

Emerald shiner immune stress in the upper Niagara River

by Jo Johnson

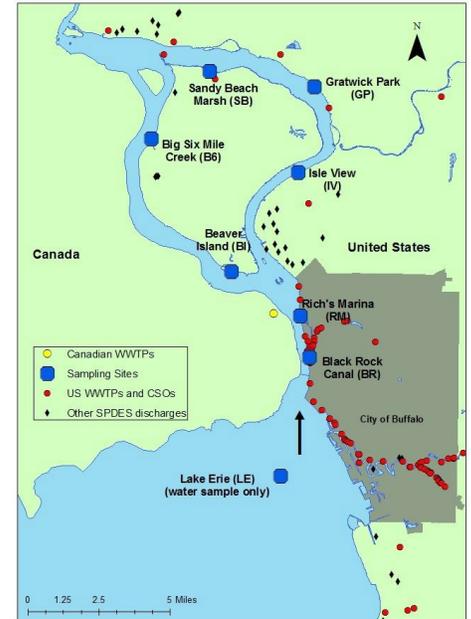
For my thesis project I chose to assess the functional health of the Niagara River – whether it can adequately sustain life – by evaluating the health status of a keystone species, the **emerald shiner**. I hypothesized that sewage input from combined sewer overflows (CSOs) are negatively impacting the immune systems of emerald shiners, which are subjected to this intermittent pollution source.

I sampled the Niagara River for emerald shiners at seven sites, biweekly from May to October of 2016. At each site, I also took a water sample for *Escherichia coli* enumeration, which is a good indicator of fecal contamination sources entering the water. After capturing the fish, I conducted a full necropsy dissection using a method called the Health Assessment Index (HAI). The HAI is a scoring system where a high score indicates that the fish is immunologically stressed and in poor health condition. I then analyzed the health status of the fish population statistically, and made comparisons for fish captured at each site.

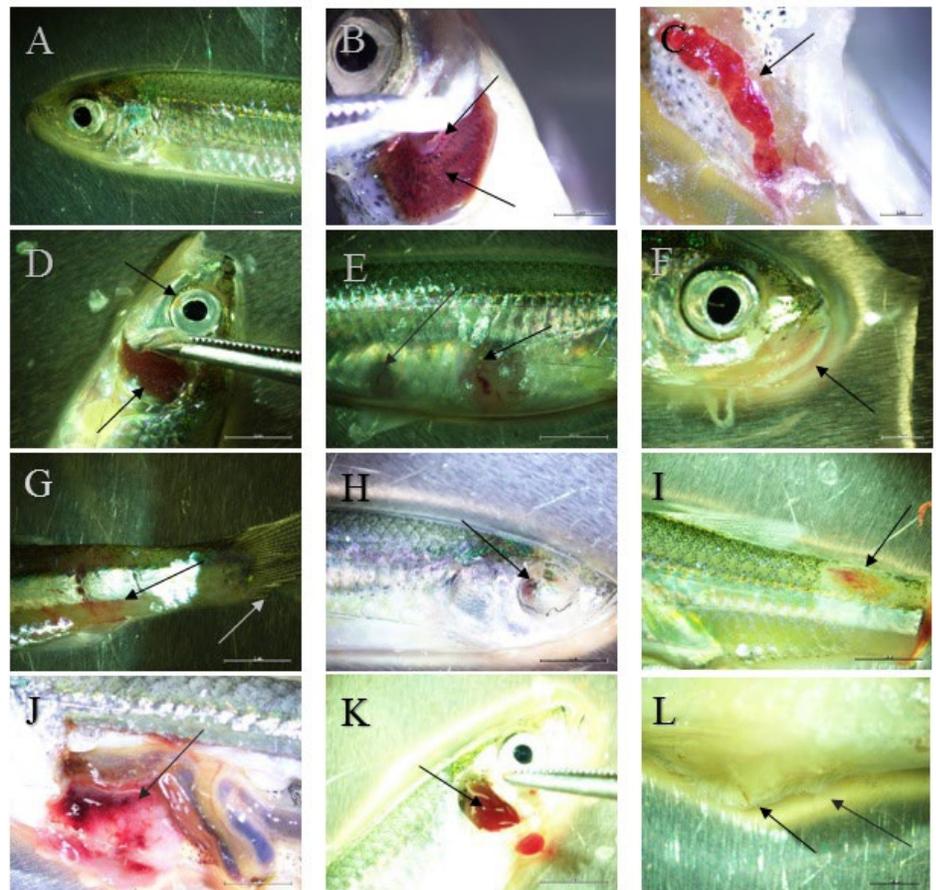
The water samples I took showed that the eastern branch of the river (which includes the waterfront from Buffalo and Tonawanda) occasionally had *E. coli* bacteria levels above EPA regulations and the samples from the Black Rock Canal showed that the water there was consistently degraded. On the western branch of the river, which is the waterfront of Grand Island and Canada and has less sewer input, water coliform samples were within the EPA regulatory levels. Emerald shiners captured from the eastern branch of the Niagara River were in poorer health condition and had a greater number of parasites compared to those captured from the western branch. Additionally, 35% of the emerald shiners captured had bacterial contamination in their livers, which is strong supporting evidence for immune stress in a sewage impacted environment. Some fish exhibited signs of severe systemic stress, such as widespread hemorrhaging, fungal infections, ruptured organs in the internal cavity, and pale, mucous-covered gills. Many of these signs of systemic stress were associated with poor overall condition, high parasite loads, and internal bacterial contamination.

My results showed that emerald shiners captured in the eastern branch of the Niagara, which is highly urbanized and receives a large amount of sewage input, were in poorer

health and condition than the fish captured in the western branch. Consistent with other studies, the Niagara River was generally in compliance with legal regulations for *E. coli* pollution, yet did not appear to be a functionally adequate environment for aquatic organisms living in the river. Most likely there are synergistic effects of all the cumulative pollution and altered water velocities due to hardened shorelines. However, if important forage species such as the emerald shiner are not able to withstand these stressors, there will be irreversible effects on the rest of the food web and the ecosystem. It is imperative that the Niagara River be restored and protected to improve the aquatic habitat, or else we may lose this integral forage fish species, with cascading negative effects to the rest of the food web (sport fish and fishing birds). •



Map of my sampling sites, which also shows the location of combined sewer overflow discharge points, and non-sewage discharges from industrial sources (State Pollutant Discharge Elimination System, or SPDES). Lake Erie water samples were taken as a reference for *E. coli* observations.



Photos of the Health Assessment Index Process: A. A typical, healthy appearing emerald shiner. B. Typical, healthy gills and pseudobranch. C. Typical, non-impacted liver. D. Pale, mucous-covered gills and a hemorrhaged eye. E. Severe lesions and bloated body. F. Severe fungal infection on the mouth. G. Widespread hemorrhaging on the body, loss of scales, and degraded caudal fin. H. Missing eye. I. Severe lesion consistent with infection by *Aeromonas* spp. (bacterial pathogen). J. Ruptured liver. K. Ruptured and mucous-covered gills. L. Severe fungal infection covering the entire abdomen, with a parasite protruding.