

**SAMPLING FOR MUSKELLUNGE, RUDD, AND THE NEARSHORE FISH COMMUNITY OF THE BUFFALO HARBOR (LAKE ERIE) AND THE UPPER NIAGARA RIVER, 2009**

*Kevin L. Kapuscinski, Michael A. Wilkinson, and John M. Farrell*

**Introduction**

The New York State Department of Environmental Conservation (NYSDEC) and State University of New York College of Environmental Science and Forestry (SUNY-ESF) began a collaborative effort to survey the muskellunge (*Esox masquinongy*) population of the Buffalo Harbor (Lake Erie) and the upper Niagara River during 2007 in response to concerns about declining angler catch rates (Figure 1). Results of sampling for spawning-stage and young-of-year (YOY) muskellunge during 2006-2008 were previously reported (Kapuscinski and Wilkinson 2008; Kapuscinski et al. 2009). This report summarizes efforts to sample muskellunge, muskellunge eggs, the non-native rudd (*Scardinius erythrophthalmus*), and the nearshore fish community of the Buffalo Harbor and upper Niagara River during 2009. The objectives of these efforts were to: 1) collect tissue samples for an ongoing study of the genetic structure of Great Lakes muskellunge, 2) identify muskellunge spawning sites via egg collection and nursery sites via YOY collection, 3) quantify catch rates of YOY muskellunge at nursery sites, 4) collect diet information from YOY muskellunge, 5) collect data to characterize the fish community at YOY muskellunge nursery sites, and 6) collect rudd for an ongoing study of their biology in the upper Niagara River.

**Methods**

**Spring Electrofishing**

We electrofished sites expected to be used by spawning or juvenile muskellunge during 18 May-11 June. Electrofishing was done with an 18ft Smith-Root SR18E electrofishing boat with a driver and two people netting; at times a fourth person served as an observer and facilitated data collection. We used pulsed (60 pulses/sec) direct current at 500 v and 7-10 amps. Muskellunge were netted and held on board in an aerated tank until they were processed. We measured (total length for all length

measurements herein) all muskellunge and northern pike (*Esox lucius*) and attempted to determine their sex via extrusion of gametes. We also collected scale samples and fin-clips (genetic samples) from all muskellunge, and applied a uniquely numbered Floy anchor T or billfish style tag at the base of the dorsal fin. In addition, muskellunge received an unnumbered, orange anchor T tag to aid in the determination of tag loss upon recapture.

**Sampling for Muskellunge Eggs**

We attempted to collect muskellunge eggs to identify spawning locations and add to our ongoing study of muskellunge genetic structure. Pine-framed egg traps (16 x 16 x 3 in) with a bottom of 0.06 in mesh nylon screen and a top of 0.25 in mesh plastic or metal screen were used to sample for muskellunge eggs in the upper Niagara River (see Farrell 2001 for egg trap details). We submerged the traps on the river bottom by securing a brick to opposite sides of the frame, and each trap was marked with a float line. A total of 25 traps were set at two sites; 20 at a site off the northwest tip of Grand Island, along the shoreline of Buckhorn Island State Park, and five just downstream of the mouth of Big Six Mile Creek (Figure 2). Traps were lifted, examined for eggs, and reset immediately every 2-4 days. Water temperature was recorded when traps were lifted, and all suspected muskellunge eggs (0.10-0.14 in diameter) were retained in non-denatured ETOH for genetic analysis.

**Seining for YOY Muskellunge and the Nearshore Fish Community**

We sampled the fish community at 18 different muskellunge nursery sites (Figures 2-4; two sites in the Chippewa Channel of the upper Niagara River not shown) during 27 July-28 August using a standardized seining protocol (Farrell and Werner 1999); six of these sites were previously sampled each year during 2007 and 2008. A fine mesh bag seine (30 ft long, ~1/32 in mesh) was used during 27 July-6 August, and a large mesh bag seine (60 ft long, 1/4 in mesh) was used during 25-28 August.

Each seine haul was 100 ft long, and we sampled vegetated areas that were typically < 5 ft deep. We identified fish to the species (rarely genus) level and counted them in two separate categories: YOY and all other age classes. We often encountered >1000 very small YOY shiners (*Notropis spp.*) and YOY bluntnose minnow (*Pimephales notatus*) per seine haul, so we recorded them as *Notropis* rather than retaining them for later identification. A few unidentifiable fish were saved for later identification. We measured the length of all muskellunge, collected fin-clips for a genetic sample, and flushed stomach contents from fish deemed large enough via gastric lavage. A small tube (0.06 in diameter) attached to a water bottle was inserted into the stomach and contents were gently flushed out. Light pressure was exerted on the abdomen with the thumb to assist in release of diet items, and forceps were used to remove items lodged in the throat or mouth. Prey items were identified and their length measured in the field.

#### **Fall Electrofishing for YOY Muskellunge**

We electrofished muskellunge nursery sites in the upper Niagara River and Buffalo Harbor during fall to obtain catch rates of YOY muskellunge and sample the fish community. We sampled a total of 13 different sites in the upper Niagara; six of these were sampled each year during 2006-2008. A total of three different sites were sampled in the Buffalo Harbor, and two of these were sampled each year during 2006-2008. Most of the sites were identified during 1992 and 1993 as muskellunge nursery sites, and their locations were described previously (Culligan et al 1994).

Sampling was completed with a 21 ft Smith-Root SR21EH electrofishing boat. A driver operated the boat while two people netted, and occasionally a fourth person served as an observer and facilitated data collection. We used pulsed (60 pulses/sec) direct current at 500 v and 9-10 amps. We identified all fish collected to the species level, measured their length, and released them. Young-of-year muskellunge were administered a partial fin clip coded for collection location; right pelvic for upper Niagara River, left pelvic for Buffalo Harbor. The removed fin tissue was retained in non-denatured ETOH for genetic analysis. Stomach contents were

removed from some YOY muskellunge, and prey items were identified and measured in the field.

#### **Sampling for Rudd**

We sampled rudd via electrofishing, seining, and trap-netting at various sites in the upper Niagara River. Rudd captured while spring electrofishing or summer seining for muskellunge were measured for length, and their stomach contents were removed via gastric lavage. We also targeted rudd on 3 November while electrofishing; all captured rudd were retained for dissection. The majority of our efforts to sample rudd, however, focused on using trap-nets. We set two hoop style trap-nets (4 ft diameter frame, 100 ft lead, and 20 ft wings) on four different dates throughout the season to collect rudd. One net was set in the Strawberry Island embayment and the other off the upstream edge of a wetland along the east shoreline of Beaver Island State Park (Figure 3). These two areas were typically 1-5 ft deep and contained submerged aquatic vegetation. The nets were fished for 1-2 days and emptied daily. All rudd captured were individually bagged, labeled, and placed on ice until they could be measured, weighed, and frozen. Rudd were kept frozen until they could be processed, which included recording the body coloration (olive or orange), extracting otoliths and some scales, determining sex, weighing ovaries, and identifying and weighing stomach contents.

### **Results**

#### **Spring Electrofishing**

Our spring electrofishing efforts consisted of 63 runs totaling 1,240 min or 20.67 hr during 18 May-11 June. We captured a total of 54 muskellunge (all ages) and 3 tiger muskellunge (*E. masquinongy x E. lucius*) from all areas sampled. Of the 54 muskellunge captured, 20 were males, two were females, and 32 were of unknown sex.

In the Buffalo Harbor and Buffalo River, we captured five muskellunge during 5.68 hr of electrofishing effort, resulting in a total catch rate of 0.88 / hr. Muskellunge from the Buffalo Harbor and Buffalo River were on average 41.6 in long (range 34.4-47.8 in; Table 1). Three of these muskellunge were males, one was a female, and one was of unknown sex. A male and female muskellunge were

captured in close proximity to each other within Ice Boom Bay; these fish were likely a breeding pair. Genetic analysis of the three YOY muskellunge captured in Ice Boom Bay during 2009 (see below) may confirm this possibility.

At upper Niagara River sites, we captured 28 muskellunge and three tiger muskellunge during 13.42 hr of electrofishing effort, resulting in a total catch rate of 2.31 / hr. One of the three tiger muskellunge was recaptured in a later electrofishing run (recapture not included in catch rate calculation). Muskellunge from the upper Niagara River averaged 31.1 in long (range 13.5-41.5 in), whereas tiger muskellunge averaged 31.4 in long (range 25.6-34.8 in; Table 1). Of the 28 muskellunge captured, 17 were males, one was a female, and 10 were of unknown sex.

We captured an additional 21 juvenile (yearling or age-2) muskellunge and four suspected juvenile tiger muskellunge from the Big Six Mile Creek Marina during 1.57 hr of electrofishing effort, resulting in a total catch rate of 15.96 / hr. The juvenile muskellunge averaged 14.2 in long (range 10.2-21.5 in) and the suspected tiger muskellunge also averaged 14.2 in long (range 7.7-16.9 in; Table 1).

The size distribution of muskellunge captured via electrofishing from the upper Niagara River was rather broad, suggesting that multiple year classes were present (Figure 5). Nineteen muskellunge <20 in were captured from Big Six Mile Creek Marina, a deepened (dredged) lower stretch of tributary to the upper Niagara River, and one muskellunge <20 in was taken from the former Niagara Yacht Club, a marina basin protected from river currents. No muskellunge <20 in were captured from the main river channel proper, and no muskellunge <34 in were captured from the Buffalo Harbor.

#### **Sampling for Muskellunge Eggs**

Efforts to sample muskellunge eggs were mostly unsuccessful, despite our observing muskellunge near the traps on three different occasions during the spawning period and despite collecting substantial numbers of YOY in close proximity to trap locations during summer. Numerous small eggs were captured, but very few (<15) eggs of the appropriate size or color to be considered muskellunge eggs

were captured and saved for genetic analysis. Most of the saved eggs appeared unviable (milky color), and only one appeared to be both viable and of the appropriate size. On numerous occasions the egg traps were inundated with thick masses of filamentous algae, especially downstream of Big Six Mile Creek where flows were not adequate to keep the traps clean.

#### **Seining for YOY Muskellunge and the Nearshore Fish Community**

We captured 76,390 fish in 81 hauls of the fine mesh seine at 16 sites during 2009; 140 of those fish were YOY muskellunge. The five most common age class / species captured was YOY spottail shiner (*Notropis hudsonius*, n=13,130), YOY bluntnose minnow (n=7,783), emerald shiner (*Notropis atherinoides*, n=2,950), YOY rock bass (*Ambloplites rupestris*, n=2,366), and YOY largemouth bass (*Micropterus salmoides*, n=2,159); 42,580 fish were recorded as *Notropis*, which were predominately spottail shiner, bluntnose minnow, and emerald shiner. We sampled 39 species with the fine mesh seine, including blackchin shiner (*Notropis heterodon*; n=26), bridle shiner (*Notropis bifrenatus*, n=507) brook stickleback (*Culea inconstans*, n=2), hornyhead chub (*Nocomis biguttatus*, n=235; includes YOY and older), and YOY northern hognose sucker (*Hypentelium nigricans*, n=1), which are all considered rare in the system. Non-native species sampled at muskellunge nursery sites included alewife (*Alosa pseudoharengus*), common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), round goby (*Neogobius melanostomus*), rudd, and white perch (*Morone americana*).

We captured 10,432 fish in 65 hauls of the large mesh seine at 10 sites during 2009; 33 of those fish were YOY muskellunge. The five most common species sampled were YOY rock bass (n=3,975), bluntnose minnow (n= 1,078), bridle shiner (n=959), YOY largemouth bass (n=930), and banded killifish (n=717). We sampled 38 species with the large mesh seine, including blackchin shiner (n=146), bridle shiner (*Notropis bifrenatus*; n=990; includes YOY and older), brook stickleback (*Culaea inconstans*; n=1), hornyhead chub (n=47; includes YOY and older), northern hognose sucker (n=4; includes YOY and older), and YOY green sunfish (*Lepomis cyanellus*, n=4). In addition to the non-

native species sampled with the fine mesh seine, we also captured rainbow smelt (*Osmerus mordax*, n=1) and YOY gizzard shad (*Dorosoma cepedianum*, n=23) with the large mesh seine. A summary table of the species caught, number caught, and number caught per haul is available from the authors upon request.

Our catch rates of YOY muskellunge ranged from 0-5.50 / haul with the fine mesh seine (0-11.00 / haul when standardized to the area sampled by the large mesh seine) and 0-1.14 / haul with the large mesh seine (Table 2). Catch rates of YOY muskellunge with the fine mesh seine were much lower in the Buffalo Harbor (0.20 / haul) compared to the upper Niagara River (1.94 / haul; Table 2). Significant declines occurred in the number of muskellunge caught per unit effort between late July / early August (3.89 / haul) and late August (0.51 / haul) in the upper Niagara River (Figure 6). The highest YOY muskellunge catch rate (5.50 / haul) occurred at a site just downstream of a concrete break wall on the western shore of Grand Island. However, this catch rate was obtained from just two seine hauls. The next highest catch rate, 4.56 / haul (nine total hauls), was observed just offshore from a wetland that was altered to prevent erosion (Figure 3; upstream of East River Marina).

Six sites were sampled with a fine mesh seine each year during 2007-2009. Catch rates were variable at four of the six sites, whereas Ice Boom Bay produced one YOY in each year and the Strawberry Island Embayment produced none (Figure 7). The site just offshore from the protected wetland upstream of East River Marina has consistently produced relatively high catch rates of YOY muskellunge.

Genetic samples were collected from all 173 YOY muskellunge captured via seine, and diet data were collected from 34 YOY muskellunge. Results of the genetic and dietary analyses will be reported in separate publications.

#### **Fall Electrofishing for YOY Muskellunge**

We captured a total of 21 YOY muskellunge at eight sites during 2009 (Table 3). The highest number of YOY muskellunge caught per hour (20.59 / hr) was observed downstream of Big Six Mile Creek (site

U19A). The average total catch rate (number of YOY muskellunge caught / hr) from sites in the Buffalo Harbor was less than half of that observed from sites in the upper Niagara River (Table 3). Eight of the sites sampled during 2009 were also sampled each year during 2006-2008 (Kapusinski et al. 2009). Although YOY muskellunge catch rates were quite variable over the time series, three sites around Buckhorn Island (U20, U21A, and U22A) consistently produced catch rates that were relatively high (Figure 8). No YOY muskellunge were captured in one or two years during 2006-2009 at the other five sites.

Genetic samples were collected from 21 YOY muskellunge, and diet data were collected from 15 YOY muskellunge captured during fall electrofishing. Results of the genetic and dietary analyses will be reported in separate publications.

#### **Sampling for Rudd**

We examined a total of 255 rudd during 2009; 74 were captured while electrofishing, 38 via seine, and 143 in trap-nets. We measured and examined the stomach contents of 60 rudd in the field, and an additional 195 rudd were retained for dissection. Of the 143 rudd captured in trap-nets, 50 were captured on 21-22 May, 50 on 9 June, 39 on 29 July, and only four on 26 August. Rudd were often observed in shallow vegetated areas during spring and early summer, but apparently emigrated from these areas by late August. Fifty-one rudd were collected on 3 November while electrofishing areas that were 5-10 ft deep. The average total length of the rudd collected was 13.7 in (range 5.1-17.5 in) and the average weight of rudd was 1.7 lb (range 0.1-3.8 lb). More detailed information on the biology of rudd in the upper Niagara River will be presented in a separate report.

#### **Discussion**

We relied exclusively on electrofishing to capture muskellunge during spring of 2009 due to the low catch rates of muskellunge in trap-nets during 2007-2008 (Kapusinski et al. 2009). While catches of spawning-stage muskellunge were higher via electrofishing (n=22 in 2009) than in trap-nets (n=3 in 2007 and n=3 in 2008), the capture of ripe female muskellunge remained a rare event (n=1 in trap-nets

in 2007, n=0 in trap-nets in 2008, and n=2 via electrofishing in 2009). The inability to capture gravid female muskellunge would greatly hamper a culture and supplemental stocking program for the Buffalo Harbor and upper Niagara River; obtaining enough gravid females for a genetically sound culture program appears improbable using the collection techniques we used.

We were unable to capture muskellunge eggs in egg traps set in the upper Niagara River, despite the presence of adult muskellunge near the traps during the spawning period. Furthermore, we captured YOY muskellunge at the sites sampled for eggs, indicating that muskellunge broadcasted their eggs near our traps. The low probability of capturing muskellunge eggs in traps set in the Niagara River is likely due to the typically low density of spawning muskellunge, the large size of spawning habitats, and the fouling of traps by filamentous algae. Future efforts to sample muskellunge eggs should incorporate nighttime spotlighting or radio telemetry of spawning adults to further define spawning locations.

Our results indicate that the muskellunge population in the Buffalo Harbor is severely depressed relative to the population in the upper Niagara River. Angler catch rates from the Buffalo Harbor during 2004-2008 were less than or equal to half the catch rates from the upper Niagara River. Similarly, the average electrofishing catch rate of muskellunge from the Buffalo Harbor was less than half that observed for the upper Niagara River during both spring (all age classes) and fall (YOY only) of 2009 and 2006-2008 (Kapuscinski et al. 2009). Catch rates of YOY muskellunge obtained with a fine mesh seine during 2009 were even more disparate, averaging 0.20 / haul in the Buffalo Harbor and 1.94 / haul in the upper Niagara River. Kapuscinski et al. (2009) reported seining catch rates of 0.32 / haul for the Buffalo Harbor during 2007-2008 compared to 2.13 / haul from the upper Niagara River. As mentioned in our 2008 report (Kapuscinski et al. 2009), we believe muskellunge production in the Buffalo Harbor is primarily depressed due to the limited quantity and quality of nursery and spawning habitats. Management efforts should focus on restoration of the habitats and fish community associated with muskellunge; such efforts would

likely benefit other native, nearshore sport fishes as well. It is important to note, however, that the angler catch rates and numbers of large muskellunge caught by anglers during the 1990s may not return solely through restoration of spawning and nursery habitats. Other factors, such as immigration of muskellunge from the upper Niagara River and Lake Erie, likely contributed to the outstanding angling of the 1990s. Other changes to the aquatic environment that may have impacted angling success for muskellunge include increased water clarity following dreissenid mussel invasion and changes in gizzard shad distribution following the removal of a warm-water discharge in the Buffalo Harbor.

We observed a dramatic decrease in the catch rate of YOY muskellunge between late July / early August (3.89 / haul) and late August (0.51 / haul) in the upper Niagara River during 2009. The summer growing period was relatively cold during 2009, which probably resulted in poor growth rates and higher mortality of YOY muskellunge. The average length of YOY muskellunge captured during 27-28, and 31 July 2009 was 2.7 in (n=77), much smaller than the 3.4 in average length observed during 28 July-1 August 2008 (n=115; Kapuscinski, unpublished data). The relative small size of YOY muskellunge during 2009 likely made them more vulnerable to predation and resulted in low abundances during late August.

The Strawberry Island embayment was once an important site for YOY muskellunge production (Culligan et al. 1994). However, we did not capture any YOY muskellunge while seining or electrofishing during 2009. Furthermore, no YOY muskellunge were captured at this site during 2006-2008 (Kapuscinski et al. 2009). We recognize that it may be difficult to restore the features that attracted muskellunge (e.g. water flow) and maintain the structural integrity and important ecological functions of the island. However, exploring the feasibility of restoring the suitability of this site for muskellunge reproduction should be a management priority.

The results of our efforts to capture muskellunge via electrofishing during spring suggest that suitable habitats for juvenile (yearling and age-2)

muskellunge are limited and were found only in locations outside of the main river channel. Nineteen of the 20 muskellunge < 20 in captured were from Big Six Mile Creek and its marina basin; one was captured from the former Niagara Yacht Club marina basin. We sampled a number of marinas and embayments throughout the Buffalo Harbor and Niagara River, but failed to capture juvenile muskellunge in 2009. However, we did not sample other tributaries to the upper Niagara River where a total of 56 muskellunge (we assume juveniles) were collected via electrofishing, fyke nets, and seine in 2003, such as Burnt Ship Creek (n=2), Gun Creek (n=3), Spicer Creek (n=17), and Woods Creek (n=20; New York Power Authority, Gomez and Sullivan Engineers, P.C. 2005). Furthermore, other tributaries that likely contain muskellunge were not sampled, such as Tonawanda Creek (Barge Canal), Ellicott Creek, and Cayuga Creek. The sampling of these tributaries to the upper Niagara River, and other marina basins and embayments that remain unsampled, should be a priority. Our knowledge of what constitutes suitable habitat for juvenile muskellunge is very limited—identification and protection of such habitats should benefit management of muskellunge in the Buffalo Harbor and upper Niagara River.

Big Six Mile Creek and its marina basin may be unique in the system due to the combination of relative large size, high turbidity, warm water temperatures, high prey densities, and flow. Big Six Mile Creek is also upstream of some of the most productive muskellunge nursery sites; YOY muskellunge may cue in on the warm outflow and abundant forage once they emigrate from their first-year nursery sites. It is unclear how long juvenile muskellunge stay in Big Six Mile Creek or if they use it to over-winter. Research that elucidates why this site is attractive to juvenile muskellunge is needed so that similar habitats can be identified, protected, and restored. The Big Six Mile Creek watershed should be protected from further degradation, and restoration of similar sites should be a priority of resource managers.

Our results demonstrate that some areas important for muskellunge reproduction may remain unidentified, and therefore, not fully protected. For example, the site downstream of River Lea on the

southeast shore of Grand Island along Beaver Island State Park produced a relatively high number of YOY muskellunge in 2009. This site was last sampled in 1992, when no YOY muskellunge were observed, although sampling may have been done in excessively shallow water where suitable habitat conditions did not exist. Habitat alterations, including the construction of offshore rock break-walls, were recently proposed for this site—we strongly oppose such alterations as they could compromise the natural reproduction of muskellunge and other native fishes in this area. This example illustrates the importance of surveying sites that are not known to be important for muskellunge reproduction, and doing so during more than one year to detect muskellunge use (Farrell and Werner 1999). In addition to the site downstream of River Lea, we found YOY muskellunge for the first time at a site off the western shore of Grand Island near Long Road, between Big Six Mile Creek and Buckhorn Island State Park. We also found YOY muskellunge at two other sites, in one case upstream (during summer seining) and in the other case downstream (during fall electrofishing) of existing monitoring sites, thus expanding the size of the known nursery areas at these two sites. Efforts to survey suspected spawning and nursery sites should continue.

The standardized electrofishing and seining surveys described above have provided important information regarding YOY muskellunge production at recently altered and unaltered sites, the presence of non-native and rare native fishes, and the identification of previously unknown nursery areas. We recommend that standardized surveys be conducted annually at index sites (e.g. the sites sampled during 2006-2009). Such long-term monitoring efforts are invaluable for documenting changes in the fish community and guiding management decisions. A small amount of additional effort should be expended each year to survey sites that have not been previously assessed but appear suitable for muskellunge reproduction and first year growth.

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Table 1. Summary of electrofishing efforts in the Buffalo Harbor and Buffalo River, upper Niagara River, and Big Six Mile Creek Marina during spring of 2009. The total electrofishing effort (min), number of electrofishing runs (# runs), number of muskellunge captured (N), sex ratio (Male:Female:Unknown), mean total length (in) and length range (in) of muskellunge captured, and the catch rate (catch per electrofishing hour) are provided.

System	Effort (min)	# runs	Muskellunge			Catch rate	Tiger muskellunge		
			N	Sex ratio M:F:U	Mean TL (range)		N	Mean TL (range)	Catch rate
Buffalo Harbor and River	341	18	5	3:1:1	41.6 (34.4-47.8)	0.88	-	-	-
Upper Niagara River	805	40	28	17:1:10	31.1 (13.5-41.5)	2.09	3 <sup>a</sup>	31.4 (25.6-34.8)	0.22
Bix Six Mile Creek Marina	94	5	21	0:0:21	14.2 (10.2-21.5)	13.40	4 <sup>b</sup>	14.2 (7.7-16.9)	2.55
Total	1,240	63	54	20:2:32	25.5 (10.2-47.8)	2.61	7	21.5 (7.7-34.8)	0.34

a = excludes one recaptured tiger muskellunge

b = suspected tiger muskellunge

Table 2. Seining sites, number of young-of-year muskellunge caught, number of seine hauls, catch rate of young-of-year muskellunge (number caught per seine haul), and the catch rate of the fine mesh seine standardized to the area sampled by the large mesh seine (Std catch rate) for seining conducted in 2009. Note: DS = downstream, W = west, E = east, NW = northwest, GI = Grand Island, S = south, and US = upstream.

Site	Fine mesh seine				Large mesh seine		
	Number of muskellunge caught	Number of hauls	Catch rate	Std catch rate	Number of muskellunge caught	Number of hauls	Catch rate
<b><u>Buffalo Harbor, Lake Erie</u></b>							
Bell Slip	1	6	0.17	0.33	-	-	-
Ice Boom Bay	1	4	0.25	0.50	-	-	-
Buffalo Harbor total	2	10	0.20	0.40			
<b><u>Upper Niagara River</u></b>							
102nd St. Embayment	0	4	0.00	0.00	-	-	-
Beaver Island Inlet	0	2	0.00	0.00	-	-	-
DS Big Six Mile Creek	8	4	2.00	4.00	10	5	2
DS River Lea	26	8	3.25	6.50	8	7	1.14
DS Strawberry Is W	0	4	0.00	0.00	-	-	-
E River DS GI Bridge	16	9	1.78	3.56	5	11	0.45
E River US GI Bridge	16	9	1.78	3.56	2	10	0.2
Grass Island	3	2	1.50	3.00	-	-	-
Head of Cayuga Island	-	-	-	-	0	2	-
Long Road	-	-	-	-	2	6	0.33
Motor Is W	5	5	1.00	2.00	0	4	0
NW GI S Buckhorn	11	7	1.57	3.14	2	5	0.4
Strawberry Is Embayment	0	4	0.00	0.00	-	-	-
US of W River Boathouses <sup>a</sup>	1	2	0.50	1.00	-	-	-
W River DS Concrete Breakwall <sup>a</sup>	11	2	5.50	11.00	0	5	0
Wetland	41	9	4.56	9.11	4	10	0.40
Upper Niagara River total	138	71	1.94	3.89			
Grand total	140	81	1.73	3.46	33	65	0.51

a = site not depicted in Figures 2-4

Table 3. Electrofishing sites and dates sampled, number of seconds electrofished, number of young-of-year muskellunge collected, number observed, total (collected + observed), and the catch rate (catch per electrofishing hour) during 2009.

Site Number	Site description	Date	Effort (sec.)	Number of YOY muskellunge			Catch rate
				Collected	Observed	Total	
<b><u>BUFFALO HARBOR, LAKE ERIE</u></b>							
BH1	Bird Island Marsh	1-Oct-09	1017	0	0	0	0.00
BH3	Ice Boom Bay	1-Oct-09	1187	2	0	2	6.07
BH4	Bell Slip	1-Oct-09	1028	0	0	0	0.00
	Buffalo Harbor Total		3232	2	0	2	2.23
<b><u>UPPER NIAGARA RIVER</u></b>							
U6B	West Side Motor Island	24-Sep-09	710	0	0	0	0.00
U11A	Wetland (outside breakwalls)	24-Sep-09	781	0	2	2	0.00
U12A	River Lea downstream to U11A	24-Sep-09	586	1	1	2	6.14
U18B	Concrete jetty downstream to Fix Rd.	24-Sep-09	844	2	0	2	8.53
U19	Six Mile Creek Marina	24-Sep-09	1677	0	3	3	0.00
U19A	Sixmile Creek Downstream Past Emergents	24-Sep-09	874	5	1	6	20.59
U20	Buckhorn Island Downstream of Utility Bldg.	25-Sep-09	649	3	0	3	16.64
U21A	Power Line Upstream to N. Grand Island Bridge	25-Sep-09	1002	2	0	2	7.19
U22A	Upstream of N. Grand Island bridge-S. Shore	25-Sep-09	1130	3	0	3	9.56
U23	Grass Island	21-Oct-09	922	3	0	3	11.71
U26	102nd Street Embayment	21-Oct-09	1109	0	0	0	0.00
na	Upstream of N. Grand Island bridge-N. Shore	21-Oct-09	429	0	0	0	0.00
na	Gratwick Park Offshore of Breakwaters	21-Oct-09	817	0	0	0	0.00
	Upper Niagara River Total		11530	19	7	26	5.93
	Grand total		14762	21	7	28	5.12

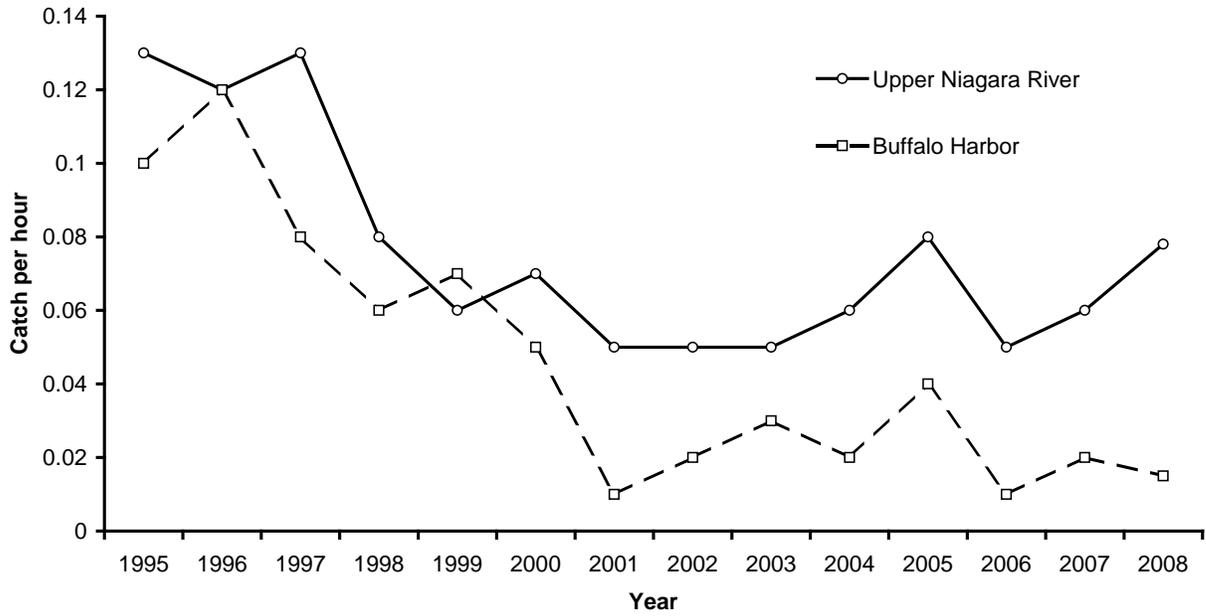


Figure 1. Mean catch rate of muskellunge (number caught per hour) by anglers participating in the Niagara River Musky Association Angler Cooperative Program on the upper Niagara River and Buffalo Harbor from 1995-2008.

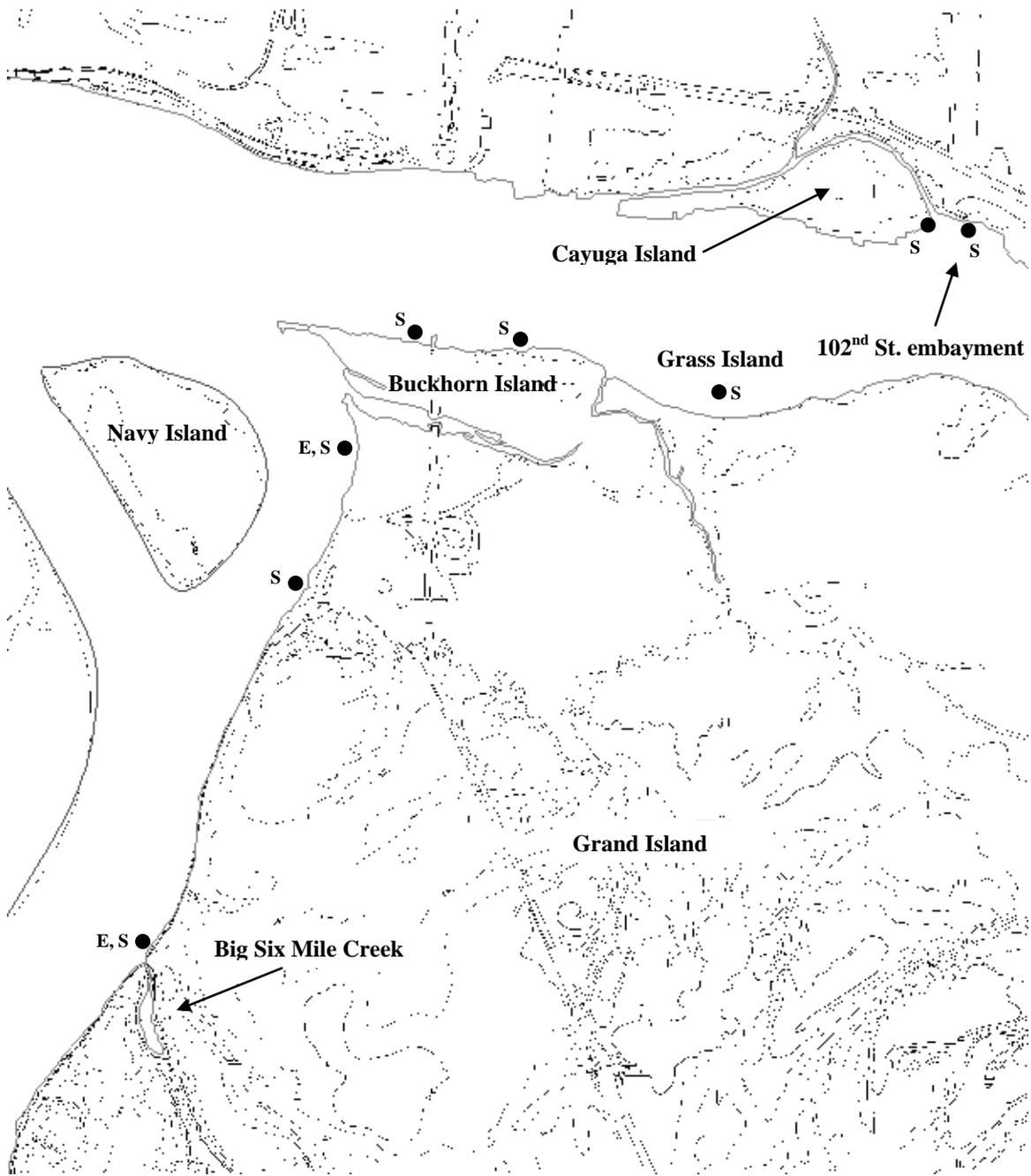


Figure 2. Image of a portion of the upper Niagara River, depicting egg trap (E) and seining (S) sites.

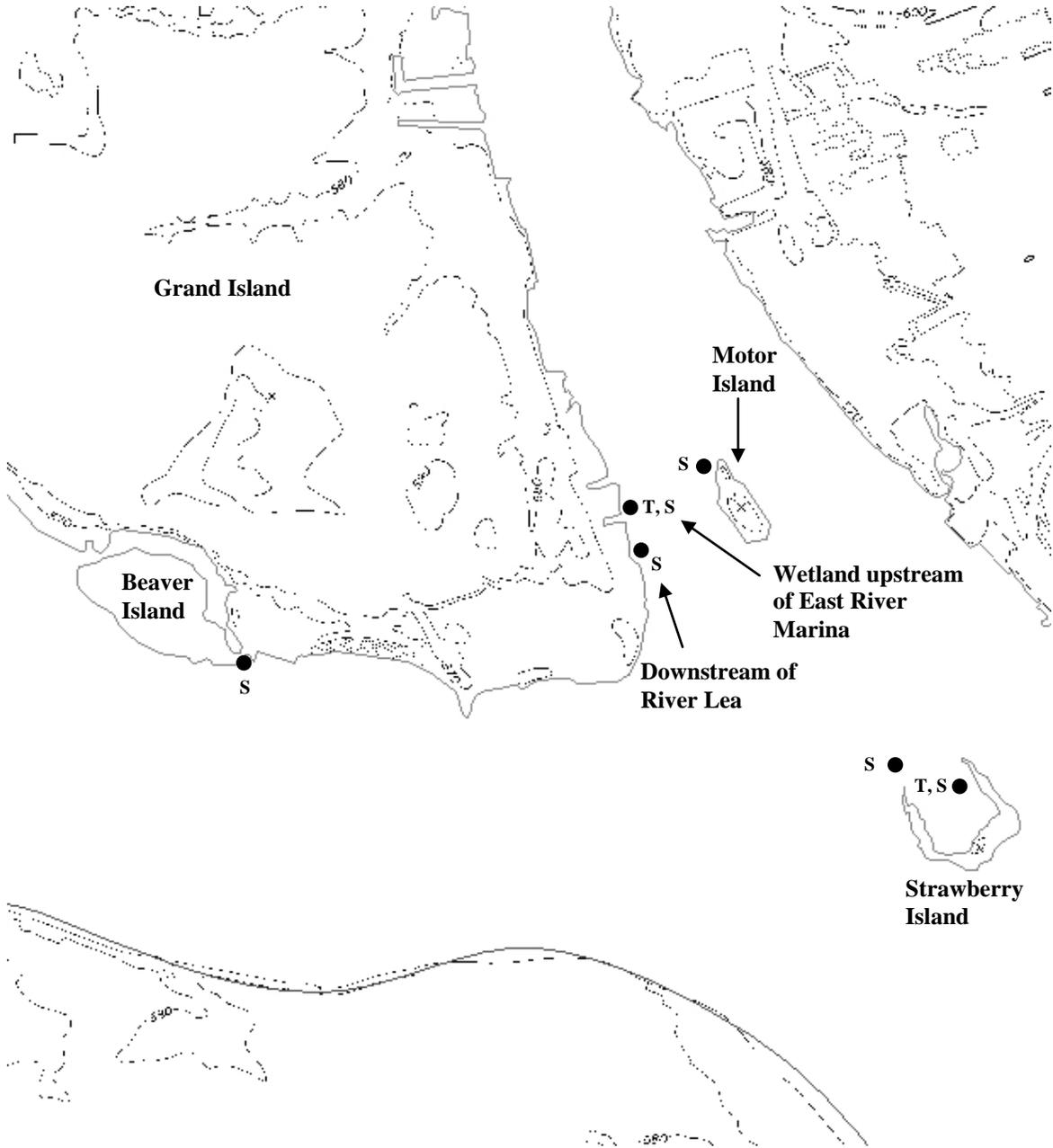


Figure 3. Image of a portion of the upper Niagara River, depicting trap-net (T) and seining (S) sites.

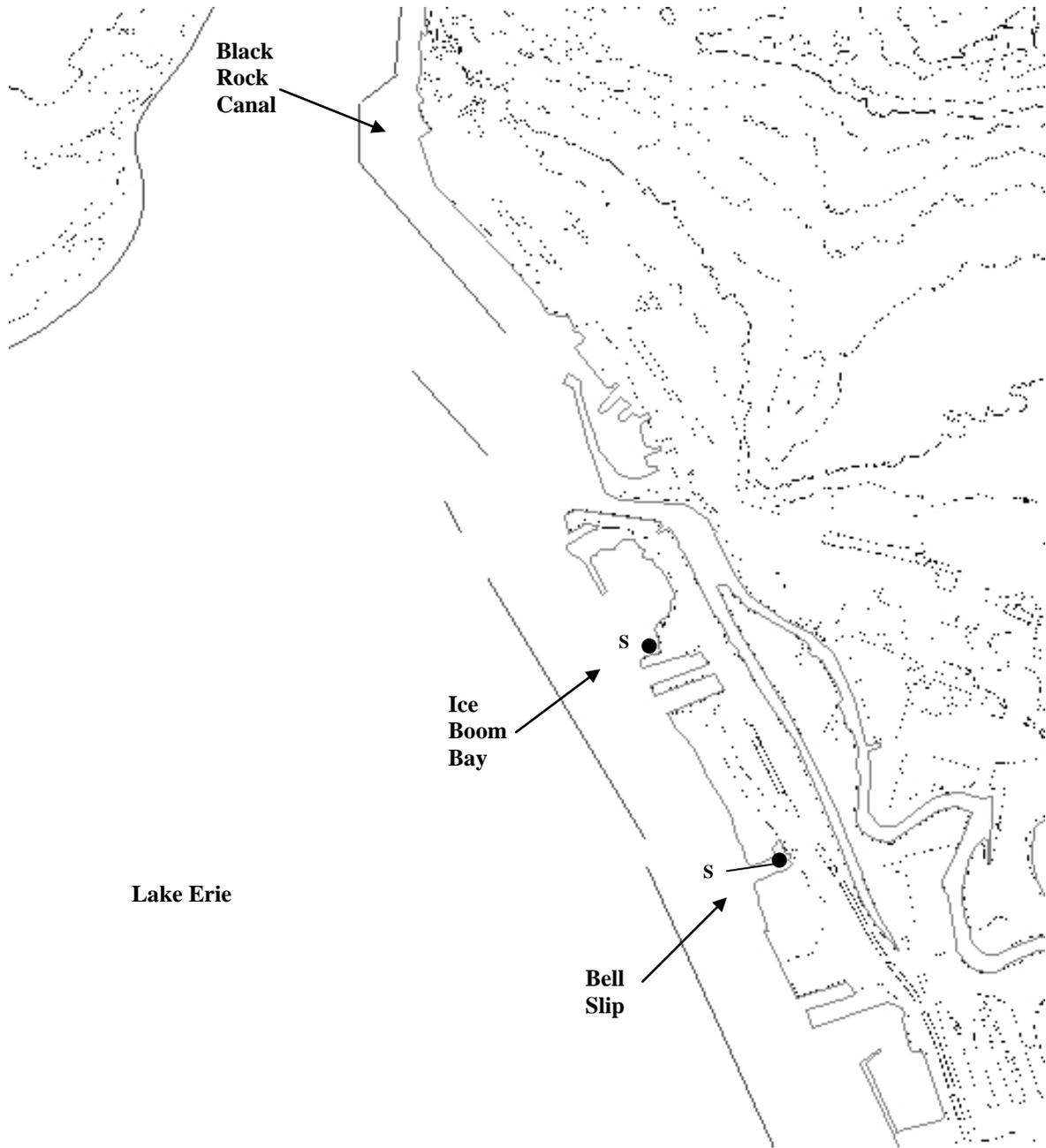


Figure 4. Image of a portion of the Buffalo Harbor, Lake Erie, depicting seining (S) sites.

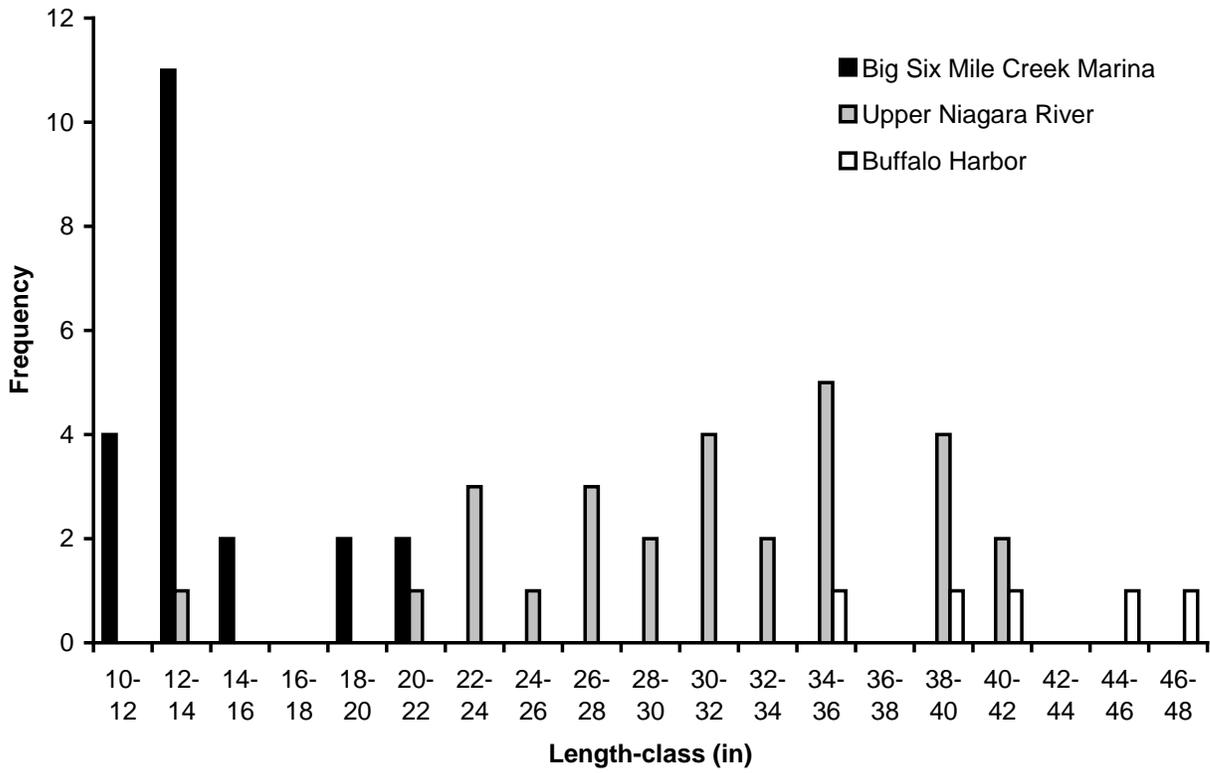


Figure 5. Length-frequency (in) histogram of muskellunge captured via electrofishing from the Big Six Mile Creek Marina, upper Niagara River, and Buffalo Harbor, Lake Erie during 18 May-11 June 2009.

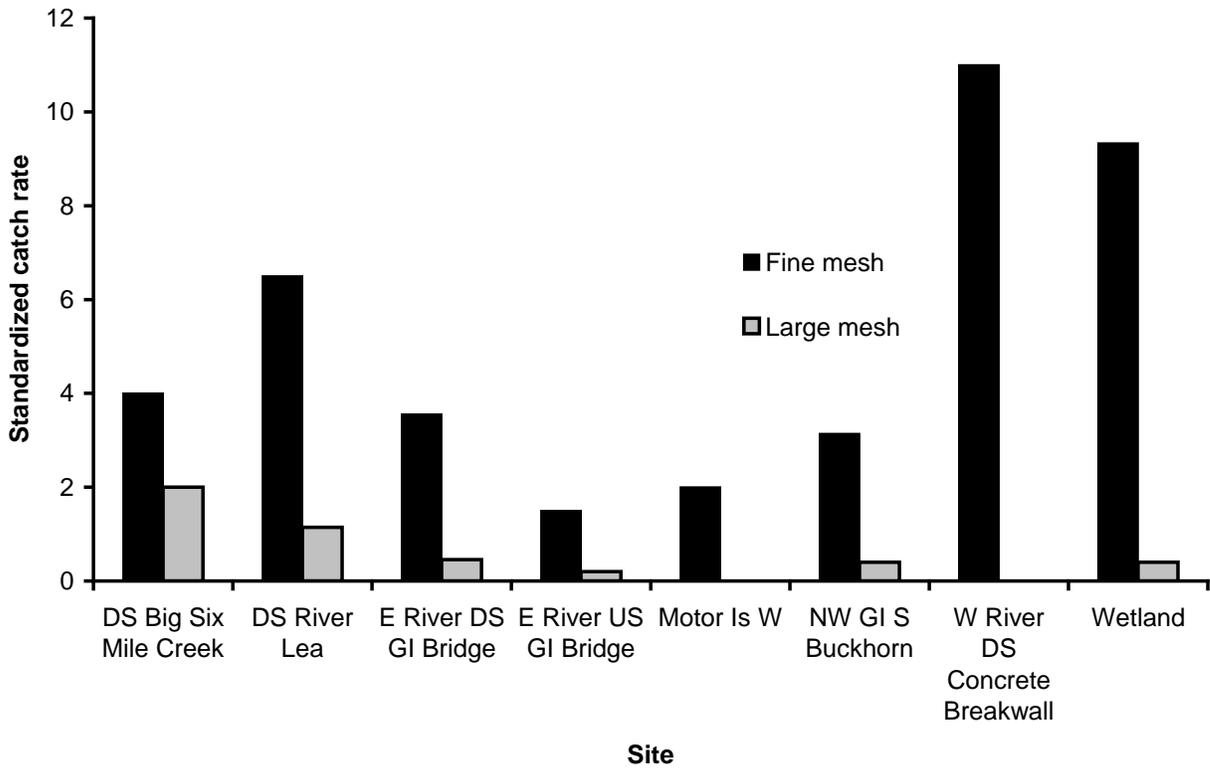


Figure 6. Number of young-of-year muskellunge caught per seine haul (standardized catch rate) at sites surveyed during both late July-early August and late August. Fine mesh catches were doubled to standardize catch rates to the same amount of area sampled. Note: DS = downstream, E = east, GI = Grand Island, US = upstream, W = west, NW = northwest, and S = south.

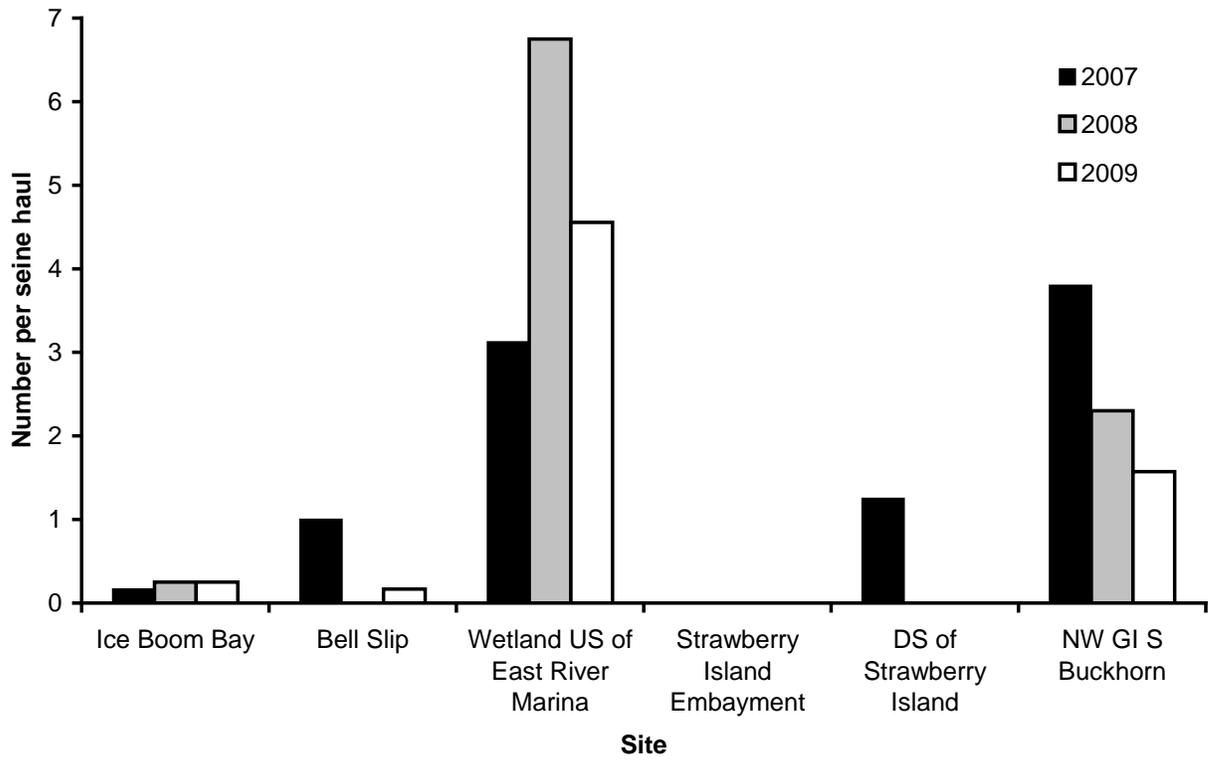


Figure 7. Catch rate (number per seine haul) of young-of-year muskellunge at sites surveyed with a fine mesh seine each year during 2007-2009.

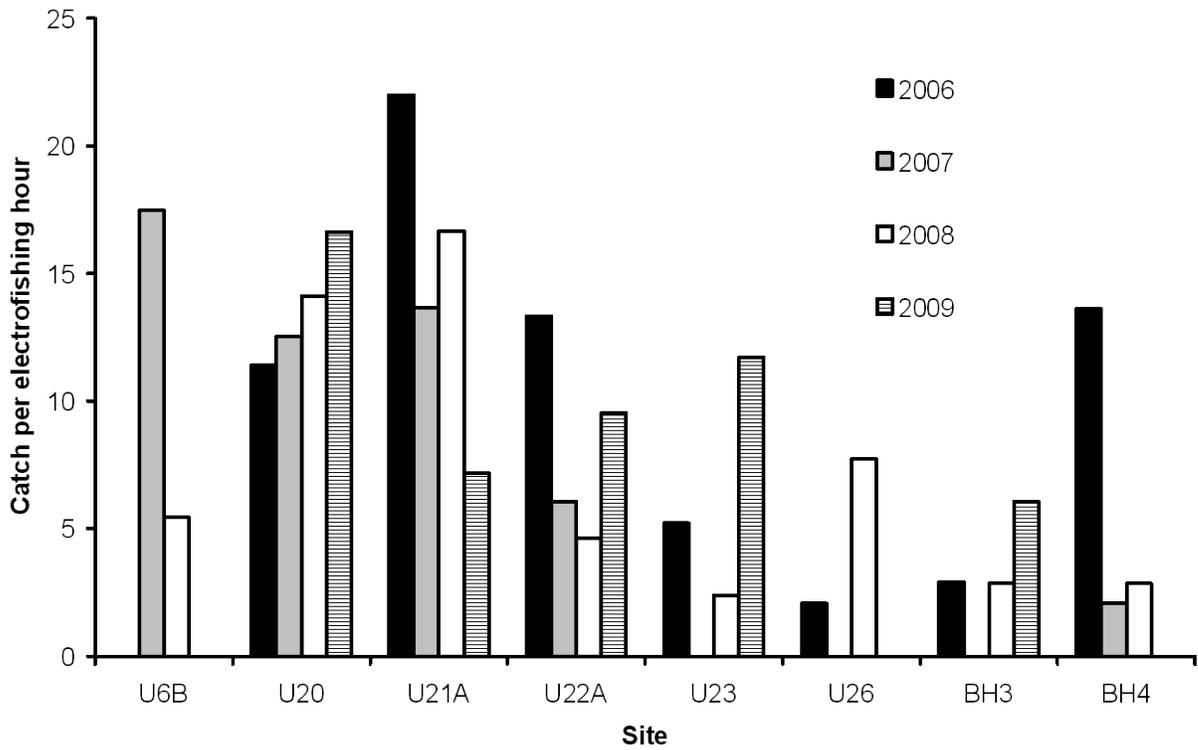


Figure 8. Catch rate (number per electrofishing hour) of young-of-year muskellunge at sites in the Buffalo Harbor and upper Niagara River that were sampled each year during 2006-2009. See Table 3 for descriptions of site codes. Note: BH3 and BH4 are Buffalo Harbor sites, and all others are upper Niagara River sites.