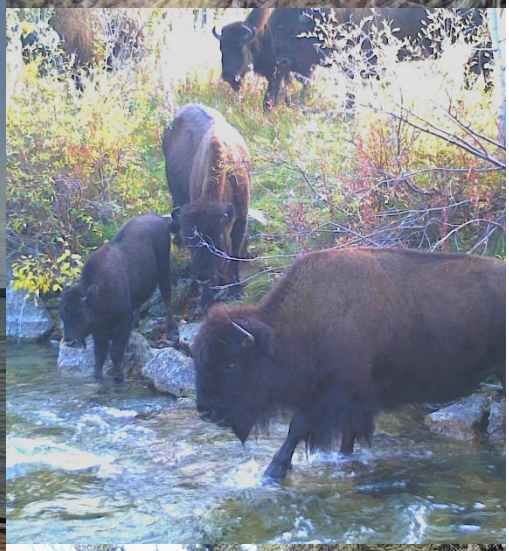

Merging Advanced Technologies with Traditional Knowledge for Species at Risk Protection

North Slave Métis Alliance

5-year report (2019-2023)

Funded by Environment and Climate Change Canada's Aboriginal Fund for Species at Risk and the Northwest Territories Species Conservation and Recovery Fund.

May 2024

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Merging Advanced Technologies with Traditional Knowledge for Species at Risk Protection (2019-2024)

Executive summary

One of the biggest obstacles to conservation in Northern Canada is capacity limitations in an extremely large area of study. This means that we have limited baseline information on species occurrences. In the Northwest Territories, less than 40,000 people live in a territory spanning 1.346 million km^2. Climate change, rising temperatures and loss of permafrost are having a significant impact on northern communities, peoples, biodiversity and habitats.

Conservation of northern species, especially those that are culturally important to Indigenous people, is critical. The North Slave Métis Alliance (NSMA) represents Indigenous peoples who are part of the broader Métis of the Great Slave Lake region within the NWT. Métis of the Great Slave Lake region have inhabited the lands and waters of their traditional territories for generations, and continue to use and inhabit them to this day. NSMA members can contribute heavily to documenting areas of importance to species diversity, historical presence of these species, as well as the habitats that are critical to local species.

Research questions/objectives:

Our overarching objective was to use a combination of western science and Traditional Knowledge to identify as many targeted species as possible at roughly one dozen sampling locations in the North Slave Region of the NWT. Targeted species are defined here as culturally important species and species at risk, notably Boreal Caribou, Wood Bison, Wolverine, Northern Leopard Frog, Western Toad and Little Brown Myotis. We used a combination of eDNA analysis and environmental sensors (game cameras and autonomous recording units) to create species baselines for each location to inform potential future conservation actions. We placed a special emphasis on creating an enhanced species baseline for Old Fort Rae which is located within the boundaries of the proposed Dınàgà Wek'èhodì protected area.

Results:

Over the past five years this program has enabled NSMA to build our internal capacity to monitor wildlife across the North Slave Region. Through eDNA analysis we have confirmed the presence of 44 different species of mammals, birds and amphibians across 13 locations of which, four are species at risk (Caribou, Wolverine, Wood Bison and Horned Grebe). Game cameras have enabled us to confirm the presence of several other species that were not picked up through eDNA sampling such as Gray Wolf and Canadian Lynx. ARUs picked up 54 different species of birds on the NWT species at risk list, including Lesser Yellowlegs, Evening Grosbeak and Olive-sided Fly Catcher. In the future we hope to conduct temporal analysis to be able to track changes in species detections over time.

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Figures and Tables

Acknowledgements

North Slave Métis Alliance would like to thank all the members that participated in this project over the years, giving it life and meaning. These members include, Wayne Langenhan, Wayne Mercredi, Darryl Bohnet, Shirley Coumont, Joel Dragon Smith, Taylin Gibeault, Dylan Coumont, Al Harman Jr, Alan Harman Sr, Evelyn D'hont, Melissa MacLellan and Stefany Bulmer. Thanks in particular to Alan Harman Jr., Wayne Mercredi, Chloe Dragon Smith, and Stefany Bulmer for your knowledge and guidance in identifying some of the true gems of the North Slave region at the inception of this project.

Thank you to all NSMA staff who have also participated and helped to shape this program over the years including Alan Alex, Jessica Smart, Noah Johnson, Orna Phelan and Jaimee L'Heureux. A huge thank you to Jessica Hurtubise, previous NSMA environmental manager who ran this project for many years. Much of the information in this report comes directly from previous reports authored by Jessica.

Our deepest appreciation also goes to Whatì community member Joseph Moosenose from the Tłı̨chǫ First Nation, who welcomed us into his boat and onto his land, and who graciously shared his stories of local species and changing ecosystems. We also thank Environment and Climate Change of the Government of the Northwest Territories for their contribution of key species tissue and blood samples required to expand the metabarcoding genetic database to detect species of interest in this project. We would like to sincerely thank the members of the GNWT Sensor Advisory Committee, in particular Caroline Bampfylde, who met with us and provided us with some incredibly useful training material for working with game cameras and ARUs.

We would like to thank our partners at SPYGEN and Zoetica consulting for always being willing to offer support and guidance for this project. Thank you to the Biodiversity Pathways team, in particular, Alex McPhail and Kevin Kelly who helped to process and analyse our ARU data and who provided insight and advice on sampling protocols for future years.

Finally, we thank Environment and Climate Change Canada (Aboriginal Fund for Species at Risk) and the Government of the Northwest Territories (Species Conservation and Recovery Fund) for providing the funding necessary to implement this project.

Acronyms and abbreviations

AFSAR- Aboriginal Fund for Species at Risk

ARUs- Autonomous recording units

CCME - Canadian Council of Ministers of the Environment

COSEWIC- Committee on the Status of Endangered Wildlife in Canada

DO- Dissolved Oxygen

ECC – Environment and Climate Change (Government of Northwest Territories)

ECCC- Environment and Climate Change Canada

eDNA- Environmental DNA

NSMA- North Slave Métis Alliance

PCR- Polymerase Chain Reaction

SAR- Species at risk

SARA- Species at Risk Act

SCARF- Species At Risk Recovery Fund

TDS- Total dissolved solids

TK- Traditional Knowledge

WMIS- Wildlife Management Information System

Introduction

1.1 North Slave Métis Alliance & Species at Risk

The North Slave Métis Alliance (NSMA) was established in 1996 to represent the section 35 Aboriginal rights-bearing Métis people of the Great Slave Lake area of the Northwest Territories. It is dedicated to promoting a sense of pride in Métis culture, heritage, and environment while enhancing the political, economic, social, and cultural development of its members. One of NSMA's core values is respect and protection for the land we live on. The NSMA Environment Department runs several community-based environmental monitoring and research programs which involve community members directly in the fieldwork. NSMA guardians are "watchers of the land" and are committed to being the eyes and ears for the land, animals and water. NSMA members can contribute heavily to documenting areas of importance to species diversity, historical presence of these species, as well as the habitats that are critical to local species.

There are two bodies that assess and list various species in Canada. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is an independent group of experts that assesses the status of species at a national level (Government of the Northwest Territories, 2024). The Species at Risk Committee (SARC) is similar to COSEWIC, except it operates at the territorial level as opposed to a national level. After receiving the Species at Risk Committee's assessment, the Conference of Management Authorities develops a consensus agreement on whether to add the species to the NWT List of Species at Risk. Therefore, species status may differ between SARC and COSEWIC assessment. Table 1 shows the status of each species discussed in this report in NWT versus Canada. A status ranking of "Not Applicable" means that the Species at Risk (NWT) Act does bot apply to this species. This species protection falls under a different Act.

NSMA traditional territory encompasses the ranges for many Species at Risk (SAR) and contains designated Critical Habitat for Boreal Caribou (*Rangifer tarandus*). In addition to Boreal Caribou, our project targeted the following species: Wood Bison (*Bison bison athabascae*), Little Brown Myotis (*Myotis lucifugus*), Wolverine (*Gulo gulo*), Northern Leopard Frog (*Lithobates pipiens*), Western Toad (*Anaxyrus boreas*), Shortjaw Cisco (*Coregonus zenithicus*) and several bird species including Bank Swallow (*Riparia riparia*), Barn Swallow (*Hirundo rustica*), Lesser Yellowlegs (*Tringa flavipes*), Short- eared Owl (*Asio flammeus*), Rusty Blackbird (*Euphagus carolinus*), Olive-sided Flycatcher (*Contopus cooperi*), Horned Grebe (*Podiceps auratus*), Harris's Sparrow (*Zonotrichia querula*), Evening Grosbeak (*Coccothraustes vespertinus*) and Common Nighthawk (*Chordeiles minor*). These species were selected based on their distribution (either historic or current) in NSMA asserted traditional territory, and on local and traditional knowledge of their distribution in the North Slave region.

Although the program focuses on several species at risk, caribou has and always will be the most vital species for Great Slave Lake area Métis. Many NSMA members speak to the interconnectedness between people and caribou and the importance of caribou to Métis

tradition and culture. NSMA is particularly invested in conservation plans for caribou and prioritizes caribou conservation in its environmental work.

Members have also hunted bison in the Mackenzie and Athabasca basins for many generations. Community bison hunts allow NSMA member to pass on their knowledge and skills to the younger generation while also providing meat to the community. As well as investigating species at risk, this program is beneficial to NSMA members as it provides information about the distribution of many important fish and aquatic species and water quality in areas around the North Slave region.

Species	Status in NWT	Year Assessed	Status in Canada	Year Assessed
Mammals				
Barren-ground Caribou	Threatened	2018	Threatened	2016
Boreal Caribou	Threatened	2017	Threatened	2003
Little Brown Myotis	Special Concern	2017	Endangered	2013
Wolverine	Not at Risk	2014	Special Concern	2014
Wood Bison	Threatened	2016	Special Concern	2013
Birds				
Bank Swallow	Not Applicable	Not Applicable	Threatened	2013
Barn Swallow	Not Applicable	Not Applicable	Special Concern	2021
Lesser Yellowlegs	Not Applicable	Not Applicable	Threatened	2020
Short- eared Owl	Not Applicable	Not Applicable	Threatened	2021
Rusty Blackbird	Not Applicable	Not Applicable	Special Concern	2017
Olive-sided Flycatcher	Not Applicable	Not Applicable	Special Concern	2018
Horned Grebe	Not Applicable	Not Applicable	Special Concern	2023
Harris's Sparrow	Not Applicable	Not Applicable	Special Concern	2017
Evening Grosbeak	Not Applicable	Not Applicable	Special Concern	2016
Common Nighthawk	Not Applicable	Not Applicable	Special Concern	2018
Amphibians				
Northern Leopard Frog	Threatened	2013	Special Concern	2009
Western Toad	Threatened	2014	Special Concern	2012
Fishes				
Shortjaw Cisco	Not Applicable	Not Applicable	Threatened	2003

Table 1. Status of Species at Risk in NWT (SARC assessment) and Canada (COSEWIC assessment) at the time of publication (Government of the Northwest Territories, 2024).

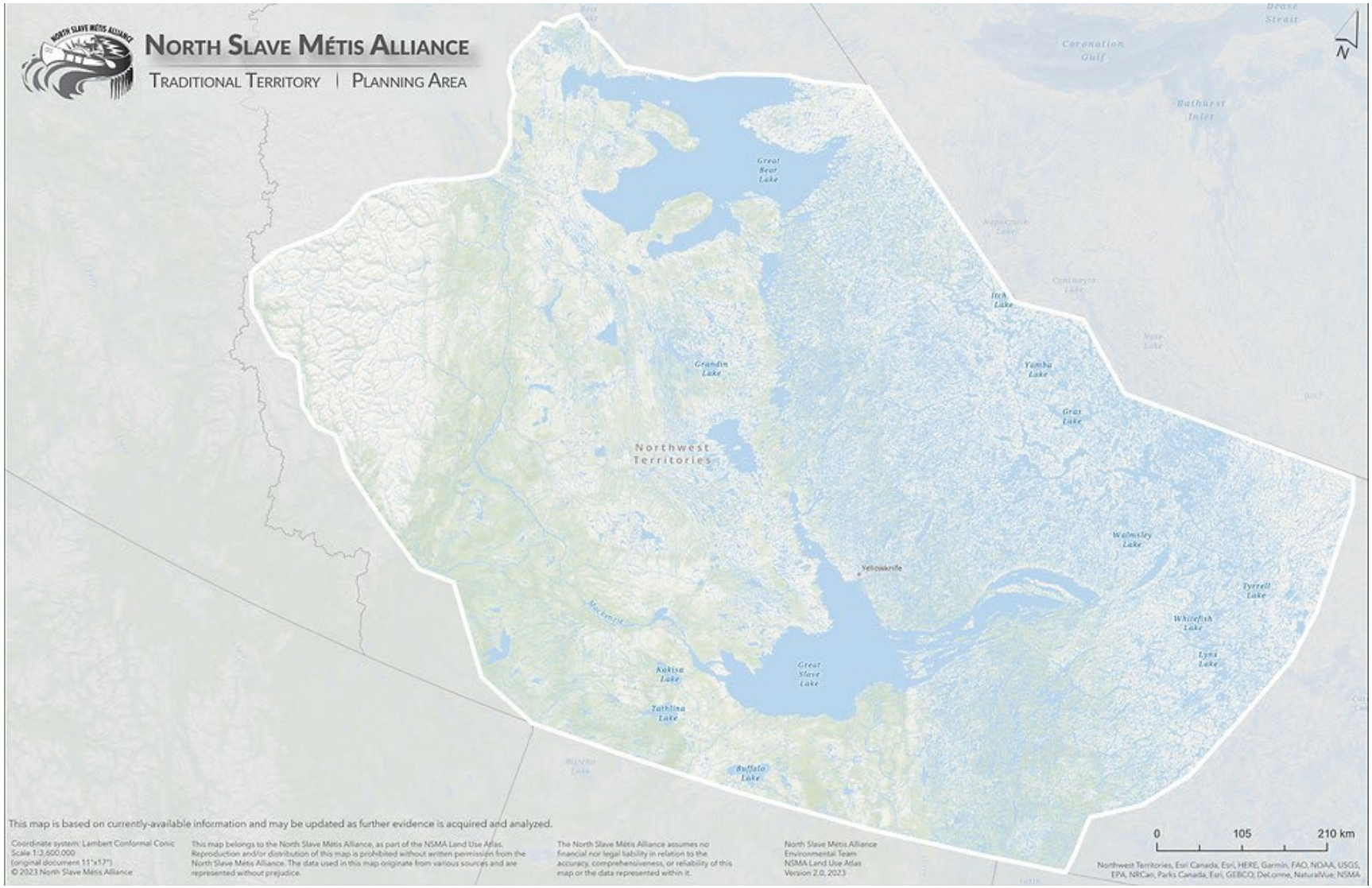


Figure 1. NSMA traditional territory

1.2 Funding Programs

Two species at risk conservation funds supported the work of this project. The Northwest Territories Species Conservation and Recovery Fund (SCARF; previously known as the Species At Risk Stewardship Program), is a fund that "supports the long-term conservation, recovery, and protection of species that are at risk in the NWT". Its priorities are to "fill knowledge gaps related to a species, its habitat or its threats" (NWT Species At Risk, "Species Conservation and Recovery Fund"). Environment and Climate Change Canada's Aboriginal Fund for Species At Risk (AFSAR) is a federal fund specifically supporting the work of Indigenous Peoples and organizations. AFSAR supports "the development of Indigenous capacity to participate activity in the implementation of the Species at Risk Act (SARA)", in which the Act "recognizes the important role that Indigenous Peoples play in wildlife conservation and the need to consider Aboriginal Traditional Knowledge (ATK) in the assessment of which species may be at risk, as well as in the development and implementation of protection and recovery measures" (Environment and Climate Change Canada, "Aboriginal Fund for Species At Risk"). NSMA has received funding under both programs from 2018-2023 fiscal years to run this project.

1.3 Project timeline

2018: The NSMA eDNA project began in 2018 as a community-based monitoring program focused on investigating the presence of various species at risk in the North Slave Region. In 2018, four NSMA members were interviewed to identify areas of interest to this study. These members are regular land users of the North Slave region and are knowledgeable about historic and current distribution of species traditionally harvested by the Métis. Locations were chosen based on members on-the-land knowledge of various species at risk (see Table 2.). Some of the aspects that we focused on when determining locations to sample were: 1) current or historical presence of the target species at risk in the North Slave region; 2) bodies of water (lakes or rivers) nearest to those locations; 3) locations of importance to traditional harvesting of NSMA membership; and 4) locations where multiple species, SAR or non-SAR, are present. Seven locations that included a combination of lakes and rivers were chosen and are as follows: Whatì river (Lac La Martre), Marian Lake, North Arm of Great Slave Lake, Mosquito Creek, Prosperous Lake, Tartan Rapids, Cameron River Ramparts and Pauline Lake. 1 NSMA member and 3 staff were trained in eDNA sampling through a combination of in-person and online training.

2019: In 2019 we completed our first round of eDNA sampling. 5 NSMA members, 2 staff and 2 GNWT-ECC staff were trained. NSMA collaborated with two community members from Tłı̨chǫ First Nation, Joseph Moosenose and Edward Rabesca who provided safe passage on lakes while water sampling. Our eDNA sampling detected 36 different species within the fish, amphibian, bird and mammal groups. Some species of interest to NSMA members that were detected were: pickerel (*Sander vitreus*; Marian Lake, Old Fort Rae, Pauline Lake) and lake cod (*Lota lota*; Cameron River, Pauline Lake). The only amphibian we detected was the wood frog (*Rana sylvatica*; Whatì River). We were pleased to detect moose (*Alces alces*) on Prosperous Lake and at Tartan Rapids, as these are historical locations for member harvesting of this species. Fur bearers such as muskrats and beaver were detected at multiple sites. In addition, a dead bat was discovered at Old Fort Rae and identified by ECC as a Little brown myotis.

2020: Due to feedback from SPYGEN (research laboratory that completes the eDNA analysis), sampling locations were modified to include only rivers as opposed to rivers and lakes. Based on SPYGEN's sampling methodology, the lakes of interest to NSMA are too large for the level of sampling effort possible for us. Instead, we shifted our sampling locations to the rivers downstream from the lakes of interest (ex. sampling Tartan Rapids and at the Yellowknife River Day Use Park rather than on Prosperous Lake). All together, 10 locations were sampled. This year sampling also included measuring water quality parameters such as conductivity, pH, total dissolved solids, water temperature and dissolved oxygen. Significant findings included the detection of caribou DNA at Whatì river. This was the first time we detected one of our target species. In addition, moose was detected at Cameron River, Pauline lake and Yellowknife River.

2021: In 2021, the program continued to expand to include sampling a total of 13 locations, including Old Fort Rae, a culturally important site for NSMA members and a hub for biodiversity. Old Fort Rae is the traditional outpost of the North Slave Métis Alliance in the North Arm of Great Slave Lake. This year wildlife cameras were installed at some of the eDNA locations to try to capture species occurrences that were being missed by eDNA sampling. This year several target species were detected including wood bison (Franks channel) and caribou (Baker Creek, Stagg River). Many important fish species such as lake cod, whitefish, northern pike and pickerel continued to be detected in many locations as was found in previous years.

2022: In 2022 we began sampling each of the 13 locations twice during the ice-free seasons, once in early summer and once in late summer/ fall to detect temporal differences. Although the eDNA sampling was detecting some birds such as waterfowl, there are some non-aquatic bird species listed as threatened or endangered found in the North Slave region that were not being picked up. This year we installed autonomous recording units (ARUs) alongside the game cameras to detect birds during the breeding season. This year more of our target species including caribou (Cameron river, Old Fort Rae, Whatì) and wolverine (Old Fort Rae) were detected. Muskox was also detected for the first time at Cameron River. Although muskoxen have been expanding their range into the South Slave over the past 20 years, this occurrence was interesting as it is outside their regular distribution (Winbourne and Benson, 2021). In addition, another dead bat was found at Old Fort Rae which was sent to ECC who confirmed it was a female juvenile little brown myotis. ECC collected a tissue sample for the DNA archive and took swabs to test for *Pseudogymnoascus destructans*, the fungus that causes white-nose syndrome. All data was entered into WMIS, ECC'S wildlife occurrences database. The carcass was then sent as a voucher specimen to a museum, since bats from the northern edge of the range are very under-represented in museum collections.

2023: As of now, 5 staff and more than 10 NSMA members have been trained on eDNA sampling. This year, a wildlife biologist and an environmental technician were hired to assist with the project. All but one of the 13 locations were sampled twice each, with all game cameras and ARUs being serviced and SD cards retrieved at the same time. Staff have begun processing the thousands of camera images that have been taken thus far and ARU recordings were sent to Biodiversity Pathways, a consulting firm that specialises in acoustic monitoring to be processed. We detected a total of 54 different bird species in the North Slave region, including Lesser Yellowlegs (Listed as threatened under COSEWIC), Evening Grosbeaks (Listed as special concern) and Olive-sided fly catchers (Listed as special concern).

Sampling location	Targeted species	Details on importance in this area
Whatì River	-Wood bison -Caribou	Whatì river is a known area for multiple fish species, including cisco. It is also an area where, historically, bison and caribou migrated through in large numbers. They still occupy parts of this area, but in smaller numbers.
North Arm of Great Slave Lake (Frank Channel, Stagg River, Old Fort Rae)	-Little brown myotis -Wood bison	The North Arm of Great Slave Lake is of great importance to NSMA members. Along its banks can be found the traditional harvesting outpost, Old Fort Rae, where traplines run up and down Great Slave Lake. A little brown myotis was found in one of the cabins of Old Fort Rae during a community gathering in winter 2019. Given this, we planned it as a sampling location due to its historical importance to NSMA and the sighting of the elusive little bat. Although wood bison typically stay on the western side of the North Arm, members occasionally see bison roam on the northeastern and eastern sides, making Old Fort Rae a good spot for sampling this species as well.
Mosquito Creek	-Shortjaw cisco -Various fish species	Mosquito Creek, which leads into the North Arm of Great Slave Lake, is a water body known to host the pickerel fish run in the fall. Although unlikely that shortjaw cisco occupies it, Mosquito Creek was requested as a sampling area out of interest to identify current species occupying this body of water during the fall fish run.
Yellowknife River & Tartan Rapids	-Shortjaw cisco -Various fish species -Western toad -Various frog species	The Yellowknife River system is an extremely important area for harvesting. Interviewees all stated the diversity in this area including moose, multiple fish species, frogs and toads, and historically bison. The Tartan Rapids are a known location important for the fall fish run, notably for the cisco species.
Cameron River Ramparts and Tibbit Lake	-Little brown myotis -Various fish species	Some members noted that the Ingraham trail (a highway leading northeast out of Yellowknife) has had some sightings of little brown myotis over the last decade, including around Tibbit Lake. The Cameron River Ramparts, a fast-moving section of the upper reaches of Yellowknife River, gives a good overview of this area.
Pauline Lake	-Ciscos -Various fish species	Located on the northern shore of the East Arm of Great Slave Lake, Pauline Lake is part of the Beaulieu River system. The East Arm is a productive part of Great Slave Lake and is a popular harvesting area (both hunting and fishing) for local Indigenous groups.

Table 2. Areas of interest as determined by NSMA members for the eDNA project, based on local and traditional knowledge of species distribution (including Species At Risk) (Hurtubise, 2021).

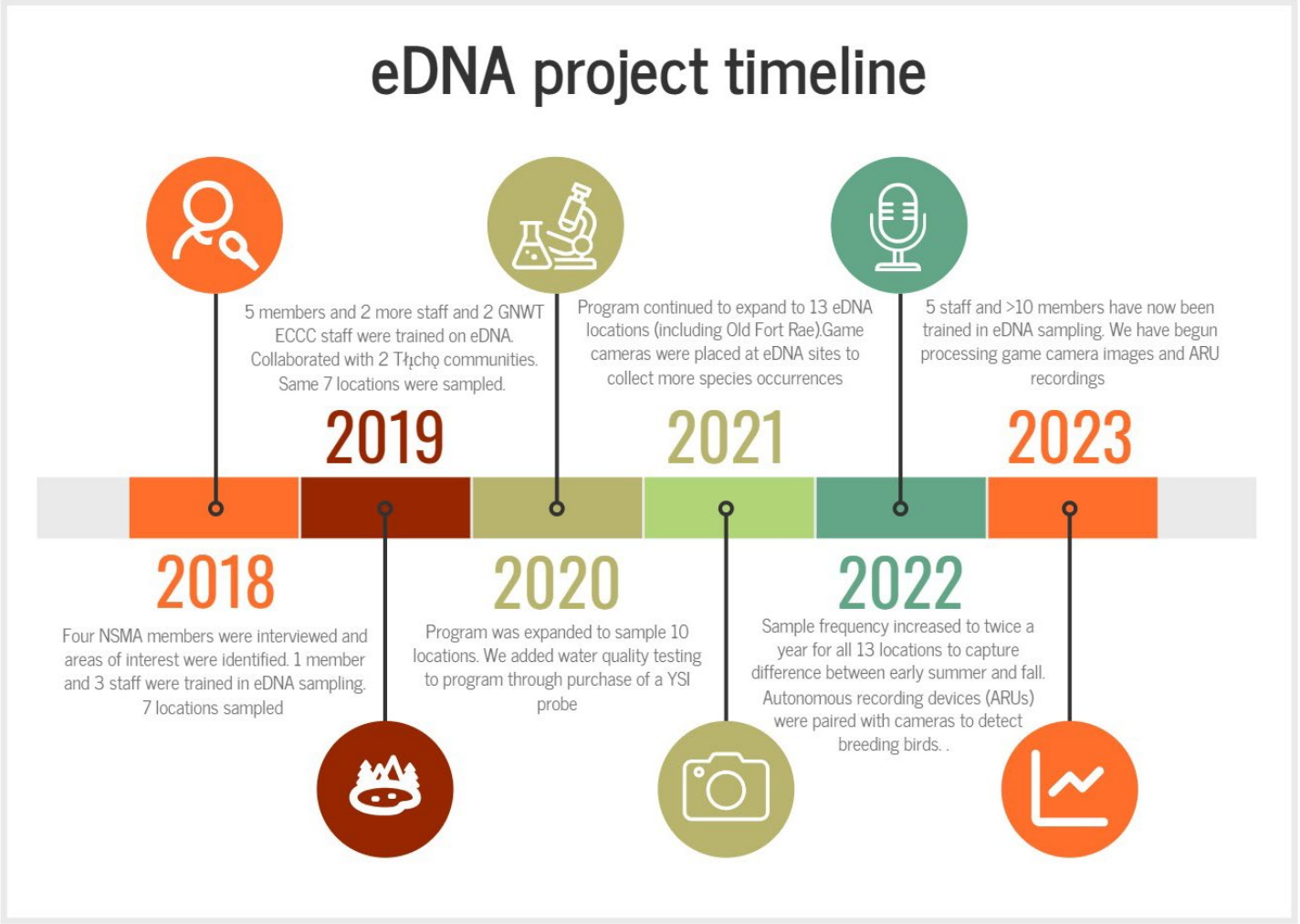


Figure 2. Timeline for NSMA's eDNA project "Merging Advanced Technologies with Traditional Knowledge for Species At Risk Protection" 2018-2023".

1.4 What is eDNA analysis?

Environmental DNA or eDNA is DNA that is collected from environmental samples such as water bodies rather than directly from an individual animal. All animals leave behind eDNA through the shed of biological materials such as skin, feces, urine or mucus. By collecting water samples from various locations and analysing them, we can get a species inventory of the species that are present in the water body at the time of sampling.

This project uses a type of technology called “VigiDNA M” or eDNA metabarcoding which can be used to detect many taxa within the same sample. Every animal has a unique DNA sequence or barcode that is a highly variable region between conserved genomic regions. Metabarcoding involves amplifying and sequencing these target regions of DNA to identify what species it belongs to. Metabarcoding is a powerful tool for species detection and can be used to address significant questions in ecology and conservation. Studies have shown that eDNA metabarcoding shows a much better detection probability overall than traditional surveys such as electrofishing, gill nets, and seines. (Valentini *et al.*, 2016; Keck *et al.*, 2022).

Advantages and limitations

Aquatic species, like fish and amphibians, are easiest to detect through eDNA as they reside in water bodies. Terrestrial species can also be detected through this method although within a shorter window of time. eDNA sampling is a powerful tool for monitoring threatened or endangered species as it detects species’ presence even in low populations. In addition, eDNA analysis is non-invasive as it does not involve catching animals or damaging habitats. However, the limitations of eDNA analysis must be considered when designing a study. For example, non-detection of a species in a water sample does not mean that the species is not present in the area and similarly, a positive detection does not necessarily mean that a species is present at the exact sample location. eDNA could have been transported or preserved after an animals death (Roussel *et al.*, 2015). The distance of detection depends on multiple factors such as eDNA persistence but also on water flow and so can be highly variable (Civade *et al.*, 2016). In addition, eDNA analysis cannot provide any information regarding factors such as the life stage, reproduction and fitness of a species (Herder *et al.*, 2013).

1.5 Passive environmental sensors

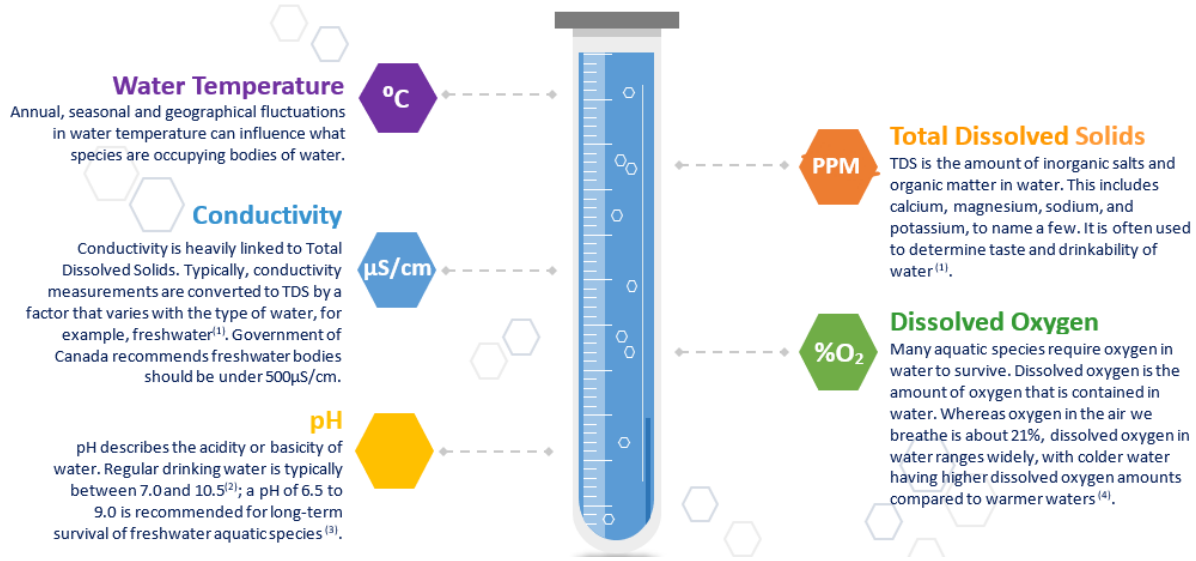
The use of passive environmental sensors such as game cameras and autonomous recording devices (ARUs) can be useful to detect rare or elusive species. Game cameras are triggered by a motion sensor and capture images of animals as they move through the field of vision. They are useful for detecting mid to large sized mammals such as caribou, bears, moose, wolves etc. On the other hand, ARUs are self-contained recording devices that can be used for bioacoustic monitoring of many vocalizing species including birds, bats and amphibians. ARUs can be programmed to record at certain times of the day or night depending on the study question. They can also monitor non-animal soundscapes such as anthropogenic noise from development, traffic and environmental noise such as ice cracking.

Both cameras and ARUs have the advantage of being non-invasive. They can document the activity of rarely seen wildlife and monitor animals without disturbing them. The use of passive sensory equipment makes sense for guardian-led programs as both game cameras and ARUs are relatively user friendly to operate and can be left in the field for long periods of time (Green *et al.*, 2020). However, one challenge when using environmental sensors is processing the large amount of data that is produced. For example, 100 ARUs each sampling 100 min/day generates 37TB/year with a play time of 2.8 years. In addition, remote cameras have a narrow field of view and may be unable to detect species that are in fact present.

Nonetheless, the use of game cameras and ARUs in combination with eDNA analysis can help to build up a species inventory at various locations. Cameras and ARUs may be able to pick up species that eDNA analysis is unable to detect and visa-versa. Another key advantage is the validation of on-site presence that camera/ARU data provide for positive eDNA results (since a positive eDNA result can occur when water transports DNA from another location). Visual observations and wildlife signs such as tracks, droppings, and fur are also noted whenever sampling sites are visited. At this time NSMA's primary goal with this monitoring is detection of as many species at risk as possible at each site. However, in the future, data collected by sensors could be used for a range of other types of analysis such as, determining landscape use by mammals, investigating the effect of industrial noise on species and abundance estimates of various species.

1.6 Water quality testing

Since 2020, water quality testing has been incorporated in addition to the eDNA sampling in order to evaluate the health of the water bodies. We use a YSI multiparameter digital water quality meter to test parameters such as: water temperature, conductivity, pH, total dissolved solids and dissolved oxygen. A description of what these different parameters can tell you is listed in the graphic below.



References

[1] Government of Canada – Total Dissolved Solids

[2] Government of Canada - pH

[3] Canadian Council of Ministers of the Environment

[4] Environment and Natural Resources – Dissolved Oxygen

Figure 3. Description of commonly measured water quality parameters (Hurtubise, 2021).

Methods

2.1 Areas of interest identification

Sampling locations took place in the asserted traditional territory of NSMA members. Four NSMA members were interviewed in 2018 for identification of areas of interest to this study. Originally, five lakes and five rivers were identified as areas of interest for sampling based on members' traditional and local knowledge. However, since then, we have modified the sampling locations to rivers exclusively. Based on SPYGEN's sampling methodology, the lakes of interest to NSMA are too large for the level of sampling effort possible for us. Instead, we shifted our sampling locations to the rivers downstream from the lakes of interest (ex. sampling Tartan Rapids and at the Yellowknife River Day Use Park rather than on Prosperous Lake. Figure 4 shows the locations of water bodies that NSMA samples each year.

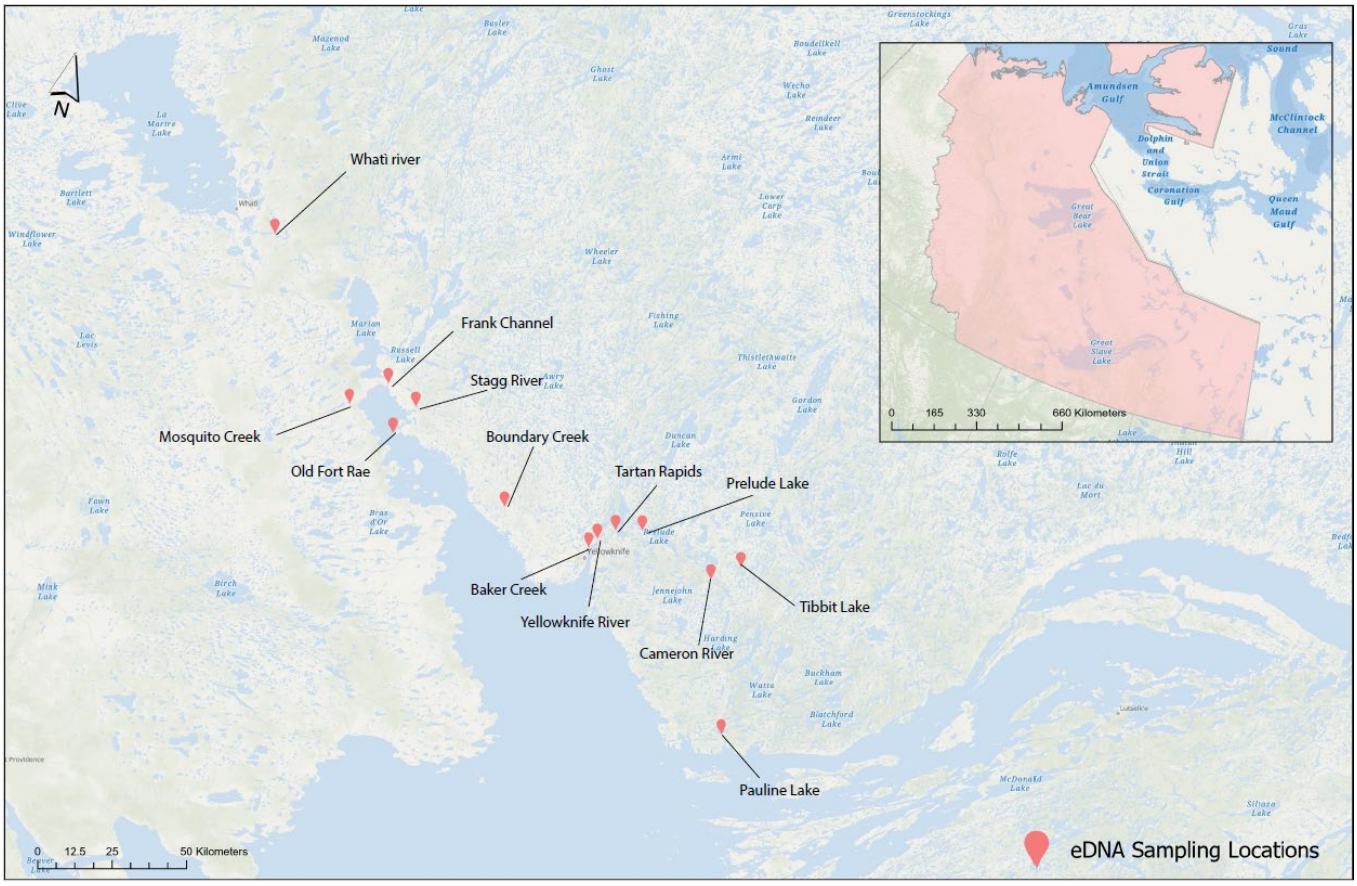


Figure 4. Sampling locations for NSMA eDNA project.

2.2 eDNA

A major component of this project involves providing training to NSMA members and staff in the eDNA sampling process. The training was offered jointly by SPYGEN and Zoetica Environmental Consulting. The Zoetica team came to Yellowknife to offer a training session in summer of 2018, and SPYGEN offered online training in the winter of 2019. NSMA staff have conducted in-field training with new members who want to be involved in the project every summer since. Training materials are available for any member or staff that would like to be trained in eDNA sampling and include: sampling process videos, guidebooks, equipment, and this report. NSMA plans to continue this sampling project, funding dependent, and will be looking to train additional members to conduct sampling.

2.3 Sampling – Lotic (Running) Water

Sampling methods are applied using the procedure developed by SPYGEN laboratories. Samples are collected using the RW1 kit with Vampyre sampling equipment. The Vampyre is a modified drill with a peristaltic pump at the head of the drill, where tubing can be attached to filter water through the filtration capsule. A sampler can collect the water sample from either shore or by vessel and by means of a rod covered in sterilized plastic, as long as samples are collected upstream from the sampler or the boat. Sterilized gloves are worn to prevent any contamination to the water sample and all equipment is only taken out of sterile packaging immediately prior to sampling. Samplers insert a silicone tube through the peristaltic Vampyre pump, attaching one end of the tube to a filtration capsule and dropping the other end (the end with the strainer) into the river. Filtration is carried out for 30min. The pump must run at a consistent speed and the tubing must remain in the top 30cm of the water column. Once filtration is complete, the sampler removes the tubing from the water and lets the pump filter air through the entirety of the tube to dispel remaining water from the capsule. Then the capsule is filled with buffer and shaken vigorously for 1min. The sampler records time, date, coordinates, sampler, sample ID, any notes, and photographs of the sampling location. Two water samples are collected for each location, ideally sampled at the same time.

Figure 5. River samples (lotic) taken using a modified drill made by SPYGEN, which pumps water through the filter capsule by the power of the peristaltic pump on the drill head. In both events, the samplers uses paddles to ensure the filtering tube remained underwater for the duration of sampling.

Figure 6. Syringe and filtering capsule (photo: SPYGEN).

2.4 SPYGEN eDNA analysis

Samples are stored at room temperature out of sunlight until sent to the SPYGEN laboratory for analysis. SPYGEN conducts DNA analysis through the following process: DNA extraction, polymerase chain reaction (PCR) to amplify the DNA by means of universal primers and identification of genetic sequences using “Next Generation” genetic database. This yields a list of species and the number of sequences per species per sample. Quality control tests are conduced for both DNA extraction and PCR procedures to ensure there is no contamination of samples.

2.5 Game camera and ARU set up

Over the last 3 years, game cameras have been placed at various sites across the North Slave region and in 2023 a game camera was paired with an ARU at each eDNA sampling site. Because Old Fort Rae is a significant site in terms of biodiversity, we decided to do a larger study and set up 8 cameras and 6 ARUs at this location. Although eDNA can detect vertebrates in water samples, it is more suitable for detection of aquatic species and amphibians that reside in water bodies. For this reason, we decided to pair our eDNA sampling with game cameras to try to capture more vertebrate species.

Placement of cameras was variable between sites and areas close to trails where animals were thought to use frequently were prioritized. NSMA community members and staff gave input on where to place cameras. These camera sites are targeted, non-random locations based on local knowledge. Two different camera models were used: the Browning Recon Force EDGE Trail Camera (BTC-7E) and the Spypoint solar dark trail cameras. Cameras were secured to trees at each location. Motion activated sensors on the cameras detect animals or objects when they pass in front of the detection zone. Each time an animal passed in front of the camera a series of 3 photos is taken.

Game camera analysis

Once SD cards are retrieved, the environmental technician uploads all photos to Wildtrax, an online platform that simplifies the processing, organization, storage, and sharing of environmental sensor data. Images are processed using an auto-tagger (an AI tool in Wildtrax) to detect whether an image shows an animal, human, vehicle or none (i.ie., false-fires). The auto tagger does not identify animals, it just finds them. Then, the environmental technician sorts through the filtered images and assigns species identification tags.

Due to malfunctions in some of the cameras only useable images were obtained from 7 locations. Depending on when sites were able to be visited to change SD cards, there are data gaps at some locations. A list of all date ranges that images were taken is provided in Table 3.

Once all images are tagged, a metadata sheet is produced. All instances of no animals, staff set up and humans are removed from the dataset. Then, the data is further cleaned to remove instances where the same animal or group of animals is detected multiple times within a time frame of one hour. The instance with the highest number of animals is kept. For example, sometimes a large group of bison passed through the detection zone and hundreds of pictures were taken. This was reduced to count this instance as one detection per individual in the group. This way, we tried to reduce the probability of over-estimating species abundance.

Sound file analysis

All sound files collected by ARUs were sent to Biodiversity pathways, a consulting firm that specialises in bioacoustic monitoring for processing. Because we were targeting breeding birds, we chose to analyse recordings from mid-May to the end of June. Recordings somewhat varied in length so we standardized by processing the first 3 minutes of the chosen recording. Four morning surveys and four evening surveys (within ~1 hour of sunrise/sunset) were randomly chosen for each location. Because the ARUs at Old Fort Rae were so close together, we chose to only analyse two sites at Old Fort Rae. The transcribers listened and examined the spectrograms of those three minutes to find the first instance of each species/individual within the 3 minute task. This means that if there is only 1 individual calling/singing for a species then there is only a single tag for that species in the recording. If there are multiple individuals of the same species then there will be 1 tag/individual of that species in the recording.


Figure 7. Camera deployed at eDNA site by NSMA guardians 2023 (Left), camera and ARU deployed at eDNA site by NSMA guardian 2023 (Right).

Location	Date ranges images were taken
Pauline lake	2022-10-14 to 2023-05-10 2023-5-18 to 2023-05-18
Mosquito creek	2021-09-21 to 2022-02-02 2022-05-28 to 2022-06-30 2022-09-18 to 2022-09-19 2023-05-25 to 2023-09-12
Stagg River	2021-10-13 to 2021-12-04 2023-05-19 to 2023-07-13
Baker Creek	2023-07-21
Boundary Creek	2021-10-13 to 2022-02-02
Yellowknife River	2023-05-17 to 2023-06-30
Cameron River Ramparts	2021-07-25 to 2021-08-25 2023-05-17 to 2023-08-09

Table 3. Game camera image timeframes that were used for analysis.

Results

3.1 Results- Game camera

All together we have processed almost 60,000 images taken by cameras at eDNA sites. The cameras detected a total of 27 different vertebrate species across 7 locations including a wolverine (species at risk) at Mosquito Creek (2021, 2022) and Pauline Lake (2022). Because the amount of data collected varied per location, this data should not be used to interpret which location had the highest species diversity, instead it can be used to confirm the presence of various species at these locations. Cameras were able to detect the following species that were not detected by eDNA water sampling: gray wolf (*Canis lupus*) and Canadaian lynx (*Lynx canadensis*). In addition, we were able to identify some birds to species level where eDNA was only able to identify broader taxonomic groups. For example, we knew from eDNA analysis that the family Anatidae, that includes water fowl such as ducks, geese, and swans, was being detected in some locations but through camera images we were able to identify specific species such as northern pintail (*Anas acuta*).

Figures 8, 9, and 10 show all species detected across our locations. Figures 11 and 12 show some highlighted photos taken by cameras. We are still currently processing game camera images for Old Fort Rae but have included some highlights in Figures 11 and 12.

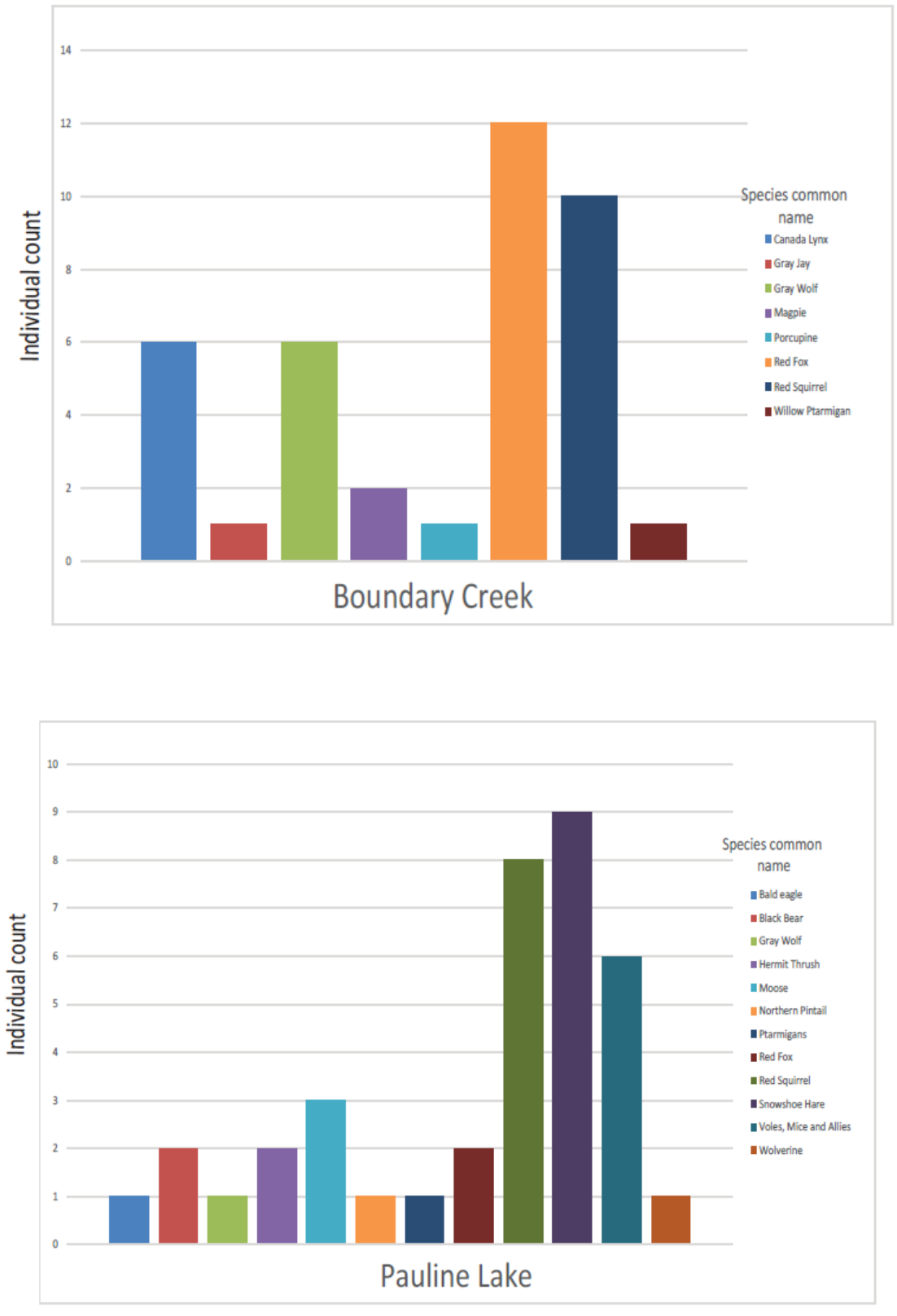


Figure 8. Graph of species detections from game cameras at Boundary Creek (top) Pauline Lake (bottom)

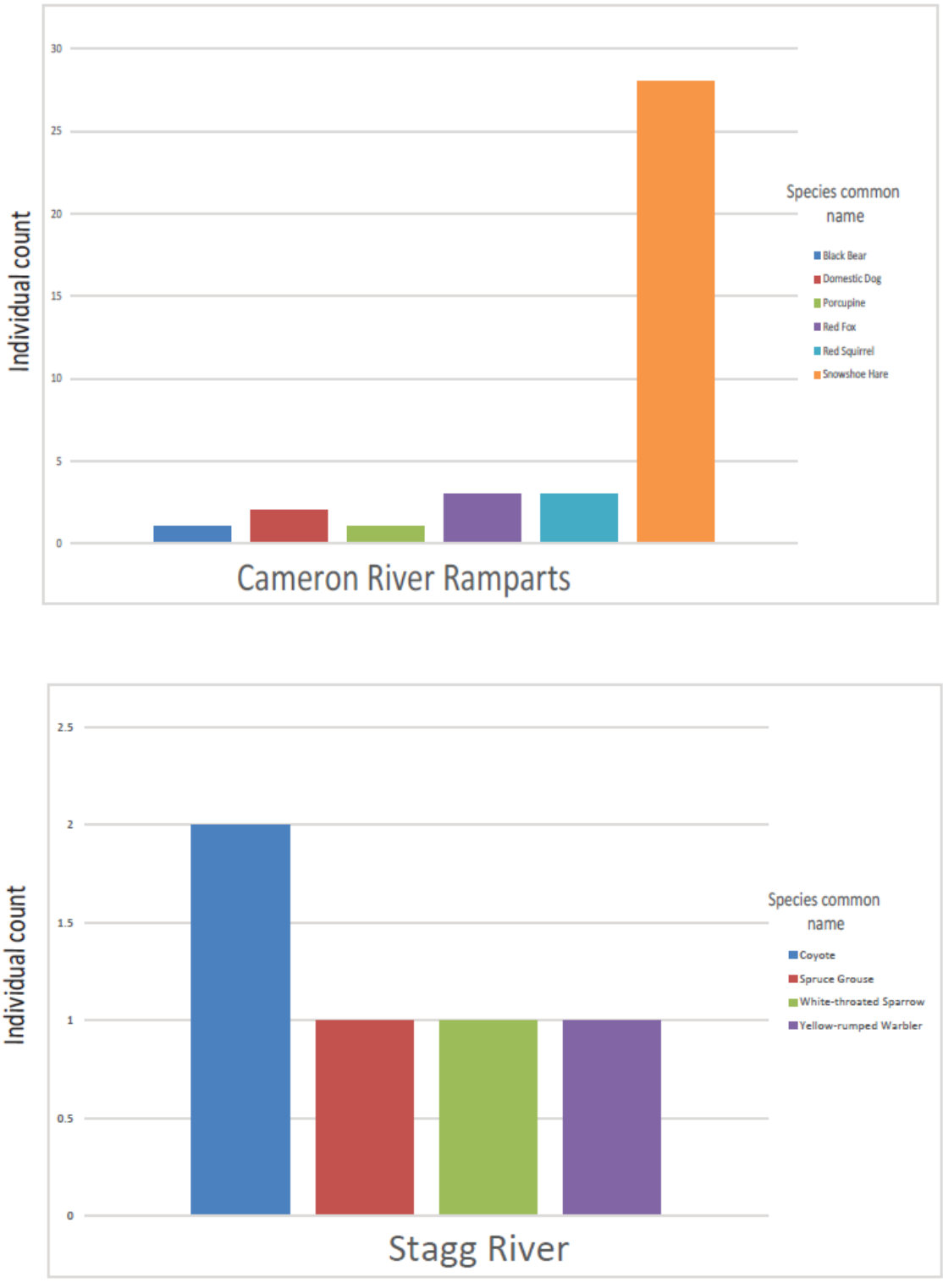


Figure 9. Graph of species detections from game cameras at Cameron River (top) Stagg River (bottom)

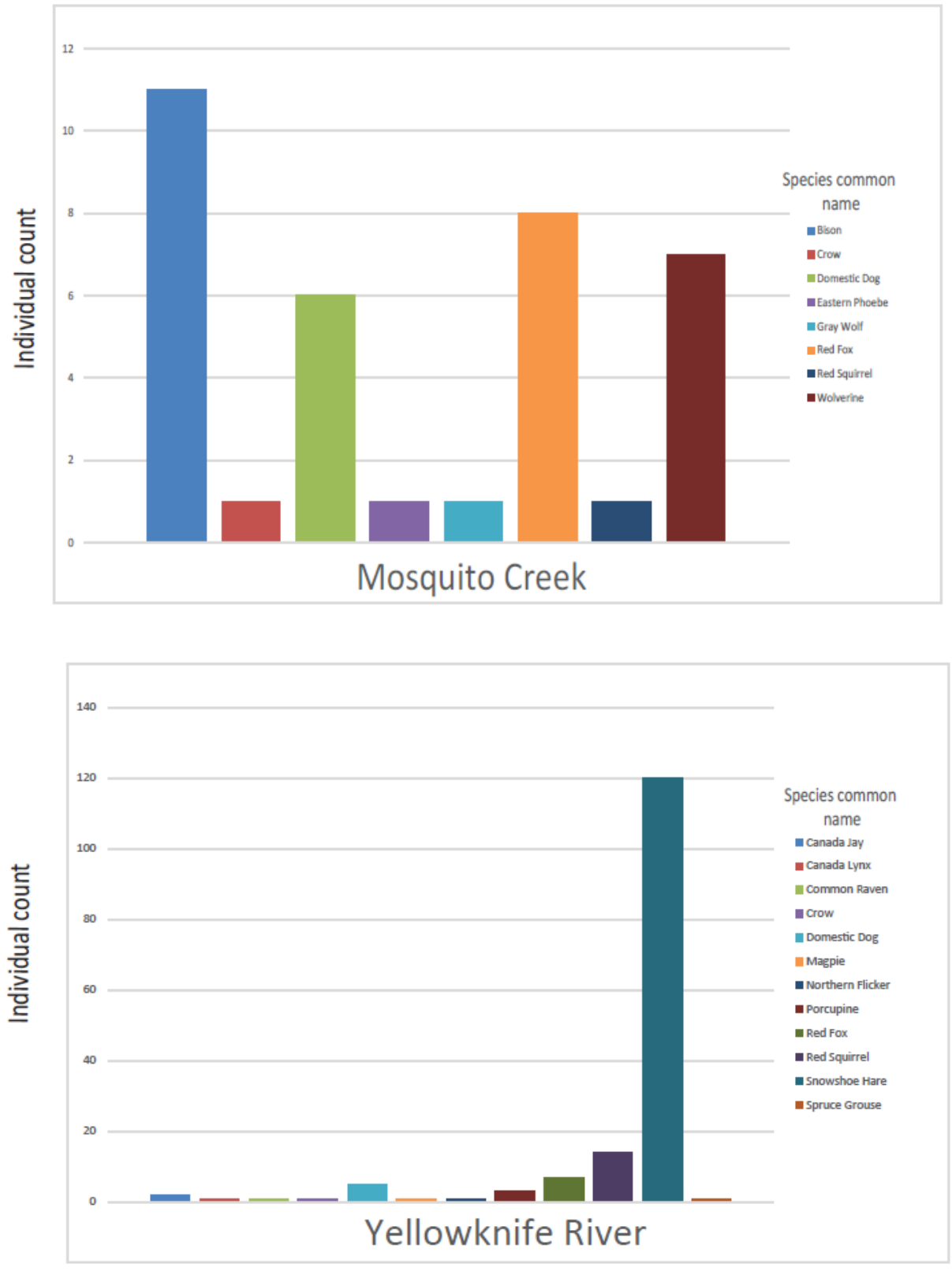


Figure 10. Graph of species detections from game cameras at Mosquito Creek (top), Yellowknife River (bottom)

Wolverine, Old Fort Rae, 2023-10-22

Gray wolf, Boundary Creek, 2021-05-12

Moose, Old Fort Rae, 2023-09-28

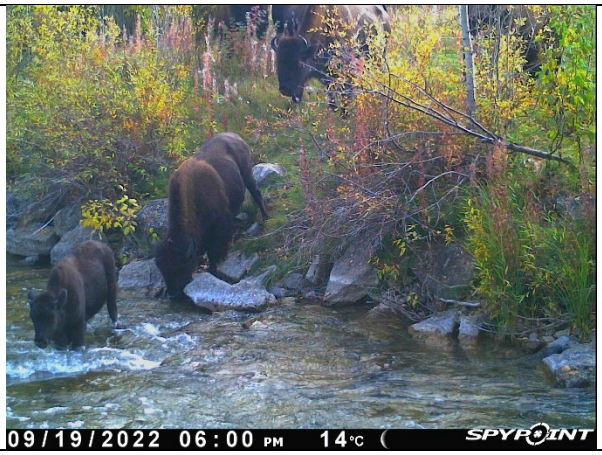
Lynx, Frank Channel, 2022-10-05

Moose chased by wolves, Old For Rae, 2024-01-10

Moose chased by wolves, Old For Rae, 2024-01-10

Figure 11. Various images from eDNA camera sites

Bald eagle, Pauline lake 2023-06-18



Bison, Mosquito creek, 2022-09-19

Fox, Boundary Creek, 2021-11-07

Black bear and cub, Old Fort Rae, 2021-09-14

American marten, Old Fort Rae, 2022-03-05

Snow bunting, Old Fort Rae, 2022-04-11

Figure 12. Various images from eDNA camera sites

3.2 Results - eDNA

Over the years our eDNA sampling has confirmed the presence of many traditionally important fish species to NSMA members in water bodies of the North Slave Region including Northern pike (also known as jackfish, *Esox lucius*), whitefish (*Coregoninae*) and walleye (also known as pickerel, *Sander vitreus*). Figure 14 shows the most common species detected through our analysis. Figure 15 shows this same information but by vertebrate class. It is important to note that with this kind of analysis detection to species level was not always possible. For example, eDNA analysis detected *Coregoninae* in many of our samples which represents a subfamily that includes around 60 species of whitefishes and ciscoes (Behnke, 2010). Therefore, this could represent lake whitefish, round whitefish or the short-jaw cisco (SAR). Detections that represent groups rather than specific species are annoted with a red star on each figure.

eDNA analysis has been able to detect three of our targeted species at risk (Figure 13):

- Caribou (*Rangifer tarandus caribou*) at Whati river (2020, 2022), Baker creek (2021, 2023), Stagg river (2021), Cameron river (2022), Yellowknife river (2023), Frank channel (2023), Boundary Creek (2023) and Old Fort Rae (2022)
- Wood bison (*Bison bison athabascae*) at Frank channel (2021, 2023) and Mosquito Creek (2023)
- Wolveine (*Gulo gulo*) at Old Fort Rae (2022)
- Horned Grebe (*Podiceps auritus*) at Baker Creek (2022, 2023)

Some other non-SAR species of interest that have been detected include: moose, american marten, North American river otter, muskox, black bear, American mink and wood frog.

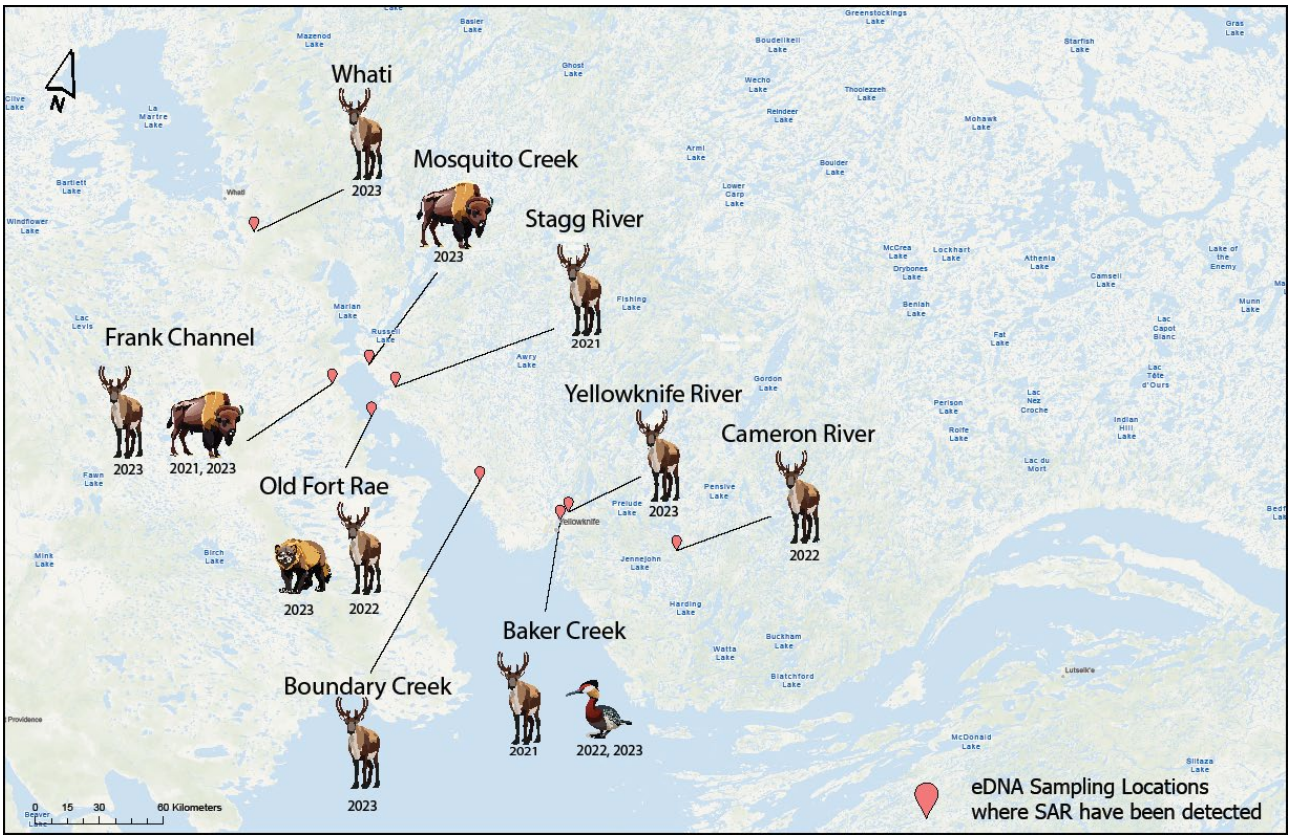


Figure 13. eDNA sampling locations where Species At Risk have been detected 2019-2023

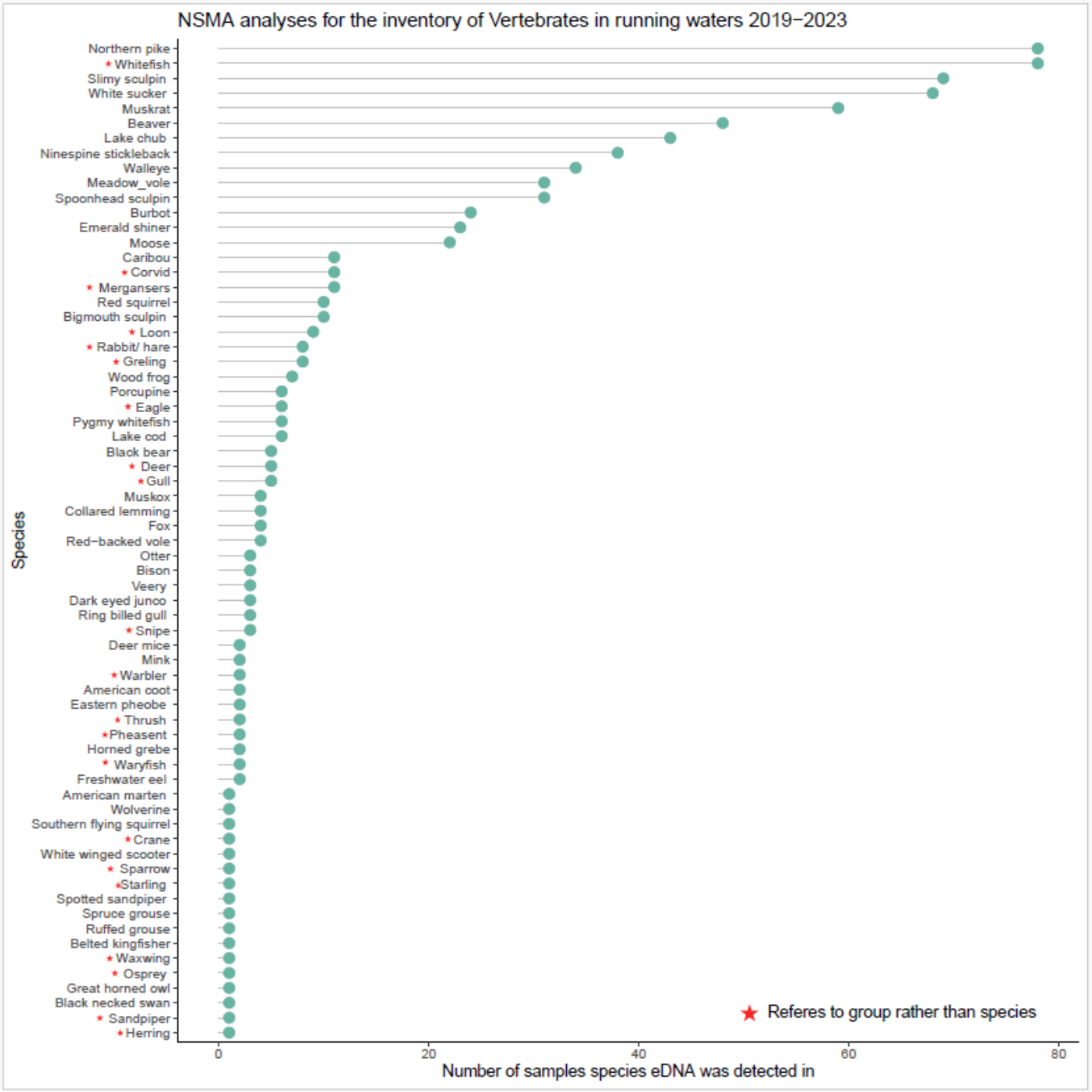


Figure 14. Most common species detected through NSMA eDNA sampling 2019-2023

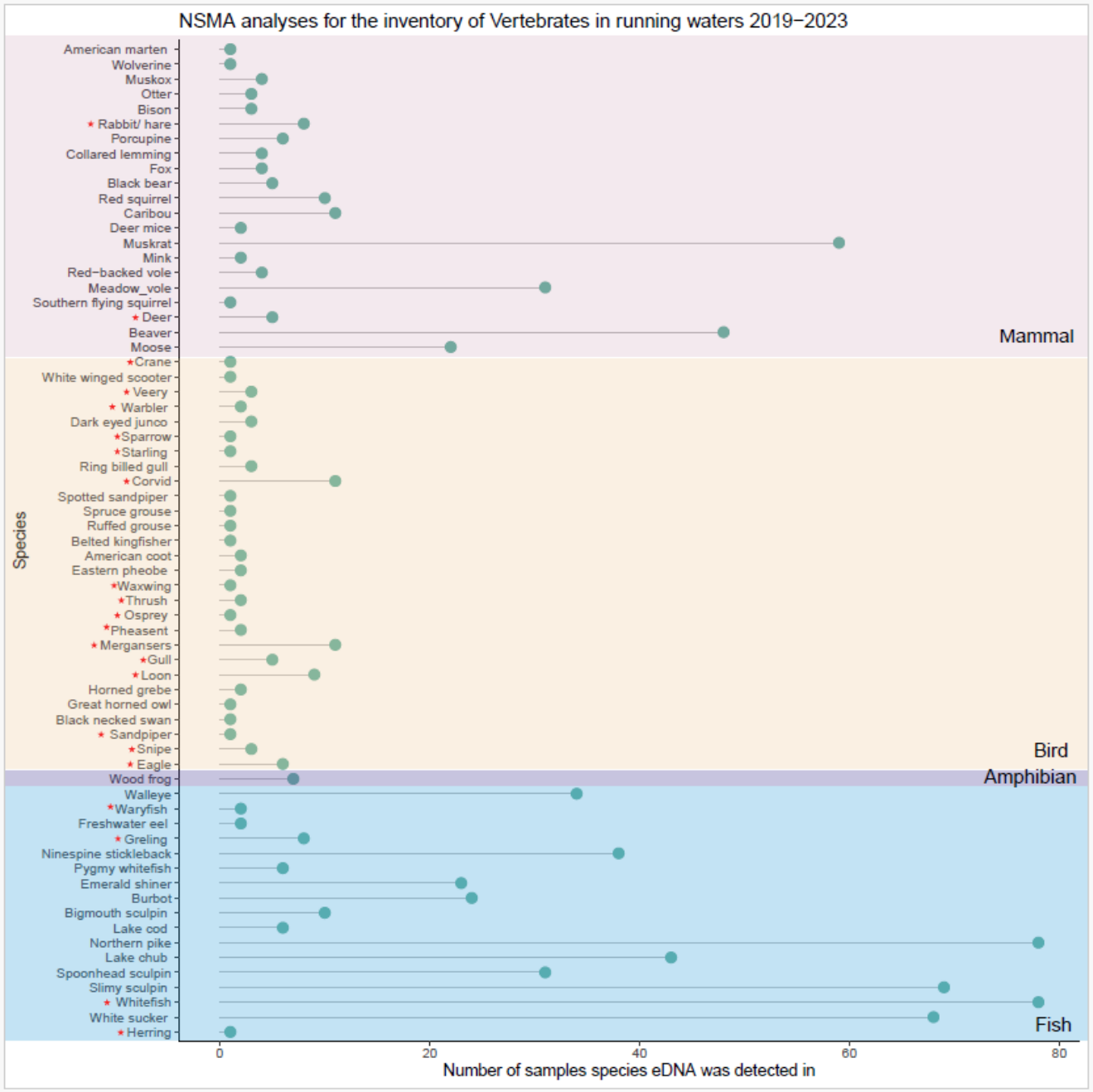


Figure 15. Most common species detected through NSMA eDNA sampling by group 2019-2023

3.3 Results – ARUs

Overall, ARU recorders picked up 54 different species of birds in the North Slave region. The full list of species detected can be found in Table 4. Species of interest include:

- Lesser Yellowlegs – Listed as threatened under COSEWIC. Detected at Cameron River (May 2023), Stagg River (May 2023), Tibbit Lake (May 2023)
- Evening Grosbeak- Listed as special concern under COSEWIC. Detected at Yellowknife River (May 2023)
- Olive-sided fly catcher- Listed as special concern under COSEWIC. Detected at Mosquito Creek (June 2023)

Species common name	**Scientific name**	**Number of detections**
Alder Flycatcher	*Empidonax alnorum*	4
American Robin	*Turdus migratorius*	24
American Wigeon	*Mareca americana*	4
Belted Kingfisher	*Megaceryle alcyon*	1
Boreal Chickadee	*Poecile hudsonicus*	3
Bonaparte's Gull	*Chroicocephalus philadelphia*	1
Canada Jay	*Perisoreus canadensis*	3
Cedar Waxwing	*Bombycilla cedrorum*	2
Chipping Sparrow	*Spizella passerina*	27
Common Loon	*Gavia immer*	3
Common Raven	*Corvus corax*	1
Dark-eyed Junco	*Junco hyemalis*	18
Evening Grosbeak	*Coccothraustes vespertinus*	1
Gadwall	*Anas strepera*	2
Great Horned Owl	*Bubo virginianus*	1
Greater Yellowlegs	*Tringa melanoleuca*	1
Herring Gull	*Larus argentatus*	2
Hermit Thrush	*Catharus guttatus*	16
House Wren	*Troglodytes aedon*	1
Least Flycatcher	*Empidonax minimus*	1
Lesser Yellowlegs	*Tringa flavipes*	4
Lincoln's Sparrow	*Melospiza lincolnii*	23
Mallard	*Anas platyrhynchos*	6
Northern Pintail	*Anas acuta*	2
Northern Waterthrush	*Parkesia noveboracensis*	5
Northern Shrike	*Lanius borealis*	1
Orange-crowned Warbler	*Leiothlypis celata*	12
Olive-sided Flycatcher	*Contopus cooperi*	1
Pacific Loon	*Gavia pacifica*	1
Palm Warbler	*Setophaga palmarum*	1
Pine Siskin	*Spinus pinus*	1
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	1

Ring-billed Gull	*Larus delawarensis*	2
Ruby-crowned Kinglet	*Corthylio calendula*	10
Red Crossbill	*Loxia curvirostra*	2
Red Squirrel	*Tamiasciurus hudsonicus*	6
Red-eyed Vireo	*Vireo olivaceus*	5
Red-necked Grebe	*Podiceps grisegena*	31
Ruffed Grouse	*Bonasa umbellus*	6
Red-winged Blackbird	*Agelaius phoeniceus*	2
Sandhill Crane	*Antigone canadensis*	3
Sora	*Porzana carolina*	10
Spotted Sandpiper	*Actitis macularius*	4
Swamp Sparrow	*Melospiza georgiana*	3
Swainson's Thrush	*Catharus ustulatus*	27
Tennessee Warbler	*Leiothylpis peregrina*	3
White-crowned Sparrow	*Zonotrichia leucophrys*	1
Wilson's Snipe	*Gallinago delicata*	9
Wood Frog	*Rana sylvatica*	3
White-throated Sparrow	*Zonotrichia albicollis*	21
Yellow Warbler	*Setophaga petechia*	2
Yellow-rumped Warbler	*Setophaga coronata*	28

Table 4. Full list of species detected through ARUs in the North Slave region 2023

3.4 Results- Water quality testing

Conductivity

Conductivity is a measure of how well water can pass an electric current. It is useful as a general measure of water quality because water bodies tend to have a relatively constant range of conductivity that can be used as a baseline for comparison. Large changes in conductivity could indicate that a discharge or some other source of pollution has entered the water body (US EPA, 2013). For all sampling locations except Mosquito Creek, conductivity levels were below the Canadian freshwater quality conductivity limit (Figure 16). Conductivity levels increase as water temperature increases and can also increase if a water body does not receive enough rain or stream water. However, because water quality testing is only done at our locations 2 times per year, it is likely that our data is not wholly representative of the water quality at each location throughout time due to natural seasonal variability. The large spikes in conductivity readings at Mosquito creek may be observer or machine error or it could potentially indicate runoff from the highway. It will be important to continue to monitor conductivity levels at Mosquito Creek to determine if pollution is in fact entering this water body.

Conductivity

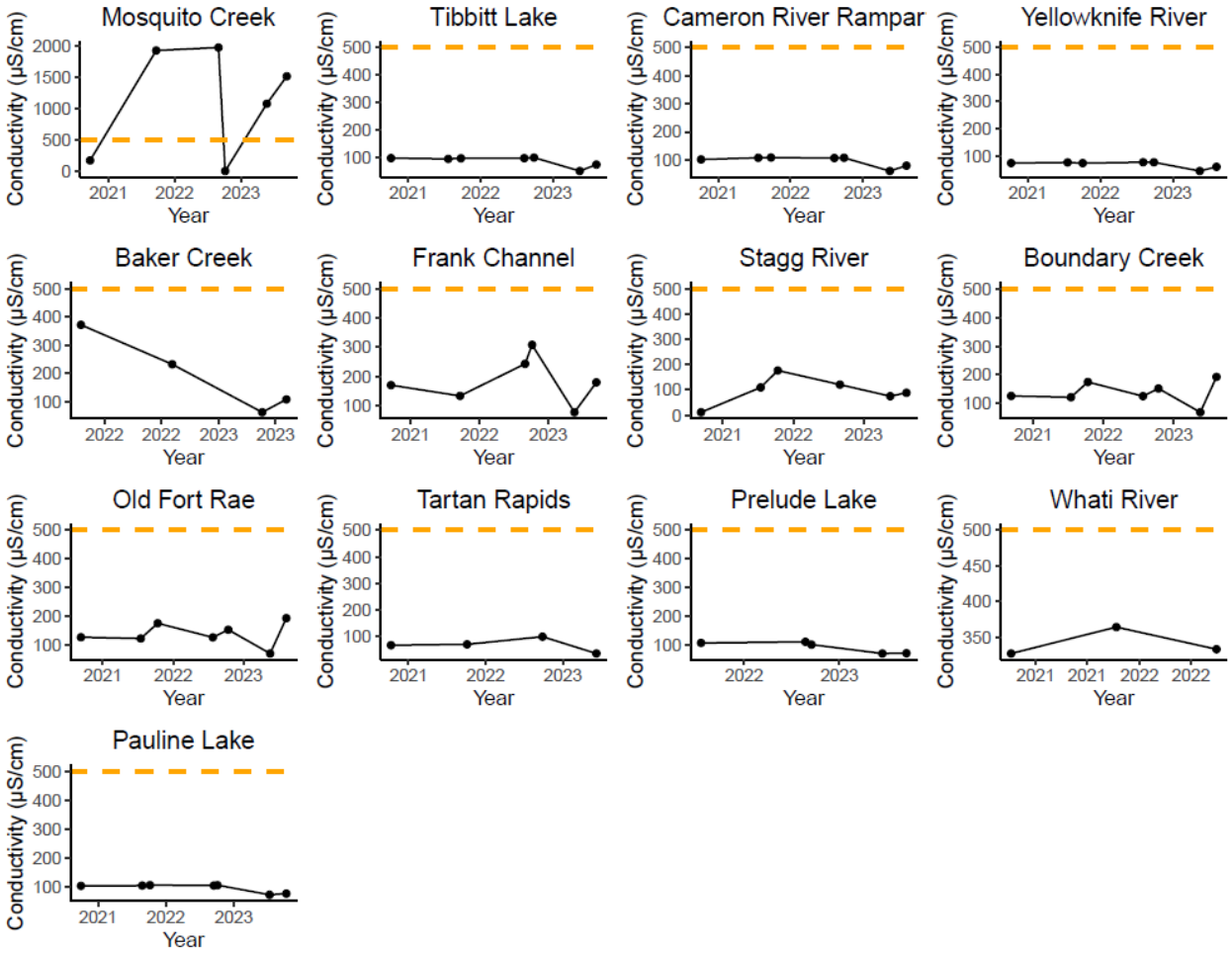


Figure 16. Conductivity levels at each eDNA site from 2021-2023. The dashed orange line indicates Canadian freshwater quality conductivity limit (500 µS/cm)

Total Dissolved Solids

Total dissolved solids is a measure of the inorganic salts, organic matter, and other dissolved materials in water. For all sampling instances except Mosquito Creek in early summer and fall 2023 TDS levels were below Canadian safe drinking water quality limits (Figure 17).

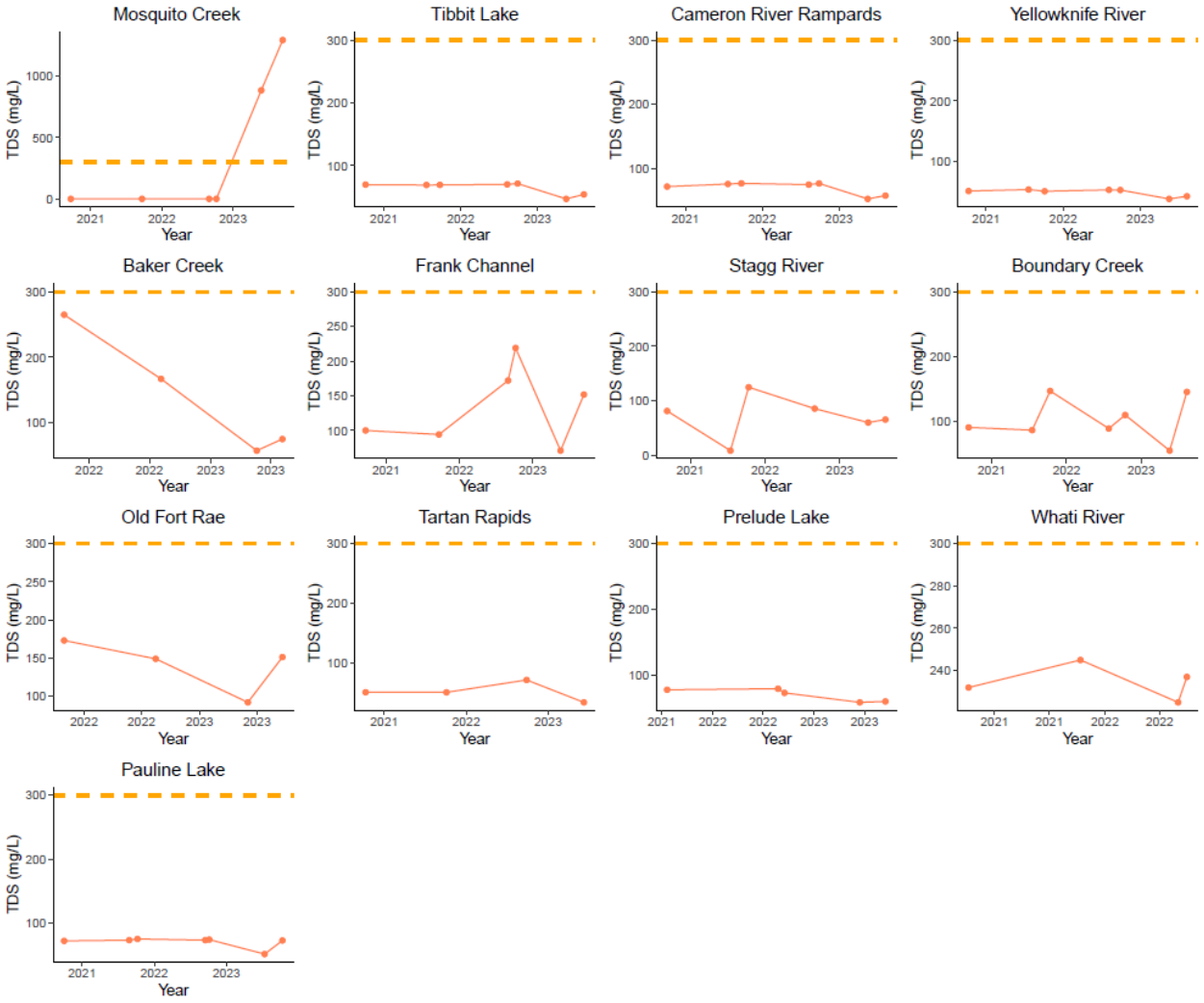


Figure 17. Total dissolved solids levels at each eDNA site from 2021-2023. The dashed orange line indicates Canadian safe drinking water quality limit (300 mg/L)

pH

For all locations the pH ranges were within CCME pH limit range (6.5-9) (Figure 18).

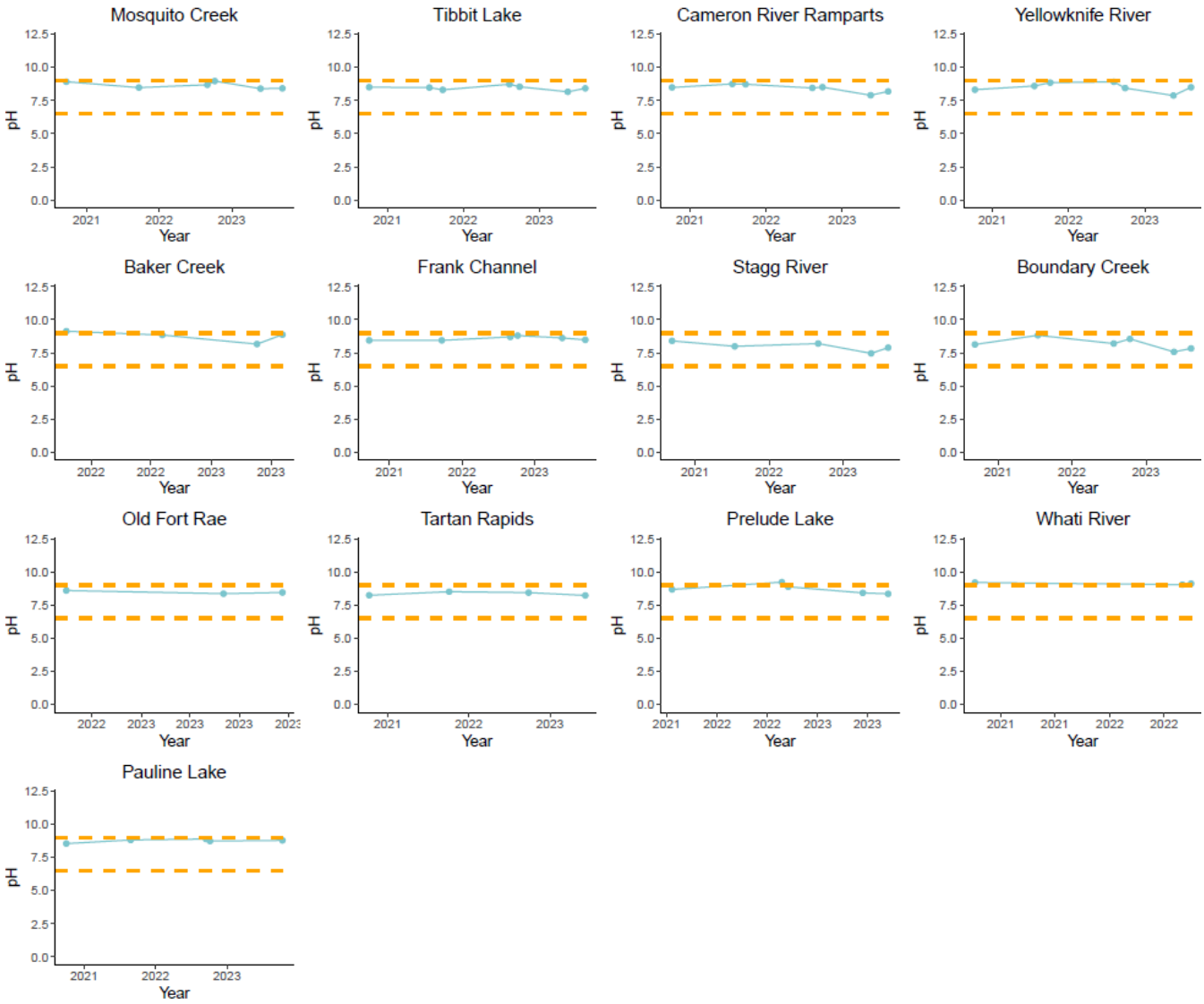


Figure 18. pH levels at each eDNA site from 2021-2023. The dashed orange line indicates CCME pH limit range (6.5-9).

Dissolved oxygen

Dissolved oxygen (DO) is the amount of oxygen that is present in water. All aquatic animals need dissolved oxygen in order to survive and low levels (hypoxia) can occur when excess organic materials such as large algal blooms deplete oxygen levels in the water. DO is considered an important measure of water quality as it is a direct indicator of the water bodies ability to support aquatic life. According to the Canadian Water Quality Guidelines for the Protection of Aquatic life, dissolved oxygen in cold water should be above 9.5 mg/L for early life stages and above 6.5 mg/L for other life stages (Canadian Council of Ministers of the Environment, 1999). For all locations, measurements in 2023 showed low levels of DO (Figure 19). Because measurements were extremely similar across locations it is possible that these values are due to a malfunction with the probe. It will be important to re-calibrate the probe and re-sample in 2024. However, these results could also be consistent with the drought and hot temperatures that we experienced across the territory in 2023.

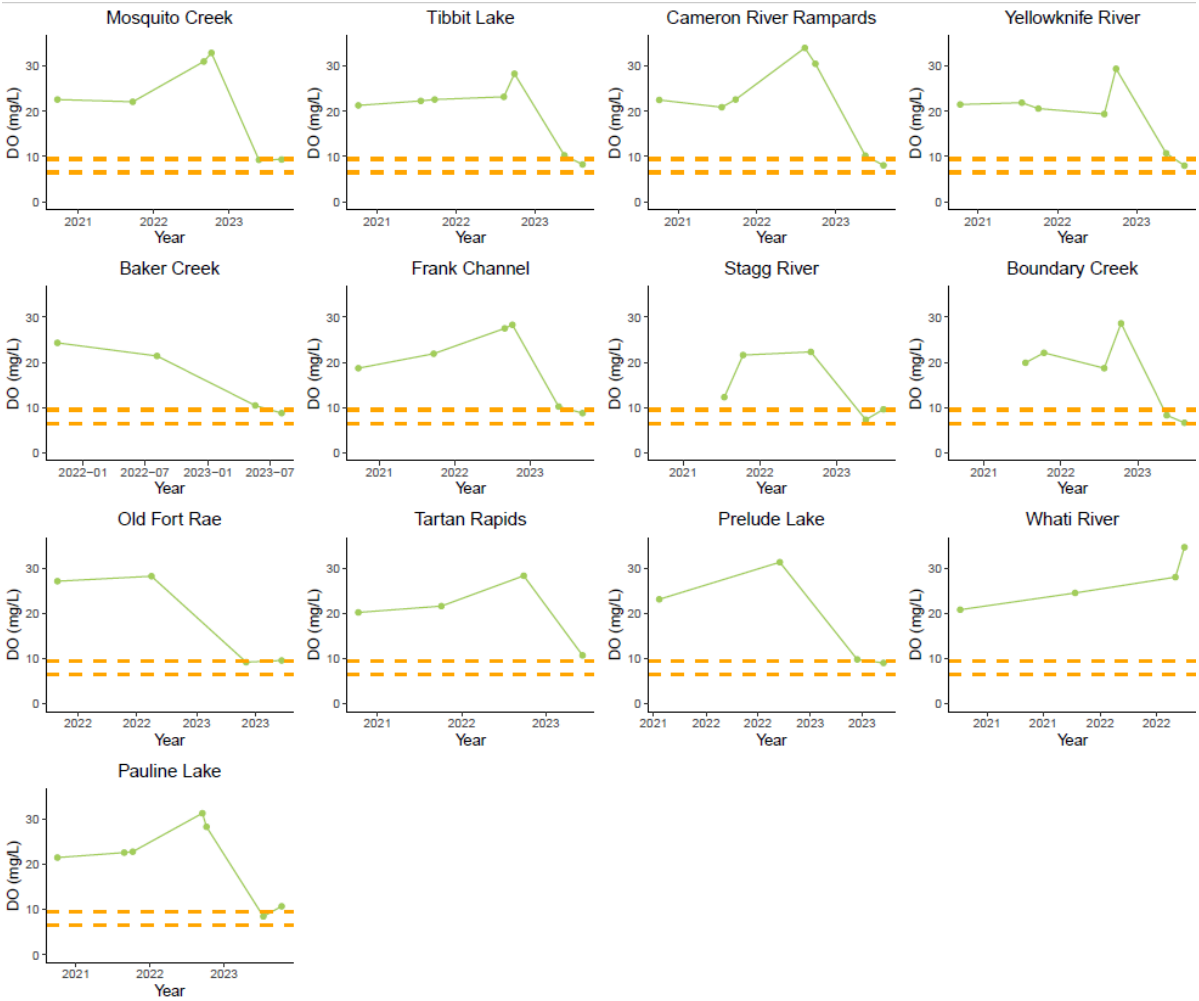


Figure 19. Dissolved oxygen levels at each eDNA site from 2021-2023. The dashed orange line indicates CCME dissolved oxygen minimum ranges (9.5 mg/L for early life stages and above 6.5 mg/L for other life stages).

4. Outcomes and deliverables

In the 5 years that this project, “Merging Advanced Technologies with Traditional Knowledge for Species At Risk Protection” has been running, membership engagement has increased each year. Today, 5 staff and more than 10 members are now trained on how to take eDNA samples, service wildlife cameras and ARUs and take water quality measurements. Through funding from AFSAR and SCARF, NSMA has been able to build its capacity to contribute to environmental monitoring in the North Slave region.

Some notable outcomes and deliverables from 2023 are as follows:

- Valuable data on species distribution (notably, Species at Risk) in the North Slave Region from 3 different sources:
  1. eDNA summary data
  2. A metadata sheet containing all animal observations from wildlife cameras
  3. A metadata sheet of all bird occurrences from ARU sound data recordings
- Intergenerational training and learning between NSMA elder and youth during field work
- Development of NSMA data management procedure
- Temporal data on water quality measurements of water bodies around the North Slave region
- Acquisition of scientific monitoring devices and other field equipment that will enable years of future research.
- This summary report, detailing the results and outcomes of the eDNA project from 2019-2023

5. Conclusion

5.1 Species at risk

Boreal caribou

Through eDNA sampling, we have detected caribou in 8 of our 13 locations between 2019 and 2023. Unfortunately, eDNA cannot differentiate between boreal caribou and barren-ground caribou. From 2019-2022, detections of caribou almost always occurred in the fall sampling trips (September/ October). However, in 2023 caribou were detected in some May sampling trips. The edge of the known range for boreal caribou is west of the North arm of Great Slave lake, and we detected caribou east of the North Arm at Yellowknife River, Baker Creek and Frank Channel in 2023 (Species at Risk Committee, 2012). This area does encompass the range of the Bathurst barren-ground caribou herd, although in recent years due to massive population declines, the Bathurst's range as significantly retracted and it is rare to see them this far south anymore. Therefore, we could be detecting either barren-ground caribou or boreal caribou at these sites. Studies have shown that eDNA can be transported over long distances in flowing water and so it is possible that we could be detecting boreal caribou DNA at these locations that has been transported from west of Great Slave Lake (Shogren *et al.*, 2017). During an internal results workshop with NSMA members in May of 2024, members expressed their belief that the caribou DNA that we are detecting belongs to boreal caribou as opposed to barren-ground caribou. Many members have been closely watching the barren-ground herds in the NWT for over 40 years and believe that they do not travel this far south anymore. Boreal caribou have never been sighted on our wildlife cameras and so eDNA is a good method to uncover the location of this elusive species.

Wood bison

So far wood bison have been detected at Frank channel (2021, 2023) and Mosquito Creek (2023). This lines up with previously known ranges for wood bison close to the Behchokǫ̀ area. Bison were also detected through our wildlife cameras at Frank Channel.

Little brown myotis

eDNA sampling has never confirmed the presence of the little brown myotis at any of our sample locations. This is probably due to the fact that bats spend very little time in and around water and so the likelihood of detecting bats through aquatic sampling is minimal. However, two dead little brown myotis have been found at Old Fort Rae in 2019 and 2022. We hope to continue to collect ARU data to confirm the presence of this species at Old Fort Rae.

Northern leopard frog and Western Toad

Although our sampling locations are outside the range for the Northern leopard frog and the Western Toad, due to the lack of data on species distribution in the North, we continue to monitor for these species through eDNA sampling.

Wolverine

We have confirmed the presence of wolverine through eDNA sampling and wildlife camera images at Old Fort Rae. In addition, wildlife cameras have detected wolverine at Mosquito Creek and Pauline lake. Wolverines require large areas of wilderness to thrive. They only breed once every 2 years and because of this, they do not recover easily from population declines. For this reason, although the wolverine is not threatened in NWT, it is still important to monitor the population.

Horned grebe

Through eDNA sampling we have detected horned grebe, a species of special concern in Canada, at Baker Creek in both 2022 and 2023, indicating that this is an important habitat for them. Through ARU recordings, we detected ~57 species of bird including Lesser Yellowlegs (threatened), Evening Grosbeak (special concern) and Olive-sided fly catcher (special concern). We hope that through continued monitoring of birds in the North Slave region, we will be able to track temporal trends in species presence.

5.2 Final conclusion

In a rapidly changing climate, community-based monitoring projects are essential for on-the-ground observations in remote locations and to build capacity in indigenous organizations. This project combines many different methods including eDNA sampling, passive environmental sensor monitoring and Traditional Knowledge to investigate the distribution of species at risk in the North Slave region. Our hope is that all these different methods will help to provide a wholistic view of biodiversity. eDNA sampling has proved to be the most effective method for capturing certain species while passive sensors may be more effective for others.

This project, through funding from the Environment and Climate Change Canada Aboriginal Fund for Species At Risk (AFSAR) and the Northwest Territories Species Conservation and Recovery Fund (SCARF), will continue to provide baseline data for SAR conservation in traditionally important locations in the North Slave region of the Northwest Territories.

Our members highlighted the importance of developing Indigenous-led monitoring projects on species that are of cultural importance to local people, all the while having the knowledge to safely travel in remote areas. NSMA plans to continue expanding this project, so that more members, especially youth, can be trained in this up and coming sampling method.

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7. Appendix

7.1 2023 Field season pictures

Picture 1. NSMA member Shirley Coumont canoeing to Pauline lake rapids from floatplane to collect eDNA sample.

Picture 2. On route to Pauline Lake sampling location via floatplane from Yellowknife

Picture 3. Cabins at Old Fort Rae. Staff and members stay here when sampling the North Arm of Great Slave Lake.

Picture 4. Moose tracks at Old Fort Rae eDNA sampling confirmed presence of moose in this area.