Poplar River First Nation Community Based Monitoring Project:

Droning on for Climate Monitoring: Equipping Poplar River First Nation With Remotely Piloted Aerial Systems and Data Analysis Capacity for Measuring Algal Blooms and Shoreline Erosion on Lake Winnipeg - 2021-2024

Year 4 (2024) Water Quality Monitoring & Remotely Piloted Aircraft System Training Field Activity Report

By:

Poplar River First Nation

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Introduction

During summer 2024, in support of their Community-Based Monitoring Project titled “Droning on for climate monitoring: Equipping poplar river first nation with remotely piloted aerial systems and data analysis capacity for measuring algal blooms and shoreline erosion on Lake Winnipeg - 2021-2024”, Poplar River First Nations Lands Guardians and staff (Aiden HINDMARCH, Owen BEAR, Seth FRANKLIN) collected water quality samples and conducted aerial drone surveys with the assistance of North/South Consultants Inc. personnel (Jesse BELL, Jeremy BALDWIN). The samples were collected at locations that were initially selected from satellite maps at the outset of the project and then verified on the ground to be representative of the general location and the objectives of the program (i.e. lake water vs river water). Two of the sites on Lake Winnipeg were also mapped with a DJI Matrice 300 RTK Remotely Piloted Aerial System (RPAS) (drone) using a RedEdge Mx multispectral camera to determine the extent of algal blooms at the sites. A third nearshore/shoreline area at the end of Franklin Road was selected as a shoreline erosion monitoring site and was also surveyed with the drone. To ensure the program could be conducted by community members in the future Aiden HINDMARCH, Owen BEAR and Seth FRANKLIN were trained to fly the RPAS and acquired their Basic Pilots License, they will continue studying in order to obtain the advanced pilots license in the next year. The following report summarizes the main field activities conducted and data collected during year 4 of the project.

Water Quality Sampling

A total of seven sampling sites covering the Franklin and Poplar Rivers and Lake Winnipeg were selected for study (Table 1; Figure 1). The first sampling site was moved back to its original year 1 location during year 3 and 4 due to lower water levels. The new site, WQ 6, created 400 meters downstream from WQ 1, will be used as an alternate site in the future if high water does not allow sample collection at WQ-1. The WQ 2 site is approximately 300 m upstream of the Lagoon Discharge Creek that flows into the Franklin River. The WQ 3 site is located where the flow from the Franklin River meets the Poplar River. Sites WQ 4 and WQ 5 are in Lake Winnipeg and were selected to represent nearshore and offshore lake environments, respectively. The influence from the Poplar River was determined to be minimal due to the decrease in turbidity at the Lake Winnipeg sites.

Table 1: List of water quality (WQ) sampled locations in the Poplar River, North Poplar (Franklin) River and Lake Winnipeg, MB.

Site	Zone	Co-ordinates		Depth (m)	Site Description
		Easting	Northing		
WQ 1	14 U	619276	5871933	2.3	Reference site upstream of community-Poplar River
WQ 2	14 U	614648	5873308	3.9	Franklin River-upstream of Lagoon Discharge site
WQ 3	14 U	613864	5873219	4	Poplar River near confluence of Franklin River downstream of Lagoon Discharge
WQ 4	14 U	606528	5876597	3.3	Lake Winnipeg Nearshore
WQ 5	14 U	606072	5875025	6	Lake Winnipeg Offshore
WQ 6	14 U	618741	5872274	4.1	Alternate reference site upstream of community for use during high water years.
WQ 7	14 U	614559	5873654	1.6	Lagoon Discharge sampling site

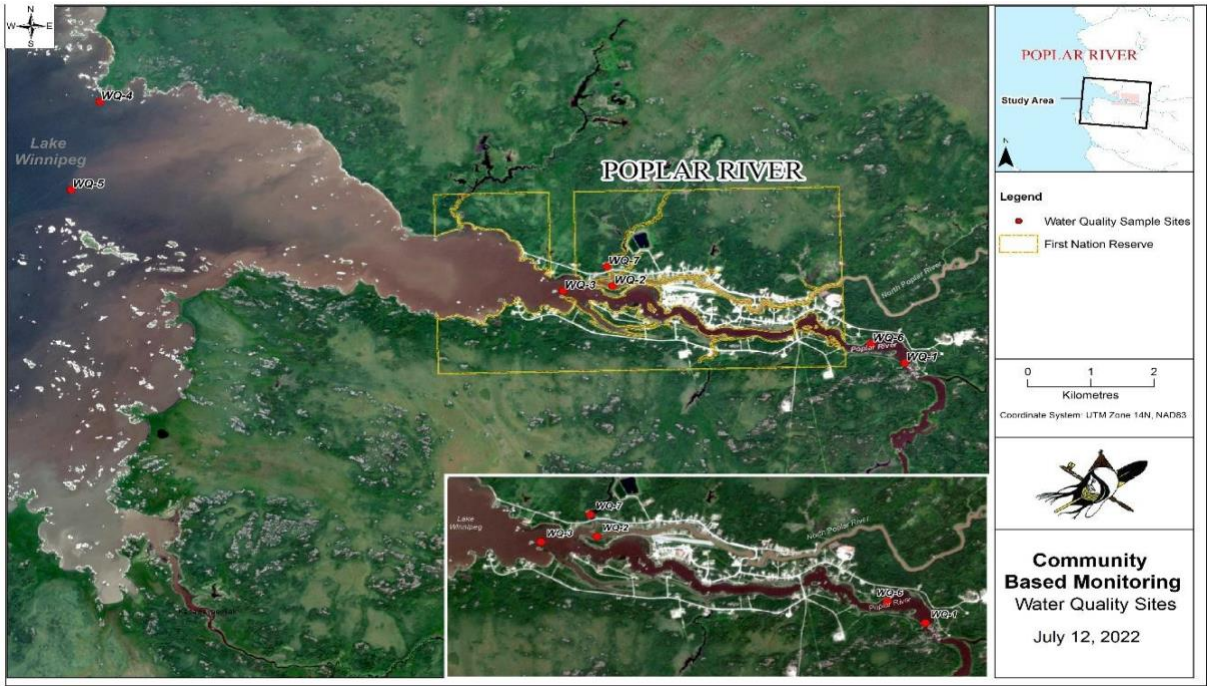

Figure 1: Water quality sample sites 2024, in the Poplar River, North Poplar (Franklin) River and Lake Winnipeg, Manitoba.

Before heading out into the field to sample, Poplar River Lands Guardians and Staff were taught to pre-label bottles in the office so they did not have to be labelled in the boat as labeling in the boat can be difficult in adverse weather conditions (Figure 2). Sampling was conducted at each of the five sites on August 14, 2024. A seventh site, WQ 7, just downstream of the Lagoon Discharge location was not sampled this year because there was no lagoon release prior to the scheduled water quality monitoring.

A pre-field safety meeting was conducted on the morning of August 14 before heading on the Poplar River and Lake Winnipeg to discuss safe sampling techniques while sampling off the side of the boat. Participants were reminded to always wear life jackets and were asked if there were any concerns before heading out onto the water.

Figure 2: Poplar River First Nation (PRFN) Land Guardians and NSC personnel Pre-labelling Water quality sampling bottles in the Band office prior to conducting water quality sampling the next day. From left to right: Aiden RABLIAUSKAS (PRFN), Jeremy Baldwin (NSC), Owen BEAR (PRFN), Seth FRANKLIN (PRFN).

At each site several in situ parameters are measured and recorded in field data sheets. The following equipment was utilized in the field to collect required site data: a Kestrel to measure wind speed and direction, a handheld GPS to collect accurate site coordinates, a pair of long sleeve gloves for sample collection, a handheld sonar to measure water depth, a digital thermometer to measure water temperature and ambient air temperature, a Secchi disc to measure water transparency, a camera to collect site photos and 3 ALS water sample containers provided by ALS Laboratories.

Upon arrival at each site, the following information was collected and recorded on field data sheets: Site ID, GPS coordinates, wind speed and direction, weather, cloud percentage, last precipitation, water temperature and depth (Figure 3). To collect a more accurate measurement of water transparency, the average of the Secchi disk reading was recorded for each site, determined by taking 2 depths: 1 on the lift and another when lowering. Prior to site departure, 1 photo was taken in each direction from the sampling location to provide details of the adjacent riparian area.

Figure 3: Seth FRANKLIN Collecting a water sample in the Franklin River at water quality site WQ-2. Aiden RABLIAUSKAS writes site attributes on the data sheet while Owen BEAR assists the sampler collect water.

At each site there were three water samples collected for laboratory analysis of chlorophyll, nutrients, and routine analysis. Water samples were collected and sealed approximately one foot below the water's surface to ensure excess nutrients and total suspended solids (TSS) on the surface did not contribute to the sample.

During sample collection the routine sample container was filled and closed approximately one foot below the water's surface, ensuring all air was released from the container. The water collected in the first routine bottle was transferred to the chlorophyll and nutrient sample bottles and was then refilled below the water's surface and then preserved. At each site the water samples were labelled with the site ID (WQ 1, 2, etc.) followed by 1, 2 or 3 identifying the 3 sample containers per site.

Aiden RABLIAUSKAS was trained to collect water quality samples for this program in 2022 and showed new PRFN Lands Guardians Owen BEAR and Seth FRANKLIN how to properly collect samples (Figure 4). New Guardians Owen BEAR and Seth FRANKLIN were instructed on how to complete data sheets, properly sample water and record relevant data such as weather observations while on the boat.

Figure 4: Left, Aiden RABLIAUSKAS prepares to take a water sample with shoulder length gloves. Right, Aiden RABLIAUSKAS collecting a surface water quality sample to be submitted to ALS labs for Analysis.

Sampling was conducted at each of the five sites on August 14, 2024. During sampling visible algae formations (balls) could be seen in the water sample at site WQ-4. Immediately after samples were collected, they were packed into a cooler containing the chain of custody form, an ice pack to maintain desired temperature and a total of 5 bags with 3 different bottles for each site. Water quality samples from each site were placed in separate Ziploc bags and labelled with PRFN, site ID, date and time sampled (Figure 5).

On this trip sample submission was within the 48-hour field hold time, however some attributes of analysis such as Nitrates, Nitrites and HDPE had a hold time exceedance of 2 days due to internal processing delays at the lab. Even though the samples were dropped off at the lab within their field hold time the lab took extra time to process the samples. The ALS Global analysis result data from the processed samples included remarks indicating that it is best to submit the samples within the same 24 hours they were collected to ensure there is no exceedance in the hold times due to internal delays at the lab.

Figure 5: Seth FRANKLIN puts Nutrients/ Total organic Carbon (TOC) samples into a ziplock bag while being observed by Owen BEAR and Aiden Rabliauskas.

PRFN Lands Guardians were instructed on how to properly fill in a chain of custody form (See Appendix 1) so that samples can be identified and sorted for their individual analysis when they arrive at the lab for processing. The Chain of Custody form is crucial to the sample submission process because it ensures the samples can be processed quickly and efficiently once they arrive at the lab. Guardians were shown where to properly fill in the contact information, site names and collection times on the form. The individual analysis for each water sample gathered such as nutrients, chlorophyll and routine sampling were also explained to ensure Guardians knew why each sampling bottle was collected individually. Once the chain of custody form was filled in a picture was taken and the information was sent to ALS Environmental Labs in an email before the samples arrived at the lab. This step ensures the lab knows samples will be arriving soon and to rectify any analysis related issues or questions they have before the samples arrive. The form was then sealed in a waterproof bag and put in the cooler with all the water samples.

Throughout this program there will be an increasing amount of excel and picture data to manage. It is imperative to keep the data gathered throughout the summer in proper order so that data sets are comparable from year to year. In year 1, NSC was helping manage the data, while in year 2 PRFN started to take over archiving the pictures and water quality site data sheets. The types of data that will need to be archived in the future are water quality data received from ALS Environmental Labs, site picture data from in situ field measurements, field data sheets, excel spreadsheets of the water quality data over

time and drone picture data. The drone picture data may be the most difficult to manage due to its large format and corruptibility. From experience gained over the past three years it has been determined that drone data should be backed as soon as possible when returning from the field.

Water Quality Sampling Results

Table 2 summarizes water quality analysis results for water quality trips during the summer for the past 4 years. July and August are the only months that samples were consistently collected and will therefore be used in the future for analysis of algae blooms on Lake Winnipeg. The detailed ALS laboratory analysis results for 2024 are attached in Appendix 2.

Table 2: ALS laboratory water quality sampling results 2021-2024 Summary.

Poplar River First Nation Community Based Monitoring-Water Quality 2021-2024										
Date	Time	Site I.D.	Location	Chlorophyll a (ug/L)	Pheophytin a (ug/L)	Phosphorus Total (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
Summer 2021										
13-Jul-21	9:19	WQ-1	Poplar River	4.69	4.09	0.0510	0.60	0.60	4.8	14.7
13-Jul-21	9:53	WQ-2	Franklin River	6.93	5.52	0.0571	0.52	0.52	9.5	20.7
13-Jul-21	10:06	WQ-3	Poplar River	6	4.5	0.0532	0.47	0.47	6.6	14.8
13-Jul-21	10:28	WQ-4	Lake Winnipeg Near-shore	1.67	2.16	0.0489	0.49	0.49	2.4	8.29
13-Jul-21	10:48	WQ-5	Lake Winnipeg Off-shore	5.76	2.77	0.0405	0.40	0.40	2.8	7.82
Summer 2022										
07-Jul-22	12:50	WQ-6	Poplar River	5.6	3.04	0.0432	0.64	0.64	7.5	9.74
07-Jul-22	13:15	WQ-2	Franklin River	10.1	3.26	0.0473	0.98	0.98	7.8	9.14
07-Jul-22	13:30	WQ-3	Poplar River	6.18	2.83	0.0445	2.38	2.38	4.0	9.35
07-Jul-22	14:00	WQ-4	Lake Winnipeg Near-shore	11.3	3.61	0.0425	0.68	0.68	4.3	10
07-Jul-22	14:20	WQ-5	Lake Winnipeg Off-shore	8.81	2.8	0.0391	0.63	0.63	5.1	7.14
08-Jul-22	10:00	WQ-7	Lagoon Discharge channel	2.7	1.36	0.0494	0.83	0.83	3.0	2.81
Summer 2023										
12-Jul-23	10:00	WQ-1	Poplar River	3.83	3.91	0.06	0.68	0.717	5.9	14.6
12-Jul-23	10:15	WQ-2	Franklin River	5.51	4.98	0.0606	0.84	0.86	7.3	18.4
12-Jul-23	10:35	WQ-3	Poplar River	5.5	4.4	0.597	0.67	0.699	6.3	14.8
12-Jul-23	11:00	WQ-4	Lake Winnipeg Near-shore	72.6	7.1	0.123	1.44	1.47	12.9	12.3
12-Jul-23	15:00	WQ-5	Lake Winnipeg Off-shore	12.2	2.98	0.0655	0.69	7.4	4.3	9.03
13-Jul-23	11:00	WQ-7	Lagoon Discharge Channel	4.68	4.18	0.722	1.38	1.42	4.3	8.45
Summer 2024										
14-Aug-24		WQ-1	Poplar River	3.71	3.54	0.0526	0.982	1.01	7.3	13.7
14-Aug-24		WQ-2	Franklin River	4.81	4.53	0.0511	1.38	1.38	7	8.68
14-Aug-24		WQ-3	Poplar River	3.47	3.36	0.0536	0.992	1.03	6.8	13.3
14-Aug-24		WQ-4	Lake Winnipeg Near-shore	7.08	3.06	0.0624	0.743	0.812	4	8.96
14-Aug-24		WQ-5	Lake Winnipeg Off-shore	1.89	1.86	0.0619	0.613	0.731	3.2	8.38

Algae bloom severity and extent are the primary concern of this program which is measured by the amount of chlorophyll present in the water. According to the State of Lake Winnipeg Report Second Edition (Manitoba, 2020) from 2008-2016 it was not unusual to find average Chlorophyll-a summer concentrations between 20 and 25 ug/L with a maximum of 35 ug/L during the summer months. However, the chlorophyll-a concentration of 72.6 ug/L found on in July 2023 at WQ-4 (Table 2) is far beyond the normal range (Figure 6). This is believed to be because of the sewage lagoon discharge which was released 4 days prior to sampling.

Figure 6: Algae Bloom at the Franklin Beach erosion monitoring site (July, 2023).

During the 2024 Sampling season the algae balls were still visually evident at WQ-4 however chlorophyll did not spike the same way it did during the 2023 sampling season. This is likely because sampling did not coincide with a lagoon discharge event. The absence of high algae and chlorophyll this year potentially shows that the lagoon discharge event is causing the increase in chlorophyll-a at water quality sampling site WQ-4. Though future sampling will be required to pinpoint this as a definitive contributing cause of algae blooms at the mouth of the Poplar River since there are many other influences affecting the health of Lake Winnipeg such as agricultural inputs from other river systems (Figure 7).

Figure 7: Algae blooms on East shore of Lake Winnipeg 30 km South of PRFN August, 2024.

RPAS Training

Owen BEAR, Aiden Rabliauskas and Seth FRAKLIN acquired their Basic Pilot's License by passing an exam that is certified through Transport Canada in 2024 (Figure 8). They will continue to study to acquire their Advanced Pilots License so they can safely fly the drone within their community. The final advanced test will involve assessing one's ability to fly an RPAS in a controlled manner and properly land the RPAS. The

Advanced Pilot Certification allows pilots to fly around aerodromes if abiding by certain rules and regulations.

Figure 8: Owen BEAR fly's RPAS while Seth FRANKLIN visually observes to learn how to use the H20T thermal camara and to ensure the pilot in command avoids collisions with trees.

These pilots will pass their skills on to the next Lands Guardians to help them attain their advanced pilots certification. It is important to create mentorship programs to teach Guardians field techniques and procedures to experience how environmental monitoring data is collected. Field trips like this will motivate them to pursue Land Guadian opportunities that will benefit the needs of the community as it grows.

RPAS Surveys for Algal Bloom and Shoreline Erosion Monitoring

Satellite imagery has been used to monitor algal blooms in the past but new technology using multispectral cameras attached to drones can allow for more precise higher resolution monitoring. The community of Poplar River First Nation is interested in monitoring algal blooms that are present on Lake Winnipeg. They are also interested in understanding if the periodic discharge from the PRFN wastewater treatment lagoon adds to increased nutrients leading to additional algal growth. Using an RPAS to monitor specific sites helps develop a relationship between what the multispectral camera can see and

real-world water chemistry results allowing for more extensive and precise monitoring in the future. The community also hopes to better understand ongoing changes to the shoreline along Lake Winnipeg due to erosional processes by imaging and mapping the shoreline condition over time.

The purpose of using a multispectral camera attached to drone is to capture the extent and density of algae growth at select sites on the surface of Lake Winnipeg during the summer and fall. The MicaSense RedEdge Mx will use various multispectral indices (e.g. Normalized Difference Vegetation Index - NDVI) to detect differences in algal bloom extent and intensity. Survey areas at the nearshore and offshore Lake Winnipeg water quality sites and the beach at the end of Franklin Road were imaged using the RPAS during summer water quality sampling runs from 2021-2024.

Multispectral camera image data gathered this year will help develop a relationship between the baseline monitoring conducted in 2021 and current lake levels and shoreline retreat in 2024. Individual red, green, blue, red edge and near infrared images (Figure 9) taken at water quality sites and the beach at the end of Franklin Road are layered, stitched together, and analyzed using using Pix4D Mapper photogrammetric software to view differences in algal blooms over time. Individually these pictures look uninteresting but when layered they create a unique image that can be analyzed in many ways.

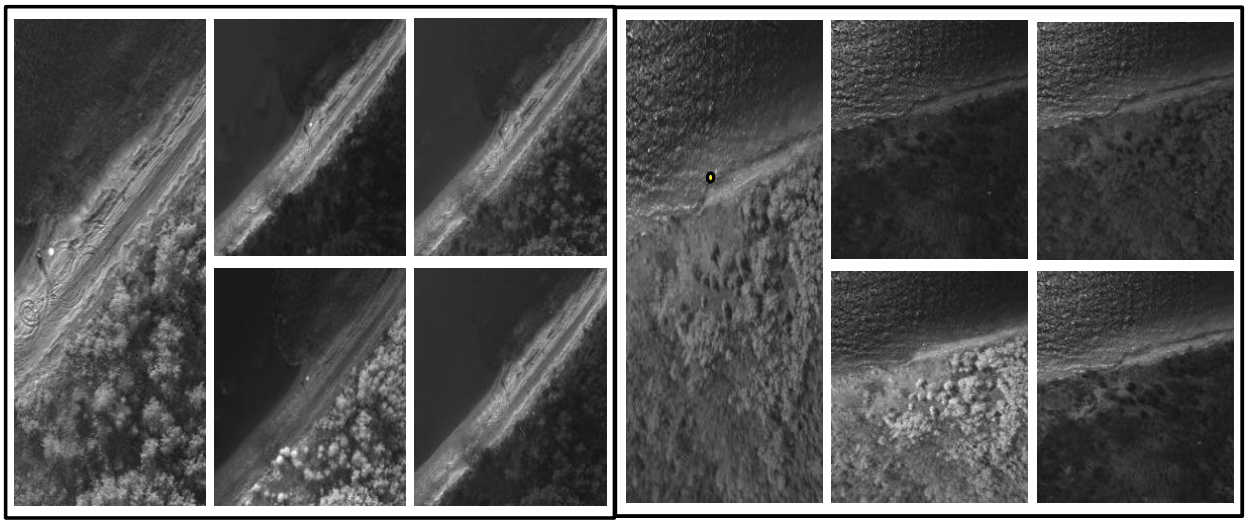

Figure 9: Drone Imagery of Franklin Beach showing low water in August 2021 (top 5) compared to high water in June 2022 (Bottom 5). Yellow dot in bottom left photo is location of white dot (drone landing pad) in top photos.

The beach at the end of Franklin Road (Figure 10) was selected as an area that may show signs of shoreline erosion over time. By analyzing multispectral imagery and digital elevation models (DEMs) generated from the imagery it is possible to map shoreline change over time. Additional data processing and analyses are expected to occur at a later date.

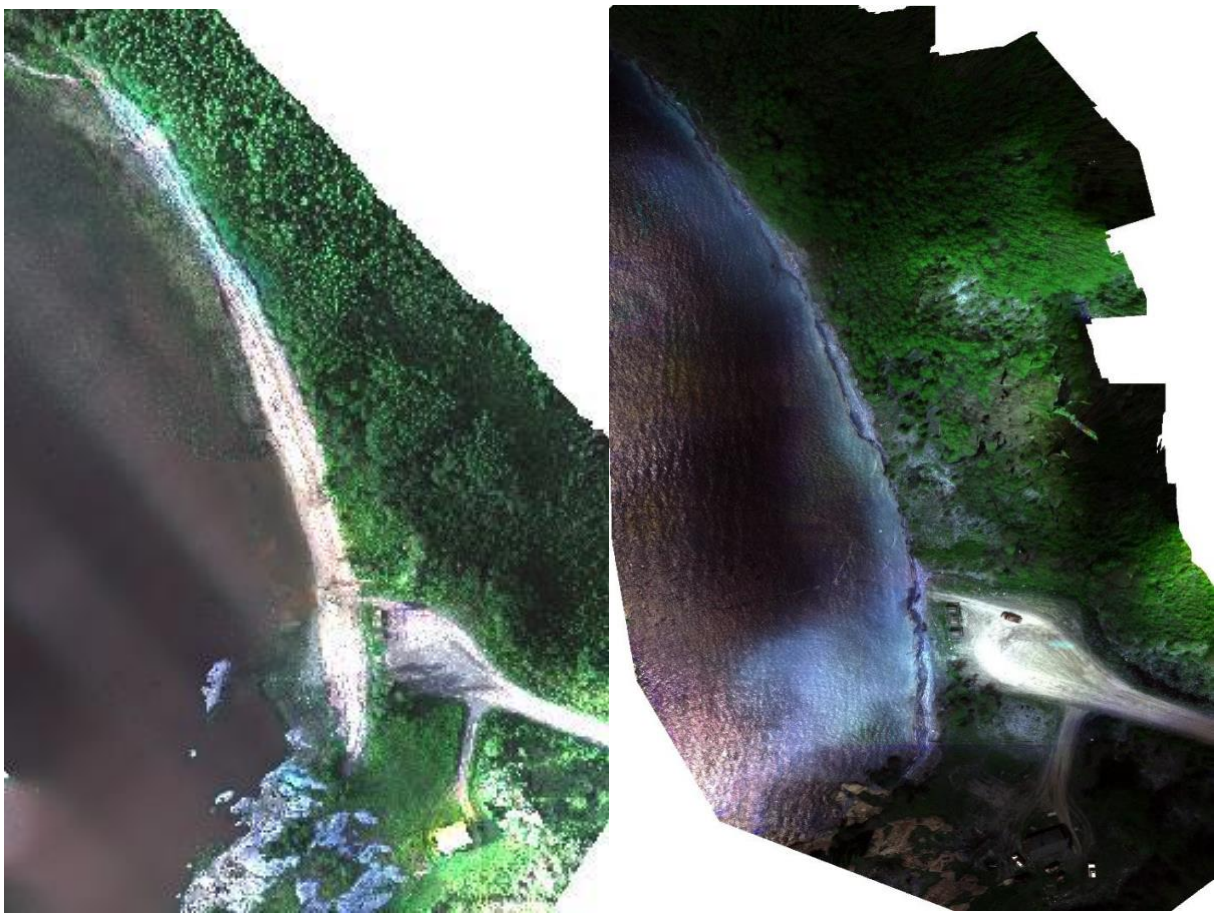

Figure 10: Large area (15 acres) mapped at the end of Franklin Road using the red, green, and blue multispectral drone image data collected August 2021 (Left) and June 2022 (Right). Note the difference in the water levels from the left picture (low water) to the right picture (high water)

RPAS Shoreline and Erosion Monitoring Results

After 4 years of monitoring, observations have indicated shoreline erosion is occurring at the beach at the end of franklin road due to water level fluctuations, and wind events. The rate of shoreline erosion is slow but consistent within the 4-year period. In 2022 high water levels persisted on Lake Winnipeg throughout the year which eroded the soft under layer of the banks that is not held together by vegetation. When this happens, the bank is no longer supported underneath and can break off, this type of shoreline retreat is called cantilever bank failure.

In 2023 a crack formed along the shoreline where the unsupported layer started to break away and low water on the beach allowed one foot of bank material to break off from the shore (Figure 11). 2024 brought even lower water therefore the banks were eroded from weather erosion such as surface water runoff and wind. Once the bank begins to detach it becomes unstable and even light erosion such as surface water will cause most of the bank to wash into the water over time. The banks that had been affected in the previous 2 years were completely detached and slumping onto the beach (Figure 12).

Figure 11: Beach at the end of Franklin Road: Left - High water all year in 2022 eroded the soft soil layer under the grass roots of the bank; Right - bank can be seen breaking away in July 2023 causing Cantilever Bank Failure.

Figure 12: left - low water reveals the failed portion of the bank is now fully detached and washing into the lake due to overland runoff in August 2024. Right - Picnic seating areas near the shore at Franklin Beach will need to be moved back as the shoreline continues to erode.

Future RPAS Usage

The water quality monitoring program is coming to an end after four years but PRFN still wants to use the RPAS for other purposes such as the expansion of their community garden, mapping their traditional lands and for emergency use during search and rescue operations. The following sections will provide details on how PRFN plans to continue using RPAS technologies to improve their community and steward the land.

Community Garden

As a fly-in community PRFN has limited availability to fresh produce and has been successfully growing their own vegetables for generations. Eight years ago, a community gardening project was started to help boost gardening efforts around the community. Since the program has grown to be so successful PRFN would like to increase the capacity to grow fresh produce by expanding the current footprint of the community garden from one acre to three acres (Crabb, 2024).

To survey the area and ensure the new garden is placed in the correct location the RPAS was used to take aerial pictures of the garden and its surrounding forested areas designated for expansion (Figure 13). Using the pictures as a guide will help community members clear brush up to the gardens boundary without disturbing the surrounding natural area. The pictures will also be used to show other community members the progress of the garden expansion.

Figure 13: PRFN Lands Guardians Setting up RPAS to survey Community Garden

Mapping Asatiwisipe Aki

PRFN would like to use the RPAS to map traditional lands around the community as part of their contribution to the Pimachiowin Aki mapping efforts that aims to map the whole area which is part of a UNESCO World Heritage site. They would like to map the land within the community up to their Fire Break Cut Line which is approximately one kilometer from the community (Figure 14). Mapping the

whole community is also beneficial when considering community expansion and mapping locations of emergency infrastructure such as fire hydrants and hospitals.

The community members have been excellent stewards of this land for generations therefore the key aspect of mapping the lands is the ability to conduct surveys independently. The RPAS allows PRFN to conduct the surveys and store the data in a manner that is secure and not available to third parties. They would like to limit access to the data gained through mapping efforts to retain traditional knowledge of the land that shouldn't be available to the public.

Before flying over the community or beginning search and rescue duties it is required that PRFN updates and maintains the AVSS parachute that should be mounted on the DJI Matrice 300 when operating over people as per section IX of the Canadian Aviation Regulations. The brackets need to be re-mounted to the legs to mount the parachute.

Figure 14: Seth FRANKLIN and Aiden RABLIAUSKAS explaining how to use RPAS to PRFN elder Ray RABLIAUSKAS.

Search and Rescue

PRFN has no access to aerial support such as a helicopter to search for missing people during emergency search and rescue operations. The RPAS with the DJI H20T thermal camera will become an important instrument in their tool kit to help find people that get lost in the forested areas around PRFN (Figure 15). It has been used previously to search for missing persons and will be used in the future.

Figure 15: PRFN Lands Guardians learning how to use the DJI H20T thermal camera at the rapids upstream of the community on the Poplar River.

Lands Guardians were trained in how to use the thermal functions on the RPAS which had 12 different thermal imaging options, they practiced searching for NSC personnel in the forest and determined which setting worked best in a dense canopy mixed forest environment to find heat signatures of people. It was determined that cycling different thermal filters may work best to try and find the right setting in a search and rescue situation.

Conclusion

A total of 9 lands guardians and summer staff from PRFN were mentored throughout the four-year duration of the program including Norway RABLIAUSKAS, Owen BEAR, Aiden RABLIAUSKAS, Seth FRANKLIN, Sherman DOUGLAS, Monique BRUCE, Nicolas HUDSON, Brad BUSHIE and Luke MITCHELL. Lands Guardians and summer staff were taught water quality sampling techniques and mentored in flying an RPAS. The community-based monitoring will continue to use the RPAS purchased through this program through the Lands Guardian Program in several different ways such as high-resolution mapping of PRFN lands. Pilots that received their license through this program will be able to mentor youth land guardians to fly RPAS's in the future to continue to monitor their land independently with a distinctively indigenous approach while using modern cutting-edge technology.

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