

First Nations Environmental Contaminants Program

For Communities and Organizations
South of 60th Parallel, 2026-2027

Proposal for Primary Research:

Legacy and novel pesticides in moose from New Brunswick and implications for traditional hunting and communities

Submitted by:

North Shore Mi'kmaq Tribal Council
Anqotum Resource Management Department

22 September 2025





Project title: Legacy and novel pesticides in moose from New Brunswick and implications on traditional hunting and communities

Proponent information

Name of community or organization: North Shore Mi'kmaq Tribal Council

Name of Chief: George Ginnish

Name of community lead/coordinator for project: Siobhan Curry

Scientific partners:

Name of academic institution: Mount Allison University

Name of principal investigator: Dr. Joshua Kurek

Name of academic institution: McGill University

Name of principal investigator: Dr. Katie Chong

Date of submission: 22 September 2025

Funding request: \$150,000

Duration of the project: Two (2) years

EXECUTIVE SUMMARY

The North Shore Mi'kmaq Tribal Council (NSMTC) is requesting funding support to study two environmental contaminants and their potential impacts on traditional foods and human health.

Kurek et al. (2025) recently discovered high concentrations of dichlorodiphenyltrichloroethane (DDT)s, above ecological guidelines, in fish tissue and lake sediments from north-central New Brunswick (NB). DDT was last used in NB in 1968. This region is important for the harvest of wild plants and animals sought after by Mi'kmaq. The results suggest that the region is among the highest areas for DDTs in the world and that this legacy pesticide remains in ecosystems at levels that harm animals. Also in NB, 15,000 ha of Crown Forest are sprayed annually with glyphosate (New Brunswick Environmental Network, n.d.). Glyphosate kills hardwoods, other broadleaf plants, and grasses to increase softwood production. It is linked to forests becoming more susceptible to wildfires as fire-resistant hardwoods are eliminated and conifers prevail (Lindenayer et al., 2023). Wildlife may also be impacted indirectly (e.g. reduced food and habitat). Moose, a traditional food to the Mi'kmaq, graze on hardwood foliage and marshland plants. As a keystone species, they shape forest stands. Our communities depend on healthy forests and animals, and if contaminants are harming a primary food source, leadership would see this as an infringement of protected rights.

The goal is to collect moose liver samples from the 2026 and 2027 Fall hunts in NB's Wildlife Management Zones 7 and 8. We will test tissues for glyphosate/AMPA and DDTs and collect Indigenous Knowledge (IK) on moose populations and observed behavioural changes in their habitats. We will also document IK on hunting grounds and food consumption, comparing past practices with those of today's hunters and community members. We will also estimate community members' exposure to the contaminants via ingestion of moose liver in the diet. This will be done using a Food Frequency Questionnaire (FFQ), which is a survey that assesses dietary intake and can be used to estimate contaminant intake in traditional food sources (Ratelle et al., 2020).

Our study could be a first step to determine if levels of two contaminants applied broadly in NB are present in the terrestrial food web and whether they are high enough to affect biota and human health. We expect high concentrations of DDT, as shown in other studies, but low levels of glyphosate due to its ability to break down quickly in nature. Mi'kmaq have harvested moose since time immemorial and if harmful contaminant levels are found, current practices would need to be managed in accordance with treaty protections.

Access to traditional food currently does not meet community needs. The loss of traditional foods is not the only concern for community members but the loss of traditional practices, the potential effects on human health, and the potential effects on wildlife and their habitat. We are the stewards of the land. We advocate having an active role in forestry and moose management and helping these lands be productive and healthy for future generations. Our goal is to have as many community members involved, not only harvesters but youth and Elders as well. We also aim to bring awareness to our community about environmental contaminants and traditional foods.

TABLE OF CONTENTS

1. COMMUNITY BACKGROUND	4
2. PROJECT DESCRIPTION	5
2.1 Introduction	5
2.2 Literature Review	5
2.3 Rationale	7
2.4 Objectives	9
2.5 Methodology and Data Collection	9
2.6 Data Management	11
2.7 Activities and Outcomes	12
2.8 Strengthening Capacity	13
2.9 Traditional Knowledge	14
2.10 Youth Engagement	15
3. WORKPLAN AND TIMELINES	16
4. PROJECT TEAM	18
5. COMMUNICATIONS PLAN	19
6. PROJECT EVALUATION	20
7. REFERENCES	26

1 COMMUNITY BACKGROUND

The NSMTC represents seven Mi'kmaq communities in NB: Uggi'ganjig, Oinpegitjoig, Natoaganeg, Metepenagiag, L'nui Menikuk, Tjipögtötjig, and Amlamgog. These Nations are located along the Bay of Chaleur, the Miramichi River, the Gulf of St. Lawrence, and the Petitcodiac River, with histories of settlement from thousands of years ago. Metepenagiag is recognized as one of the oldest continuously settled communities in NB, with over 3,000 years of habitation (Metepenagiag Heritage Park, n.d.).

Community members have depended on hunting, fishing, and forestry, with moose, salmon, sturgeon, oysters, and other traditional foods remaining central to diet and culture. Today, employment is a mix of resource-based activities, local governance, trades, and small business, but subsistence harvesting remains vital to food security and cultural continuity. This dependence makes the health of local lands, waters, and wildlife an essential concern. Climate change is also exacerbating pressures on ecosystem health and traditional foods.

The presence of environmental contaminants has long been an issue in the region. In NB, approximately 15,000 hectares of Crown Forest are sprayed annually with glyphosate to promote softwood production, directly affecting the hardwood foliage and marshland plants that moose depend on for forage (New Brunswick Environmental Network, n.d.). Past research has also identified concerning levels of legacy contaminants such as DDT in fish tissue and lake sediments, underscoring the persistence of banned pesticides in the modern environment.

Health vulnerabilities make these environmental risks a serious concern. The First Nations Food, Nutrition and Environment Study (2008–2018) found that almost half of First Nations households on reserve experience food insecurity, with even higher rates among families with children (Batal et al., 2021). Diets are often nutritionally inadequate due to limited access to affordable, healthy food options, while traditional foods, when available, provide much higher nutritional quality and support connections with our culture. Additionally, 56% of First Nations adults report being diagnosed with one or more chronic health conditions—higher than that observed in non-Indigenous populations (Chan et al., 2021).

These realities mean that environmental contaminants pose risks not only to the land and wildlife, but also to community health, food sovereignty, and treaty-protected practices. Families with children and active harvesters are particularly affected, both through direct and indirect exposures and through the loss of safe, healthy traditional foods that are central to Mi'kmaq well-being.

2 PROJECT DESCRIPTION

2.1 Introduction

The purpose of the project is to determine whether the modern herbicide glyphosate is entering and contaminating the traditional food sources (moose) of the Mi'kmaw in NB. It also seeks to determine if DDT, a legacy insecticide used in the 1950s and 1960s, has contaminated these same traditional food sources. We will also estimate community members' exposure to the contaminants via ingestion of moose liver in the diet. This project will be a collaborative effort between Mount Allison University, McGill University and the NSMTC and directly involve the members of two Mi'kmaq communities as well as non-Indigenous hunters in the Greater Miramichi Area and the Acadian Peninsula. This is a primary research project designed to determine whether two specific environmental contaminants are currently affecting traditional Indigenous food sources in northern NB and if and whether they are affecting human health during consumption.

2.2 Literature Review

DDT is a persistent organic pollutant that is widespread in the environment due to its mobility and persistence in soil, aquatic sediments, and biota (CCME 1999a). Common transport pathways of DDT in the environment are through the atmosphere and surface waters. DDT was widely applied as an insecticide in agriculture, forestry, and urban settings during the 1940–1960s. Due to its ability to bioaccumulate, degrade into toxic breakdown products, and its effects on non-target biota, DDT use was phased out in the 1970s in North America. DDT is classified as a probable carcinogen to humans by the International Agency for Research on Cancer. Diet is the main exposure route in humans and wildlife. Humans that consume wild game are often at greatest risk of exposure to DDT and its toxic breakdown products, DDD and DDE (Langlois and Langis 1995). Health Canada has established Maximum Residue Limits of DDT for human health and food safety at 5 ppm for fish, 1 ppm for meat, fat, cheese, and milk, and 0.5 ppm for eggs and vegetables.

The province of NB is recognized as one of the most heavily applied areas for DDT in North America because of its past use by the forest industry (Hartz et al. 2023). About 50% of NB was sprayed with DDT between 1952 and 1968, followed by more than 10 other insecticides. Of all the legacy insecticides used in NB, DDT comprises ~66% of the estimated toxicity load to aquatic invertebrates, supporting DDT's role as the major legacy insecticide of concern in the region (Sugden et al. 2025). Recently, very high levels of DDTs (DDT + DDD + DDE) were detected in both lake sediments and brook trout from five remote lakes in north-central NB (Kurek et al. 2019; Kurek et al. 2025). On average, brook trout were ten times higher than ecological guidelines (CCME 1999b) but below human health guidelines (Health Canada 2008). These findings gained international media attention and confirmed that legacy DDTs are likely widespread in NB at levels comparable to the highest reported globally.

Legacy DDTs from use more than 50 years ago are suspected to be moving from their storage pools in forest soils and aquatic sediments into the modern food web (Kurek et al. 2025). Ecological effects on aquatic biodiversity were noted by Kurek et al. (2019); however, there remains a clear knowledge gap between contamination by legacy DDTs and other wildlife, especially terrestrial biota of cultural importance

such as moose. DDTs bind to organic matter and bioaccumulate in plant tissues at levels that may present a cancer risk to humans (Wu et al. 2019). Studies from Maine (USA) and NB show that DDTs persist for decades at high concentrations in both forest soils and aquatic sediments (Dimond and Owen 1996; Kurek et al. 2019).

Moose consume both terrestrial and aquatic plants. Thus, we expect NB moose to be exposed to legacy DDTs through their plant-based diet. No studies have investigated legacy DDT contamination in moose from NB, a region where historical use of DDTs was exceptionally high and widespread (Heartz et al. 2023; Kurek et al. 2019; Kurek et al. 2025; Sugden et al. 2025). Studies examining DDTs in moose tissues in North America are rare. In Alaska (USA) and northern Canada (Landers et al. 2008; Larter et al. 2017), where DDTs were transported via long-range atmospheric deposition in very low amounts, moose muscle and liver showed mostly very low DDTs, often below detection limits. However, one of three moose studied showed high DDT concentrations (Landers et al. 2008). Danielsson et al. (2008) reported that moose tissue from Sweden were mostly below detection limits for DDTs and DDTs decreased over time in their temporal survey of contaminants. Contrasting legacy DDT bioaccumulation in moose from a high-use region (NB) with findings from regions where DDT inputs to the environment were/are significantly less will provide key data on legacy contaminants in a culturally important large mammal.

Approximately 15,000 hectares of NB forests are sprayed with herbicides, in which a major component is glyphosate (Conservation Council of New Brunswick, 2025). Glyphosate is a broad-spectrum herbicide sprayed in areas designated to be clear-cut, mainly targeting young hardwood trees (Government of New Brunswick). However, because glyphosate is non-selective, it affects nearly all broadleaf plants and grasses by inhibiting what is known as the shikimate pathway, which plants use to synthesize amino acids (Holländer and Amrhein, 1980). It is also sprayed aerially, leaving the capacity for the spray to drift beyond the cut area and affect other plants such as berries and other culturally and ecologically important forage plants. Aquatic areas are generally avoided in treatments, and run-off of glyphosate into waterways as a result of forestry applications is generally low, likely due to high binding of glyphosate into soil (Edge et al., 2023). Thus, it is most likely that moose, as herbivorous grazers that incorporate terrestrial and aquatic plants in their diet, would be exposed to glyphosate through terrestrial foraging.

Widespread claims have indicated that glyphosate does not remain in the environment for long (Duke, 2010). However, the findings of *Botten et al.* (2021) contradict this claim, showing that surviving plants in designated clear-cut areas in British Columbia that were treated with herbicides containing glyphosate may contain glyphosate residues in roots, shoots and fruits for up to one year or more post-treatment. Additionally, some plants also contained aminomethylphosphonic acid (AMPA), the main metabolite of glyphosate (Botten et al. 2021). Duckweed is a common aquatic plant in NB and one that moose ingest as part of their summer diet (Morris, 2014). Sikorski et al. (2019) concluded that the uptake of glyphosate in common duckweed was proportional to herbicide concentrations, with plants exposed to 1 µM concentration of glyphosate for 7 days exceeding the Maximum Residue Level (MRL) by 10-fold. Not only has it been shown that glyphosate is absorbed by plants deemed a food source for moose; there is also evidence that the compound and its metabolite is present in plants for an extended period of time.

Glyphosate-containing herbicides are detrimental to food sources for moose. However, studies showing whether glyphosate is being consumed and metabolized from the diets of moose in Mi'kmaq territory in NB are lacking. A study done by Maliseet Nation Conservation Authority (2018) in NB found that glyphosate is not detectable in moose tissue samples. This study was conducted for the Wolastoquey Nation in western NB. One study is never enough. A comparative study within the Mi'kmaq territory of NB would be beneficial as it can provide more robust evidence for concerned Mi'kmaq who rely on moose as a traditional food source.

The First Nations Food, Nutrition and Environment Study (2008–2018) found that almost half of First Nations households on reserve experience food insecurity, with even higher rates among families with children (Batal et al., 2021). Diets are often nutritionally inadequate due to limited access to affordable, healthy food options, while traditional foods, when available, provide much higher nutritional quality and support connections with our culture. Additionally, 56% of First Nations adults report being diagnosed with one or more chronic health conditions— higher than that observed in non-Indigenous populations (Chan et al., 2021).

2.3 Rationale

Currently, it is unknown to what extent these two environmental contaminants may have affected traditional foods of our communities and the habitats we rely on for cultural practices. However, both DDT and glyphosate were/are widely used in the traditional territory of the Mi'kmaq, including our communities' most popular hunting grounds, most of which are located within NB Wildlife Management Zone (WMZ) 7. Historically, DDT was sprayed over approximately 95% of WMZ 7, and research on lakes located within WMZ 7 revealed that the pesticide is still present to this day at levels above ecological guidelines. Glyphosate, a herbicide designed to kill broadleaf plants to eliminate competition for conifers, is widely used today in NB forests, including in WMZ 7.

The forest industry stopped spraying DDT on forests in 1968. Furthermore, recent research has been done to understand the lasting impact that legacy DDT has had on aquatic environments. This project aims to further the understanding of pesticide impacts, as thus far an impact has only been measured on aquatic organisms in NB (Kurek et al., 2025) and has yet to be investigated in terrestrial life/mammals. Glyphosate has been classified as a Group 2A carcinogen (International Agency for Research on Cancer, 2015), meaning it is probably carcinogenic to humans. It has also been studied with respect to how quickly it breaks down in the environment, which contrasts the long persistence of DDT in the environment. Yet, it is still unclear whether the intense spraying of glyphosate has an impact on the traditional food sources of the Mi'kmaq and whether this could translate to human health impacts and links with food insecurity and loss of traditional hunting practices.

Environmental contaminants in animals used for sustenance have been a concern for First Nations across the country. Even to the point where some First Nations will refuse to eat animals that have traditionally been in their diets for generations, such as the Aamjiwnaang people of Ontario who have grave concerns regarding contaminants in local deer (Bedeau, 2006). Many Mi'kmaw of NB

share similar concerns when it comes to moose, and the impacts of pesticide applications, both from today and from decades ago. This study will benefit the local community because they will be made aware of their potential exposure risks to both legacy DDT and glyphosate and whether they should be concerned about where they harvest wild foods from, including moose. This will be relevant for Indigenous communities not only in NB, but across the country. Knowing whether legacy DDT and/or glyphosate bioaccumulate in traditional food sources and to what extent is important to anyone who derives part or a majority of their diet from natural food sources. If very low levels of these contaminants are detected, there is also the benefit of knowing that traditional foods are safe to eat and part of a healthy diet and important connection to First Nations culture.

People often eat the liver, heart, and muscle from the moose. We chose to focus on liver measures to be comparable with previous studies and to ensure that our tissue samples reflect chronic, low-level exposures of moose to the contaminants we are studying. DDTs tend to accumulate in tissues with greater fat content and so moose muscle may not be appropriate for detecting low levels of DDT and its metabolites. We plan to complete a human health survey and information learned from that aspect of the project, in combination with Year 1 results, will guide our tissue selection for Year 2 moose measurements. For example, if we observe glyphosate/AMPA at below detection limits then we may decide to focus solely on legacy DDTs and target tissues other than the liver. In addition, if community members report other tissues and/or muscle of the moose is commonly consumed then we can adjust and target those tissues as well.

There is a symbiotic relationship between land and Indigenous Peoples. This relationship should be recognized at the forefront of sustainability and conservation, as it is their way of living. Considering the Reconciliation Mandate, it is important to recognize Indigenous stewardship and participation in scientific research. Communities used to have an active role in forestry management, specifically in silviculture but as time went on, the connection to the land was lost. Indigenous Peoples bring a balance to nature; forests and natural environments are managed as a whole ecosystem and not just one species at a time. The health of our communities is dependent on the health of the forest and the animals within the forest. Stewardship would naturally follow since Indigenous Peoples and their leadership protect their food source and their habitats which is the basis of their way of living.

NB focuses only on softwoods and single-species plantations; this creates a loss of biodiversity, the ability to fight against disease, climate change vulnerability, and losing the ability to regenerate itself after a forest fire. Indigenous leadership and participation in decision-making would provide the two-eyed seeing knowledge which is required to find a balance, and having Indigenous representation would allow space for recommendations, an opportunity to build relationships with Industry and the Province. Equal representation in decision-making for forestry management will facilitate economic opportunities for both Indigenous and non-Indigenous peoples.

This study will provide an opportunity for our Indigenous Peoples to have an active role in forestry management and decision-making. Using the two-eyed seeing approach (Etuaptmuk), it will help sustain a productive and healthy forestry landscape in an environmentally, socially, and culturally appropriate

manner; as stewards of the land, we can adopt more environmentally friendly practices, and engage the land in ceremony – where land-based teachings occur, a step towards Reconciliation.

2.4 Objectives

The short-term objectives are to determine whether legacy insecticides (DDT) and modern herbicides (glyphosate) or their metabolites (DDD, DDE, and AMPA) are present in the moose liver tissues, and to what degree, and whether they are at potentially harmful levels based on ecological or human health guidelines.

The long-term objectives are to develop awareness of environmental contaminants in the traditional food sources of the Mi'kmaw in northern NB, what degrees of caution might be necessary when harvesting and consuming these food sources, and to inspire further research into said environmental contaminants should this project find concerning levels of these contaminants in traditional food sources.

2.5 Methodology and Data Collection

The field sampling will be conducted in northern NB in WMZs 7 and 8. These zones were selected because they are popular hunting areas and the use of glyphosate is widespread in both zones. In addition, Zone 7 had 95% of its area treated with DDT compared to only 38% of Zone 8 treated with DDT. In NB, moose hunts occur in September (non-Indigenous hunters) and again later in October/November when Indigenous community hunts take place. The timing of the September hunt will allow for an accurate body condition assessment, as it is at the beginning of the moose 'rut' or breeding season, which is important as males make up over 70% of the recorded moose harvest. The later October/November sampling from the community hunts will be useful for ensuring enough moose are sampled and that we obtain samples of moose tissue from a variety of habitats in Zones 7 and 8. This is important because exposure to pesticides in ungulates, including moose, is through what they feed on in their preferred habitats (Collas et al., 2024; Klich et al., 2020). The community hunts also provide an ideal time to collect IK on moose and their habitats and share this with the community.

Moose will be sampled post-hunt for liver tissue. About 5–10 g of liver tissue will be requested from each successful hunter. Liver samples will then be stored in sterile, labelled containers and kept cool on ice until frozen for transport to the laboratory for pesticide measures following standard protocols. Body condition, sex, and where the moose was hunted (approximate location) will also be recorded. Checks will be in place to ensure that liver samples and moose data are coded in such a way as to associate each liver measurement with a specific moose from Zones 7 or 8 (e.g. Zone7_Moose_1). Liver sampling will be coordinated with the NB Department of Natural Resources checkpoints, local butchers, and Indigenous communities. We aim to sample 20 moose per year, with 10 moose from Zone 7 and 10 from Zone 8.

Moose typically have ranges of ~10 km² and feed on both aquatic and terrestrial vegetation. Given their large range, high-resolution sampling of local vegetation and sediments/soils may not be representative of moose exposure to these contaminants. Additionally, our budget does not allow for additional environmental samples of vegetation, sediment, or soils. What we can determine from the location of where

the moose was harvested is an association with other geospatial information about cumulative DDT and glyphosate applied, some of which has been published in recent scientific articles or is reported by the government. Additionally, studies by Kurek's lab showed that legacy DDTs in modern lake sediments were positively correlated with historical amounts applied to surrounding forests. A major assumption is that moose exposure to contaminants through their diet is likely greater in habitats where more pesticides were applied, hence the comparison between moose harvested from WMZs 7 and 8. Once hunter's report the coordinates of where a moose was harvested (a requirement of our sampling design) then we can compare historical and recent pesticide applications to understand potential exposure.

During October and November, only Indigenous hunters can harvest moose; nonetheless, we expect good co-operation with the communities of Natoaganeg and Metepenagiag based on previous collaborations and our 18-year relationship as the Aboriginal Aquatic Resource and Oceans Management (AAROM) body representing them. Participants in the study will include Indigenous hunters and youth, as well as non-Indigenous hunters, local butchers, and the NB Department of Natural Resources.

Chemical analysis of liver tissue will be conducted for both DDT (dichlorodiphenyltrichloroethane) and its by-products DDE (dichlorodiphenyldichloroethylene) and DDD (dichlorodiphenyldichloroethane), as well as glyphosate and its metabolite AMPA (aminomethylphosphonic acid). This is integral to understanding exposure as contamination of food sources will be the primary mode of contact with these environmental contaminants by humans. Data will be analyzed and results will be interpreted collaboratively between Drs. Josh Kurek and Christopher Edge. Guidelines for concentrations of pesticides in animal tissues and findings in similar Cervidae studies will be compared to our results, both ecological and human health (e.g. CCME, Health Canada, relevant literature).

Chemical analyses of moose livers will occur at Queen's University in Kingston, Ontario and Sherbrooke University in Sherbrooke, Quebec. The Queen's Analytical Services Unit (ASU) is accredited by CALA (formerly CAEAL) to the standards of ISO/IEC 17025. Queen's ASU is an environmental chemistry laboratory, and has provided analytical services to industry, government and universities for over 25 years. Kurek frequently uses the environmental chemistry expertise and services of ASU, including his research on DDT in fish (Kurek et al. 2025). ASU follows standard protocols and best practices for measuring contaminants in a variety of environmental samples. For DDTs, ASU will follow standard methods used by the US EPA, including gas chromatography with a mass-spectrometer as a detector after extraction and sample cleanup. For glyphosate and its metabolite AMPA, ASU will follow aspects of several laboratory methods reported in the literature for mammal tissues (i.e. there is no "standard" method for measuring glyphosate/AMPA compared to DDT and its metabolites). The lipid fraction of moose livers will also be analyzed gravimetrically and reported as percent dry weight. For all pesticide measures, control samples, replicates, and blanks will also be completed on a subset of samples. Method detection limits will be established and clearly reported. For example, Queen's ASU detection limit for DDT and its metabolites in fish tissue was 10 ng/g dry weight or 10 ppb, which allows for accurate comparisons to ecological and human health guidelines.

Queen's University Analytical Services Unit, a CALA accredited lab, has agreed to provide detailed instructions to our team to ensure integrity of tissue samples during collection, handling, and transport to their laboratory. The PI often uses that laboratory to provide contaminant measures from environmental

samples. He has always been satisfied with the lab's professionalism in helping coordinate best practices for maintaining sample integrity throughout the research process.

As part of ASU's accreditation requirements, the lab routinely participates in proficiency testing studies from various accredited providers including CALA. "The principals and methodology applied to CALA accredited methods are applied to all analysis performed in our laboratories. Rigorous quality control procedures are employed. The use of certified laboratory control standards (LCS), analysis of preparation duplicates and blanks, repeat recalibration and use of separate source calibration check standards ensures that the data we provide is of the highest quality and is completely reproducible."

In addition to collecting moose liver samples and analyzing them for the named contaminants (DDT and Glyphosate), we will also estimate community members' exposure to the contaminants via ingestion of moose liver in the diet. This will be done using a Food Frequency Questionnaire (FFQ), which is a survey that assesses dietary intake and can be used to estimate contaminant intake in traditional food sources (Ratelle et al., 2020). We will follow a methodology similar to that used in the First Nations Food, Nutrition and Environment Study (FNFNES), which was a Canada-wide study that examined the dietary intake of selected contaminants in 92 First Nations communities in eight assembly of First Nations regions (Chan et al., 2021). We will modify the FNFNES dietary survey for Atlantic Canada, focusing primarily on the dietary intake of moose.

We will estimate human exposures to the contaminants in question using consumption information from the FFQ in addition to contaminant information from the traditional food samples collected. Our exposure assessment can then be compared to regulatory guidelines to inform our understanding of potential human health risks and impacts. Our survey will be administered at the same time as the workshops/engagement sessions in year 1. The results of the survey will also help us to determine traditional food sampling priorities for year 2 of the project.

We will focus on liver samples for this first round of sampling, additionally collecting consumption information on all types of moose tissues through the survey. Year one results will help guide our priorities for year two. A broader traditional food sample collection strategy will help understand potential human health risks. Contaminants will most likely be found in higher concentrations in the liver but if results show differently, we will consider including other tissues to our sampling protocol in year 2.

The Research Ethics Board will be approved by Mount Allison University.

2.6 Data Management

Data may include any of the following: interview transcripts from collecting IK; animal sample collection forms and spreadsheets of results; photos; maps and videos. The data will be protected and shared throughout the research project by the NSMTC Anqotum Resource Management department following the principles of Ownership, Control, Access, and Possession (OCAP®), thereby allowing participants and communities to have control over the information they share (First Nations Information Governance Centre, 2023).

Data collection will follow the principles of OCAP®. Before field collection and prior to IK interviews, the participants will be asked to review and sign a consent form so that written evidence of consent is obtained. The consent form will explain the purpose and process, how the data will be used, and emphasize the control participants have over the data they choose to share. NSMTC Anqotum staff will also explain verbally how participants have control over the information they share and how it will be used, shared, and cited. No identifiable information about the participants will be shared without their consent. Participants can choose to withdraw consent or change how they would like to be cited at any time during the research.

When necessary, data-sharing agreements with project partners will be put in place.

Data will be stored securely in the NSMTC Anqotum OCAP® community server. Information obtained via field collection and during the IK interview phase will be forwarded securely to NSMTC Anqotum for safeguarding and storage.

A post-interview form will be provided to participants to allow them to review the information they shared, as well as to provide feedback on the interview process. This allows the participants to review the information and decide if they would like to edit the information and/or withdraw consent to some or all information being shared.

2.7 Activities and Outcomes

Activity 1: Harvest 40 moose liver samples with the help of Indigenous and non-Indigenous harvesters, 10 each from the Fall hunting seasons of 2026 and 2027 from WMZ 7 and 8. This will be done as a group effort, (harvester, biologist, field technician, project manager and/or research scientist). Sample collections are necessary to achieve Objective 1, testing tissue for contaminants. We aim to develop maps, publications, expert and general presentations, and engage the community through newsletters, social media, and knowledge-sharing meetings.

Activity 2: Test moose liver tissue for glyphosate and its metabolites in an accredited laboratory with a scientific protocol performed by the University of Sherbrooke. Testing the tissue is a necessary step to achieve Objective 1. We expect to see low levels of glyphosate as it breaks down quickly. The results will provide insight into whether glyphosate is present in moose liver tissue and at what concentration. These results would be presented to the harvesters at our yearly Annual General Meeting (AGM), including Chief and Council, and included in potential publications, presentations, and newsletters, social media, and knowledge-sharing meetings. This activity will achieve both short-term and long-term objectives.

Activity 3: Test moose liver tissue for legacy DDT and its metabolites by contracting out the analytical expertise of the CALA-certified Queen's ASU. Testing the tissue is a necessary step to achieve Objective 1. We expect to see high or measurable levels of DDTs in the

moose liver tissue, especially from Zone 7. The results will provide insight into whether legacy DDTs are present in moose liver tissue in NB and if ecological or human guidelines are exceeded. These results would be presented to the harvesters at our yearly AGM including Chief and Council, and included in publications, presentations to expert and general audiences, and shared to the community through diverse channels. This activity will achieve both short-term and long-term objectives.

Activity 4: Collect IK from our local Elders and Knowledge Holders on moose behaviour, traditional hunting grounds, traditional food consumption, cultural importance and any other relevant information pertaining to our project. We will collect, transcribe and develop a summarized IK report. We expect a lot of participation in this activity as our members are concerned about the current state of our environment, their health and the loss of traditional and cultural activities. The results of the IK study will be used in a two-eyed seeing way with our scientific findings, to potentially develop a more sustainable forestry plan and best-practices guidelines. IK will be collected by Joe Augustine and Nelson Cloud. This activity supports the long-term objective.

Activity 5: Analysis of glyphosate/AMPA and DDTs in liver tissues by CALA-accredited lab and Sherbrooke University lab, compare results between Zones 7 and 8, compare DDT levels to CCME and Health Canada guidelines, compare both pesticides to other relevant peer-reviewed Cervidae (deer family) studies. The analysis of these environmental contaminants will be performed by the Research Scientist and the Science Advisor and support provided by the lead biologist and project manager. This activity supports both short and long-term objectives.

Activity 6: Pre- and post-engagement sessions will be held with community members, harvesters, Chief and Council and all other interested parties to discuss the project, their interests and/or concerns and to also present the results once the project is completed. We will also hold ceremony with our Elders and youth to provide an opportunity to transfer knowledge and to bring awareness to our research, and future opportunities. The Promoting Lifelong Learning (PLL) program will be adopted to engage with youth by sharing the knowledge of environmental contaminants and their potential impacts on wildlife, their habitat, and on human health. We expect a lot of support from our communities as this is of great concern to our members. This will be a team effort, depending on resource availability. Results will be summarized in a report, and a presentation with maps will also be developed and shared with members. This activity will support our long-term objective.

Activity 7: A human health risk assessment advisor will develop and conduct a traditional food frequency survey, data analysis and interpretation, and provide a report.

2.8 Strengthening Capacity

As one of our pillars in our NSMTC Anqotum Strategic Plan (2025-2030), the department prioritizes capacity building. From inception to project results, community members will be involved in this research project. We will be hosting pre-engagement sessions to discuss the study and bring awareness of the

potential harm contaminants may have on our environment and our health. The post-engagement sessions will be to present the results of the study and to discuss potential future projects the community members would like to explore. We will also tap into our Promoting Lifelong Learning program by engaging youth in classrooms and in the field, and even during story time around ceremonial fires. Because the exact time and date a moose will be culled are difficult to predict, we will hold a ceremonial prayer for all members and harvesters prior to heading out onto traditional hunting grounds.

With the support of our communications officer, we will be developing newsletters for members to keep them updated on the project including information on contaminants and current forestry practices. We will discuss potential health concerns, and how to become leaders in the field of science and forestry. Through the various tools and methods used throughout the project, members will be exposed to traditional hunting, current forestry practices, and the field of scientific research, which are great opportunities to transfer knowledge from traditional harvesters to youth, and from biologists to interested members. This knowledge can be applied to our summer student program, where endless opportunities exist within our organization, including sciences, forestry, education, and health services.

2.9 Traditional Knowledge

The collection of IK will provide us with data on the cultural, social, and environmental changes occurring in the use of traditional foods and traditional hunting grounds, and how forestry practices, such as spraying, are affecting the terrestrial landscape and the wildlife that inhabits it. The scientific data collected from moose liver tissue will provide insight on how glyphosate and DDT are potentially affecting moose health. Depending on the results, follow-up research may be necessary to fully understand the scope of contaminant exposure and the impacts on human health. The data will be collected, analyzed, disseminated, and stored via discussion with the community and directed by the guidelines in the *New Brunswick Mi'gmaq Indigenous Knowledge Study Process Guide* covering data collection, data access, control, and ownership. The two-eyed seeing approach of the Indigenous Peoples will be beneficial to our research. We will interact with our Knowledge Holders, Elders, and traditional harvesters and non-traditional harvesters through engagement sessions. Based on interviews, we will summarize these results for the final report. The IK study will help us understand how the Mi'kmaq people interact with the land and animals. Maps identifying areas where the Mi'kmaq people interact with the land will be developed as part of the study; however, it will be shared only in summary to protect these sacred areas.

Our goal will be to engage our Elders and traditional harvesters and provide them with an active leadership role in land-based teachings and ceremonies, as well as a potential future role in forestry management plan development to ensure sustainable practices are used, conservation of the land and its wildlife for generations to come. The project seeks to involve all aspects of the community – from leadership to male and female harvesters, youth awareness sessions and transfer of knowledge during the annual moose hunt, and conversations with Elders. It is our vision that we can share the results of the study with all our communities in the region given the common geographical areas where they hunt, as they too will find the information useful in their current and future consideration of traditional food consumption and the availability of the resource.

In addition to their roles as Knowledge Holders, Elders will give opening and closing ceremonies/prayers at Indigenous Knowledge Workshops and community engagement sessions.

For sample shortfalls (ie. amount of IK interviews), Anqotum will collaborate with other Indigenous organizations who have undertaken similar Indigenous knowledge projects to explore data sharing agreements as per OCAP principles. Also, it is our experience, that the quality of the interviews is sometimes more impactful than the quantity of interviews.

Expected outcomes from IK integration include an increased understanding of how moose behaviour has changed due to degrading habitat; the changes in the traditional hunting grounds ie. Known moose corridors; dietary changes due to lack of available resources and a significant reduction in cultural knowledge transfer between generations about the importance of traditional foods such as moose.

2.10 Youth Engagement

Every year, NSMTC Anqotum hosts a Promoting Lifelong Learning program in which we teach Indigenous students from local schools about culturally important animals to the Mi'kmaw and species at risk. Each year, we reach three Indigenous schools, providing two sessions to each school. Through this program we can provide information on the cultural and historical value moose had and still have to the Mi'kmaq people, with further emphasis on how contaminants can impact the well-being of the animal. Additionally, hunters and Elders in our communities put on a communal hunt, in which they take young Indigenous students back to the woods to experience a harvesting of a moose. NSMTC Anqotum will tag along in these hunts, allowing us to not only acquire moose liver samples, but also provide valuable information to students regarding the animal's behaviour, morphological characteristics, and possible threats to the species, such as contaminants. This program allows the students to gain valuable insights into the cultural and scientific importance of moose to the Mi'kmaq people. This transfer of both traditional and scientific knowledge will help foster a newfound interest in the environment, the animals within, and the importance of striving for a healthy ecosystem.

3 WORKPLAN AND TIMELINE

Table 1. Project Activities and Timeline

ACTIVITY	PROJECT OBJECTIVE	DESCRIPTION	TIMELINE	BARRIERS TO COMPLETION
1	To determine whether DDT and Glyphosate or their metabolites (DDD, DDE, and AMPA) are present in the liver tissues of moose, and to what degree/whether they are at potentially harmful levels based on ecological or human health guidelines.	Harvest 40 moose liver samples with the help of Indigenous and non-Indigenous harvesters, 10 each from Fall hunting season 2026 and 2027 from WMZ 7 and 8.	Fall 2026/2027	Not enough samples for a good data set
2	To determine whether DDT and Glyphosate or their metabolites (DDD, DDE, and AMPA) are present in the liver tissues of moose, and to what degree/whether they are at potentially harmful levels based on ecological or human health guidelines.	Test moose liver samples for glyphosate and its metabolites.	Winter 2026/2027	Sample contamination
3	To determine whether DDT and Glyphosate or their metabolites (DDD, DDE, and AMPA) are present in the liver tissues of moose, and to what degree/whether they are at potentially harmful levels based on ecological or human health guidelines.	Test moose liver samples for DDT and its metabolites.	Winter 2026/2027	Sample contamination

4	To develop awareness of environmental contaminants in the traditional food sources of Mi'kmaq people, and to inspire further research into said environmental contaminants should this project find concerning levels of contaminants in traditional food sources.	Collect Indigenous Knowledge (IK) from our local Elders and Knowledge Holders on moose behaviour, traditional hunting grounds, traditional food consumption, importance culturally and any other relevant information pertaining to our project	One workshop per year	Lack of available resources
5	This activity supports both short-term and long-term objectives.	Processing samples, analysis and findings	Winter 2027/2028	Lack of samples, equipment malfunction, contamination
6	To develop awareness of environmental contaminants in the traditional food sources of Mi'kmaq people, and to inspire further research into said environmental contaminants should this project find concerning levels of contaminants in traditional food sources.	Pre- and post-community engagement sessions, ceremony with Elders and youth, adopting PLL program for youth and students	Spring/Summer 2026/2027	Lack of available resources
7	To determine human health exposure through consumption	A human health risk assessment advisor will develop and conduct a traditional food frequency survey, data analysis and interpretation and provide a report	Will be delivered at same time as engagement sessions	Lack of available participants

4 PROJECT TEAM

Table 2. Project Team Members and Activities

NAME	AFFILIATION	ROLE	ACTIVITY
Siobhan Curry	North Shore Mi'kmaq Tribal Council	Project Manager	All
Dr. Josh Kurek	Mount Allison University	Research Scientist	3, 5
Dr. Chris Edge	Department of Natural Resource Canada	Science Advisor	2, 5
Ethan Augustine	North Shore Mi'kmaq Tribal Council	Senior Biologist	1, 6
Joe Augustine	North Shore Mi'kmaq Tribal Council	Field Technician	1, 4, 6
Nelson Cloud	North Shore Mi'kmaq Tribal Council	Senior Field Technician	1, 4, 6
Vladimir King Trajkovic	North Shore Mi'kmaq Tribal Council	Geomatics Specialist	1, 2, 3, 4
Dr. Katie Chong (Dr. Nil Basu – supervisor)	McGill University	Human Health Advisor	7
Vanessa McLaughlin	North Shore Mi'kmaq Tribal Council	Communications Officer	4, 6

5 COMMUNICATIONS PLAN

The project results will be communicated through both community-facing channels and academic/scientific avenues, ensuring broad awareness and accessibility.

Launch: At the launch of the project, a media release will be issued. This release will be shared on the NSMTC website, social media channels, and distributed to external media outlets. A project overview will be shared in the Anqotum quarterly bulletin and posted on the NSMTC website under Anqotum's *What We Do* section.

Ongoing Updates: Throughout the project, updates will be provided to Chiefs to ensure Member Nations are kept informed. Project highlights will continue to be shared via social media.

Completion: When the project is complete, a final report will be prepared and presented to Chiefs. The release of this report will be supported by a second media release, posted to the NSMTC website, shared on social media, and distributed to external media. The final report will also be featured in the NSMTC Annual Report, which is circulated to government and funding partners.

Academic Dissemination: Results will also be shared through academic and professional channels. Engagement sessions will be held with research collaborators and interested partners. Dr. Josh Kurek will present findings at regional, national, and international conferences, with the goal of publishing results in a peer-reviewed journal. These academic activities will ensure the research contributes to broader scientific knowledge while complementing community-based dissemination.

Communications Materials: For further accessibility, plain-language materials such as rack cards will be developed to share key results with community members.

6 PROJECT EVALUATION

Table 3. Objectives, Activities, and Performance Indicators

PROJECT OBJECTIVE	PROJECT ACTIVITY	PERFORMANCE INDICATORS	DATA COLLECTION	COMMENTS
To determine whether DDT and Glyphosate or their metabolites (DDDs, DDEs, and AMPA) are present in the liver tissues of moose, and to what degree/whether they are at potentially harmful levels based on ecological or human health guidelines.	Harvest 40 moose liver samples with the help of Indigenous and non-Indigenous harvesters, 10 each from Fall hunting season 2026 and 2027 from WMZ 7 and 8.	Quantitative: Activity logs	10g of liver tissue will be collected at harvest time. The sample will be placed in a container, in a Ziplock bag and placed on ice.	Additional data collected on site will include date, time, location, and harvesters contact info.
To determine whether DDT and Glyphosate or their metabolites (DDDs, DDEs, and AMPA) are present in the liver tissues of moose, and to what degree/whether they are at potentially harmful levels based on ecological or human health guidelines.	Test moose liver samples for glyphosate and its metabolites.	Quantitative: Activity logs	ASU will follow laboratory methods reported in the most recent literature for mammal tissues. The lipid fraction of moose livers will also be analyzed gravimetrically and reported as percent dry weight.	For all pesticide measures, control samples, replicates, and blanks will also be completed on a subset of samples. Method detection limits will be clearly reported.
To determine whether DDT and Glyphosate or their metabolites (DDDs, DDEs, and AMPA) are present in the liver tissues of moose, and to what degree/whether they are at potentially harmful levels based on ecological or human health guidelines.	Test moose liver samples for DDT and its metabolites.	Quantitative: Activity logs	ASU will follow standard methods used by the US EPA, including measures by gas chromatography with a mass spectrometer as a detector (GC-MSD) after extraction and sample cleanup.	For all pesticide measures, control samples, replicates, and blanks will also be completed on a subset of samples. Method detection limits will be clearly reported.

<p>To develop awareness of environmental contaminants in the traditional food sources of Mi'kmaq people, and to inspire further research into said environmental contaminants should this project find concerning levels of contaminants in traditional food sources.</p>	<p>Collect Indigenous Knowledge (IK) from our local Elders and Knowledge Holders on moose behaviour, traditional hunting grounds, traditional food consumption, importance culturally and any other relevant information pertaining to our project.</p>	<p>Qualitative: Interviews</p>	<p>We will be using NB MEK's guide to collect IK. Interviews can be one on one or in group settings.</p>	<p>Summary of interviews will be transcribed, and some information will be shared in our report.</p>
<p>This activity supports both short-term and long-term objectives.</p>	<p>Processing samples, analysis and findings</p>	<p>Quantitative: activity logs</p>	<p>ASU follows standard protocols and best practices for measuring contaminants in a variety of environmental samples.</p>	<p>The Queen's ASU is accredited by CALA (formerly CAEAL) to the standards of ISO/IEC 17025. The Queen's ASU is an environmental chemistry laboratory, and has provided analytical services to industry, government, and universities for 25+ years.</p>
<p>To develop awareness of environmental contaminants in the traditional food sources of Mi'kmaq people, and to inspire further research into said environmental contaminants should this project find concerning levels of contaminants in traditional food sources.</p>	<p>Pre- and post-community engagement sessions, ceremony with Elders and youth, adopting PLL program for youth and students.</p>	<p>Qualitative: community engagement</p>	<p>Host pre and post engagement sessions to discuss project, bring awareness, and discuss results. Hold ceremony with Elders and youth and use the PLL program to inspire future students.</p>	<p>The number of members reached will be recorded, discussion summary recorded and summarized in a report.</p>
<p>To determine human health exposure through consumption</p>	<p>A human health risk assessment advisor will develop and conduct a traditional food frequency survey, data analysis and interpretation, and provide a report</p>	<p>Qualitative and Quantitative: Community engagement and data analysis/interpretation</p>	<p>Survey will be presented at engagement sessions.</p>	<p>The number of members reached will be recorded, discussion summary recorded and summarized in a report</p>

7 REFERENCES

- Batal, M., et al. (2021). *First Nations households living on-reserve experience food ...* <https://pmc.ncbi.nlm.nih.gov/articles/PMC8239078/>
- Bedeau, K. (2006). Perceptions of health and environmental contamination on the Aamjiwaang First Nation reserve (Ontario). *Electronic Theses and Dissertations*, 3035. University of Windsor.
- Canadian Council of Ministers of the Environment. Canadian sediment quality guidelines for the protection of aquatic life: DDT, DDE, and DDD. In: *Canadian Environmental Quality Guidelines*. Winnipeg: Canadian Council of Ministers of the Environment; 1999a.
- Canadian Council of Ministers of the Environment. Canadian tissue residue guidelines for the protection of wildlife consumers of aquatic biota: DDT (total). In: *Canadian Environmental Quality Guidelines*. Winnipeg: Canadian Council of Ministers of the Environment; 1999b.
- Chan, H. M., et al. (2021). *The First Nations Food, Nutrition and Environment Study ... 56% report chronic conditions*. <https://pmc.ncbi.nlm.nih.gov/articles/PMC8239066/>
- Chan, L., et al. (2021). FNFNES Final Report for Eight Assembly of First Nations Regions: Comprehensive Technical Report. Assembly of First Nations, University of Ottawa, Université de Montréal.
- Collas, C., Helder, R., Guillon, E., Sayen, S., Quintaine, T., Feidt, C., Jurjanz, S., & Fournier, A. (2024). Roe deer exposure to trace metals and pesticides in forests and agricultural plains of North-eastern France. *Environmental science and pollution research international*, 10.1007/s11356-024-34926-y. Advance online publication. <https://doi.org/10.1007/s11356-024-34926-y>
- Conservation Council of New Brunswick. 2025. <https://www.conservationcouncil.ca/herbicides/>
- Danielsson, S., T. Odsjo, A. Bignert, and M. Remberger. (2008). Organic Contaminants in Moose (Alces alces) and Reindeer (Rangifer tarandus) in Sweden from the past twenty years. Stockholm, Sweden, Department of Contaminant Research, Swedish Museum of Natural History.
- David B. Lindenmayer, Marta Yebra, Geoffrey. J. Cary (2023). Perspectives: Better managing fire in flammable tree plantations. *Forest Ecology and Management*, Volume 528. <https://doi.org/10.1016/j.foreco.2022.120641>.
- Dimond, J.B., Owen, R.B., (1996). Long-term residue of DDT compounds in forest soils in Maine. *Environmental Pollution* 92, 227–230.

- Duke, S. 2010. Glyphosate Degradation in Glyphosate-Resistant and –Susceptible Crops and Weeds. *J. Agric. Food Chem.* 2011, 59, 5835–5841. [dx.doi.org/10.1021/jf102704x](https://doi.org/10.1021/jf102704x) |.
- Edge, C. B., Haines, W., Blaney, M., & Noël, M. (2023). Low detection of glyphosate in rivers following application in forestry. *Pest management science*, 79(8), 2951–2958. <https://doi.org/10.1002/ps.7473>
- First Nations Information Governance Centre. 2023. *The First Nations Principles of OCAP®*. <https://fnigc.ca/ocap-training/>.
- Friesen, J. (1997). *Rediscovering the First Nations of Canada*. Calgary: Detselig Enterprises Ltd. Government of New Brunswick. 2025. *Vegetation Management*. <https://www2.gnb.ca/content/gnb/en/departments/erd/forestry-conservation/content/vegetation-management-herbicides/faq.html>
- Health Canada. 2008. *Consumer Product Safety. Maximum Residue Limit for Pesticides*.
- Hartz S, MacLean DA, Johns RC, Carleton D, Amos-Binks L, Anderson Q, et al. (2023) Historical pesticide applications for the treatment of eastern spruce budworm infestations in New Brunswick. *Ecology*. 2023;104(7):e4068. <https://doi.org/10.1002/ecy.4068> PMID: 37248722
- Holländer H, Amrhein N. The Site of the Inhibition of the Shikimate Pathway by Glyphosate: I. INHIBITION BY GLYPHOSATE OF PHENYLPROPANOIC SYNTHESIS IN BUCKWHEAT (*FAGOPYRUM ESCULENTUM* MOENCH) . *Plant Physiol.* 1980 Nov;66(5):823-9. doi:10.1104/pp.66.5.823.
- Klich, D., Łopucki, R., Stachniuk, A., Sporek, M., Fornal, E., Wojciechowska, M., & Olech, W. (2020). Pesticides and conservation of large ungulates: Health risk to European bison from plant protection products as a result of crop depredation. *PLoS one*, 15(1), e0228243. <https://doi.org/10.1371/journal.pone.0228243>
- Kurek J, Fraser MP, Nakamoto BJ, Kidd KA, Edge CB. (2025). Legacy DDT and its metabolites in Brook Trout from lakes within forested watersheds treated with aerial applications of insecticides. *PLoS ONE* 20(4): e0320665. <https://doi.org/10.1371/journal.pone.0320665>
- Kurek J, MacKeigan PW, Veinot S, Mercer A, Kidd K. (2019). Ecological legacy of DDT archived in lake sediments from eastern Canada. *Environmental Science & Technology* 53 (13): 7316-7325.
- L'nuey. (2021). The Concepts of Netukulimk and Two-Eyed Seeing. https://lnuey.ca/wp-content/uploads/2021/03/CONCEPTS-FactSheet_2021.pdf
- Landers, D. H., et al., (2008). The Fate, Transport, and Ecological Impacts of Airborne Contaminants in Western National Parks (USA). EPA/ 600/R-07/138. U.S. Environmental Protection Agency, Office

of Research and Development, NHEERL, Western Ecology Division, Corvallis, Oregon, USA.

Langlois C, Langis R. (1995) Presence of airborne contaminants in the wildlife of northern Québec. *Sci Total Environ.* 1995 Jan 15;160-161:391-402. doi: 10.1016/0048-9697(95)04372-8. PMID: 7892577.

Maliseet Nation Conservation Authority. 2018. *Investigation of glyphosate residues in deer or moose tissues, browse, and berries in Maliseet Territory in New Brunswick.* <https://fnecp-plcepn.ca/investigation-of-glyphosate-residues-in-deer-or-moose-tissues-browse-and-berries-in-maliseet-territory-in-new-brunswick/>

Metepenagiag Heritage Park. (n.d.). *Tour groups.* <https://www.metpark.ca/tour-groups/packages/>

Morris, D. 2014. Aquatic Habitat Use by North American Moose (*Alces alces*) and Associated Richness and Biomass of Submersed and Floating-leaved Aquatic Vegetation in North-central Minnesota. *Lakehead University.* <http://knowledgecommons.lakeheadu.ca/handle/2453/583>.

New Brunswick Environmental Network. (n.d.). *Glyphosate ban.* <https://www.nben.ca/en/component/tags/tag/glyphosate-ban>

Nicholas C. Larter, Derek Muir, Xiaowa Wang, Danny G. Allaire, Alicia Kelly, and Karl Cox. *Persistent Organic Pollutants in the Livers of Moose Harvested in the Southern Northwest Territories, Canada.* *Alces* VOL. 53: 65–83.

Ratelle, M., et al. (2020). Food frequency questionnaire assessing traditional food consumption in Dene/Métis communities, Northwest Territories, Canada. *International journal of circumpolar health*, 79(1), 1760071. <https://doi.org/10.1080/22423982.2020.1760071>

Sikorski, L., Baciak, M., Beś, A., Adomas, B. 2019. The effects of glyphosate-based herbicide formulations on *Lemna minor*, a non-target species. *Aquatic Toxicology.* 209:70-80. <https://doi.org/10.1016/j.aquatox.2019.01.021>.

Sugden S, White AB, Lento J, Kurek J, Dimitrovas I, Emry S, Hua X, Ijzerman MM, Kidd KA, Morrow KL, Ollinik JE, Schnell L, Thormeyer M, Edge CB. (2025). Legacy effects of four decades of insecticide applications on contemporary riverine benthic macroinvertebrates. *Environmental Pollution* <https://doi.org/10.1016/j.envpol.2025.126397>

Wu X R, Yuan Ping Li, Shu Xin Tu, Yong Zhen Ding, Rui Gang Wang, Christopher Rensing, Ren Wei Feng. (2019). Elevated atmospheric CO₂ might increase the health risk of long-term ingestion of leafy vegetables cultivated in residual DDT polluted soil. *Chemosphere:* 227, 289-298.

International Agency for Research on Cancer (2015). Some Organophosphate Insecticides and Herbicides. *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, Volume 112.

Kurek J, Fraser MP, Nakamoto BJ, Kidd KA, Edge CB. (2025). Legacy DDT and its metabolites in Brook Trout from lakes within forested watersheds treated with aerial applications of insecticides. *PLoS ONE* 20(4): e0320665. <https://doi.org/10.1371/journal.pone.0320665>