Fresh Water Sampling in the Acadian Peninsula for the Monitoring of Commonly Used Agricultural Products in the Wild Blueberry Industry

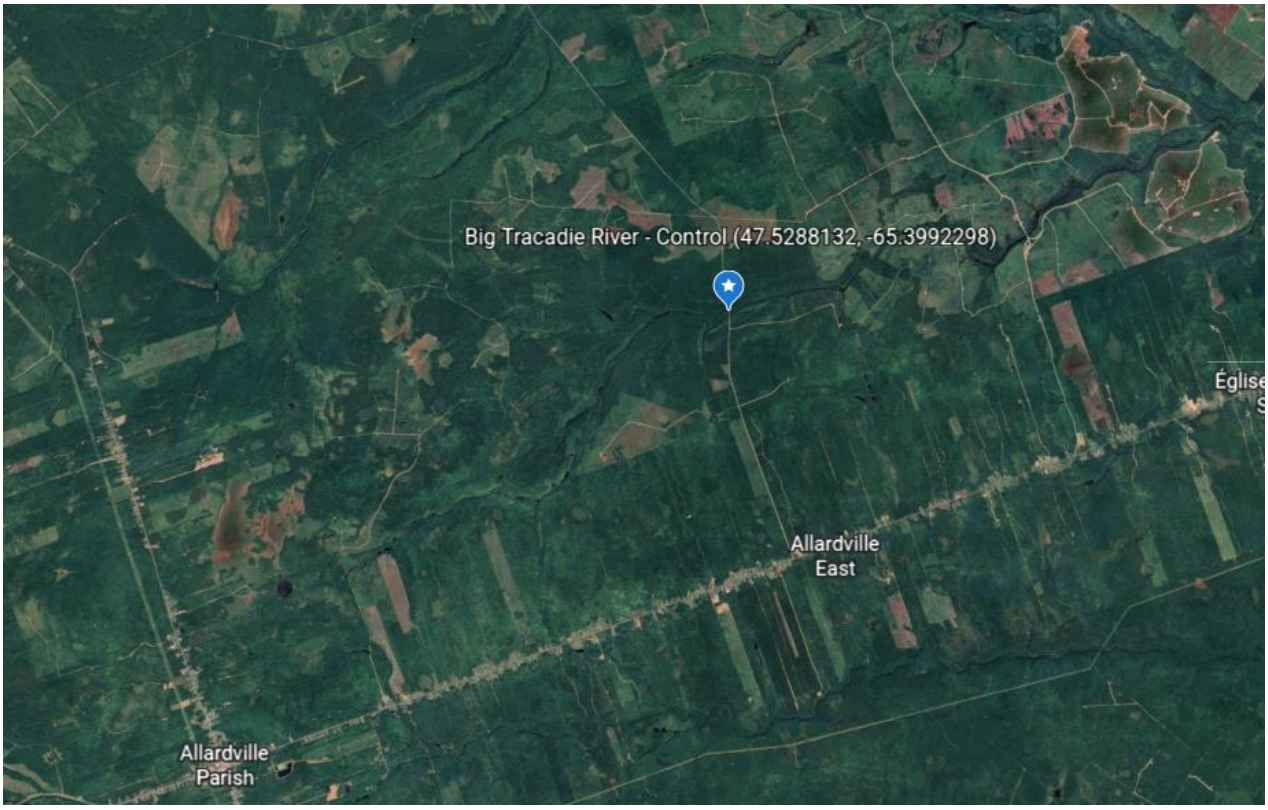
Introduction

The Acadian Peninsula is located in Northeastern New Brunswick, and it is home to approximately 70% of New Brunswick's wild blueberry production. New Brunswick's wild blueberry industry is the province's second largest horticultural commodity after potatoes. It contributes approximately $80 million annually to the provincial GDP with an average annual production of 55 million pounds. Wild blueberries are native to New Brunswick and although we do not know exactly when they started to be farmed commercially it's generally accepted that the industry's foothold grew in the 1950's. Since then, the industry has seen consistent growth which accelerated during the 1990's. Today, the majority of wild blueberries are produced on a commercial scale using all modern-day farming techniques and practices. This includes the use of inorganic fertilizers as well as synthetic pesticides to control weeds, diseases, and insects.

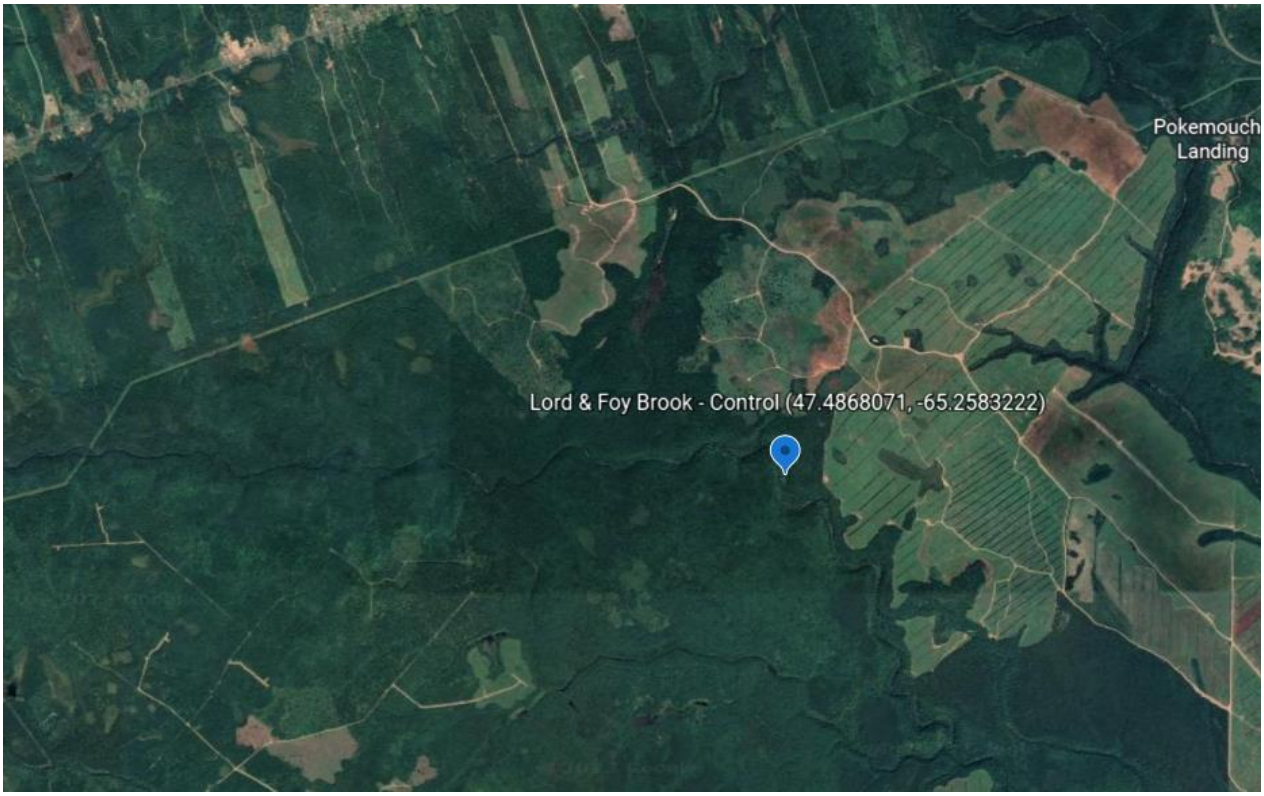
With the expansion of the wild blueberry industry and a growing concern over the use of synthetic agricultural products there is a concern that surface water quality could be affected. To determine if agricultural products are making their way into our water ways, two rivers in the Acadian Peninsula, the Big Tracadie River, and Lord & Foy Brook, were selected for evaluation. Tests performed on these 2 rivers was to detect the presence and levels of the following agricultural products, nitrogen, phosphorus, Hexazinone (Velpar™ - herbicide, Prothioconazole (Proline™ - fungicide, Acetamiprid (Assail™ - insecticide These compounds were selected for this study because they are the most commonly used products in wild blueberry production.

Methodology

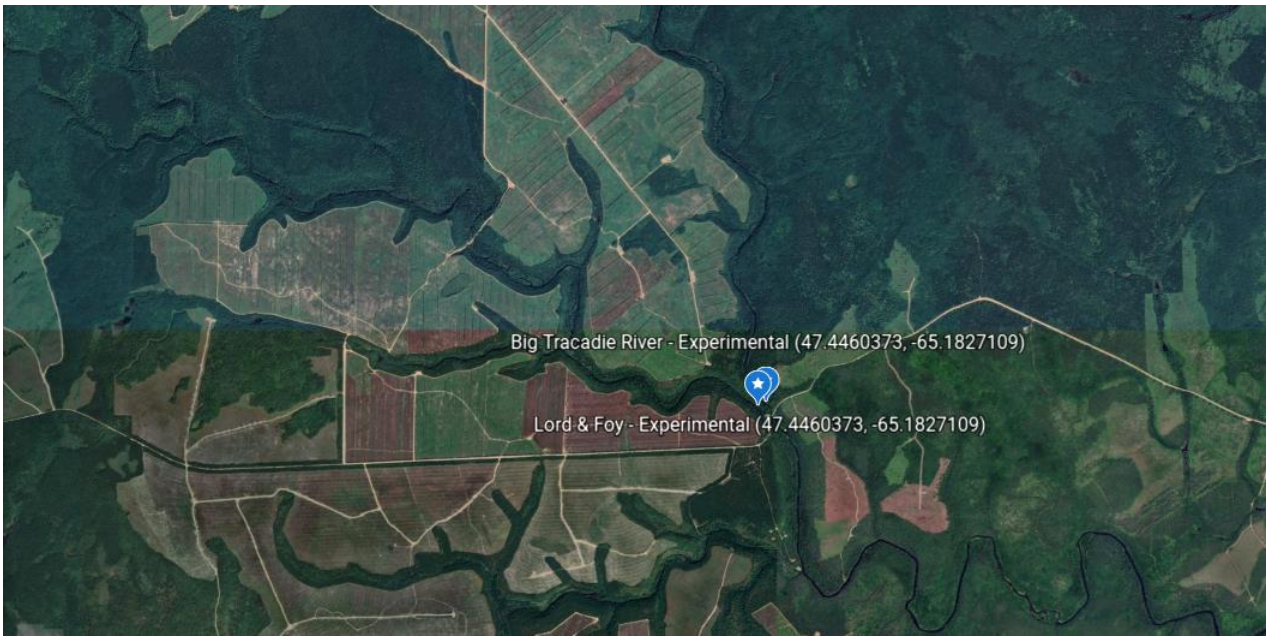
To determine if agricultural fertilizers and pesticides are making their way into surface water, 2 freshwater streams have been identified for water sampling. The selected streams, Big Tracadie River, and Lord & Foy Brook were chosen because of the extensive wild blueberry production and activity in their proximity. Each stream was sampled 3 times during the active growing season. The first sample was taken on June 1st, 2022, the second sample on July 29th, 2022 and the last sample on September 9th, 2022. Water samples destined for pesticide analysis were collected in an amber glass bottle whereas water samples collected for nitrogen and phosphorus testing were collected in a plastic bottle. All samples were collected in the middle of the stream halfway between the surface of the water and the bottom of the river. Each stream was sampled prior to its waters reaching wild blueberry production areas (control sample) and again when it exited (experimental sample). The maps below show the general location of all samples with the corresponding latitude and longitude. Water samples were labeled and referred to RPC Laboratories in Fredericton, NB for analysis. Once at the lab the water was tested for the following compounds: nitrogen, phosphorus, Hexazinone, Prothioconazole, Acetamiprid.



Map 1: Big Tracadie River control sample location



Map 2: Lord & Foy control sample location



Map 3: Location of experimental sample of the Big Tracadie River and Lord & Foy Brook

Results

Compound	Detection limit	June 1st Control | experimental	July 29th Control | experimental	September 9th Control | experimental
Nitrogen (ppm)	0.2 ppm	0.4 | 0.3	0.3 | 0.3	0.4 | < 0.2
Phosphorus (ppm)	0.002 ppm	0.024 | 0.016	0.022 | 0.008	0.017 | 0.007
Hexazinone (ppb)	0.02 ppb	< 0.02 | 0.03	< 0.02 | < 0.02	< 0.02 | < 0.02
Prothioconazole (ppb)	5.0 ppb	< 5.0 | < 5.0	< 5.0 | < 5.0	< 5.0 | < 5.0
Acetamiprid (ppb)	0.01 ppb	< 0.01 | < 0.01	< 0.01 | < 0.01	< 0.01 | < 0.01

Table 1: Big Tracadie River water sampling results

Compound	Detection limit	June 1st Control | experimental	July 29th Control | experimental	September 9th Control | experimental
Nitrogen (ppm)	0.2 ppm	0.4 | 0.3	0.2 | 0.2	0.2 | < 0.2
Phosphorus (ppm)	0.002 ppm	0.020 | 0.019	0.010 | 0.012	0.006 | 0.006
Hexazinone (ppb)	0.02 ppb	< 0.02 | 0.02	< 0.02 | < 0.02	< 0.02 | < 0.02
Prothioconazole (ppb)	5.0 ppb	< 5.0 | < 5.0	< 5.0 | < 5.0	< 5.0 | < 5.0
Acetamiprid (ppb)	0.01 ppb	< 0.01 | < 0.01	< 0.01 | < 0.01	< 0.01 | < 0.01

Table 2: Lord & Foy Brook water sampling results

Discussion

For both the Big Tracadie River and the Lord & Foy Brook, nitrogen and phosphorus levels in the experimental samples never exceed those of the control samples. This would indicate that wild blueberry farming activities in these areas are not contributing additional nutrients to the tested waterways. For the Lord & Foy Brook, concentrations were usually identical or similar in the control sample and the experimental sample. This was not the case for the Big Tracadie River where control samples often had higher levels of nitrogen and phosphorus compared to the experimental samples. It is not possible to know if the observed differences are statistically significant due to the sampling protocol used. But a possible explanation for the observed differences is that the water level at the control sampling location was very low compared to the experimental sampling location. The lower water level could have the effect of increasing the concentration of nitrogen and phosphorus in the water when compared to the samples from the experimental sampling site.

Although the objective of this study was not to determine if nitrogen or phosphorus levels are excessive in these streams, it is good to note that according to Environment and Climate Change Canada (1) surface water with total phosphorus ranging from 0,01ppm to 0.02ppm is considered as Mesotrophic or with moderate-low levels of phosphorus. Phosphorus levels in the range of 0.02ppm to 0.035ppm is considered Meso-eutrophic or moderate-high level of phosphorus. Phosphorus levels in the range of 0.035ppm to 0.1ppm of phosphorus would then be considered Eutrophic or high level of phosphorus, which contributes to excessive growth of aquatic plant. For both these streams, and for all 3 samplings dates, none of the samples would have been considered as having high levels of phosphorus. How nitrogen impacts water quality seems to vary depending on other factors such as the hardness of the water and phosphorus levels. Nonetheless, according to Environment and Climate Change Canada and the Canadian Counsel of Ministers of the Environment (2), for optimum water quality, nitrate levels should not exceed 2.9ppm. Since we tested for total nitrogen which corresponds to the combined amount of nitrate + nitrite, and that our samples never exceeded 0.4ppm of total nitrogen, we can conclude that nitrate levels were not above the recommended 2.9ppm of nitrate.

Prothioconazole has a photo-degeneration half-life of 47.7 hours (3). In the soil, it is known to be mobile but has a short soil half-life ranging from 3.45 to 9.9 days (4). Acetamiprid is soil mobile and has a short half-life of less than a day to 8.2 days (5). For all tests performed on both streams, Prothioconazole and Acetamiprid was never detected. These findings suggest that the use of buffers along streams combined to the fact that soils are not disturbed in wild blueberry production, are preventing these two pesticides from reaching waterways. Hexazinone has an average half-life of 90 days (30 to 180 days) (6). It is also known to be highly soluble which makes it very mobile in the soil, especially in sandy soils such as those found in commercial wild blueberry fields (7). Because of Hexazinone's characteristics and the fact that hexazinone is applied in May it was anticipated that it might be detected in the June experimental samples. What

needed to be confirmed was how much of it could make its way to the tested streams. In the Big Tracadie River, hexazinone was detected at 0.03ppb in the June experimental sample but was not detected in later season sampling. Similarly, hexazinone was detected in the Lord & Foy Brook experimental sample at 0.02ppb in the June 1st sampling but not on the other sampling dates. According to Health Canada the maximum residue limit for Hexazinone in beverages such as milk is 0.09ppm or 90ppb (8). That is approximately 3000 times higher than the amount found in the June sample for the Big Tracadie River. As for drinking water, the U.S. Environmental Protection Agency set the limit to 200ppb (9). Health Canada has set acceptable daily intake (ADI) for hexazinone of 0.1 mg/kg bw/day, based on a NOAEL of 10 mg/kg bw/day and a composite assessment factor of 100 (7). This means that an average Canadian women (70kg) would have to drink 23 300L of Big Tracadie River water (daily) to reach Health Canada's daily intake limit. As for aquatic life, Hexazinone has been shown to be a risk for algae which are the link between solar radiation, aquatic animals and humans, which are dependent on the oxygen produced by algae during photosynthesis. The specie of algae most sensitive to Hexazinone is *Selenastrum capricornutum* with an EC_{50} of 0.007mg/L or 7ppb (7). This means that the concentration of Hexazinone in the Big Tracadie River in the June sample was 233 times lower than the concentration needed to observe an effect on 50% of *Selenastrum capricornutum* population.

The results support the hypothesis that the use of treed buffers combined to the low input nature of wild blueberry production does not pose an elevated risk to surface water quality in the Acadian Peninsula.

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