A disappearing act:

In Search of the Elusive Young-of-the-Year Muskie

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Our lab's search for the elusive musky began shortly after we started conducting research in Georgian Bay in 2003. It was a stroke of luck that during the first year of surveying wetlands with an electrofishing boat, we caught our first juvenile musky in the summer of 2004. We had been searching for "reference" wetlands, that is, sites in pristine condition that have been protected from human development. We needed these healthy sites to add to our list of degraded sites so that we had a strong gradient of degradation to develop our ecological indicators of wetland health. But as things tend to go in research, our search for pristine wetlands had many spin-off projects, and one of these was to determine what makes habitat in wetlands suitable for young-of-the-year (YOY) muskies.

Prior to Georgian Bay, almost all wetlands we had sampled (primarily in southern Ontario) showed some signs of degradation, as reflected by dominance of species tolerant of high nutrients and turbidity in the fish and plant communities. It was clearly the other way around in Georgian Bay. Between 2003 and 2011, we surveyed the fish communities in 102 wetlands and set 370 fykenets (see Photo 1--fykenets in Sturgeon Bay in 2015), throughout eastern and northern Georgian Bay, and the North Channel, and we only found a handful that had slightly turbid conditions. And it is this amazing water clarity that allows a diverse assemblage of submersed aquatic vegetation (SAV) to be widely distributed, and make these coastal marshes such excellent nursery habitat for many species of fish, not the least of which is the young-of-the-year (YOY) musky (Photo 2--YOY musky captured in northern Georgian Bay). The trophy status of the musky fishery in Georgian Bay may be legendary, but probably few are aware that it is one of only a few remaining naturally reproducing populations in the Great Lakes (Photo 3a--JP holding a newly tagged muskellunge captured in one of our sites; Photo 3b--Dan holding a large muskelluge .

Between August 1997 and July 1999, water levels of Lake Huron (and Georgian Bay) were drastically reduced from 177.16 m to 176.42 m, a drop of 74 cm (nearly 2.5 feet). What is more significant is that over the next 14 years, water levels stayed near record lows, when normally, water levels would have rebounded to higher levels within 2 to 3 years. This compression in water-level fluctuations is known to affect the type of plant communities in wetlands, and may compromise the suitability of

Fyke net set in a Sturgeon Bay wetland in Pointe au Baril.

the wetland to support musky YOY and juveniles. Any loss of nursery habitat would of course have dire consequences for self-sustaining populations. Indeed, one objective of our wetland surveys throughout Georgian Bay was also to look for the elusive musky YOY. But over the 8 summers of fykenetting, we only found 2 juveniles, one in northeastern Georgian Bay (see Photo 4--Pat holding a juvenile musky) and another in the North Channel. Since fykenetting is a passive gear (i.e. the fish are not actively pursued), we decided to carry out a survey to target YOY muskies using active gear.

Our targeted effort to study muskies originally included two locations in Georgian Bay: one in a northern region and the other in a southeastern region. We selected these sites because in both regions, local anglers or the Ontario Ministry of Natural Resources (OMNR; renamed the Ontario Ministry of Natural Resources and Forestry in 2014) had observed muskies spawning as recently as the mid 2000s. There are no documented reports of YOY having been found at the northern site, while there is documented evidence of YOY having been found in surveys of the southeastern region 30 years earlier. OMNR biologists had sampled 103 potential nursery sites and netted thirty-four YOY at twenty sites during the summer of 1981. Based on these historic data, we expected to find YOY in southeastern Georgian Bay but not necessarily in northern Georgian Bay. During the summers of 2012 and 2013, we re-sampled sixteen of the twenty original sites sampled by OMNRF, and fifty-five in the northern region. To increase our chance of encountering YOY, we doubled the seining effort per wetland used by OMNR in 1981. Despite our increased sampling rigour, we did not find any YOY in southeastern Georgian Bay. By contrast, we found young muskellunge in sixteen of the fifty-five (almost 30%) wetland units in northern Georgian Bay, which was contrary to our expectations.

Dr. John Paul Leblanc holding a newly tagged muskellunge from Georgian Bay.

Naturally we sought to explain the lack of YOY in the southeastern region and abundance of YOY in the northern region we surveyed. Noting that there were no significant differences in the water chemistry or physical characteristics

A young-of-the-year muskellunge caught in a seine haul.

Mr. Dan Weller (Ph.D candidate) holding a newly tagged muskellunge.

among our sites, we carried out a systematic comparison of the vegetative characteristics of sites where we found YOY muskies (southeastern sites in 1981 and northern sites in 2013), and where we did not (southeastern sites in 2012 and northern sites in 2013). Between 1981 and 2012, many of the wetlands in southeastern Georgian Bay had experienced losses of more than 50% of their original areas because of the shallow contours of the wetlands. These alterations can have profound effects on musky reproduction primarily because muskies have a very narrow range of suitable environmental parameters which promote successful reproduction. We also found some losses due to modifications along the shoreline, where new cottages, docks and marinas had been built. By contrast, wetlands in the northern region tended to have steeper slopes and there were only slight differences in wetland area over the three decades.

By far, the largest physical change in wetlands in the southeastern region was the overall reduction of tall, canopy-growing plant species (e.g. pondweed) in favour of short, low-growing species (e.g. stonewort). There was an increase in the relative abundance of the invasive eurasian milfoil, a less diverse community of emergent and floating species, and overall less vertical structure in the water column. Similarly, we observed a significant change in the fish community, with a shift in species composition, which unfortunately included the establishment of round goby, an invasive species from Eurasia that is a known egg predator of other piscivores (Photo 5--abundant round gobies captures in a seine haul) as well as an overall reduction in species diversity through time. Compared with 1981, we observed a lower catch of largemouth bass but significantly higher catch of yellow perch, which we observed (on videotape) to have fed aggressively on muskellunge eggs when they were left on a platform. We suggest that the marked changes in the southeastern region's habitat (less vertical structure from vegetation) and increased abundance of egg predators may have reduced the suitability of the habitat for young muskellunge. Even if egg depredation had not occurred, the hatchling and YOY would have been highly vulnerable to predation because of loss of canopy-growing plants. Based on these results, we have developed an Index of Nursery Habitat Suitability that can be used to help identify probable nursery sites in novel habitats.

Given that muskellunge are long-lived, and are known to exhibit fidelity to spawning sites (see article by Dan Weller), we must use known spawning habitat to help identify probable nursery sites and ensure that both breeding habitat types are protected from human development. We must do so if we want to keep the trophy fishery self-sustaining. Furthermore, we plan to model how changes in water-level fluctuations associated with climate change will interact with basin morphometry to alter the plant community in wetlands and thereby influence the reproductive success of muskellunge sub-populations.

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Dan Weller and JP Leblanc in a boat beside a large pen that holds a newly tagged musky that is recovering from the surgery and anaesthetic. Use of boat was arranged by Mary Muter through funds provided by the Sierra Club Canada Foundation.