NIACS,2018; Swanston et al, 2016). Both of these strategies work to manage the climate change impact of invasive species.

Below are some general guidelines for invasive plant management, as outline by the Maine Natural Areas Program (MNAP), this broad guideline corresponds to the afore-mentioned adaptive strategies and approaches. The guidelines are not true management objectives as that recommendation is to be given by Tribal forest resource managers.

General Invasive Species Adaptation Guidelines:

In general utilizing an integrated pest management (IPM) approach to address invasive plant species has been seen to be effective. MNAP identifies 5 key steps in successfully applying an IPM approach.

- **Step one** is identifying your invasive plant species. For this reason, it is Important to familiarize all natural resource staff with the concerning invasive plant species mentioned above. Staff should be aware of the plants and if possible, become familiar with the biology of these plants, how they grow, their impact to the forest, and how they reproduce. This information is often vital to understanding the management actions necessary for managing that plant.
- **Step two** is establishing a threshold to determine when to begin treating that invasive plant species. This should be considered by the Tribal forest resource managers and could vary from species to species.

- **Step three** is to monitor the invasive species abundance before and following treatment. Monitoring before allows you to determine when to take action whereas monitoring after allows you to track the progress of management and determine if additional action is required.
- **Step four** is selecting an appropriate control strategy. This is determined on a case by case basis based upon the severity of the invasive plants' threat, abundance, associated cost for treatment, and cultural considerations. Forest resource staff will assess this and provide a recommendation for management of that invasive species. These may include but not be limited to one or a combination of some of the following a "cultural treatment (tilling a field, allowing animals to graze, burning etc.), a mechanical treatment (mowing cutting, or pulling), biological (release of native enemies note: Often requires State and/or Federal permits), or chemical (herbicides). And lastly;
- **Step five** continual monitoring and evaluation of your management to inform future decision making the next year (MNAP, 2019).

Invasive Vegetation of Public Health Concern:

As with many other climate change impacts there are considerations that must go beyond our natural resource management and into the field of public health. Certain invasive species present here in the state of Maine are of significant public health concerns. The Maine Department of Agriculture, Conservation and Forestry have identified two invasive plant species that pose serious public health concern.



Giant Hogweed

- ❖ **Giant Hogweed:** Is an invasive plant species from Eurasia. It is a member of the carrot family and can stand anywhere from 8 feet to 15 feet tall. This plant has enormous leaves that can be 5 inches wide and are found alternating around the main stem of the

plant. The main stem is ridged and hollow. It is covered in bristles and is green in color with purple blotches. This plant is somewhat shade tolerant, hardy and difficult to eradicate due to its 2-foot long tap root that can re-sprout a new individual if not completely pulled out.



Extreme caution should be taken when in the area of this plant as the sap can cause extreme dermatitis or blistering. The sap, once on your skin, reacts when exposed to sunlight causing irritation and eventual blistering of the skin. If the sap enters an individual's eye it can cause serious damage and possible blindness. Proper safety gear should be worn when working with giant hogweed.



Wild Parsnip

- ❖ **Wild Parsnip:** Is an invasive plant species from Eurasia it is also from the carrot family. This entire plant is smooth and hairless. Leaves are long (16-inches) and wide (6-inches) pinnately compound. Each leaflet is variably lobed with coarsely serrate leaf margins. Flowers occur in 8-inch wide umbels and are yellow in color. This plant is shade intolerant and persists well due to its over abundant seed production. These small dry seeds are easily transported in surface water, mulch, hay, and straw and are small

enough to cling to vehicles, mowers and other equipment along transportation corridors. Much like giant hogweed wild parsnip also has sap that can cause extreme dermatitis or blistering. The sap, once on your skin, reacts when exposed to sunlight causing irritation and eventual blistering of the skin. This plant is often consumed by livestock and has been seen to reduce weight gain and fertility. Proper safety gear should be worn when working with this plant and serious monitoring should be done in agricultural settings.

Information Source: MIPFG-2019, Maine Natural Areas Program, *Maine Invasive Plants Field Guide*.

Health impacts of climate change by Dena L. Winslow, Ph.D.

There are a number of health impacts of climate change, including more extreme weather events; reduced air quality resulting from rising temperatures and increasing wildfires which leads to more smog; and increases in plant allergens including from new invasive species. These risks can include increased episodes of asthma; chronic lung disease; heart disease and death; and spreading diseases from mosquitoes and ticks – which can lead to serious illnesses and even death such as Lyme disease and West Nile Virus.

Rising temperatures can mean more frequent heat waves that last longer. The health risks associated with rising temperatures include dehydration, heat stroke, worsening heart and lung diseases, and death.

Increasing extreme weather events include more hurricanes, severe storms, flooding, droughts, and wildfires, which are increasing in intensity, frequency, and length. Health risks include water and food-related illnesses, respiratory illnesses, injuries, mental health problems, and death.

Expanding water-related illnesses result from increasing water and air temperatures; heavy rainfall; flooding; and rising water levels. Health risks include diarrhea; skin and eye infections; and in Aroostook County, run off from extreme rainfall events can cause pesticides and other chemicals to be washed into the rivers and streams where they can be ingested by fish, and ultimately expose humans and animals to these contaminants along with all of their impacts when the fish are consumed.

Decreasing food security results from warming temperatures and extreme weather which allow for food contamination, spoilage, and disrupted food supply distribution. The health risks include food poisoning, diarrhea, and reduced access to food. There is also some evidence to indicate that plants are losing nutrients due to climate change.

Mental health is also impacted in humans as a result of mood and anxiety disorders; increases in strong emotions and stress; a loss of connection to homelands and social networks. Health risks include depression, anxiety, stress, fear, and post-traumatic stress syndrome.

Education is the key adaptation strategy to address the health impacts of climate change. In addition, the Tribe is providing warming and cooling centers during times of extreme cold and heat; as well as being prepared with an emergency management plan to address severe climate events that may impact the Tribe.

Domesticated Animals by Dena L. Winslow, Ph.D.



Not only are wild animals impacted by climate change, but domesticated animals are as well. Many pets are displaced by such significant events as hurricanes and tornadoes. They can also die in these extreme events.

The rising costs of grain as a result of climate change has caused abandonment and starvation of many horses and any other grain dependent animals – particularly in the western United States. Although we have not seen many of these severe impacts for large animals in Micmac country, we are seeing abandoned household pets such as cats and dogs due to the high costs of providing care for the animals. The animals also sometimes lack veterinary care due to the high costs associated with it. Diseases spread by invasive species are also moving with the changing climate. This is exposing more domestic animals to diseases they would not otherwise have been exposed to. Increasing heat is also having a negative impact on domestic animals.

Adaptation will involve education for the Micmac community and awareness programs to provide assistance in where to go for help with meeting the needs of pets, such as the humane society pet shelters – with one located not too far from the Tribal Administration offices.

Growing Season/Crops by Dena L. Winslow, Ph.D.

Climate change is having both positive and negative impacts on the growing season and the crops that can be grown in Aroostook County. For example, the longer growing season that will result as the temperatures continue to warm will allow for more crops to be grown that require a longer growing season. However, with more drought conditions, there may be a need to irrigate the crops. Irrigation comes with a whole host of concerns such as agricultural runoff getting into streams and waterways. Spreading of chemicals that are applied to the crops can also occur through irrigation practices. At times, however, there will also be a lot more precipitation, so we will likely also see the chance for flooding of fields and crops, and the washing away of the topsoil so important to farming.

Adaptation will be on-going with the Micmac Farm staff continuing to monitor and assess growing seasons and agricultural practices.

Emerging Concerns by Dena L. Winslow, Ph.D.

With the potential for more wildfires as a result of drier and hotter temperatures, there is an emerging area of concern related to perfluorinated chemicals (PFC's) that are found in firefighting foam, waterproofing and stainproofing products, as well as others, and are linked to a number of adverse health effects. The substance has been found in fish tissue in the brook located at Loring on the Tribal property, and as far away as the Aroostook River, which is believed to have come from the Air Force firefighting training area also located on Tribal property at Loring. Tribal members have been advised to limit their consumption of fish as a result of this contaminant.

The substance can be found in the air, water, and soil, and because the substances do not biodegrade, but remain stable in the environment forever, there is cause for concern should a major forest fire occur that would require the use of firefighting foam that could potentially contaminate drinking water sources that Tribal members use.

Exposure to PFCs has been shown to have several adverse effects on human health, including delayed fetal and neurological development and reduced liver, kidney, and immune function. Additionally, exposure to PFCs has been linked to kidney, liver, testicular, thyroid, and pancreatic cancer. The potential for a major fire as a result of changing climate in Aroostook County could lead to more contamination with PFC's.

Glyphosates, although primarily an environmental concern, are also an emerging climate related concern due to their use in the forestry industry in clearing large areas of vegetation for forestry related purposes, and thus removing carbon sequestration (storing carbon to prevent it from getting into the atmosphere and increasing greenhouse gasses). Glyphosates are known carcinogens for humans and can also have negative impacts on wildlife. Clearing areas of vegetation in the forest can have negative impacts related to food sources for wildlife, as well as through creating areas where there is less vegetation available. More research is needed on this important topic.

Conclusions by Dena L. Winslow, Ph.D.

The Mi'kmaq Nation is being proactive in addressing the impacts of climate change on the Tribal community. One major project has been the construction of a large solar farm to produce clean electricity for the Tribal Administration buildings. There are also potential plans to build more solar farms for supporting the Tribally owned housing. By developing and constructing these projects, the Tribe is doing their part to reduce greenhouse gas emissions and thus, cut down on the causes of the increased climate change impacts. In addition, the Tribe has installed heat pumps in the Tribally owned houses, which are also cutting down on greenhouse gas emissions in the environment.

By continuing to be proactive, and by developing and implementing this plan, the Micmac community will be more aware of and more prepared to address these important issues. There is a recognition that reducing impacts and risks, as well as taking advantage of the positive impacts of climate change, such as a longer growing season, and other species that are now able to exist in our changing environment is very important for the Micmac community. Planning and education will best prepare the Tribe to adapt to the changes that are now happening and will be happening in the environment around us, and allow the Micmac community to be more resilient to the impacts of climate change.