Collaborative Monitoring and Education of Cyanobacteria and Cyanotoxins in the Wolastoq Watershed

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Introduction

As one of the largest rivers on the Eastern Seaboard, found within the traditional and unceded territory of the Wolastoqey Nation, the Wolastoq [St. John River] is home to five cities and over 115 municipalities, and is the backbone of many industries including agriculture and forestry. Originating in Maine, the river travels over 600 km through the province of New Brunswick to its outlet at the Bay of Fundy. Environmental challenges in the watershed are actively being researched and the Canadian Rivers Institute's State of the Watershed Report (2011) identified nutrients and water quality as primary issues. These findings are further supported by WWF Canada's Watershed Report (2020) which identified pollution, habitat fragmentation, and altered flows as threats to the watershed. Overall, the Wolastoq is at risk to several environmental issues and this research focuses on water quality and in particular the distribution of cyanobacteria in the mainstem and tributaries of the watershed.

Water quality, including cyanobacteria proliferation and the presence of nutrients, is a very important aspect of ensuring a healthy watershed. Cyanobacteria are a natural part of the ecosystem, however when the conditions are favourable (light, nutrients, flow, etc.) they can proliferate to cause water quality and potentially human health issues. There are two different overall types of cyanobacteria found in New Brunswick – species that create surface blooms and those that form benthic mats (Figure 1). The first recorded cyanobacteria advisory for the occurrence of surface blooms in New Brunswick were in two reservoirs in the Moncton region prior to 2009, since then there have been advisories placed on 18 other waterways across the province. In 2018, after the death of multiple dogs along the banks of the Wolastoq, the presence of benthic cyanobacteria mats was confirmed in the Fredericton region and an advisory was placed on the mainstem of the river from Woodstock to Fredericton.

Figure 1: Cyanobacteria can appear in two forms. Left: a surface bloom covering the surface of the water. Right: benthic mat growing on a rock lifted from the bottom of a waterway.

Although cyanobacteria can cause certain environmental issues (decreased oxygen levels, fish kills etc.), the main concern for regulators and citizens is the toxins that certain species can produce. Within the context of surface blooms, the most common cyanotoxin to be produced by these species are microcystins. Microcystin and its many variants are a hepatotoxin that can cause liver failure long-term and exposure to microcystins can cause gastrointestinal issues, rashes, and headaches. In the environment, microcystins are fairly stable to biological and chemical breakdown and are therefore regarded as the most prevalent cyanotoxin (Health Canada, 2022). Within the benthic mats, the cyanobacteria species present can create a class of cyanotoxins called anatoxins, which are a neurotoxin that can disrupt the nervous system leading to paralyses and death. Worldwide there has only been one reported human death from anatoxin poisoning; in contrast, there have been numerous reports of pet and livestock death leading to the understanding that ingestion of the mat material is likely needed for a lethal dose (Health Canada, 2022). There are three other classes of cyanotoxins – cylindrospermopsins (hepatotoxin), nodularins (hepatotoxin), and saxitoxins (sodium channel blocking; also called paralytic shellfish poisoning toxins), however their presence in New Brunswick freshwater waterways have not been explored.

Collaborative Monitoring Partnership

Since the death of dogs near Fredericton, New Brunswick, and the discovery of benthic cyanobacteria mats in the mainstem of the Wolastoq in 2018, much research has been undertaken to understand the distribution of cyanobacteria and cyanotoxins in the watershed. Under the leadership of ACAP Saint John, multiple watershed organizations - Kennebecasis Watershed Restoration Committee, Nashwaak Watershed Association, Oromocto Watershed Association, Jemseg Grand Lake Watershed Association, Tobique Watershed Association, Canaan Washademoak Watershed Association, Belleisle Watershed Association, and the Hammond River Angling Association, came together to build cyanotoxin monitoring within the watershed. Originally monitoring was done in conjunction with researchers at the Lawrence Lab at the University of New Brunswick and the Canadian Rivers Institute using Solid Phase Adsorption Toxin Tracking (SPATT) collectors to passively adsorb cyanotoxin. Unfortunately, lab analysis for these samples was not available during this project, so ACAP Saint John pivoted the monitoring to using test strips for anatoxin-a and total microcystins to ensure readily available data and that all watershed groups would have the capacity to conduct the testing.

Cyanotoxin Monitoring

Rapid strip test kits for both anatoxin-a and total microcystins were obtained from Eurofins Abraxis and distributed to all partners. The anatoxin-a kit chosen was for drinking water (PN 520043) with a range of 0 to 2.5 ppb as no recreational test kit is currently on the market likely due to no official recreational guideline for anatoxin-a exposure. A recreational test kit was chosen for total microcystins (PN 520022) with a range of 0 to 10 ppb that compiles with the 10 μg/L maximum Health Canada recreation limit for microcystins.

ACAP Saint John created a monitoring plan for the watershed partners to follow that ensured all groups had the knowledge and capacity to conduct the sampling. This monitoring program outlined a brief background on cyanobacteria and monitoring techniques, the protocol and instructions on using the kits, and next steps to follow if a positive test was obtained (full monitoring procedure can be found in Appendix A). Once groups attended a training session provided by ACAP Saint John they were able to begin monitoring at locations of their choosing. A mixture of routine monitoring locations and site-specific response to potential cyanobacteria sightings were sampled over the 2022 field season resulting in 93 samples reported back to ACAP Saint John (the full list of sites and coordinates is presented in Appendix B). It should be noted that additional samples were taken by partner organizations and were not reported back to ACAP Saint John as they were negative and not recorded.

Results

Out of 93 samples reported, only 4 (0.04%) were positive for anatoxin-a and 18 (0.2%) were positive for microcystin (Table 1). Overall, these positive tests represent a very low percentage of positive samples however it does highlight that when present, these kits will provide timely identification of toxin presence. It is also apparent through the data that there are emerging hot spots within the watershed that are repeatedly testing positive for cyanotoxins, notably Darlings Lake and parts of the Belleisle Bay. Within Darlings Lake 10 of the 15 (66%) samples taken were positive for microcystin and within the Belleisle Bay 11 of 19 samples (58%) were positive for either anatoxin-a or microcystin. Both of these waterbodies have had persistent cyanobacteria blooms over the past couple of summers and a benthic mat was discovered within the Belleisle Bay this field season.

Table 1. Sites where positive samples were obtained for either anatoxin-a or microcystins in the 2022 field season. Numbers within the cyanotoxin columns represent the total number of positive samples for that site over the field season.

Site	Positive Anatoxin – a	Positive Microcystin
Hatfield Point Wharf		4
Kiersteadville		1
Kiersteadville		1
Hatfield Point Trail	3	
Erbs Cove		1
Jenkins Cove		1
Darlings Lake- Below EMF		3
Darlings Lake- Above EMF		3
Darlings Lake- At EMF		3
Main Stem- Nature Camp		1
South Sisters	1	

These test kits have proven to be a value tool for watershed groups to be able to detect cyanotoxins in suspected cyanobacteria sightings and report their findings to the Department of Environment in their local area for additional instructions and response. Building off the SPATT collectors, the kits provided a timelier response which as community representatives, the partnering groups appreciate. As we move forward into the 2023 field season, these test kits will be utilized again and included in monitoring plans across our partner subwatersheds to continue to monitor for and prepare groups for an increase in cyanobacteria sightings as awareness and public concerns continue to grow.

Education

ACAP Saint John continued to provide education opportunities for our partner watershed organizations through staff training initiatives. Along with training the partner organizations on how to properly conduct the cyanotoxin testing, ACAP Saint John staff also held brief cyanobacteria information sessions with interested new staff (mostly summer staff) from partner groups to help build capacity within these organizations to be able to successful identify cyanobacteria. These info sessions were mostly office based with photos and tip and tricks for identification. The lack of training on cyanobacteria identification, especially field based, has been identified as a gap going forward and further training sessions are being considered.

To engage with, and increase knowledge and understanding within the public, ACAP Saint John attended local markets to promote our cyanobacteria research and educational materials, continued the distribution of printed education materials at a business level, and posted on social media for a wider audience. Along with general public engagement, ACAP Saint John staff also responded to individual questions and concerns about cyanobacteria and visited a number of local waterfront residences to help people understand difference between cyanobacteria and true algae.

Conclusion

Overall, this ETF funded project was highly successful and was able to not only provide timely cyanotoxin data but also helped to build capacity within our partner watershed organizations. Together the collaborative partnership was able to collect over 93 samples for cyanotoxin analysis and were able to detect toxins in a small number of samples. As this collaborative groups continues to work together for years to come, additional toxin monitoring and capacity will be built to continue and expand this project.

Appendix A: Monitoring Protocol

Appendix B: Monitoring Sites

Table 2. Full list of cyanotoxin sampling sites monitored in the 2022 field season with the number of samples taken presented.

Subwatershed	Site	Coordinates		# samples taken
Belleisle Bay	Hatfield Point Wharf	45.652654	-65.848001	8
Belleisle Bay	Kiersteadville	45.635326	-65.865983	1
Belleisle Bay	Kiersteadville	45.63544	-65.86611	1
Belleisle Bay	Hatfield Point Trail	45.64771	-65.86144	4
Belleisle Bay	Earle Cove	45.612517	-65.91575	3
Belleisle Bay	Erbs Cove	45.57987	-65.94836	1
Belleisle Bay	Jenkins Cove	45.59041	-65.95728	1
Hammond River	Darlings Lake- Below EMF	45.505235	-65.868028	5
Hammond River	Darlings Lake- Above EMF	45.51561	-65.848369	4
Hammond River	Darlings Lake- At EMF	45.507803	-65.863289	4
Hammond River	Main Stem- Nature Camp	45.456877	-65.906326	2
Jemseg River/ Grand Lake	Jemseg River @ SJR	45.785242	-66.09883	2
Jemseg River/ Grand Lake	Waterborough Wharf	45.907633	-66.015102	2
Jemseg River/ Grand Lake	Cumberland Point	45.984393	-65.989269	2
Jemseg River/ Grand Lake	Salmon River	46.109778	-65.925576	2
Jemseg River/ Grand Lake	Indian Lake	45.930278	-66.294167	2
Jemseg River/ Grand Lake	French Lake	45.903889	-66.28	2
Jemseg River/ Grand Lake	Lakeville Corner	45.901267	-66.256733	2
Kennebecasis River	Hampton Boat Launch	45.5417	-65.837353	1
Nashwaak River	Neil's Flats	45.961317	-66.602648	2
Nashwaak River	Napadogan	46.34275	-67.00069	1
Nashwaak River	Narrows Mountain	46.29074	-67.0253	2
Nashwaak River	Ryan Brook	46.31371	-66.81944	1
Nashwaak River	Barkers Point	45.956483	-66.617404	2
Nashwaak River	South Sisters	46.32542	-67.15558	2
Nashwaak River	Gorby Gulch	46.40867	-67.1589	1
Nashwaak River	Taymouth	46.18041	-66.62131	1
Nashwaak River	Dunbar	46.14135	-66.61685	1

Nashwaak River	NVF	46.05401	-66.597	1
Nashwaak River	Penniac	46.03149	-66.5715	1
Nashwaak River	Campbell Creek d/s	45.98887	-66.58306	2
Oromocto River	Three Bridge Brook	45.4677778	-66.5191667	1
Oromocto River	Forks	45.655564	-66.570263	2
Oromocto River	Below French Lake	45.79741	-66.538197	1
Oromocto River	Lower Rusagonis	45.80876	-66.599264	2
Oromocto River	Upper South Oromocto River	45.448638	-66.643406	1
Oromocto River	South Oromocto Lake	45.441308	-66.643894	2
Oromocto River	North Oromocto Lake	45.606449	-67.018131	1
Oromocto River	Deer Park	45.854911	-66.50687	1
Loch Lomond	Ratcliffe Brook 1	45.367051	-65.810384	2
Saint John	Ratcliffe Brook 2	45.386838	-65.776734	2
Saint John	Ratcliffe Brook 3	45.397334	-65.730799	2
Saint John	Ratcliffe Brook 4	45.387129	-65.816552	2
Saint John	McBrien Lake Brook	45.367693	-65.873473	2
Saint John	Terro Lake Brook	45.404040	-65.82067	2
Saint John	Third Lake Trib 1	45.414117	-65.767816	2
Saint John	Third Lake Trib 2	45.423424	-65.765258	2