Diet Overlap and Mercury Bioaccumulation of Two Invasive Goby Species in the St. Lawrence River

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Background

The Laurentian Great Lakes basin is considered an invasive species hotspot (Holeck et al. 2004) and many of introduced species have had negative impacts on both the local ecology, through shifts in food web dynamics and similar effects, and economy, as they affect the productivity of important fisheries (Vilá et al. 2011). One of the more recent aquatic invaders, the Tubenose Goby (*Proterorhinus semilunaris*), has a very similar ecology to another invasive species, the Round Goby (*Neogobius melanostomus*), especially in their native range. Both gobies originate from the Black and Caspian Seas and were likely transported by ballast water to the Great Lakes (Kornis et al. 2012; Goretzke 2019). Both species were first detected in the 1990s in the St. Clair River (Kornis et al 2012; Jude et al. 1992). Despite arriving at the same time, the two gobies proliferated spatially at different rates. The Round Goby was first detected in the St. Lawrence River in 2005 (Farrell et al. 2017) whereas the Tubenose Goby was first detected there in 2011 (Goretzke 2019). It is still uncertain how similar their behavior and ecology will be in their invasive range. In addition, it is unknown how the presence of both species affects mercury bioaccumulation in predators of the St. Lawrence River. Depending on the degree of overlap in habitat and feeding preferences between the two species, the effect on the local food web and methylmercury bioaccumulation in piscivorous organisms will vary. One of the main factors that determines the quantity of mercury in an organism is diet, as well as the overall mercury pathway as it travels through a food web (Swanson et al. 2003). As such, any changes to a food web could lead to changes in the mercury content within those organisms. Depending on the direction of the shift in mercury concentration in the fish's muscle tissue, it could have positive or negative implications on the health of humans as well as the ecosystem.

Methods and Preliminary Results

The main objectives of this study were to 1) compare the diets and degree of diet overlap of the Round Goby and Tubenose Goby in the St. Lawrence River, 2) estimate the rate of mercury bioaccumulation for each goby species, 3) Identify if local piscivores prefer one goby species and if the diet preferences affected mercury bioaccumulation in the piscivores. I hypothesized that 1) dreissenids mussels (*Dreissena polymorpha and Dreissena bugensis*) would make up an insignificant portion or be entirely absent from the Tubenose goby diet compared to the Round Goby, 2) the Tubenose Goby diet would include more benthic food sources, while the Round Gobies would be more pelagic due to their high consumption rate of dreissenids mussels 3) large Round Gobies would occupy a higher trophic level than the small Round Gobies and Tubenose Goby, 4) Piscivores that consume a larger proportion of Round Gobies than Tubenose Gobies will have higher concentrations of mercury than piscivores that prefer Tubenose Gobies.

To collect fish, I collaborated with the Thousand Islands Biological Station (TIBS) to collect Gobies and with the Department of Environmental Conservation at the Lake Ontario unit to gather diet data and piscivore tissue samples. Round Gobies were categorized as large (>130 mm) or small (<130 mm) as past studies show a diet shift with size in the St. Lawrence River (Miano 2015), while all Tubenose Gobies diets analyzed together. Goby collection occurred at 4 primary sites (Figure. 1), with supplemental collection at 10 additional sites in the Thousand Islands region. Fish were captured using trap nets, minnow traps(Figure. 2), fyke nets and seining.

Collection periods were focused on capturing adult Tubenose Goby(Figure. 3), and for each Tubenose Goby collected, one large and one small Round Goby was saved from that site. Over the field season, I collected 373 gobies (Table 1). One main obstacle in the goby collection was that Tubenose Gobies are only caught consistently between mid-July and August, and most Tubenose Gobies captured were juveniles. Fish were then dissected using clean techniques. Thus far, I have dissected 93 of the gobies (81 Round Goby and 12 Tubenose Goby). Diet analysis reveals that Round Gobies consume large numbers of snails (*Bithynia tentaculata* and *Valvata spp*.), dreissenids (*Dreissena spp.*), and caddisflies (Tricoptera) (Figure. 4). However, the only identifiable prey items found in the Tubenose Goby stomach were Gammarus amphipods (Figure. 4). In addition to gobies, I collected predator tissue samples with the NYSDEC at the mouth of the St. Lawrence River. In total I collected 75 Yellow Perch, 3 Walleye, and 13 Smallmouth Bass tissue samples from fish caught in gill nets set by the NYSDEC, and collected diet data from 132 fish from 12 different species(only eight species contained food). Of the 132 fish, 43 contained food, none contained Tubenose Goby in their stomachs, but 11 contained Round Gobies and 9 contained Alewife (*Alosa pseudoharengus*) (Figure. 5).

Table 1: Distribution of gobies collected in Summer 2019.

Species	# individuals collected
Large Round Goby (>130 mm)	58
Small Round Goby (< 130 mm)	107
Adult (>40 mm) Tubenose Goby	59
Juvenile Tubenose Goby	149

Current and Future Work

This project is still ongoing. I am currently dissecting the gobies and processing the samples for the mercury and stable isotope analyses. In addition, I will process the otoliths collected in order to create an age-growth curve for the Tubenose Gobies and see if it matches the Tubenose Goby growth data in their native range collected by Valová et al. (2015). Next summer I will focus more on Phase 2 of the project which involves additional stomach content analysis of piscivorous fish, analyzing the mercury content of the goby prey items), and analyzing piscivore tissue samples for mercury and stable isotope analyses to estimate predator mercury intake and source. I intend to present the preliminary findings at the NY Chapter of the American Fisheries Society in February 2020 and at the Association for the Sciences of Limnology and Oceanography – Society for Freshwater Science joint meeting in June 2020. The results will be submitted for publication and the Sussman Foundation will be acknowledged in future publications and presentations of this data.

Works cited

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Figures

Figure 1: Map of Thousand Islands region. The green dot is TIBS, the red stars mark the primary goby collection sites: A4, Flynn, Swan Bay and Bartlett point.

Figure 2: Checking minnow trap for Gobies

Figure 3: Tubenose Goby

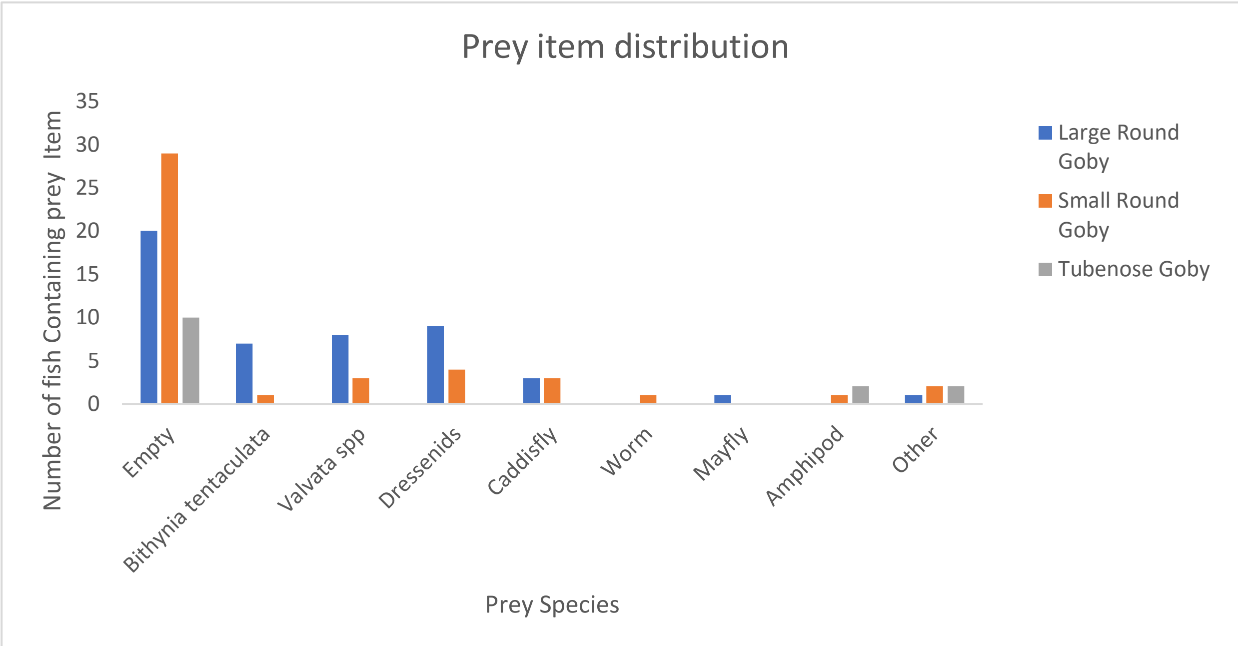

Figure 4: Prey item distribution for Round Gobies and Tubenose Gobies in the St. Lawrence River from the summer of 2019. Two snail species identified most likely: *Bithynia tentaculata*, *Valvata spp*, possibly *Valvata sincera*. 'Other' encompasses diet items include items that cannot be speciated: shell fragments, scales, vertebrae etc.

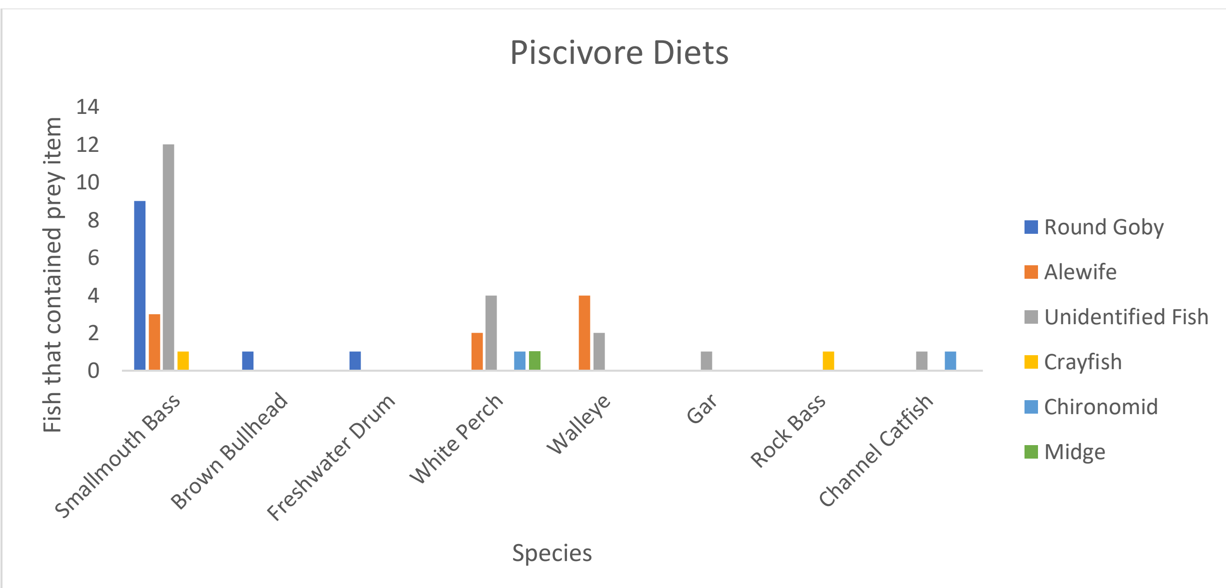

Figure 5: Predator prey item distribution. Only Smallmouth Bass, Brown Bullhead and Freshwater Drum were found with Round Gobies in their stomachs. Smallmouth Bass, White Perch and Walleye had identifiable Alewife in their stomachs.